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NAVAL SUPPORT ACTIVITY MID-SOUTH
MILLINGTON, TENNESSEE

ASSEMBLY A RCRA FACILITY INVESTIGATION REPORT AIRCRAFT FIRE FIGHTING TRAINING FACILITY SWMU 5

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The Contractor, EnSafe Inc., hereby certifies that, to the best of its knowledge and belief, the technical data delivered herewith under Contract No. N62467-89-D-0318 is complete, accurate, and complies with all requirements of the contract.

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List of Abbreviations and Acronyms

AFFTF	Aircraft Fire Fighting Training Facility
AST	Aboveground storage tank
BEQ	Benzo(a)pyrene-equivalent concentration
bls	Below land surface
BRA	Baseline Risk Assessment
BCT	Base Closure and Realignment Cleanup Team
BRAC	Base Closure and Realignment
CEC	Cation exchange capacity
CLEAN	Comprehensive Long-term Environmental Action Navy
CLP	Contract Laboratory Program
cm/sec	Centimeters per second
CMS	Corrective measures study
CNS	Central nervous system
COC	Chemicals of concern
COPC	Chemicals of potential concern
CPSS	Chemicals present in site samples
CSI	Confirmatory sampling investigation
CT	Central tendency
DEQ	Dioxin equivalent concentration
DNAPL	Dense nonaqueous phase liquid
DPT	Direct Push Technology
DRO	Diesel Range Organics
DQO	Data Quality Objective
E/A&H	EnSafe/Allen & Hoshall
ECPC	Ecological chemicals of potential concern
EPC	Exposure point concentration
ERA	Ecological risk assessment
f_{oc}	Fraction organic carbon
FDEM	Frequency domain electromagnetics
FI/FC	Fraction ingested/fraction contacted
FSA	Full scan analysis
ft/day	Feet/day
g/cm^3	Gallons per cubic centimeter
gpm	Gallons per minute
gpm/ft	Gallons per minute per foot
GRO	Gasoline Range Organic
HEAST	Health Effects Assessment Summary Tables
HHRA	Human Health Risk Assessment
HI	Hazard Index
HSWA	Hazardous and Solid Waste Amendments
HQ	Hazard Quotient

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IAS	Initial Assessment Study
ID	Inside diameter
ILCR	Incremental Lifetime Cancer Risk
IM	Interim Measures
IRIS	Integrated Risk Information System
k_{oc}	Carbon partition coefficient
LC	Lethal concentration
LD_{50}	Lethal dose for 50% of the population
L/day	Liters per day
MCL	Maximum contaminant level
MCPA	2-Methyl-4-chlorophenoxyacetic acid
mg	Milligrams
mg/L	Milligrams per liter
mg/cm^2	Milligrams per square centimeter
mg/day	Milligrams per day
mg/m^3	Milligrams per cubic meter
mg/kg	Milligrams per kilogram
msl	Mean sea level
NCEA	National Center for Environmental Assessment
NAVSUPPACT	Naval Support Activity
OSHA	Occupational Safety and Health Administration
OWS	Oil water separator
PAH	Polycyclic aromatic hydrocarbons
PCBs	Polychlorinated biphenyls
PID	Photoionization detector
ppm	part per million
PVC	Polyvinyl chloride
QA/QC	Quality Assurance/Quality Control
RAGS	Risk Assessment Guidance for Superfund
RBC	Risk-based concentration
RC	Reference concentration
RCRA	Resource Conservation and Recovery Act
Redox	Oxidation/reduction
RFA	RCRA Facility Assessment
RfD	Reference Dose
RFI	RCRA Facility Investigation
RGO	Remedial goal options
RME	Reasonable maximum exposure
SF	Slope factor
SSL	Soil screening level
SSRL	Site specific remediation level
SVOCs	Semivolatile organic compounds
SWMU	Solid waste management unit

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TCDD	Tetrachlorodibenzodioxin
TCE	Trichloroethene
TDEC	Tennessee Department of Environment and Conservation
TEF	Toxicity Equivalency Factor
TOC	Total organic carbon
TPH	Total petroleum hydrocarbons
TTAL	Treatment technique action level
UCL	Upper confidence limit
USDA	U.S. Department of Agriculture
USEPA	U.S. Environmental Protection Agency
USGS	U.S. Geological Survey
USTs	Underground storage tanks
VCA	Voluntary corrective action
VOCs	Volatile organic compounds
μg/L	Micrograms per liter
μg/kg	Micrograms per kilogram

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EXECUTIVE SUMMARY

This report details the findings of the Resource Conservation and Recovery Act Facility Investigation (RFI) and a summary of the 1992 underground storage tank (UST) investigation for Solid Waste Management Unit (SWMU) 5, the Aircraft Fire Fighting Training Facility (AFFTF), at Naval Support Activity (NAVSUPPACT or NSA) Mid-South, in Millington, Tennessee. The following summarizes conclusions and recommendations presented in the report.

SWMU 5, on Dakar Street on the NSA Mid-South Northside, was used for simulating burning aircraft and contained associated fuel and drainage systems. The AFFTF was active from 1949 until October 1996. The facility consisted of two double-bermed concrete mats — Mat 305 (east) and Mat 392 (west). Mat 305 was removed along with petroleum-contaminated soil in November 1997 through a voluntary corrective action (VCA). Each mat was approximately 75 feet in diameter with a mock aircraft cockpit in the center. Jet fuel (JP-5), from USTs, was supplied on demand through underground piping to the cockpits and was ignited to simulate fire-rescue situations. Firefighters extinguished blazes with high-pressure water or foam sprays. Wastewater, foam, and fuel collected by drains in the mats were piped underground to a 5,000 gallon oil-water separator (since removed) northeast of Mat 305. Separated fuel was then piped back to Mat 305 on demand. Wastewater was discharged to the sanitary sewer system.

Since implementation of the RFI, several source areas of contamination have been removed through either UST closures or implementation of the VCA. USTs 1490 and 1491 were removed by the U.S. Army Corps of Engineers on May 13, 1997, along with approximately 1,200 cubic yards of petroleum-impacted soil (EnSafe, January 28, 1998). The oil-water separator was removed by the U.S. Army Corps of Engineers on August 11, 1997, along with approximately 3,100 cubic yards of petroleum-impacted soil (EnSafe, January 28, 1998). In 1997, a VCA was implemented by the Navy to remove the remaining sources of SWMU 5 soil contamination, specifically, contaminated soil beneath Mat 305 and the concrete-lined fire extinguisher pits (north of Mat 305). At the conclusion of the VCA, approximately 3,000 cubic yards of soil were excavated from the two areas and included the removal of loess (shallow) monitoring well FFMW-8, which had a history of significant benzene contamination

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(EnSafe, May 26, 1998). The soil contaminants identified during the RFI and 1992 UST investigation, before the soil removal activities, are presented below and again in Section 6; however, many of the contaminants were removed during the VCA and tank closures, therefore, contaminants corresponding with sample locations that fell within these areas have been excluded in the evaluation of risk to human health and the environment (Sections 7 and 8).

Findings:

Contaminants in Surface Soil exceeding RBCs

- Volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), pesticides, and dioxins were detected in SWMU 5 surface soil at concentrations exceeding their residential risk based concentrations (RBCs). VOCs identified in surface soil exceeding their RBCs consisted of benzene and methylene chloride, which were detected at maximum concentrations of 110 micrograms per kilogram (μg/kg) and 120 μg/kg, exceeding their residential RBCs of 22 and 85 μg/kg, respectively. These contaminants were identified near the former concrete-lined fire extinguisher pits (boring B-15), which were removed along with the pits during the November 1997 VCA. The SVOC benzo(a)pyrene exceeded its residential RBC (87 μg/kg) at one surface sample location (boring 05SB07 at 150 μg/kg), but was below its industrial RBC (780 μg/kg). The pesticide dieldrin was detected at three out of six surface sample locations (borings 05SB02 at 43 μg/kg, 05SB03 at 60 μg/kg, and 05SB04 at 290 μg/kg), exceeding its residential RBC (40 μg/kg) but below its industrial RBC (360 μg/kg). However, only one sample (05SB04 with 290 μg/kg) exceeded the anthropogenic background reference concentration (RC) of 262 μg/kg established for dieldrin at NSA Mid-South. Dieldrin is present in surface soil throughout NSA Mid-South due to its aerial applications in the 1950s and 1960s during the U.S. Department of Agriculture white fringed beetle quarantine. None of the organics detected in surface soil exceeded their industrial RBCs. Several metals detected in surface soil exceeded their RCs, but all were below their respective RBC values. No PCBs, herbicides, or oranophosphorous pesticides were detected in surface soil exceeding their residential RBCs.

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- Contaminants detected in surface and subsurface soil were compared to soil screening levels (SSLs) provided in the U.S. Environmental Protection Agency's *Soil Screening Guidance; Technical Background Document* (USEPA, 1996). Default SSL values corresponding to a dilution and attenuation factor of 1 were used to conservatively estimate the potential cross-media transfer of contaminants from soil to groundwater. They are conservative because they assume no dilution of soil leachate concentrations before reaching groundwater. The absence of many of these contaminants in groundwater indicates they are sorbed onto soil and not leaching. Organics detected in surface and subsurface soil exceeding the SSLs are primarily petroleum based and are listed below.

Organics in SWMU 5 Surface and Subsurface Soil Exceeding Their Respective SSLs

Contaminant	Frequency of SSL Exceedances in Surface Soil	Frequency of SSL Exceedances in Subsurface Soil	Range of Concentrations (μg/kg)	SSL (μg/kg)
Acetone	0/7	1/22	1,500	800
Benzene	1/7	4/22	3 - 4,800	2
Toluene	0/7	1/22	3,300	600
Ethylbenzene	0/7	4/22	2,600 - 20,000	700
Xylenes	0/7	3/22	21,000 - 97,000	9000
Methylene Chloride	1/7	7/22	1.1 - 690	1
Trichloroethylene (TCE)	0/7	1/22	3.4	3
Tetrachloroethylene (PCE)	0/7	1/22	25	33
1,2 Dichloropropane	0/7	1/22	9.5	1
Dieldrin	6/6	3/14	8.3 - 290	0.2
Naphthalene	0/7	2/19	4,100 - 6,300	4,000
2-Methylnaphthalene	0/7	2/19	18,000 - 24,000	4,000[a]
Benzo(a)anthracene	1/7	0/19	140	80

Note:
a — Surrogate SSL value corresponding with naphthalene

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Metals in surface and subsurface soil exceeding the SSLs and RCs established for surface and subsurface soil include barium, cadmium, chromium, nickel and selenium. The frequency of exceedances and range of detections are listed below.

Metals in SWMU 5 Surface and Subsurface Soil Exceeding Their Respective RC and SSLs

Contaminant	Frequency of SSL Exceedances in Surface Soil	Frequency of SSL Exceedances in Subsurface Soil	Range of Concentrations (mg/kg)	SSL (mg/kg)
Barium	1/8	3/18	261 - 375	82
Cadmium	6/8	4/18	2.4 - 8.1	0.4
Chromium	0/8	1/18	32.8	2
Nickel	0/8	18/18	11.4 - 36	7
Selenium	3/8	0/18	0.31 - 0.51	0.3

Groundwater Contaminants in Loess Groundwater

- Groundwater samples collected from loess wells during the RFI and 1992 UST investigation indicated VOCs exceeding their applicable screening levels. TCE was detected in loess well FFMW-5 (2 micrograms per liter [μg/L]) in excess of its tap water RBC (1.6 μg/L), but less than its maximum contaminant level (MCL) (5 μg/L). TCE was also detected at a similar concentration (1.6 μg/L) in loess groundwater collected near well FFMW-5 with direct push technology (DPT). Methylene chloride was detected in loess well FFMW-8 (31 μg/L) in excess of its tap water RBC (4.1 μg/L) and MCL (5 μg/L). Benzene was also detected in this well at a concentration of 3,900 μg/L, exceeding its tap water RBC (0.36 μg/L) and MCL (5 μg/L). Benzene concentrations increased in this well since the 1992 UST investigation when 1,300 μg/L were detected. The presumed source of contamination, the former fire extinguisher pits, was removed in the November 1997 VCA along with the well. Preliminary indications are that the VCA effectively removed the source and the contaminants in groundwater — benzene and methylene chloride were not detected in the FFMW-8 replacement well (sampled in February 1999). Before the VCA, benzene was also detected in loess groundwater at wells FFMW-9 (5 μg/L during

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the RFI) and FFMW-11 (280 μg/L during the 1992 UST investigation). Further groundwater monitoring will be conducted as part of the loess corrective measures study (CMS) to further evaluate the effects the VCA and tank removals have had on SWMU 5 loess groundwater.

- **The inorganics** arsenic, antimony, and cadmium were detected in loess groundwater at concentrations exceeding their RCs and MCLs or tap water RBCs. Lead was also identified in groundwater at concentrations exceeding its RC and treatment technique action level (TTAL). Metals detected in loess groundwater exceeding their screening criteria are listed below. Analytical data from the second RFI sampling event (Event 1 of long-term monitoring) indicate that the elevated metals detected in the initial sampling event were likely attributable to turbidity content in the samples due to the significant reduction of concentrations during the second sampling event. As indicated in the table below, these metals were not detected during the second RFI sampling event.

Metals in Loess Groundwater Exceeding Screening Criteria (μg/L)

Metal	Well	Maximum Detection	RC	Tap Water RBC	MCL
Arsenic	FFMW-4	11.2	7.3	0.045	50
	FFMW-5	20.9 (ND-2nd)			
	FFMW-6	12.9			
	FFMW-8	159			
	05MW03S	8.8 (ND-2nd)			
	05MW06S	8.3 (ND-2nd)			
Antimony	FFMW-5	64.8 (ND-2nd)	50.1	15	6
Cadmium	FFMW-4	7.9	5.9	18	5
	FFMW-5	11.3 (ND-2nd)			
	FFMW-6	9.1			
	FFMW-8	14.4			
	FFMW-11	11.3			
	05MW03S	6.1 (ND-2nd)			
	05MW06S	18.1 (ND-2nd)			
Lead	FFMW-5	37.7 (ND-2nd)	17.5	DNE	15 (TTAL)
	FFMW-8	26.7			
	05MW06S	56.4 (ND-2nd)			

Notes:

TTAL — Treatment technique action level (USEPA, 1996)

ND-2nd — Loess wells FFMW-5, 05MW03S, and 05MW06S were sampled twice during the RFI and concentrations during the 2nd event were non-detectable if marked with this note.

DNE — Does not exist

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Groundwater Contaminants in Fluvial Deposits Groundwater

- Groundwater samples collected from fluvial deposits wells indicated VOCs exceeding their applicable screening levels. Carbon tetrachloride was consistently detected in excess of its tap water RBC (0.16 μg/L) and MCL (5 μg/L) in wells 05MW04AUF and 05MW04BUF, which contained maximum concentrations of 6 μg/L and 10 μg/L, respectively. These wells are collocated with upgradient well 05MW04UF, which contained a maximum concentration of 3 μg/L of carbon tetrachloride, near the southeast corner of the SWMU. Carbon tetrachloride was absent in fluvial deposit wells downgradient from this area and in the loess groundwater, which led to speculation in Revision 1 of this report that SWMUs 19 and 49, upgradient and adjacent to SWMU 5, were possibly responsible for the contamination. However, investigation of these SWMUs during a confirmatory sampling investigation found no evidence of carbon tetrachloride at SWMUs 19 and 49 (E/A&H, 1997). A subsequent DPT investigation conducted in the area of the 05MW04 well cluster did not identify a source area, however, carbon tetrachloride and TCE were detected (6.7 μg/L and 5.3 μg/L, respectively) exceeding their MCLs (5 μg/L for both compounds). A lower fluvial deposits monitoring well screened at the base of the fluvial deposits, immediately downgradient from the cluster, did not contain carbon tetrachloride, indicating that it is spatially limited to the upper fluvial deposits in the area of the 05MW04 well cluster. Additional VOCs exceeding screening values were as follows: chloromethane was detected during one of six sampling events (5 μg/L at 05MW01UF) exceeding its tap water RBC (1.4 μg/L); and chloroform was detected during one of five sampling events (1 μg/L at 05MW04AUF) exceeding its tap water RBC (0.15 μg/L). MCLs do not exist for either of these compounds.

- Two fluvial deposits wells indicated metal concentrations in excess of their respective RCs and MCLs or TTAL. Cadmium was detected in excess of its RC (3.9 μg/L) and MCL (5 μg/L) in well 05MW02UF (5.4 μg/L), while lead was detected exceeding its RC (6.6 μg/L) and TTAL (15 μg/L) in well 05MW01UF (32.8 μg/L). Cadmium and lead were not detected in the resampling of these wells in February 1999. However, a relatively high detection limit (28 μg/L) was used by the laboratory for the lead analysis.

000017

Wells 05MW01UF and 05MW02UF will be further monitored as part of the CMS (using a lower lead detection limit) to verify the presence or absence of these metals.

Risk to Human Health and the Environment

- The human health risk and hazard posed by soil and groundwater contaminants at SWMU 5 were assessed using four exposure scenarios: the hypothetical reasonable maximum exposure of site workers, the child trespasser, the hypothetical future site resident and future construction worker. Risk and hazard exposures are summarized in the table below.

Summary Risk Estimates
All Exposure Pathways
NSA Mid-South SWMU 5
Memphis, Tennessee

		Site Resident			Site Worker		Construction Worker		Site Trespasser	
		Adult	Child	LWA	Adult		Adult		Adolescent	
Medium	Exposure Pathway	HI	HI	ILCR	HI	ILCR	HI	ILCR	HI	ILCR
Surface Soil	Incidental Ingestion	0.06	0.57	5E-05	0.02	5E-06	0.04	1E-06	0.014	1E-06
	Dermal Contact	0.05	0.16	2E-05	0.04	9E-06	0.02	5E-07	0.012	1E-06
	Sum	0.1	0.7	7E-05	0.06	1E-05	0.06	2E-06	0.03	2E-06
Loess Groundwater	Ingestion	21	50	5E-03	8	1E-03	4	7E-05	NA	NA
	Inhalation	63	147	2E-03	22	4E-04	11	2E-05	NA	NA
	Sum	84	196	7E-03	30	2E-03	14	9E-05	NA	NA
Soil & Loess Groundwater	Sum	84	197	7E-03	30	2E-03	14	1E-04	0.03	2E-06
Fluvial Deposits Groundwater	Ingestion	0.8	2	2E-05	0.3	5E-06	0.1	3E-07	NA	NA
	Inhalation	0.5	1.2	1E-05	0.19	2E-06	0.09	1E-07	NA	NA
	Sum	1.30	3	3E-05	0.5	7E-06	0.2	4E-07	NA	NA
Soil & Fluvial Deposits Groundwater	Sum	1	4	1E-04	0.5	2E-05	0.3	2E-06	0.03	2E-06

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No chemicals of concern (COCs) were identified in surface soil. Antimony, arsenic, barium, cadmium, vanadium, benzene, methylene chloride, carbon tetrachloride, 2-methylnaphthalene, and naphthalene were identified as COCs in loess groundwater based on their contribution to risk/hazard. Cadmium, nitrobenzene, chloroform, and carbon tetrachloride were identified as COCs in fluvial deposits groundwater based on their contribution to risk/hazard.

In summary, the exposure scenarios of concern are the hypothetical future site resident, site worker, and future construction worker with groundwater exposure as the primary pathway of concern. If the zoning were changed in the future and residences were developed, municipal water would likely be used rather than installing domestic wells (which were assumed in the risk assessment) in the fluvial deposits. Use of loess groundwater is not feasible due to its low yield and poor aesthetic water quality.

- The ecological risk assessment determined no quality habitat is available at SWMU 5. The grass fields surrounding the training area could be used by terrestrial receptors, such as passerine birds and/or small mammals, as foraging areas, but with diminished cover their occurrence would most likely be transient or opportunistic. This lack of suitable habitat at SWMU 5 limits the presence of a significant population of potentially exposed ecological receptors. Without sufficient receptors, exposure pathways associated with SWMU 5 constituents are considered incomplete.

Potential Receptors

- The generally poor groundwater quality and low yield of the loess do not make it suitable as a drinking water source, and the fluvial deposits groundwater is not used as a drinking water supply within a mile of NSA Mid-South. The relatively low concentrations of contaminants and the amount of dilution (specifically the organic compounds) they are likely to undergo minimize the impact to any potential receptors. The nearest potential receptor is production well #4, approximately 500 feet southeast of Mat 392 on the NSA Mid-South Southside. The well is not in the direction of groundwater flow in the

loess or fluvial deposits and is screened greater than 1,200 feet below the fluvial deposits with several confining units in between. If the metals detected in SWMU 5 groundwater are associated with contamination, they are also likely to undergo dilution and possibly natural filtration before reaching a potential receptor.

Recommendations:

The following recommendations are based on the information collected to date at SWMU 5:

- **Surface Soil**: Benzene, methylene chloride, and dioxins were identified in surface soil at concentrations exceeding their residential RBCs but below their industrial RBCs. Sample locations where these contaminants were identified have since been removed during the SWMU 5 VCA or UST removals; therefore, these contaminants no longer pose a risk to future users. Dieldrin and benzo(a)pyrene were also detected in one surface soil sample at concentrations exceeding their residential RBCs but below their industrial RBCs. Given the limited extent of these contaminants and the unlikely nature that the site will be used for residential purposes, no further action is recommended for surface soil.

- **Subsurface Soil:** No further action is recommended for subsurface soil. Soil in areas heavily contaminated with petroleum has since been removed through the VCA and UST removals. No contaminants of potential concern were identified in subsurface soil during the screening process, therefore subsurface soil risk was not quantified in the baseline risk assessment.

- **Loess Groundwater**: The effect recent SWMU 5 soil/source removal activities has had on loess groundwater contamination will be further evaluated during the CMS. A discrete groundwater sample will be collected using a Geoprobe or similar sampling device from the former tank pit area to evaluate whether this area still poses a concern to loess groundwater. The existing contaminant levels in loess groundwater downgradient from this area will be further evaluated through two additional sampling events of monitoring wells FFMW-6, FFMW-9 and replacement well FFMW-8. Monitoring wells will be

sampled for VOCs only. Even though metals were detected in loess groundwater exceeding their MCLs and RCs during the 1992 UST investigation and initial RFI event, their absence in subsequent sampling events indicates the exceedances are most likely attributable to turbidity. No further evaluation of metals in loess groundwater is recommended.

- **Fluvial Deposits Groundwater**: The SWMU 5 fluvial deposits groundwater is recommended to be included in the CMS slated for the NSA Mid-South Northside Fluvial Deposits Groundwater (Area of Concern A) with the focus being the carbon tetrachloride and TCE identified at the southeast corner of the SWMU. Cadmium and lead were also identified exceeding their RCs and MCL (or TTAL for lead) in the fluvial deposits groundwater during the initial sampling event (March 1995). However, cadmium was not detected in the resampling of one of these wells in February 1999. Two additional sampling events for cadmium and lead should be conducted concurrently with the loess groundwater monitoring to verify the absence or presence of these metals in the fluvial deposits groundwater.

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1.0 INTRODUCTION

As part of the U.S. Navy Installation Restoration Program, this Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI) report has been prepared for Solid Waste Management Unit (SWMU) 5, the Aircraft Fire Fighting Training Facility (AFFTF), at Naval Support Activity (NAVSUPPACT or NSA) Mid-South, Millington, Tennessee. The RFI SWMUs have been categorized into three assemblies according to their Base Closure and Realignment (BRAC) status; Assemblies A and B are on the closing portion, NSA Mid-South Northside, while Assembly E is on the portion that will realign and remain open, the Southside. The confirmatory sampling investigation SWMUs have been categorized into Assemblies C and D on the closing portion and Assemblies F, G, and H on the realigning portion. SWMU 5 is one of six Assembly A SWMUs, which are on the closing Northside portion.

SWMU 5 consisted of two concrete mats (Mats 305 and 392) on Dakar Street used to simulate burning aircraft and the associated fuel and drainage systems. The AFFTF is bounded to the south by the Navy Exchange Service Station and Navy Road, to the east by a wooded area and the Carrier Deck Fire Fighting Training Facility, and to the north and west by a drainage ditch identified as SWMU 4. Site and vicinity maps of SWMU 5 are provided in Figure 1-1.

The RFI, undertaken by EnSafe Inc. and the U.S. Geological Survey (USGS) on behalf of the Navy, adhered to the requirements of the Hazardous and Solid Waste Amendments portion (HSWA-TN002) of RCRA Permit No. TN2-170-022-600, RCRA Part B permit number TNHW-094, and applicable regulations. This report summarizes activities conducted during the investigation and the resulting findings, conclusions, and recommendations.

Report Organization

Section 2 of the report describes the site and history of the SWMU 5 operations. Section 3 summarizes the investigations conducted before and during the RFI. Section 4 presents the field

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sampling and analytical methods, and the applicable soil and groundwater screening criteria used for contaminants detected during the RFI. Section 5 presents the geology and hydrogeology. The nature and extent of contamination is presented in Section 6 and the risk to human health and the environment are presented in Sections 7 and 8. Contaminant fate and transport are presented in Section 9, the conclusions and recommendations are presented in Section 10, and the references cited in the report are presented in Section 11.

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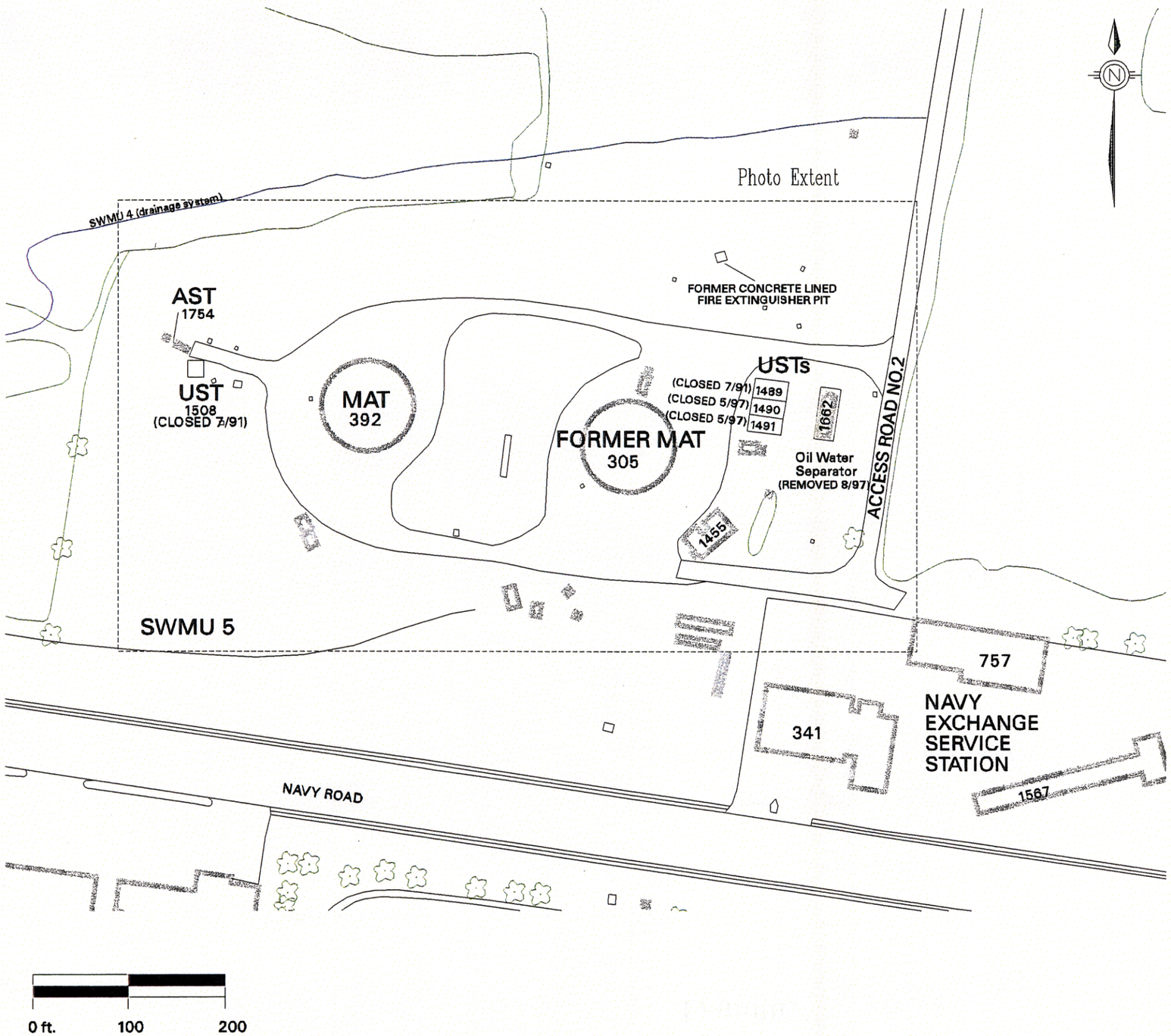

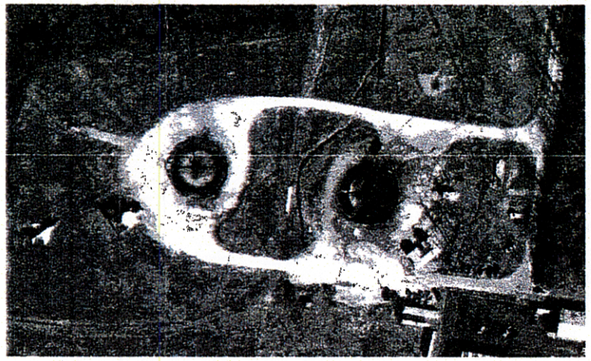

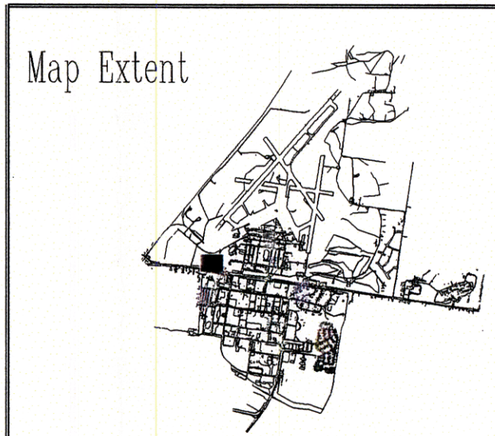

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RCRA FACILITY INVESTIGATION
NSA MID-SOUTH
MILLINGTON, TENNESSEE

FIGURE 1-1

SITE AND VICINITY MAP
SWMU 5

2.0 SITE DESCRIPTION AND BACKGROUND INFORMATION

2.1 Site Description

The AFFTF and surrounding area are characterized by level topography with approximately 5 feet of relief across the site. The site is on the flanks of a broad, flat to slightly mounded area, which descends slightly to the north and northwest to a lower area occupied by the SWMU 4 drainage ditch. The site has been partially filled and graded from construction of the fire mats, and partially excavated and bermed for water control and drainage. Surface water flow is directed northward through two earthen-lined drainage ditches, off the bermed area, and into a southwest-trending drainage ditch (SWMU 4), which drains into a tributary (SWMU 38) of North Fork Creek.

2.2 Site History

The AFFTF was active from 1949 until October 1996. The site contained two double-bermed concrete mats — Mat 305 (east) and Mat 392 (west), until November 1997 when Mat 305 was removed through a voluntary corrective action (VCA). Each mat was approximately 75 feet in diameter and had a mock aircraft cockpit in the center. Jet fuel (JP-5), supplied on demand through underground piping to the cockpits, was ignited to simulate fire-rescue situations. Firefighters extinguished blazes with high-pressure water or foam sprays. Wastewater, foam, and fuel drained from the mats were piped underground to an oil-water separator/fuel recycling system northeast of Mat 305 (shown on Figure 1-1). Separated fuel was then piped back to Mat 305 on demand and wastewater was discharged to the sanitary sewer system. The oil-water separator was installed in 1977 and removed in August 1997.

JP-5 was the last fuel used at the AFFTF. JP-4 and waste fuels such as de-planed aircraft fuels are reported to have been used in the past. The RCRA Facility Assessment (RFA) reported the common practice of mixing waste fuel with waste solvents such as naphtha, xylenes, methyl ethyl ketone, toluene, and benzene (ERC/EDGe, 1990).

In addition to the fire mats, SWMU 5 has had other sources of contamination. For example, before the installation of the oil-water separator/fuel recycling system in 1977, the water-fuel-foam mixture from training activities was routinely discharged to the network of ditches leading to the SWMU 4 drainage ditch. Occasionally, the waste liquid in the separator overflowed. Shortly after the separator was installed, several explosions of unburned fuel occurred in the underground drain line leading to the separator. In 1986, the oil-water separator overflowed, releasing approximately 500 gallons of water/fuel mixture. In 1989, the drain line from the mats to the separator ruptured in several places and was repaired in place.

SWMU 5 contained four underground storage tanks (USTs 1489, 1490, 1491, and 1508) and one aboveground storage tank (AST 1754). Originally, fuel was supplied to Mat 305 via underground piping from three 1,800-gallon USTs (1489, 1490, and 1491 on Figure 1-1) northeast of the mat. A 5,000-gallon UST (1508) and an AST (1754[1]) delivered fuel through underground piping to Mat 392 (mat and tank locations are shown on Figure 1-1).

Tank-tightness tests conducted on the USTs on July 2, 1991, indicated that USTs 1508 and 1489 were leaking. The condition of the leaking USTs was reported to Tennessee Department of Environment and Conservation (TDEC) on July 3, 1991, and the two USTs were removed from service immediately thereafter. The amount of fuel released from these tanks was unknown. A UST investigation was conducted the following summer (discussed in Section 3); relevant data from this investigation are provided in Section 6.

The two remaining USTs (1490 and 1491) were removed in May 1997 to comply with the TDEC's December 23, 1998, UST upgrade requirements. Both USTs did not appear to have any damage; however, some free product was noted in 1491's excavation. Approximately 1200 cubic

[1]AST 1754 was given to the city of Millington for reuse in December 1995.

yards of soil were excavated from a 58-foot by 42-foot by 12-foot deep pit. Excavated soil was stockpiled on site and disposed of as a non-hazardous waste through an approved special solid waste permit at the Browning Ferris Industries (BFI) landfill in Memphis (EnSafe, July 28, 1997).

Another source of contamination included three former concrete-lined pits, approximately 160 feet north of Mat 305. These pits are reported to have been used for hand-held fire extinguisher practice. Drain pipes led from these pits to adjacent drainage ditches. These pits, along with approximately 1,600 cubic yards of contaminated soil, were removed with Mat 305 during the November 1997 VCA (discussed further in Sections 3 and 6).

Two spills of JP-5 fuel from the oil water separator may have also impacted SWMU 5 soil and/or groundwater. The first spill occurred on April 9, 1993; the second was several weeks later. Following the spills, the fuel entered the sanitary sewer, surfaced near the Navy Exchange Service Station, and reached the southeast corner of the AFFTF (Figure 1-1).

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3.0 SUMMARY OF SWMU 5 INVESTIGATIONS

The investigations conducted at SWMU 5 are summarized below in chronological order.

Initial Assessment Study (1983)

An Initial Assessment Study (IAS), consisting of records research, interviews with Navy personnel, and visual site inspections, was conducted by Harmon Engineering and Testing. The IAS report concluded that only small quantities of fuel had overflowed and recommended no further investigation.

Release Detection Wells (1989/1990)

In 1989, four release detection wells were installed by the Navy at USTs 1489, 1490, and 1491, approximately 100 feet east of Mat 305. Three more release detection wells were installed in December 1990, adjacent to UST 1508, approximately 100 feet west of Mat 392. These wells were screened in the loess and checked regularly by Navy personnel for visible indications of a fuel release. The release detection wells were not installed to obtain groundwater samples; therefore, they were never used to sample groundwater. The three release detection wells around UST 1508 were closed after the UST was removed in 1991. Likewise, one release detection well was closed when UST 1489 was removed in 1991.

RFI Preliminary Screening Soil-Gas Survey (1991)

The USGS completed a soil-gas survey of the site in May 1991. Values reported at most stations were at the lower end of the method range of detection (sums of volt-seconds for peaks of unidentified compounds ranging from 1 to approximately 25). The maximum values were reported from stations near the concrete-lined pits used for hand-held fire extinguisher training, near the approximate location of the oil-water separator drain line ruptures, and about 80 feet south of the eastern USTs.

UST Investigation (1992)

A UST investigation by EnSafe/Allen and Hoshall (E/A&H) in the summer of 1992 studied the environmental impacts of decommissioned UST systems 1489 and 1508, which had failed tank tightness testing the previous summer. These tanks supplied the AFFTF mats with fuel. Soil and groundwater samples were analyzed for gasoline range organics and benzene, toluene, and xylenes. Select samples were also analyzed for RFI parameters including volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), pesticides/polychlorinated biphenyls (PCBs), metals, and cyanide. Analytical results indicated petroleum-related contamination in soil at the USTs, around Mat 305, north of Mat 305 near the former concrete pits, and east of the oil-water separator (E/A&H, 1992). Loess groundwater contamination consisted predominantly of petroleum contamination near the eastern USTs (1489, 1490, and 1491), north of Mat 305 near the concrete-lined pits, and east of the oil-water separator. 1,2-dichloroethene and 1,2-dichlorobenzene were reported at low concentrations near the southeast corner of the SWMU in upgradient well FFMW-5. Soil borings and monitoring wells installed during the UST investigation are shown in Figure 3-1.

Interim Measures Investigation (1992)

A 1992 USGS Interim Measures (IM) investigation studied the AFFTF and drainage ditch network around a proposed fire fighting training mat to be constructed northeast of Mat 305. The technical memorandum summarizing the results of the investigation is included as Appendix A.

Ten soil borings were completed in the area of the proposed mat and 12 sediment samples were collected from the drainage ditch network in the SWMU 5 area. Samples were analyzed for VOCs, SVOCs, total petroleum hydrocarbons (TPH), cyanide, pesticides/PCBs, and Appendix IX metals. TPH and individual petroleum constituents were detected in only one boring, which was approximately 100 feet north of Mat 305 and near boring and well FFMW-8 installed during the

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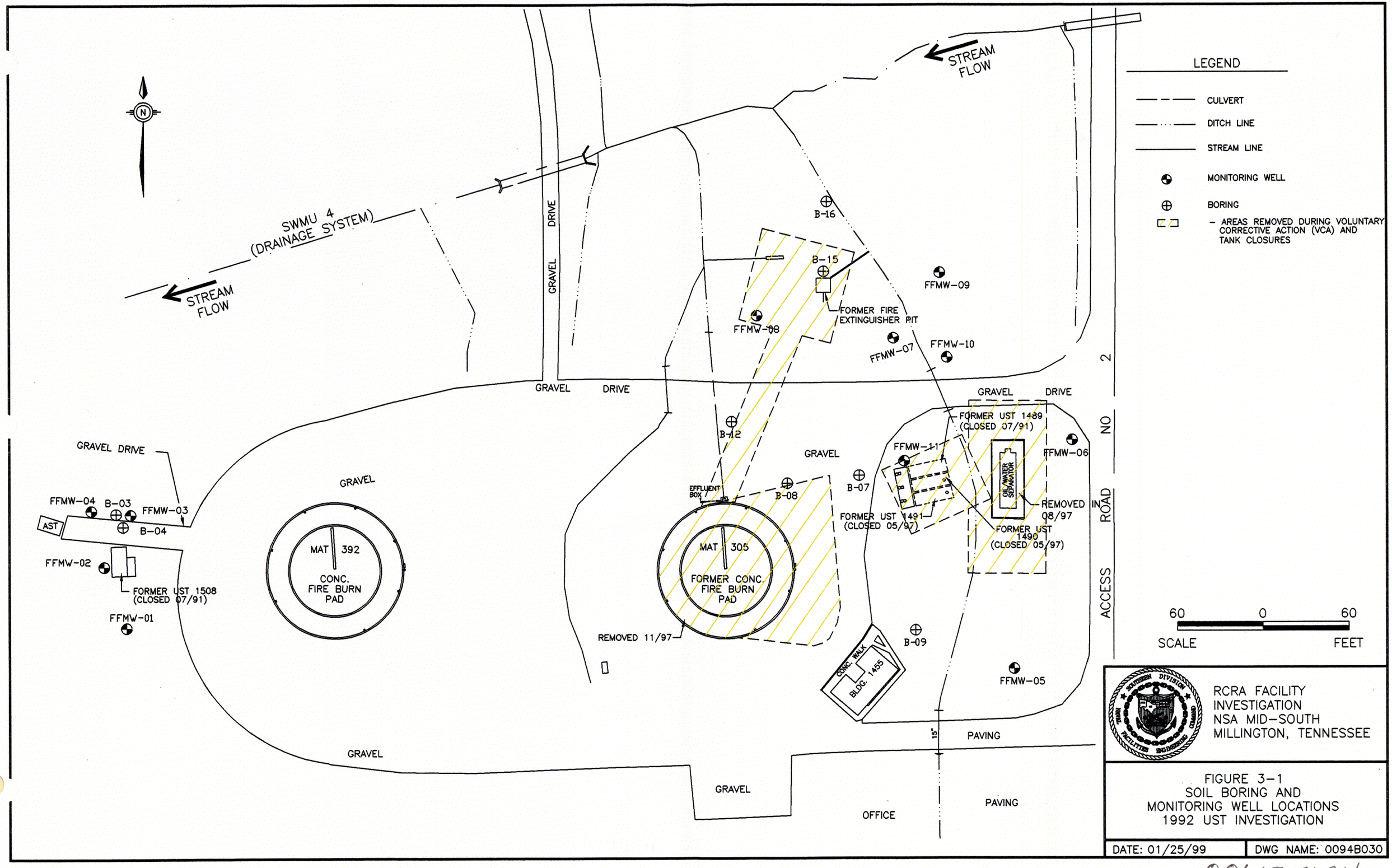

LEGEND
CULVERT
DITCH LINE
STREAM LINE
MONITORING WELL
BORING
- AREAS REMOVED DURING VOLUNTARY CORRECTIVE ACTION (VCA) AND TANK CLOSURES
N
STREAM FLOW
SWMU 4 (DRAINAGE SYSTEM)
GRAVEL DRIVE
GRAVEL
B-16
B-15
FFMW-09
FORMER FIRE EXTINGUISHER PIT
FFMW-08
FFMW-07
FFMW-10
B-12
FORMER UST 1489 (CLOSED 07/91)
FFMW-11
FFMW-06
EFFLUENT BOX
B-08
B-07
OIL/WATER SEPARATOR
REMOVED 08/97
FORMER UST 1491 (CLOSED 05/97)
FORMER UST 1490 (CLOSED 05/97)
NO ACCESS ROAD
FFMW-04
B-03
FFMW-03
AST
B-04
FFMW-02
FORMER UST 1508 (CLOSED 07/91)
FFMW-01
MAT 392
CONC. FIRE BURN PAD
MAT 305
FORMER CONC. FIRE BURN PAD
REMOVED 11/97
CONC. WALK
BLDG. 1455
B-09
FFMW-05
15'
PAVING
OFFICE
60 0 60
SCALE FEET
RCRA FACILITY INVESTIGATION
NSA MID-SOUTH
MILLINGTON, TENNESSEE
FIGURE 3-1
SOIL BORING AND
MONITORING WELL LOCATIONS
1992 UST INVESTIGATION
DATE: 01/25/99
DWG NAME: 0094B030

00617F02Y

UST investigation. TPH was also detected in several ditch sediment samples. Dieldrin concentrations were detected in surface samples from eight of the 10 borings, and in two ditch sediment samples; its presence has been attributed to aerial application during the 1950s and 1960s by the U.S. Department of Agriculture (USDA) to control the spread of the white-fringed beetle. Appendix B is a technical memorandum that discusses dieldrin concentrations in surface soil at NSA Mid-South. Reported metals concentrations in soil samples were below RCRA Subpart S action levels, except for beryllium.

RFI Direct Push Technology — Soil and Groundwater Screening (1994)

Soil and groundwater samples were collected from 14 locations surrounding SWMU 5 (Figure 3-2) during the Direct Push Technology (DPT) screening portion of the RFI and analyzed at an onsite laboratory using U.S. Environmental Protection Agency (USEPA) Method 8020 for VOCs. Forty-three soil samples were collected from depths ranging from the surface to 28 feet below land surface (bls) and 27 water samples were collected from depths ranging from 10 to 54 feet bls. Soil samples were generally collected from depths of 0 to 2 feet, 8 to 10 feet, and 23 to 25 feet; water samples were typically collected at 10 to 12 feet within the loess and 40+ feet within the fluvial deposits. In areas of previously identified contamination, petroleum constituents detected in shallow groundwater and soil included benzene, xylenes, and naphthalene. Shallow soil near the concrete-lined pits north of Mat 305 was also contaminated with petroleum constituents. The DPT screening results are further summarized in Appendix C.

RFI Soil Sampling/Monitoring Well Installation (February 1995)

The soil boring/monitoring well phase of the RFI was implemented in February 1995 by initially encircling the site with 10 monitoring wells — three screened in the loess and seven screened in the fluvial deposits (Figure 3-3). Findings from the RFI are presented in Section 6 of this report. The following groundwater contaminants were identified:

- **Inorganics**: The inorganics antimony, cadmium, and arsenic were detected in at least one of five loess monitoring wells (three RFI wells and two UST investigation wells) at concentrations exceeding their respective maximum contaminant levels (MCLs) and background reference concentrations (RCs). Cadmium was detected in one fluvial deposits well at a concentration exceeding its MCL and RC. Carbon tetrachloride and trichloroethylene were the only organics detected in the fluvial deposits groundwater at concentrations exceeding their MCL; they were detected in upgradient locations near the southeast corner of the SWMU.

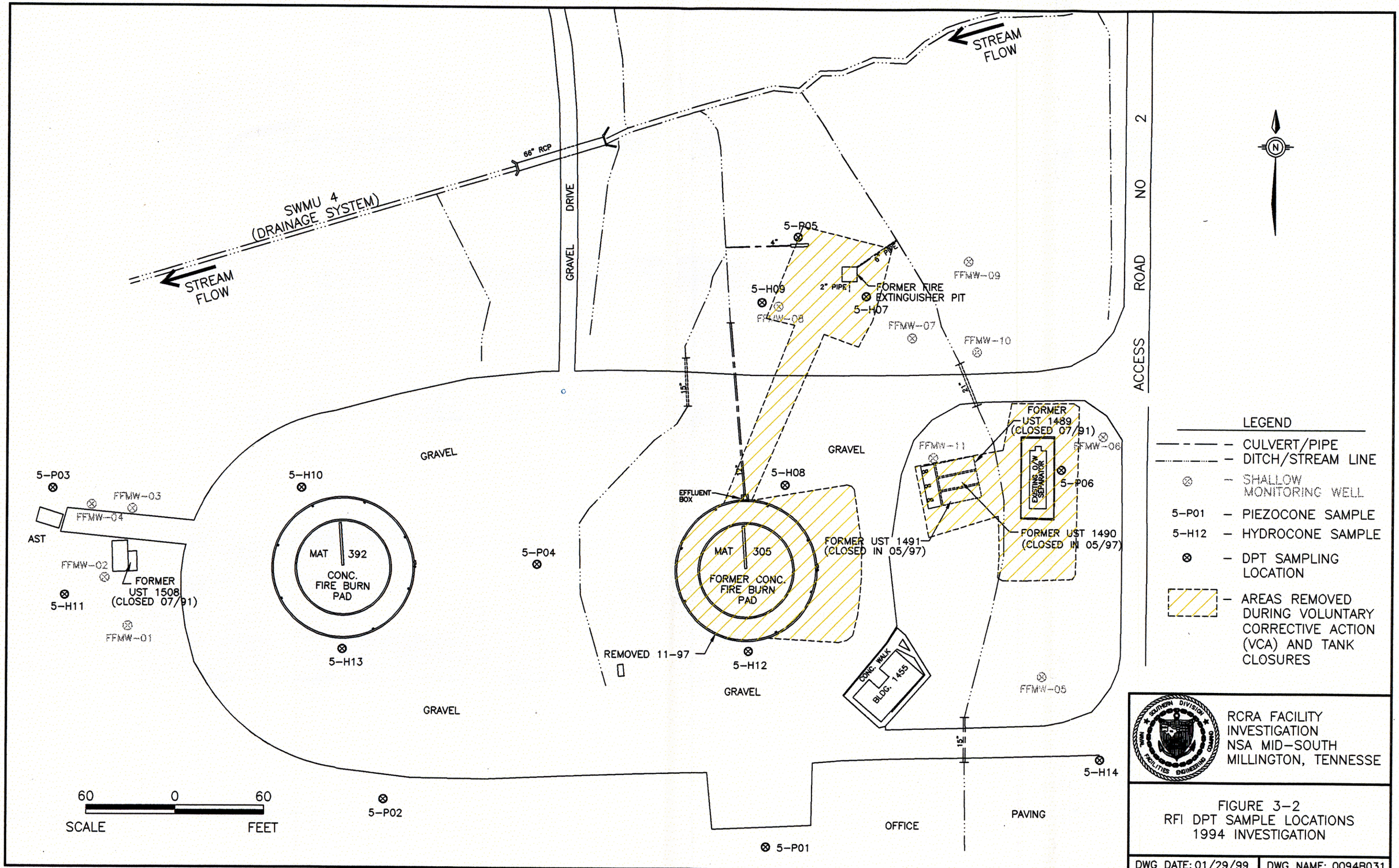
- **Organics**: 1,2-dichlorobenzene, 1,2-dichloroethene (total), and chlorobenzene were detected in the loess groundwater near the southeast corner of the SWMU; however, benzene and methylene chloride were the only organics detected at concentrations exceeding the MCL.

Dioxin Sampling (September 1995)

Five surface soil samples were collected from the former fire extinguisher pits north of Mat 305 to evaluate whether dioxins were present in the concrete from former burning operations. Analytical results, adjusted to a toxicity equivalency factor for 2,3,7,8-tetrachlorodibenzodioxin, were less than 1 microgram per kilogram (μg/kg), the threshold at which USEPA recommends limited human exposure. Dioxin sample results are presented in Section 6.

Assembly A Long-Term Groundwater Monitoring — Event 1 (November 1995)

SWMU 5 monitoring wells were again sampled in November 1995 as part of the Assembly A long-term groundwater monitoring. The seven fluvial deposits wells were sampled for VOCs and four loess wells (three RFI wells and one from the UST investigation) were sampled for a full scan analyses (VOCs, SVOCs, pesticides/PCBs, organophosphorous pesticides, herbicides, Appendix IX metals, cyanide, TPH 418.1, TPH-diesel range organics [DRO], and TPH-gasoline range organics [GRO]).


STREAM FLOW
SWMU 4 (DRAINAGE SYSTEM)
66" RCP
GRAVEL DRIVE
ACCESS ROAD NO 2
5-P05
4"
6" PIPE
2" PIPE
FORMER FIRE EXTINGUISHER PIT
5-H07
5-H09
FFMW-08
FFMW-09
FFMW-07
FFMW-10
15"
21"
FORMER UST 1489 (CLOSED 07/91)
FFMW-11
FFMW-06
EXISTING O/W SEPARATOR
5-P06
FORMER UST 1490 (CLOSED IN 05/97)
FORMER UST 1491 (CLOSED IN 05/97)
GRAVEL
5-H08
EFFLUENT BOX
MAT 305
FORMER CONC. FIRE BURN PAD
5-H12
REMOVED 11-97
CONC. WALK
BLDG. 1455
FFMW-05
5-H14
15"
5-P03
FFMW-03
FFMW-04
AST
FFMW-02
FORMER UST 1508 (CLOSED 07/91)
5-H11
FFMW-01
5-H10
MAT 392
CONC. FIRE BURN PAD
5-H13
5-P04
5-P02
5-P01
OFFICE
PAVING
60 0 60
SCALE FEET
N
LEGEND
CULVERT/PIPE
DITCH/STREAM LINE
SHALLOW MONITORING WELL
5-P01 PIEZOCONE SAMPLE
5-H12 HYDROCONE SAMPLE
DPT SAMPLING LOCATION
AREAS REMOVED DURING VOLUNTARY CORRECTIVE ACTION (VCA) AND TANK CLOSURES
SOUTHERN DIVISION NAVAL FACILITIES ENGINEERING COMMAND
RCRA FACILITY INVESTIGATION
NSA MID-SOUTH
MILLINGTON, TENNESSE
FIGURE 3-2
RFI DPT SAMPLE LOCATIONS
1994 INVESTIGATION
DWG DATE: 01/29/99
DWG NAME: 0094B031

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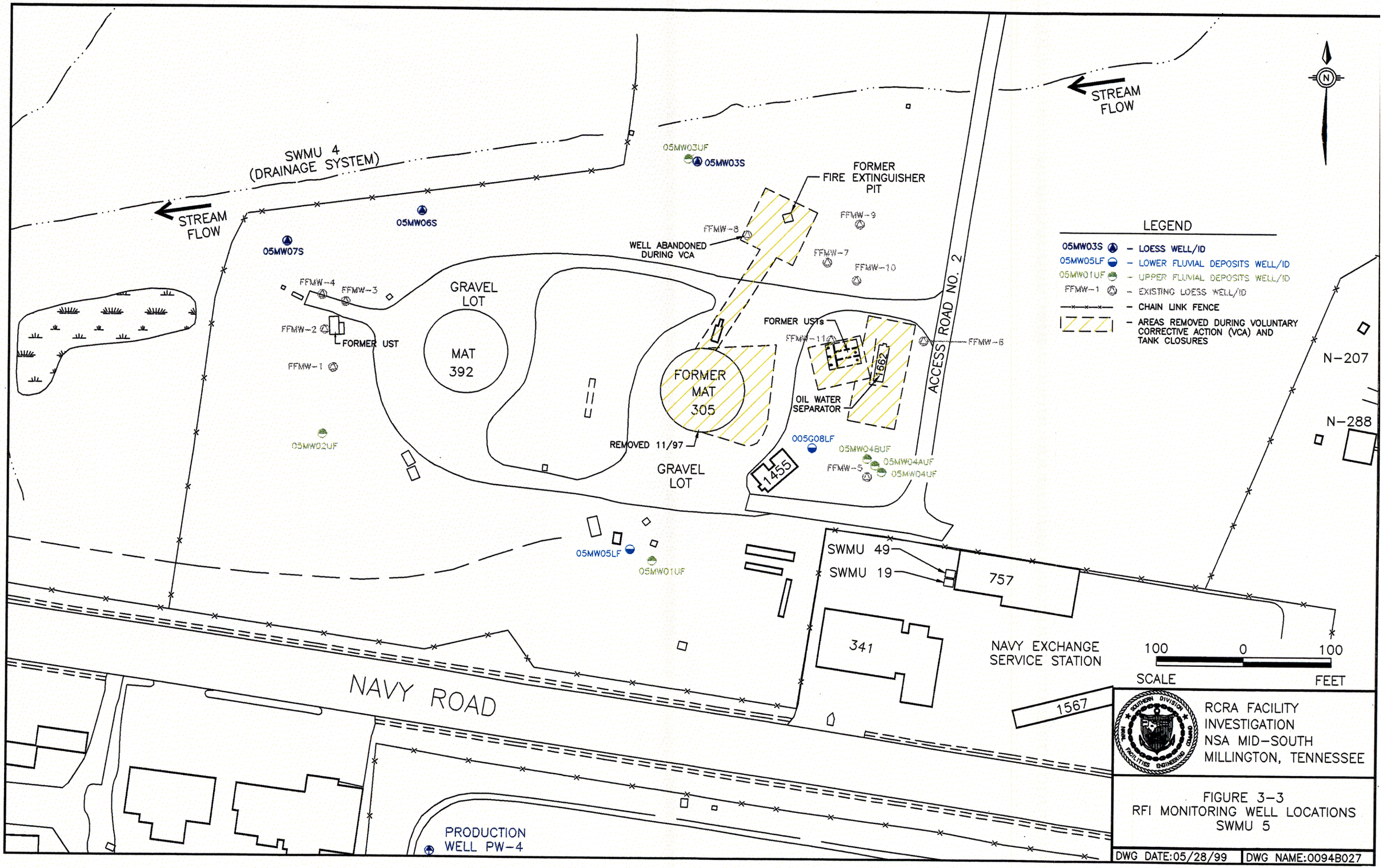

SWMU 4
(DRAINAGE SYSTEM)
STREAM FLOW
STREAM FLOW
05MW03UF
05MW03S
FORMER FIRE EXTINGUISHER PIT
05MW06S
05MW07S
FFMW-9
FFMW-8
WELL ABANDONED DURING VCA
FFMW-7
FFMW-10
FFMW-4
FFMW-3
GRAVEL LOT
FFMW-2
FORMER UST
MAT 392
FFMW-1
FORMER USTs
FFMW-11
FFMW-6
1562
FORMER MAT 305
OIL WATER SEPARATOR
ACCESS ROAD NO. 2
05MW02UF
REMOVED 11/97
005G08LF
05MW04BUF
05MW04AUF
FFMW-5
05MW04UF
GRAVEL LOT
1455
05MW05LF
05MW01UF
SWMU 49
SWMU 19
757
341
NAVY EXCHANGE SERVICE STATION
NAVY ROAD
1567
PRODUCTION WELL PW-4
N-207
N-288
N
LEGEND
05MW03S – LOESS WELL/ID
05MW05LF – LOWER FLUVIAL DEPOSITS WELL/ID
05MW01UF – UPPER FLUVIAL DEPOSITS WELL/ID
FFMW-1 – EXISTING LOESS WELL/ID
– CHAIN LINK FENCE
– AREAS REMOVED DURING VOLUNTARY CORRECTIVE ACTION (VCA) AND TANK CLOSURES
100 0 100
SCALE FEET
RCRA FACILITY INVESTIGATION
NSA MID-SOUTH
MILLINGTON, TENNESSEE
FIGURE 3-3
RFI MONITORING WELL LOCATIONS
SWMU 5
DWG DATE:05/28/99
DWG NAME:0094B027

TPH was detected in loess groundwater downgradient from the former UST 1508, northwest of Mat 392. Concentrations of metals detected in the loess groundwater during the initial sampling were below MCLs. VOCs results were similar to those from the initial sampling event — chlorinated hydrocarbons were detected in both the loess and fluvial deposits groundwater near the southeast corner of the site.

SWMUs 19 and 49, adjacent to and upgradient of the southeast corner of the site, were suspected contamination sources for the chlorinated hydrocarbons. However, eight groundwater samples collected from the upper fluvial deposits surrounding the SWMUs (Figure 3-4) during a Confirmation Sampling Investigation (CSI; E/A&H, 1997) did not contain VOCs, indicating that those detected at SWMU 5 were not originating from SWMUs 19 or 49 (discussed further in Section 6).

Assembly A Long-Term Groundwater Monitoring — Event 2 (April 1996)

All fluvial deposits monitoring wells were again sampled for VOCs in April 1996 during the second long-term groundwater monitoring event. Loess wells were not sampled at this time. Chlorinated hydrocarbons remained at similar concentrations at the southeast corner of the site in the fluvial deposits groundwater. Chloromethane and 2-butanone were also detected in a separate fluvial deposits well. No MCLs have been established for either compound. These compounds were not detected in this well during the two previous sampling events (E/A&H, May 30, 1997).

Assembly A Long-Term Groundwater Monitoring — Event 3 (August 1996)

All fluvial deposits monitoring wells and three loess monitoring wells were sampled for VOCs during the third long-term monitoring event in August 1996. Chlorinated hydrocarbons remained in the loess and fluvial deposits groundwater at the southeast corner of the site. The chloromethane and 2-butanone detected in the fluvial deposits groundwater during the second long-term monitoring were absent during this sampling (E/A&H, May 30, 1997).

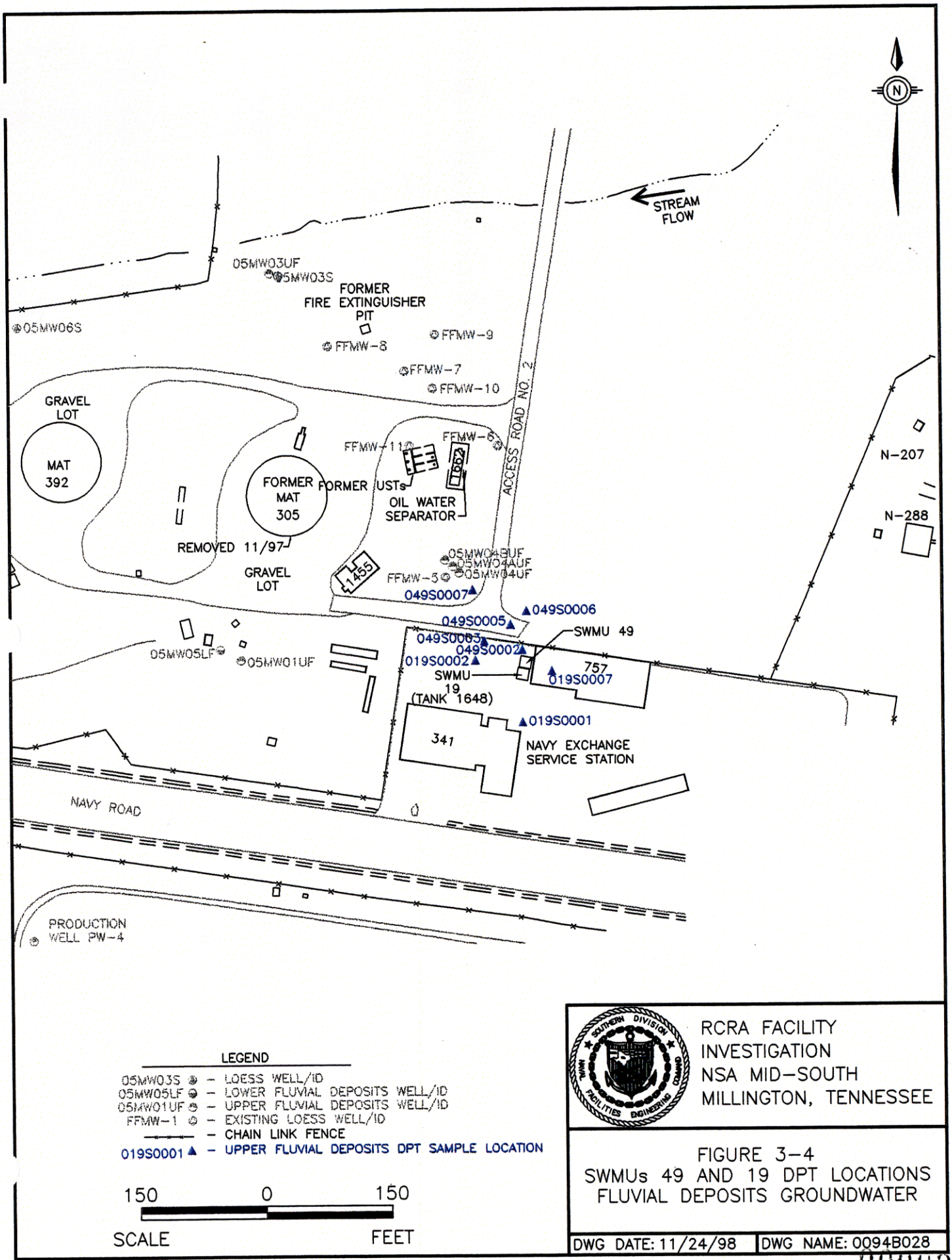
Assembly A Long-Term Groundwater Monitoring — Event 4 (April and May 1997)

Five loess and five fluvial deposits monitoring wells were again sampled in April and May 1997 during the fourth long-term monitoring event. Monitoring at two fluvial wells at the southeast corner of the site was discontinued due to their redundancy with another well.[2] The chlorinated solvents detected in earlier sampling at the southeast corner of the site were still present in the loess and fluvial deposits groundwater. Benzene concentrations exceeding the 5 μg/L MCL remained in the loess groundwater near the concrete-lined pits north of Mat 305 (EnSafe, January 26, 1998).

USTs 1490 and 1491 Removal (May 1997)

USTs 1490 and 1491 were removed by the U.S. Army Corps of Engineers on May 13, 1997. Approximately 1,200 cubic yards of petroleum-impacted soil were removed from the pit during excavation, resulting in the pit having final dimensions of 58 feet by 42 feet by 12 feet deep (shown on Figure 3-3). Excavated soil was disposed of as a non-hazardous waste under an approved special solid waste permit at the BFI landfill in Millington, Tennessee (EnSafe, January 28, 1998).

[2]Two experimental upper fluvial deposits monitoring wells (05MW04AUF and 05MW04BUF) were paired with an existing upper fluvial deposits well (05MW04UF) to evaluate: (1) whether vibrated-in-place surface casings were as effective as traditionally cemented casings and (2) whether rotary sonic drilling is an inherently safe drilling method (without the use of permanent surface casings) for preventing cross contamination while drilling/installing wells through shallow contaminated zones (discussed further in Section 4).



RCRA FACILITY INVESTIGATION
NSA MID-SOUTH
MILLINGTON, TENNESSEE

FIGURE 3-4
SWMUs 49 AND 19 DPT LOCATIONS
FLUVIAL DEPOSITS GROUNDWATER

DWG DATE: 11/24/98 | DWG NAME: 0094B028

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Oil-Water Separator Removal (August 1997)

The oil-water separator was removed by the U.S. Army Corps of Engineers on August 11, 1997. Significant petroleum contamination was identified during the removal, resulting in the excavation of a 112-foot by 50-foot by 13-foot deep pit (shown on Figure 3-3). Approximately 3,100 cubic yards of petroleum-impacted soil were removed from the excavation and disposed of as a non-hazardous waste under an approved special solid waste permit at the BFI landfill in Millington, Tennessee (EnSafe, January 28, 1998).

Voluntary Corrective Action (November 1997)

In 1997, a VCA was implemented by the Navy to remove the remaining sources of SWMU 5 soil contamination, specifically, contaminated soil beneath Mat 305 and the concrete-lined fire extinguisher pits (north of Mat 305). The VCA began with the demolition of the concrete mat followed by excavation of the underlying soil in a circular area measuring 75 feet in diameter and 2 to 4 feet deep. The excavation in the area of the fire extinguisher pits measured approximately 8 feet deep by 50 feet by 50 feet square. The loess well that historically contained elevated benzene concentrations (FFMW-8) was abandoned during excavation. At the conclusion of the VCA, approximately 3,000 cubic yards of soil were excavated from the two areas. Areas excavated during the VCA are shown on Figure 3-3. The soil was disposed of as a non-hazardous waste under an approved special solid waste permit at the BFI landfill in Memphis, Tennessee (EnSafe, May 26, 1998).

Assembly A Long-Term Groundwater Monitoring — Event 5 (November 1997)

Five loess and five fluvial deposits monitoring wells were sampled in November 1997 for VOCs as part of the fifth long-term groundwater monitoring. The chlorinated solvents detected in earlier sampling events at the southeast corner of the site were still present in the loess and fluvial deposits groundwater (EnSafe, March 20, 1998).

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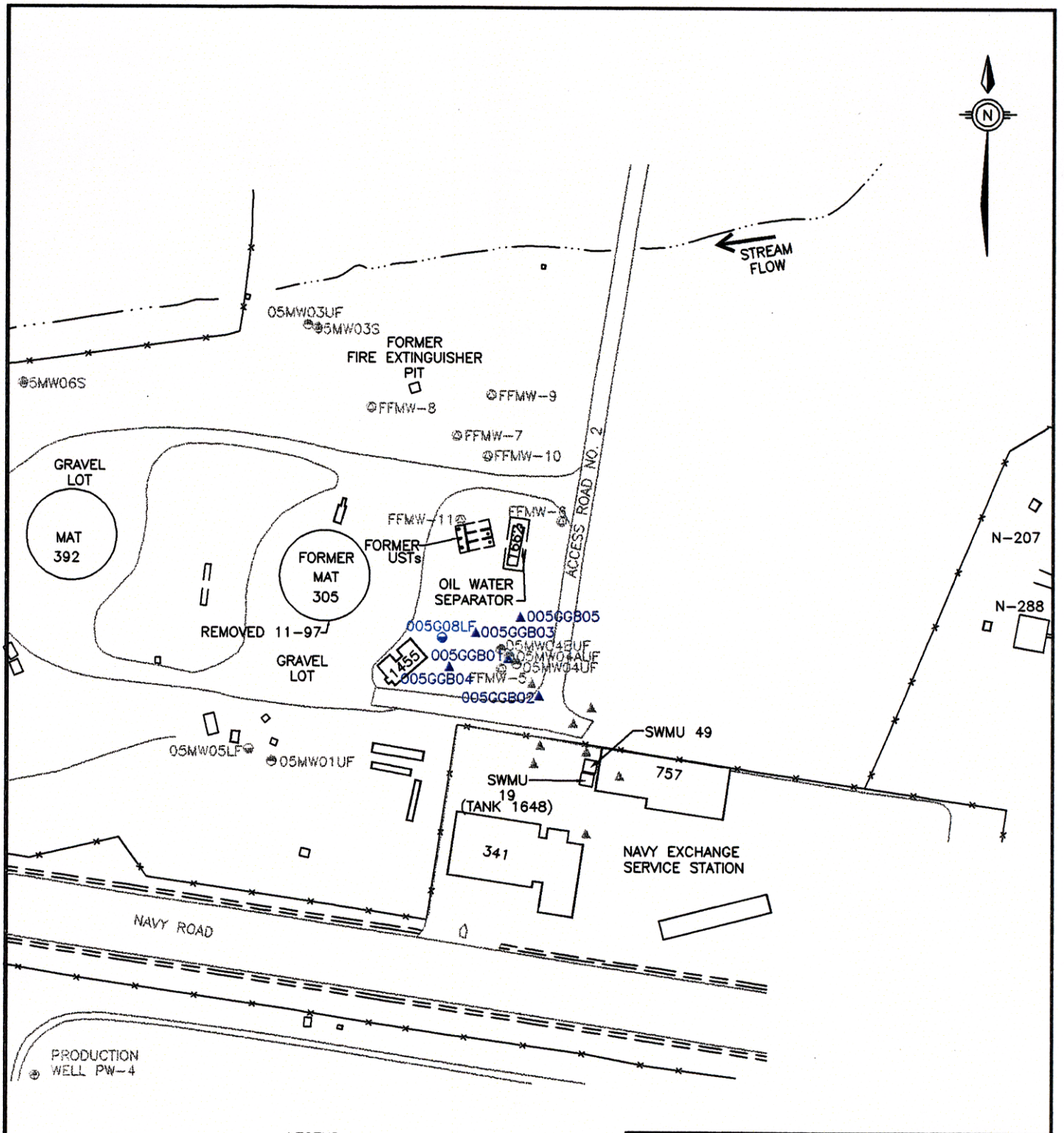
Direct Push Technology — Soil and Groundwater Screening (June 1998)

An additional DPT investigation was conducted at SWMU 5 in June 1998 to evaluate the source of the chlorinated solvents detected near the southeast corner of the site. The upper fluvial well cluster (05MW04UF, 05MW04AUF, and 05MW04BUF), where carbon tetrachloride had been consistently detected in groundwater, was encircled with five DPT locations (Figure 3-5) for groundwater sampling. Chlorinated solvents were detected in the single loess soil sample, loess groundwater, and upper fluvial deposits groundwater; however, concentrations were similar to earlier detections and not indicative of a source area. Specific solvents are listed below:

	LS	LG	UFDG
1,1,1-trichloroethane	X	—	X
benzene	X	—	—
carbon tetrachloride	—	—	X
xylenes	X	—	—
ethyl benzene	X	—	—
toluene	X	—	—
methylene chloride	X	X	X
TCE	X	X	X
1,2-dichloropropane	X	—	—
1,2-dichloroethene	—	X	—
PCE	X	—	—
2-butanone	X	—	—
2-hexanone	X	—	—

where:

LS = Loess soil
LG = Loess groundwater
UFDG = Upper fluvial deposits groundwater
X = Contaminant was identified in this sample



LEGEND

05MW03S – LOESS WELL/ID
05MW05LF – LOWER FLUVIAL DEPOSITS WELL/ID
05MW01UF – UPPER FLUVIAL DEPOSITS WELL/ID
FFMW-1 – EXISTING LOESS WELL/ID
– CHAIN LINK FENCE
019S0001 – FLUVIAL DPT SAMPLE LOCATION
005GGB03 – UPPER FLUVIAL DEPOSITS AND LOESS GROUNDWATER DPT SAMPLE LOCATION

150 0 150
SCALE FEET

RCRA FACILITY INVESTIGATION
NSA MID-SOUTH
MILLINGTON, TENNESSEE

FIGURE 3-5
RFI DPT SAMPLE LOCATIONS
1998 INVESTIGATION

DWG DATE: 01/22/99 | DWG NAME: 0094B029

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Monitoring Well Installation (August 1998)

An additional monitoring well (005G08LF) was installed on August 5, 1998, approximately 50 feet west (downgradient) of well cluster 05MW04UF (Figure 3-5) and screened at the base of the fluvial deposits aquifer, where higher concentrations of chlorinated hydrocarbons would be expected due to the relative low permeability of the Cockfield Formation beneath the fluvial deposits. Carbon tetrachloride and the other chlorinated hydrocarbons detected in the upper part of the fluvial deposits were not detected in this well. 2-Butanone was the only VOC detected in this well; it was absent in a duplicate sample. The absence of chlorinated hydrocarbons in this well, coupled with the relatively low concentrations identified during the earlier focused DPT investigations, led the BRAC Cleanup Team (BCT) to conclude that the chlorinated hydrocarbons were adequately defined at SWMU 5. This concluded investigative activities associated with the SWMU 5 RFI.

Monitoring Well Installation (February 1999)

Monitoring well FFMW-8, removed during the 1997 fire extinguisher pits VCA, was replaced in February 1999 by the USGS to evaluate the effects the removal had on VOC concentrations there, specifically benzene and methylene chloride. FFMW-8 was replaced with a 4-inch diameter monitoring well as a contingency for any loess groundwater corrective measures warranted as a result of future groundwater monitoring.

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4.0 FIELD INVESTIGATION METHODS

The RFI soil and groundwater sampling program objective was to delineate the nature and extent of contaminants associated with past AFFTF activities. Previous investigations have focused on shallow soil and groundwater contamination in the loess associated with the USTs.

Specific RFI objectives were to:

- Evaluate the downgradient extent of shallow soil and groundwater contamination in the loess by full RFI analyses.
- Evaluate soil and groundwater conditions at the oil-water separator, downgradient of the two fire mats, and near the underground drain lines.
- Evaluate surface soil conditions near the southeast corner of the site where recent spills have been documented.
- Assess the nature and extent of any deeper groundwater contamination in the fluvial deposits.
- Characterize the subsurface hydrogeology and preferred contaminant migration pathways.
- Assess the health-based and ecological risks associated with contaminants identified onsite.

This section summarizes the investigative protocols (i.e., sampling procedures, analytical methods, etc.) employed to meet the outlined RFI objectives, which were based on the USEPA- and TDEC-approved *Comprehensive RFI Work Plan* (E/A&H, 1994a) and *Assembly A*

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Site Investigation Plan (E/A&H, 1994b). The soil and groundwater sampling during the investigation followed the procedures outlined in the work plans.

Sampling locations were selected to provide complete coverage around the AFFTF. General sampling protocols, analytical methods, and rationale for the soil and groundwater investigation are presented in Sections 4.1 through 4.4 of this report. Specific sampling protocols (sample handling, field quality assurance/quality control [QA/QC], and decontamination) are presented in Sections 4.5 and 4.6.

4.1 Analytical Parameters

Soil and groundwater samples were collected and analyzed to delineate the nature and extent of contaminants. Samples were also submitted for physical and chemical characterization to evaluate potential migration pathways and for later use in remedial design, modeling, and (or) migration studies, if needed. Samples collected as part of the contamination assessment were analyzed in accordance with Solid Waste 846 methods, and reporting requirements were based on the Contract Laboratory Program (CLP). Table 4-1 summarizes the methods and reporting requirements. Soil and groundwater samples were analyzed and reported using Level III- and IV- equivalent data quality objectives (DQOs). Remedial design samples designated for physical and chemical characterization were analyzed for the parameters shown in Table 4-2.

4.2 Drilling Method — Resonant Sonic Drilling

Soil borings and monitoring wells were installed through resonant sonic, also known as rotasonic drilling, which is a relatively new and innovative drilling method for environmental investigations. This type of drilling was selected over conventional drilling techniques because of its speed, the quality of well installation, and the minimal amount of soil waste generated.

Table 4-1
Analytical Parameters
Chemical Characterization

Media	FSA Parameters	Method
Soil and Groundwater	TCL Volatile Organic Compounds	USEPA 8240 and USEPA 8260B
	TCL Semivolatile Organic Compounds	USEPA 8270
	TCL Chlorinated Pesticides/PCBs	USEPA 8080
	Organophosphorus Pesticides	USEPA 8140
	Chlorinated Herbicides	USEPA 8150
	Metals (Appendix IX)	USEPA 6010/7000 series
	Cyanide	USEPA 9010
	TPH	418.1

Notes:
TCL — Target Compound List
FSA — Full Scan Analysis

Table 4-2
Remedial Design Parameters

Media	Parameter	Method
Soil	**Physical:**	
	Permeability	ASTM 5084
	Porosity	ASTM 5084
	Particle Size	ASTM D422
	Bulk Density	ASTM 4253
	Specific Gravity	ASTM D854
	Moisture Content	ASTM 2216
	Chemical:	
	Total Phosphorus	USEPA 365.4
	Nitrate-N	USEPA 352.1
	Total Kjeldahl Nitrogen	USEPA 351.2
	Heterotrophic Plate Count	SM 9215B
	Total Organic Carbon	USEPA 415.1/9060
	Cation Exchange Capacity	USEPA 9081

000046

Table 4-2
Remedial Design Parameters

Media	Parameter	Method
Groundwater	**Chemical:**	
	5-Day Biochemical Oxygen Demand	USEPA 405.1
	Chemical Oxygen Demand	USEPA 410 (.1 to .3)
	Hardness	USEPA 130 (.1 to .2)
	Total Suspended Solids	USEPA 160.2
	Alkalinity	USEPA 310.1
	Total Phosphorus	USEPA 365.3
	Nitrate-N	USEPA 352.1
	Total Kjeldahl Nitrogen	USEPA 351.4
	Heterotrophic Plate Count	SM 9215B
	Iron	USEPA 200.7
	Turbidity	USEPA 180.1
	Manganese	USEPA 200.7

Notes:
ASTM — American Society for Testing and Materials
SM — Standard Methods

Overview of Resonant Sonic Theory

The drilling method consists of mechanically induced vibrations generated through a drill head containing two steel rollers, which rotate in eccentric orbits within a housing, creating equal centrifugal forces. The combined centrifugal forces create a vertical force that is transmitted into the steel-drill pipe and effectively transferred through the pipe to the bottom cutting edge of the pipe. A series of high-frequency, sinusoidal, wave vibrations are induced in the steel drill pipe at a rate proportional to its ability to accept and reflect each wave, or at its resonance frequency. With the pipe in resonance, the energy stored in the pipe greatly exceeds the energy being dissipated on the medium being drilled and the maximum strain is imparted to the ends of the steel pipe, and in turn, to the medium being drilled. The steel drill pipe behaves like a spring, expanding and contracting as the vibrations are imparted through the sonic head, creating a cutting action at the bit face and allowing a continuous core of the formation to move into the core barrel.

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Refer to *The Resonant Sonic Drilling Method: An Innovative Technology for Environmental Restoration Programs* by Jeffrey Barrow (1994), for a detailed discussion of this drilling method.

Sample Collection with Rotasonic

Rotasonic drilling consists of advancing two drill casings, an inner 4-inch diameter core barrel with a studded drill bit attached to its base, and an outer 6-inch diameter casing. The inner core barrel is first vibrated to the desired sample depth, capturing sample material into the barrel. The outer 6-inch casing is then vibrated around and to the inner barrel's sample depth, displacing the 1-inch soil annulus between the core barrel and casing into the formation. The outer casing serves two purposes: it ensures that the borehole remains open during sampling, eliminating borehole "slough," and prevents potential communication of shallower zones with deeper zones by continuously casing the borehole as it advances. After the outer casing is advanced, the inner core barrel is retrieved to the surface, leaving the outer casing in place, and the sample is vibrated out of the core barrel into a plastic sleeve. A cleaned decontaminated core barrel replaces the previously collected core barrel and the process is repeated until the desired sample depth is reached. Typically, 10-foot sections of core were collected at a time and samples were extruded in 3- to 4-foot lengths.

Potable water was used to drill below the saturated zone. After the inner barrel was advanced to the desired sample depth, water was pumped between the inner barrel and outer casing while the outer casing was vibrated down to flush soil from the annular space. Soil in the annular space was either circulated to the surface with the water and emptied into a tub or displaced into the borehole wall.

4.3 Soil Investigation

Soil above the first encountered water was initially assessed by collecting 18 surface and subsurface samples, excluding QA/QC samples. The samples were collected from seven boring

locations (05SB01 through 05SB07) surrounding the site, as shown in Figure 4-1. No soil samples were collected from borings 05SB05, 05SB04A, and 05SB04B, due to their proximity to other sampled borings.

4.3.1 Sample Collection — Soil

A sampling team of two field geologists was responsible for logging and processing the necessary samples to be field screened and submitted to the analytical laboratory. During the initial RFI soil boring/monitoring well phase, soil samples were collected continuously from the land surface to the water table, using the previously described rotasonic drilling methods and processed as described in Section 4.5. Some surface and shallow subsurface soil samples were collected with hand augers and processed as described in Section 4.5. At least three soil samples were collected from the following depth intervals at each boring: 0 to 1 foot bls, the soil-water interface, and an intermediate interval between the surface and the first encountered groundwater. Selection of the intermediate sample was based on results of headspace analysis as described below, or the professional judgment of the field geologist.

Soil Screening

Soil samples were screened by typical headspace analyses for VOCs using an HNu (Model GP 101, with an 11.7 eV lamp) photoionization detector (PID). The procedure was as follows:

- Several subsamples were collected from each soil core section and placed into a 1-quart resealable plastic bag. A typical core section was 4 to 5 feet long.

- The sample was allowed to equilibrate for several minutes so any VOC vapors from the soil could collect in the resealable bag's headspace.

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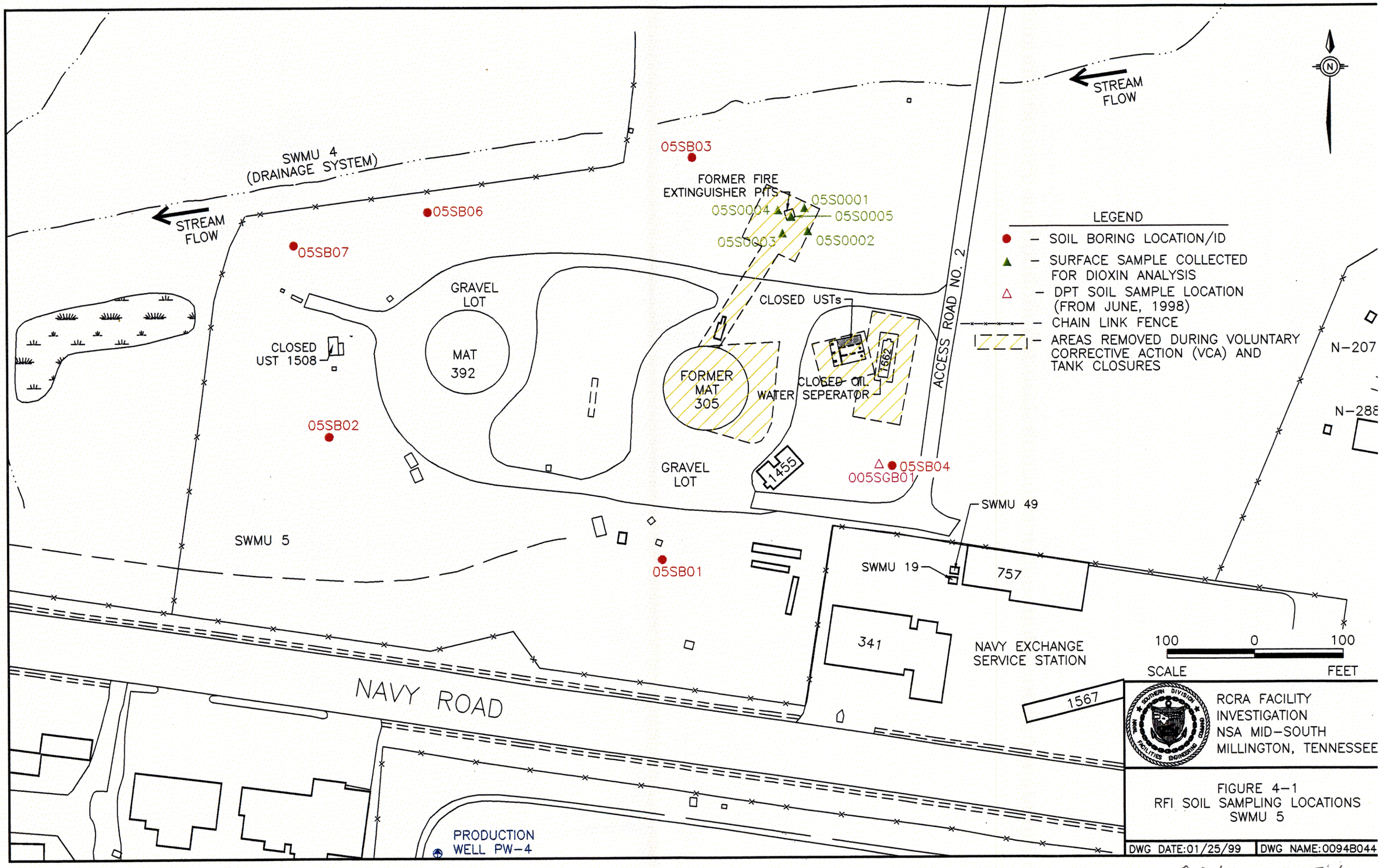
SWMU 4
(DRAINAGE SYSTEM)
STREAM FLOW
STREAM FLOW
05SB03
05SB06
05SB07
05SB02
05SB01
05SB04
005SGB01
FORMER FIRE EXTINGUISHER PITS
05S0001
05S0004
05S0005
05S0003
05S0002
GRAVEL LOT
MAT 392
CLOSED UST 1508
CLOSED USTs
FORMER MAT 305
WATER SEPERATOR
CLOSED OIL
1662
1455
GRAVEL LOT
ACCESS ROAD NO. 2
SWMU 49
SWMU 19
757
341
NAVY EXCHANGE SERVICE STATION
1567
SWMU 5
NAVY ROAD
PRODUCTION WELL PW-4
N-207
N-288
LEGEND
– SOIL BORING LOCATION/ID
– SURFACE SAMPLE COLLECTED FOR DIOXIN ANALYSIS
– DPT SOIL SAMPLE LOCATION (FROM JUNE, 1998)
– CHAIN LINK FENCE
– AREAS REMOVED DURING VOLUNTARY CORRECTIVE ACTION (VCA) AND TANK CLOSURES
100 0 100
SCALE FEET
RCRA FACILITY INVESTIGATION
NSA MID-SOUTH
MILLINGTON, TENNESSEE
FIGURE 4-1
RFI SOIL SAMPLING LOCATIONS
SWMU 5
DWG DATE:01/25/99
DWG NAME:0094B044

00617F05Y

- The PID probe was then inserted into the bag's headspace and any VOC vapors were measured. The measurement was recorded on the soil boring log.

- Additional soil samples were collected for laboratory analysis if headspace measurements or visible evidence suggested possible contamination.

Soil samples submitted for laboratory analysis were collected and processed as described in Section 4.5. All soil samples collected during this initial RFI phase were analyzed for full scan analysis (FSA) and classified in the field by an EnSafe or USGS geologist. Classifications were recorded on individual boring logs along with data such as measured PID concentrations, soil types, depth interval of samples submitted for analysis, and other relevant field information.

Hand augers were used to collect the dioxin from surface soil outside the concrete-lined fire extinguisher pits in September 1995. Soil sampling during the VCA and removal of SWMU 5's USTs and oil-water separator are outlined in the earlier submitted reports (EnSafe, January 8, 1998; EnSafe, May 26, 1998).

4.3.2 DPT Investigation — Soil

The second DPT sampling phase was conducted in June 1998. The objective of this final RFI soil sampling phase was to identify a possible source of chlorinated solvents in shallow soil and groundwater near the southeast corner of the site. During groundwater sampling of the loess and fluvial deposits groundwater, a soil sample was collected from one location (005SGB01 shown on Figure 4-1) from a depth of 10 feet bls and submitted to Savannah Laboratory for VOC analysis.

4.3.3 Design Parameters — Soil

Soil samples were collected during the RFI to obtain data for possible remedial design, modeling, and/or migration studies. One Shelby tube loess sample was collected from the 18- to 20-foot bls interval at soil boring 05SB06 to determine selected soil properties and the potential for contaminant migration near the depth of the uppermost water-bearing zone. The Shelby tube was retrieved, capped, labeled, and submitted to Tri-State Testing for analysis of the parameters listed in Table 4-2. A composite soil sample collected from boring 05SB03 from the 15- to 20-foot bls interval was submitted to National Environmental Testing (NET) for analysis of the chemical parameters previously listed in Table 4-2.

4.3.4 Stratigraphic Profiling — Geophysical Logging

The stratigraphy at SWMU 5 was characterized through physical description of continuous soil cores recovered while advancing soil borings 05SB02 through 05SB07 and from piezocone sounding plots generated during the DPT survey. Supplemental lithologic information was gathered through geophysically logging monitoring well 05MW05LF, screened from 55.5 to 65.5 feet bls. The geophysical log is provided in Appendix D. Natural-gamma and electrical-induction tools were used to generate subsurface logs, which were then used with the lithologic descriptions to determine subsurface contacts and to refine the conceptual geologic-hydrogeologic model for NSA Mid-South (Section 2.12 of the *Comprehensive RFI Work Plan*).

4.4 Groundwater Investigation

The SWMU 5 groundwater investigation focused on two water-bearing zones:

- ***Loess groundwater*** — Groundwater in the uppermost zone of saturation is considered the most likely to contain contamination associated with the AFFTF because of its shallow depth (12 to 15 feet bls typically).

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- ***Fluvial deposits groundwater*** — This preferential zone of groundwater flow in Shelby County is a potential route for contaminant transport.

Eleven new monitoring wells were installed as part of this RFI — complementing the existing 11 UST monitoring wells (FFMW-1 through FFMW-11). Three of the RFI monitoring wells (05MW03S, 05MW06S, 05MW07S) were screened from approximately 8 to 18 feet bls in the loess. Four RFI monitoring wells (05MW01UF through 05MW04UF) were screened at the 40-50-foot bls interval in the upper part of the fluvial deposits, and two RFI monitoring wells (05MW05LF and 05G08LF) were screened at the base of the fluvial deposits between 55 and 65 feet bls. Monitoring well locations are shown in Figure 4-2.

Two experimental upper fluvial deposits monitoring wells (05MW04AUF and 05MW04BUF) were paired with monitoring well 05MW04UF near the southeast corner of the site. These monitoring wells were constructed using the rotasonic drilling method in two ways: (1) a pushed surface casing, as opposed to conventional installation with a mud-rotary drill, and (2) no surface casing, relying on the temporary, outer protective casing provided by the rotasonic drilling method alone. The objective of installing these two wells was to evaluate the effectiveness of rotasonic drilling without the installation of conventional surface casings to safeguard from carrydown of contamination — shallow soil and groundwater contamination were identified in the area of the experimental wells during the 1992 UST investigation. Monitoring well 05MW04AUF was constructed inside a "pushed" (or sonically driven) permanent surface casing, while monitoring well 05MW04BUF was constructed using the standard rotasonic drilling method without installing a permanent surface casing. Section 6.3 compares the analytical results from each well.

4.4.1 Monitoring Well Construction

An initial pilot boring was advanced at each proposed fluvial deposits well location by rotasonic methods to determine the thickness of the loess and the depth to the top of the fluvial deposits.

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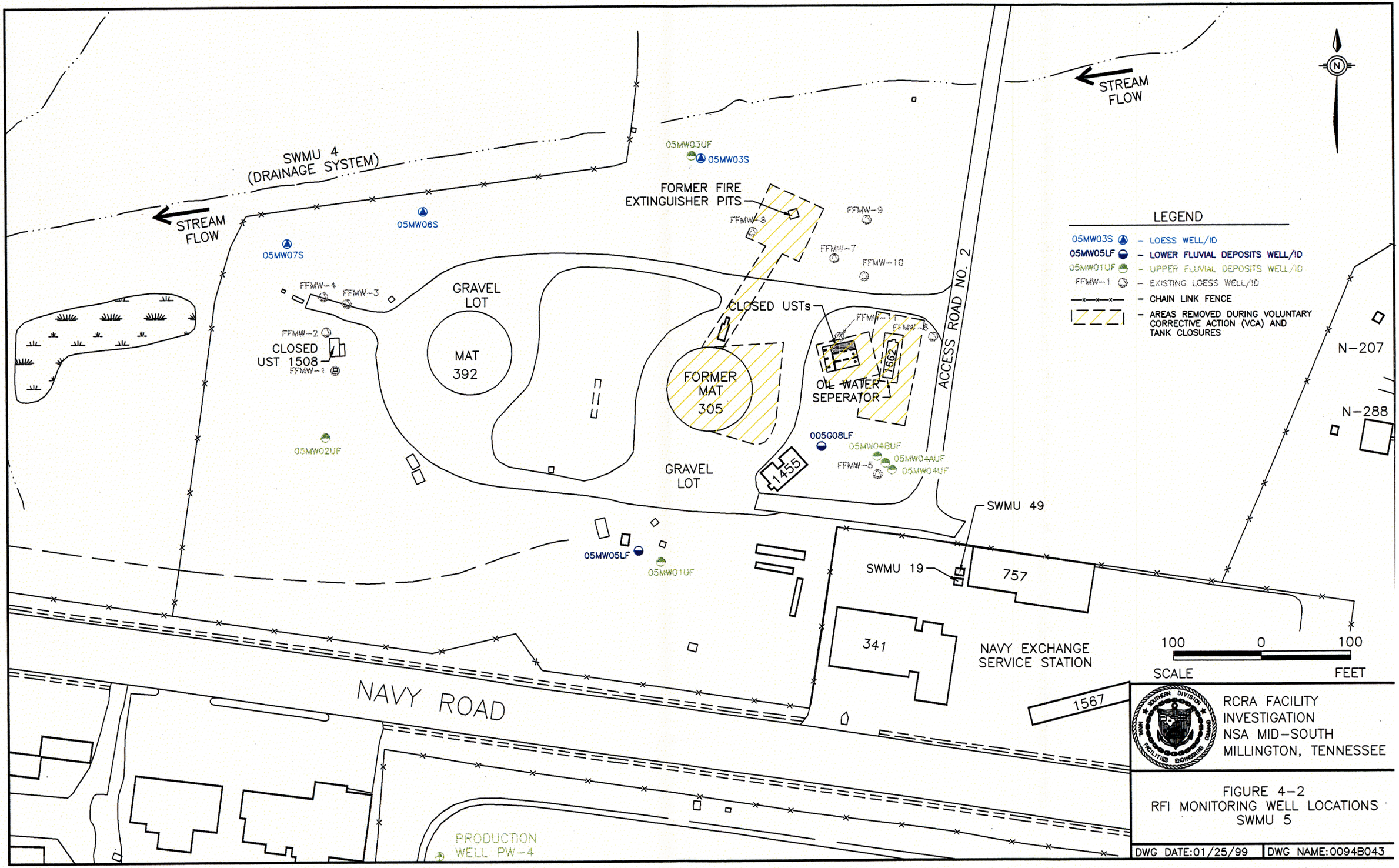
Soil samples were collected and logged, as described in Section 4.3. For setting permanent surface casings, a hydraulic-rotary rig then reamed the pilot hole to within several feet of the top of the fluvial deposits with a 12-inch tri-cone bit using only potable water as drilling fluid. Mixing potable water with silt and clay in the loess generated and circulated mud during the reaming process. After reaching the target depth, which typically was within a transition zone between the loess and fluvial deposits, the drill bit and string were removed from the borehole and an 8-inch inside diameter (ID) steel casing was lowered into the hole. Centralizers were welded on the outside of the surface casing before installation to maintain proper alignment with the borehole. Before the steel casing was lowered into the borehole, a polyvinyl chloride (PVC) slip cap was installed on the lower end to prevent borehole fluid from entering the casing. The casing was lowered into the borehole, grouted in place with a 95%/5% mixture of Portland cement and powdered bentonite injected through a tremie pipe in the annular space outside the casing.

Following at least 24 hours of grout curing, rotasonic drilling resumed through the inside of the surface casing to the target depth in the fluvial deposits. When the borehole was complete, stainless-steel centralizers were installed around a PVC well screen, and the casing and screen were lowered inside the outer rotasonic casing. All monitoring wells were constructed using a 10-foot section of 0.010-inch slotted, 2-inch ID, flush-joint, Schedule 40 PVC screen attached to 5- and/or 10-foot flush-joint sections of Schedule 40 PVC riser. Well construction proceeded through the inside of the outer rotasonic casing by pouring a 10/20 washed silica sand between it and the well screen. The 6-inch outer casing then was vibrated out from around the well screen after the sand pack was installed to prevent bridging. The sand pack was installed to at least 2 to 3 feet above the top of the well screen, followed by 2 to 3 feet of bentonite chips. The remaining annular space to land surface was pressure-grouted using a high-solids bentonite slurry.


SWMU 4
(DRAINAGE SYSTEM)
STREAM FLOW
STREAM FLOW
05MW03UF
05MW03S
05MW06S
05MW07S
FORMER FIRE EXTINGUISHER PITS
FFMW-8
FFMW-9
FFMW-7
FFMW-10
FFMW-4
FFMW-3
GRAVEL LOT
MAT 392
FFMW-2
CLOSED UST 1508
FFMW-1
CLOSED USTs
FFMW-11
FFMW-6
1662
OIL WATER SEPERATOR
FORMER MAT 305
ACCESS ROAD NO. 2
005G08LF
05MW04BUF
05MW04AUF
FFMW-5
05MW04UF
1455
05MW02UF
GRAVEL LOT
SWMU 49
05MW05LF
05MW01UF
SWMU 19
757
341
NAVY EXCHANGE SERVICE STATION
1567
NAVY ROAD
PRODUCTION WELL PW-4
N-207
N-288
N
LEGEND
05MW03S – LOESS WELL/ID
05MW05LF – LOWER FLUVIAL DEPOSITS WELL/ID
05MW01UF – UPPER FLUVIAL DEPOSITS WELL/ID
FFMW-1 – EXISTING LOESS WELL/ID
– CHAIN LINK FENCE
– AREAS REMOVED DURING VOLUNTARY CORRECTIVE ACTION (VCA) AND TANK CLOSURES
100 0 100
SCALE FEET
SOUTHERN DIVISION NAVAL FACILITIES ENGINEERING COMMAND
RCRA FACILITY INVESTIGATION
NSA MID-SOUTH
MILLINGTON, TENNESSEE
FIGURE 4-2
RFI MONITORING WELL LOCATIONS
SWMU 5
DWG DATE:01/25/99
DWG NAME:0094B043

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Fluvial deposits monitoring wells set within permanent steel 8-inch diameter casings contained approximately 3 feet of the well's protective casing sticking up above land surface as a well protector. Loess and those fluvial deposits monitoring wells not set within 8-inch diameter casings (05MW04BUF and 05MW08LF) were completed at the surface with 4-inch x 4-inch steel protective casings set approximately 3 feet above land surface. All stickup protective casings were surrounded by four outer protective guard posts set adjacent to a 4-foot x 4-foot x 6-inch concrete pad. All monitoring wells were tagged with the well number, completion date, and screened-interval depth. Monitoring well completion data are provided in Table 4-3 and well construction logs are provided with the boring logs in Appendix E.

4.4.2 Well Development

Fluvial deposits monitoring wells were developed using Grundfos submersible electric pumps and loess monitoring wells were developed using bailers. Well development was considered complete after conductivity, turbidity, temperature, and pH stabilized (Section 4.5.4 of the *Comprehensive RFI Work Plan*) and from five to 15 well volumes of water were removed. Water-quality parameters were measured with a Horiba meter (Model U-10) and recorded in the field logbook or on well-development forms.

Table 4-3
Well Completion Data

Monitoring Well Identification	Construction Date	Ground Elevation (msl)	Top of Casing Elevation (msl)	Total Depth (ft btoc)	Screened Interval (ft btoc)
Loess Wells					
05MW03S	2-12-95	265.52	267.97	21.33	10.83 - 20.83
05MW06S	1-29-95	264.20	266.83	20.78	10.28 - 20.28
05MW07S	1-29-95	264.12	266.95	21.22	10.72 - 20.72

Table 4-3
Well Completion Data

Monitoring Well Identification	Construction Date	Ground Elevation (msl)	Top of Casing Elevation (msl)	Total Depth (ft btoc)	Screened Interval (ft btoc)
Upper Fluvial Deposits Wells					
05MW01UF	1-29-95	268.68	271.09	54.50	44.00 - 54.00
05MW02UF	2-11-95	267.82	270.08	52.53	42.03 - 52.03
05MW03UF	2-12-95	265.59	267.52	52.37	41.87 - 51.87
05MW04UF	2-11-95	266.67	269.19	52.14	41.64 - 51.64
05MW04AUF	2-27-95	266.67	269.19	53.60	43.10 - 53.10
05MW04BUF	2-27-95	266.52	268.71	53.20	42.70 - 52.70
Lower Fluvial Deposits Wells					
05MW05LF	1-29-95	268.66	271.22	68.10	57.60 - 67.60
005G08LF	8-5-98	267.89	270.38	67.85	57.85 - 67.85

Notes:
msl — relative to mean sea level
ft btoc — feet below top of casing
All monitoring wells constructed with 2-inch ID, Schedule 40 PVC.

4.4.3 Groundwater Sampling

Most SWMU 5 monitoring wells were sampled six times; initially following the installation of the RFI monitoring wells and five subsequent times as part of the Assembly A long-term groundwater monitoring. The dates for each sampling event, the number of wells sampled, and their corresponding analyses are listed in Table 4-4 and discussed in Section 6. Monitoring well 005G08LF was sampled once in August 1998 for VOCs due to its late installation (August 1998); therefore, it is not included in the sampling events listed below. However, results are discussed in Section 6. One loess well (05MW07S) and one fluvial deposits well (05MW02UF) were also initially sampled for the remedial design parameters listed earlier in Table 4-2.

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Table 4-4
SWMU 5 — Groundwater Sampling and Analyses Performed

Screened Interval[a]	Initial Event March/April 1995		Event 1 Nov/Dec 1995		Event 2 April 1996		Event 3 August 1996		Event 4 April/May 1997		Event 5 November 1997	
	Samples	Analyses	Samples	Analyses	Samples	Analyses	Samples	Analyses	Samples	Analyses	Samples	Analyses
Loess	9	FSA[b]	4	FSA	NS	N/A	3	VOC	3	VOC	5	VOC
Upper Fluvial Deposits	6	FSA	6	VOC	6	VOC	6	VOC	6	VOC	4	VOC
Lower Fluvial Deposits	1	FSA	1	VOC	1	VOC	1	VOC	1	VOC	1	VOC

Notes:

a — Water-bearing zone, formation, or deposit in which the monitoring well is screened.

b — Initial sampling following RFI monitoring well installation was conducted in March and April of 1995. During March, three new RFI loess wells and one existing UST loess well (FFMW-5) were sampled for FSA. In April, five of the existing UST wells were sampled for metals, VOCs, SVOCs, and TPH. Samples from these wells were not analyzed for herbicides and pesticides since these analytes were not detected during the 1992 UST investigation. One of the nine collected loess groundwater samples represents the same well (FFMW-5) sampled twice, during March and April 1995.

FSA — Full Scan of Analyses. See Table 4-1 for a description of the parameters analyzed in FSA.

NS — Not sampled during this sampling event.

N/A — Not applicable.

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Sampling Procedures

Monitoring wells were allowed to equilibrate at least 48 hours following well development before sample collection. Monitoring wells screened in the fluvial deposits were sampled with dedicated Teflon tubing and submersible electric pumps using the low-flow micropurging technique. Micropurging techniques are based on the premise that stagnant water in the well casing does not completely mix with groundwater flowing through the screen when pumping at relatively low flow rates. Studies have suggested that flow in the well screen is horizontal and laminar and that groundwater moving through the screened portion of a well interacts minimally with stagnant water in the overlying well casing (Robin and Gillham, 1987). Purging several well volumes before sample collection is therefore unnecessary and recent studies have shown that water chemistry results from micropurging sampling methods are comparable to traditional sampling methods (Kearl et al., 1994). Additionally, low-flow micropurging reduces purge water and decreases sampling time compared to conventional methods. Information on micropurging was supplied to members of the BCT in January 1995. Micropurging was approved for use at NSA Mid-South by the USEPA Region IV project manager on February 23, 1995 (telephone conversation between Lawson Anderson, EnSafe, and David Williams, USEPA).

During micropurging, groundwater in the screened interval was removed at a rate equivalent to its recharge, which ranged from 0.3 to 1.1 gallons per minute (gpm). Depth-to-water was measured in each well before purging began and a flow rate was maintained such that drawdown stabilized between 0.3 and 0.6 feet below static conditions. Adequate volume was purged from each well to ensure that at least two hose volumes were initially removed prior to water-quality parameter measurements. Loess monitoring wells were purged and sampled using Teflon bailers. Water was considered stable and ready for sampling following three consecutive pH, specific conductance, turbidity, and temperature readings within ± 0.5 units, ± 10%, ± 10%, ± 1°C, respectively, and/or following removal of three to five well volumes.

The final water quality readings measured during the initial sampling at each well are listed in Table 4-5. Water quality readings from subsequent sampling events are provided in the *Assembly A Groundwater Monitoring Report* (EnSafe, May 30, 1997) and its addendums for Event 4 (EnSafe, January 26, 1998) and Event 5 (EnSafe, March 20, 1998). Taking precautions to minimize water disturbance, field personnel filled sample containers for VOC analysis first, then SVOC containers, and finally, the remaining sample containers. An equipment rinsate blank collected from the pump at the conclusion of sampling activities was submitted to the laboratory for FSA to ensure adequate decontamination following each sampling event. Weather conditions, initial water levels, purging and sampling times, purge volumes, and water quality parameters were recorded in the field logbook or the groundwater sampling forms.

Table 4-5
Well Purge Data (Initial Sampling Event)

Well ID	pH (SU)	Specific Conductance (mS/cm) @ 25°C	Temperature (°C)	Turbidity (NTUs)
Loess Wells				
05MW03S	6.42	0.716	14.7	830
05MW06S	6.38	0.700	14.2	>999*
05MW07S	6.82	0.871	16.2	>999*
Loess Wells				
FFMW-5[a]	6.26	0.615	14.2	931
FFMW-4	6.96	0.860	15.9	NR*
FFMW-5	7.32	0.566	15.9	NR*
FFMW-6	7.08	0.725	16.9	NR*
FFMW-8	7.14	0.989	15.5	NR*
FFMW-9	7.15	0.589	15.1	NR*

Table 4-5
Well Purge Data (Initial Sampling Event)

Well ID	pH (SU)	Specific Conductance (mS/cm) @ 25°C	Temperature (°C)	Turbidity (NTUs)
Fluvial Deposits Wells				
05MW01UF	6.24	0.256	17.9	MF
05MW02UF	6.18	0.536	17.6	14
05MW03UF	5.98	0.278	16.7	90
05MW04UF	6.12	0.284	17.5	10
05MW04AUF	6.35	0.321	17.5	2
05MW04BUF	5.97	0.299	17.4	9
05MW05LF	6.33	0.248	18.2	211

Notes:
SU — Standard unit
mS/cm — milliSiemens per centimeter
°C — degrees Celsius
NTUs — Nephelometric Turbidity Units
MF — Malfunctioning turbidity meter
NR — Not recorded due to instrument error
[a] — Sampled March and April 1995

4.5 Sampling Protocols

Sampling was conducted in accordance with the approved *Comprehensive RFI Work Plan* and the *Assembly A Site Investigation Plan*. Where warranted by field conditions, any deviations from the approved procedures were appropriately documented in the site logbook or on the groundwater sampling form.

Sample handling was minimized. When material was being transferred from the sampling device to containers, the operation was conducted expediently and in as clean an environment as possible. Plastic sheeting was placed over the sampling area and field personnel donned new gloves between each sample. Empty containers were kept packaged until use, at which time they were

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immediately chilled and placed in a cooler. VOC soil samples were containerized first from the unhomogenized sample to minimize volatilization.

4.5.1 QA/QC Samples

QA/QC samples were collected to test the level of reproducibility attainable in:

- Sampling and analytical processes
- Quality of equipment decontamination
- Quality of source waters and materials
- Sample exposure to ambient contamination during handling
- Level of laboratory precision

QA/QC samples were analyzed for the same contaminant assessment constituents as the environmental samples. The following field QA/QC samples were collected in accordance with the work plans:

- *Duplicate* samples: 10% of soil and groundwater samples.
- *Equipment rinsate*: one per week during sampling activities.
- *Material blanks*: one for each well-construction material.
- *Field blanks*: one per sampling event (week) per source of water.
- *Matrix spikes/matrix spike duplicates*: 5% of the total samples collected.
- *Trip blanks*: submitted with each cooler containing VOC samples.

Samples requiring chemical preservation were preserved in the field in accordance with the USEPA *Standard Operating Procedures/Quality Assurance Manuals* (USEPA, 1991 and 1996a) procedures. In the field, each sample was labeled with the sample identification, analysis requested, and the time and date of collection. A custody seal listing the sample identification,

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date, and sampler's name was placed over each container's lid, and the sample was immediately placed in a cooler.

4.5.2 Sample Processing

Samples were individually bubble-wrapped, secured in resealable plastic bags, and packed inside sturdy coolers on ice in resealable plastic bags. Samples were typically shipped to the laboratory overnight on the day of collection. Samples were arranged in the iced coolers to maintain uniform and appropriate preservation temperatures during shipment. A temperature blank (40-milliliter volatile organic analysis container filled with tap water) was placed in each cooler. Once the cooler arrived at the laboratory and was opened, the temperature blank was measured to verify adequate preservation during shipment. Trip blanks were placed in coolers containing samples for VOC analysis. Cooler lids were secured with packing tape and sealed with signed custody seals. Packaged samples were shipped overnight via priority service for next morning delivery. The laboratory was notified how many samples would be submitted the day of shipment. The laboratory contacted EnSafe personnel the following day acknowledging receipt and condition of samples. All sample shipments were reported to have arrived at the laboratory in good condition and at appropriate temperatures.

To ensure the integrity of the sample transfer process, a strict chain-of-custody procedure was implemented for all samples collected. This procedure was initiated in the field for each sampling event and maintained through custody transfer to the contract laboratory. A chain-of-custody form was completed for each batch of samples, itemizing sample numbers, containers, preservatives, analyses requested, date and time of sample collection, and the FedEx airbill shipment number. Custody forms were sealed in each cooler for shipment. Custody transfers were recorded by signature, date and time of relinquishment, and receipt of custody by the parties involved.

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Sample Labeling

All samples collected in the field were labeled with a 10-digit alphanumeric code that identified the site, sample type, sample location, sample depth, and QA sample type (as appropriate). The first three digits identified the site location (SWMU 05 = 005). The fourth digit identified the sample matrix (soil = S, groundwater = G). The matrix codes and analytical data are listed in Appendix F. The fifth through eighth digits represent the station location (boring 12 = 0012). The final two digits represent the deepest point of a soil sample interval (18 to 20 feet = 20) or the formation in which the well is screened (S = shallow [loess], UF = upper fluvial deposits, and LF = lower fluvial deposits).

Examples

005S000128	SWMU 05, soil, boring 001, at the 26- to 28-foot depth
005GMW01UF	SWMU 05, groundwater, well MW01, screened in upper fluvial deposits

4.6 Data Validation

NSA Mid-South Assembly A data were validated either by EnSafe or one of the following subcontractors: CKY Environmental Services Inc., of Torrance, California; Validata Chemical Services of Norcross, Georgia; or Heartland Environmental Services Inc. of St. Peters, Missouri. Data were validated in accordance with USEPA *Contract Laboratory Program National Functional Guidelines for Organic and Inorganic Data Review* (USEPA, 1994a). The data validation findings for all Assembly A SWMUs are presented in either *Data Validation Report — Assembly A — Naval Air Station Memphis* (E/A&H, 1995), *Data Validation Report — Assembly A — Naval Support Activity Memphis* (E/A&H, 1996), or Appendix F, which includes the most recent validation report for data generated during the RFI.

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4.7 Decontamination and Investigation-Derived Waste

4.7.1 Decontamination

Field equipment was decontaminated in accordance with guidelines set forth in the *Comprehensive RFI Work Plan*. All downhole equipment was decontaminated before and after use at the central decontamination pad (N-7 aircraft wash rack). Decontamination procedures consisted of:

- High-pressure water or manual soap/water wash
- Rinse with potable water
- Rinse with deionized, organic-free water
- Rinse twice with pesticide-grade isopropyl alcohol
- Air dry or second rinse with deionized, organic-free water
- Wrap with aluminum foil or plastic

Field personnel donned disposable latex gloves before handling decontaminated sampling equipment. Rinse water generated from decontamination activities was stored in a 2,000-gallon tank at the decontamination pad and discharged to the sanitary sewer after a VOC scan showed no detectable contamination and approval was received from the City of Millington wastewater consultant, Fisher & Arnold Inc.

4.7.2 Investigation-Derived Waste

Drilling mud, soil, and groundwater were stored in 55-gallon drums and labeled. The following information was recorded on the drum-tracking form: contents, date filled, boring/well identification, and a unique tracking code. Drums were loaded on pallets and staged in a fenced, paved area near the permitted hazardous-waste storage facility, Building N-1694. The drilling mud and soil have been characterized as nonhazardous and spread near the Defense Reutilization and Marketing Office facility on the NSA Mid-South Southside. Purge and development water were staged at the decontamination pad pending receipt of VOC analytical data. Once the data

were received and approval was received from the City of Millington wastewater consultant, the wastewater was discharged through an oil-water separator to the sanitary sewer.

4.8 Ancillary Data Collection

Aquifer Characteristics

The groundwater flow velocity (and thus a conservative estimate of contaminant migration) was evaluated through a specific-capacity test conducted on fluvial deposits monitoring well 05MW01UF, in accordance with Section 4.9.4.1 of the *Comprehensive RFI Work Plan*. A well's specific capacity is the ratio of yield per foot of drawdown, usually expressed as gallons per minute per foot of drawdown (gpm/ft). During a specific capacity test, water is withdrawn from a well at a known discharge rate for a designated period of time. Drawdown is measured until relative stabilization occurs at a constant pumping rate. This test may be continued at a higher pumping rate after stabilization (step-drawdown test). Specific capacity is a function of the following variables:

- Well efficiency
- The transmissivity of the zone supplying water to the well, which may be less than the transmissivity of the aquifer, depending on the length of the screen (partial penetration effects)
- The storage coefficient of the aquifer
- The length of the pumping period
- The effective radius of the well
- The pumping rate

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The relationship between specific capacity and transmissivity is based on the Theis equation:

$$T = \frac{W(u)}{4\pi} \frac{Q}{s}$$

where T is the transmissivity, Q/s is the specific capacity, Q is the pumping rate, s is the drawdown, and $W(u)$ is the well function of u. This equation requires use of consistent units.

The $W(u)$ is defined as:

$$u = \frac{r^2 S}{4Tt}$$

where T is defined as above, r is the effective radius of the well, S is the storage coefficient, and t is the duration of pumping preceding the specific-capacity duration. Once again, this equation requires use of consistent units.

Aquifer parameters were calculated from the specific-capacity test data using a computer program developed by Bradbury and Rothschild (1985), which is based on equations present in Lohman (1972). Two assumed variables entered into the specific-capacity program are the storage coefficient and well-loss coefficient. A storage coefficient of 0.25 was estimated for a confined, fine- to medium-grained sand aquifer (Todd, 1980) and a well-loss coefficient of 0.75 was used to approximate the well efficiency (of 25%). The specific capacity data were used to derive T and the hydraulic conductivity (K), which are presented in Section 5.

Borehole Geophysics

A combination probe, consisting of a natural-gamma ray detector and electrical induction equipment, was used to measure the natural gamma-ray emission and electrical parameters associated with strata penetrated by monitoring well 05MW05LF. This monitoring well was

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selected because of the absence of a steel surface casing below 44 feet and because it is the deepest monitoring well onsite. Electric logs presented in Section 5 support the site geology discussion.

The logging probe was approximately 5.5 feet long and designed to be run in 2-inch PVC-cased holes, in or out of the water column. The probe was lowered and raised at a set speed by a cable attached to a winch. The cable contained wiring connecting the electronic probe to a computer inside the logging truck.

Once the monitoring well to be logged was identified, the operator positioned the logging truck close to the hole and began entering well information into the computer, while the second operator attached the decontaminated probe to the cable and positioned the probe in the monitoring well for temperature equilibration. The probe was zeroed to ground surface by subtracting the height of the riser before lowering it to the bottom of the well. At the bottom, the temperature of the probe was again allowed to equilibrate. As the probe was ascending, data were recorded at 0.1-foot intervals by digital computer. When the probe reached the surface, it was detached from the cable and stored for transport to the decontamination center. Before the logging unit left the monitoring well, a paper copy of the data was generated to check instrument function. QC was obtained daily by repeating sampling of 20-foot sections of various monitoring wells.

4.9 Applicable Screening Levels

The RFI at SWMU 5 was directed at two different media, with two separate intervals for each medium. Soil samples consisted of both surface soil (0 to 1 foot bls) and subsurface soil (> 1 foot bls), while groundwater samples consisted of both the loess and fluvial deposits. The screening levels for each media type and interval consisted of both regulatory action levels and risk-based screening levels. Table 4-6 outlines the screening levels applied to each media type and interval.

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Table 4-6
Applicable Regulatory Screening Levels

Media	Regulatory Screening Levels	Risk-Based Screening Levels
Surface Soil (0-1 foot)	TDEC Site-Specific Remediation Level (SSRL)	Residential and Industrial RBCs SSL
Subsurface Soil (> 1 foot)	TDEC SSRL	SSL
Loess Groundwater	TDEC SSRL MCL	Tap water RBC
Fluvial Deposits Groundwater	TDEC SSRL MCL	Tap water RBC

Notes:

TDEC SSRL	—	Tennessee Department of Environment and Conservation, Division of Underground Storage Tanks, *Environmental Assessment Guidelines*, August 1996.
Residential & Industrial RBCs	—	USEPA Region III risk-based concentrations for both residential and industrial scenarios (USEPA, 1998a).
SSL	—	USEPA Region III soil screening levels for the protection of groundwater, *Soil Screening Guidance: Technical Background Documents*, (USEPA, 1996b).
Tap water RBC	—	USEPA Region III risk-based concentration for tap water (USEPA, 1998a).
MCL	—	USEPA maximum contaminant level from *Drinking Water Regulations and Health Advisory* (USEPA, 1996c).

As shown in Table 4-6, the primary screening levels governing the RFI were the USEPA Region III, Risk-Based Concentrations (RBCs) for both surface soil and groundwater (USEPA, 1998a), and the USEPA MCLs for groundwater (USEPA, 1996c). The USEPA's *Soil Screening Guidance; Technical Background Document* (USEPA, 1996b) was also used to evaluate the transfer of contaminants from soil to groundwater The identified contaminants in each medium have been compared to the applicable RBC to determine the cumulative risk associated with each medium, as discussed in the human health risk assessment (Section 7). Contaminants identified in both the loess and fluvial deposits groundwater were compared to both the risk-based screening levels (i.e., tap water RBC) and the regulatory-based USEPA MCL.

TPH Regulatory Action Levels

The petroleum-related constituents detected at SWMU 5 are regulated by TDEC's Division of USTs, which has recently established uniform soil cleanup standards for petroleum releases. These regulations *apply to both regulated and non-regulated UST sites, as well as non-tank-*

related sites (Tennessee Senate Bill 2720 [Public Chapter 864], May 3, 1996). These regulations, presented in the TDEC Division of USTs *Environmental Assessment Guidelines* (TDEC, 1996), have established site-specific cleanup levels for both TPH and benzene in soil based on groundwater classification. Tables 4-7 and 4-8 present the criteria used to determine the site-specific cleanup standards for soil under these regulations.

Table 4-7
TDEC Division of USTs Benzene Soil Cleanup Levels (mg/kg)

Soil Permeability	$>10^{-4}$ cm/sec	10^{-4} to 10^{-6} cm/sec	$<10^{-6}$ cm/sec
Drinking Water	5	25	50
Nondrinking Water	25	50	100

Notes:
mg/kg — milligrams per kilogram
cm/sec — centimeters per second

Table 4-8
TDEC Division of USTs TPH Soil Cleanup Levels (mg/kg)

Soil Permeability	$>10^{-4}$ cm/sec	10^{-4} to 10^{-6} cm/sec	$<10^{-6}$ cm/sec
Drinking Water	100	250	500
Nondrinking Water	250	500	1,000

Notes:
mg/kg — milligrams per kilogram
cm/sec — centimeters per second

The cleanup levels are based on two variables: soil permeability and groundwater classification. Groundwater is classified as a drinking water or a nondrinking water supply, based in part on whether naturally occurring metals exceed USEPA drinking water standards. Data collected during the SWMU 5 RFI indicate soil permeabilities in the loess of 1.4×10^{-7} centimeters per second (cm/sec). Soil borings did not indicate any sand stringers in the loess. Based on samples

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collected from the loess at SWMU 5, as well as background well data as presented in the Technical Memorandum *Reference Concentrations* (E/A&H, 1996), shallow groundwater at SWMU 5 and in background wells exceed certain national primary and secondary drinking water standards (*Drinking Water Regulations and Health Advisories*, USEPA, 1996c), as indicated in Table 4-9.

Table 4-9
SWMU 5 and Background Wells Loess Groundwater Data vs. USEPA Drinking Water Standards
(in micrograms per liter)

Sample ID	Date	Parameter	Results	Drinking Water Standard	Standard
05MW03LS	24-Mar-95	Cadmium	6.1	5	Primary
		Iron	29,700	300	Secondary
		Manganese	1,250	50	Secondary
05MW07LS	29-Mar-95	Iron	2,620	300	Secondary
		Manganese	727	50	Secondary
0BGG01LS01	21-Mar-95	Antimony	20	6	Primary
0BGG01LS02	10-Nov-95	Antimony	25	6	Primary
		Thallium	3	2	Primary
0BGG02LS01	17-Mar-95	Antimony	20	6	Primary
		Chromium	167	100	Primary
		Lead	33.6	15	Primary
		Nickel	143	100	Primary
0BGG02LS02	9-Nov-95	Antimony	25	6	Primary
		Thallium	3	2	Primary
0BGG04LS01	16-Mar-95	Antimony	20	6	Primary
		Chromium	213	100	Primary
		Nickel	165	100	Primary
0BGG04LS02	9-Nov-95	Antimony	25	6	Primary
		Cadmium	5.4	5	Primary
		Chromium	222	100	Primary
		Nickel	157	100	Primary
		Thallium	3	2	Primary

Table 4-9
SWMU 5 and Background Wells Loess Groundwater Data vs. USEPA Drinking Water Standards
(in micrograms per liter)

Sample ID	Date	Parameter	Results	Drinking Water Standard	Standard
0BGG05LS01	17-Mar-95	Antimony	40.5	6	Primary
		Chromium	160	100	Primary
		Nickel	114	100	Primary
0BGG05LS02	9-Nov-95	Antimony	25	6	Primary
		Thallium	3	2	Primary

Based on the information obtained during the SWMU 5 RFI and data collected from the background wells, the applicable TDEC cleanup levels for benzene and TPH in SWMU 5 soil would be 100 and 1,000 mg/kg, respectively.

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5.0 GEOLOGY AND HYDROGEOLOGY

5.1 Regional Geology and Hydrogeology

The general hydrogeology of the Memphis area is detailed in Section 2.11 and a conceptual model of the hydrogeology at NSA Mid-South is presented in Section 2.12 of the *Comprehensive RFI Work Plan*. Updated information is available in the *Hydrogeology of Post-Wilcox Group Stratigraphic Units in the Area of the Naval Air Station Memphis, Near Millington, Tennessee* (Kingsbury and Carmichael, 1995). Based on new information, the hydrogeology of NSA Mid-South is re-summarized below.

The two stratigraphic units investigated during the RFIs at NSA Mid-South are the loess/alluvial deposits of Pleistocene and Holocene age and the underlying fluvial deposits of Pleistocene to Pliocene age. The loess — eolian deposits consisting of silt, silty clay, clay, and minor amounts of sand — is the principal unit occurring at land surface throughout the NSA Mid-South Northside. Alluvium, which is restricted to stream valleys, includes alluviated or reworked loess. The loess is typically 0 to 65 feet thick in the Memphis area; at NSA Mid-South, it ranges from 15 to 45 feet thick. Water-bearing zones are present primarily in the upper part of the loess; however, yields are low and water quality analyses performed during the water use survey portion of UST investigations at NSA Mid-South indicate that loess groundwater does not meet many federal primary and secondary drinking-water standards. Previous investigations at NSA Mid-South have found depth to water in the loess varying between 5 and 15 feet bls and vertical hydraulic conductivities ranging from 10^{-6} to 10^{-8} cm/sec. Although the loess may be considered an aquitard based on the relatively low hydraulic conductivities, the shallowest water-bearing zone is present within this interval. Groundwater flow in the loess is primarily downward, although locally some groundwater in the loess may discharge to nearby streams, drainage ditches, and other surface water bodies.

The fluvial deposits, which underlie the loess in upland areas, consist of sand, gravel, and some clay, with thin layers of ferruginous sandstone and conglomerate at the base. This unit ranges from 0 to 100 feet thick in the Memphis area; on the Northside of NSA Mid-South, it ranges from 10 to 60 feet thick and represents the most significant component of the surficial aquifer. Many shallow domestic wells in Memphis rural areas are completed in the fluvial deposits. Relative groundwater elevations between wells completed in the loess/alluvium and fluvial deposits indicate semiconfined to confined conditions in the fluvial deposits. Typically, a downward vertical gradient exists between water in the loess and the fluvial deposits. Sediments in the fluvial deposits generally coarsen with depth and, typically, the upper portion consists of a mixture of very fine sand with varying degrees of silt and clay that becomes increasingly less silty with depth, grading into a fine to medium sand near the middle of the unit. Grain sizes typically continue to coarsen below this interval, grading into a gravelly sand near the fluvial deposits basal section.

The fluvial deposits are underlain by the Cockfield Formation, a part of the Jackson-upper Claiborne confining unit, which is a heterogeneous formation consisting of very fine silty sand interbedded with clay and silt lenses or clay with interbedded fine sand lenses. The more permeable characteristics of the fluvial deposits, compared to the relatively impermeable properties of the overlying loess/alluvium and the underlying Jackson-upper Claiborne confining unit, result in the fluvial deposits being the preferential zone of groundwater flow and the route for contaminant transport in NSA Mid-South subsurface.

5.2 Site-Specific Geology

A stratigraphic profile was assembled from the lithologic information collected from the borehole data and geophysical logging at SWMU 5. The profile shows the local geology from 0 to 63.7 feet bls, which is the approximate depth to the top of the Cockfield Formation at SWMU 5. Boring logs are presented in Appendix E. Geologic cross sections of the site constructed from the lithologic information are shown in Figure 5-1. The geophysical log in Appendix D shows the

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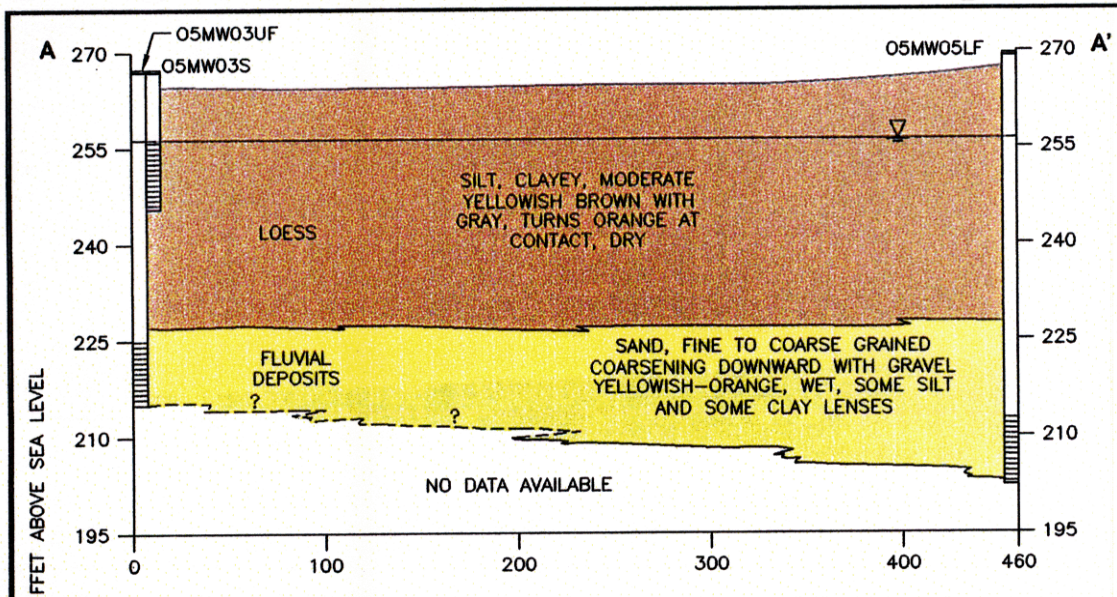
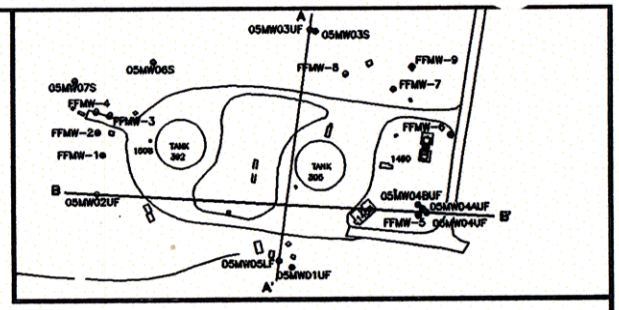
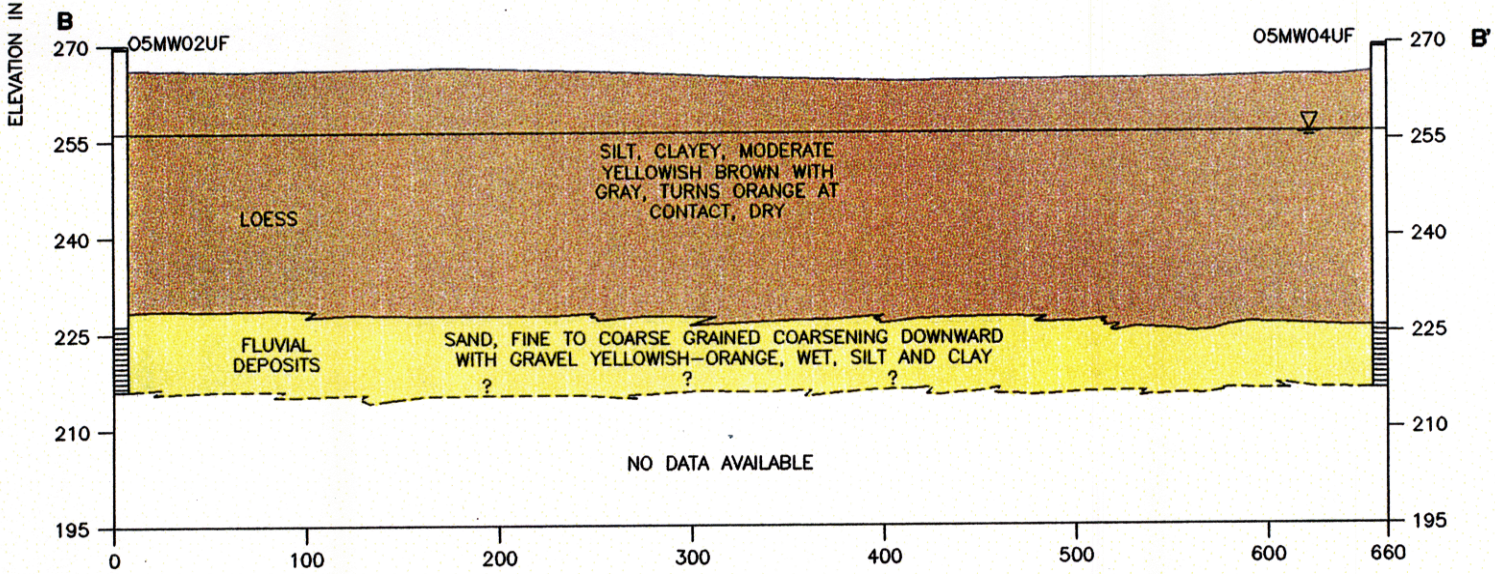




LEGEND

- POTENTIOMETRIC SURFACE FOR FLUVIAL DEPOSITS
- WELL SCREEN
- LOESS
- FLUVIAL DEPOSITS



100 0 100

HORIZONTAL SCALE FEET

RCRA FACILITY INVESTIGATION
NSA MID-SOUTH
MILLINGTON, TENNESSEE

FIGURE 5-1
GEOLOGIC CROSS SECTIONS
A-A' AND B-B'
SWMU 5

DWG DATE: 10/26/98 | DWG NAME: 94CSAB01

00617F07Y

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representative gamma-ray geophysical data at monitoring well 05MW05LF. The contact between the loess and fluvial deposits (40 feet bls) is apparent in the gamma-ray log as seen by the decrease in signal at approximately 19 to 20 feet bls. The loess and fluvial deposits from soil-boring information are described below.

Loess/Alluvium

Silt and clay soil types were encountered from land surface to the top of the fluvial deposits, which ranged from 31 to 40 feet bls. The loess consists of a moist yellowish-brown silt changing in color at about 15 to 20 feet bls to a gray to medium gray. The observed loess thickness at SWMU 5 is approximately 38 feet, which is the typical thickness identified throughout the NSA Mid-South Northside (E/A&H, 1994a).

A Shelby tube sample collected from boring 05SB06 at the 18- to 20-foot depth interval was analyzed for vertical hydraulic conductivity per American Society of Testing and Materials Method D-5084-90 using a flexiwall permeameter. The results indicated a permeability coefficient of 1.4×10^{-7} cm/sec. Sieve analysis indicated a lean clay soil type. The soil laboratory report is presented in Appendix G.

Fluvial Deposits

The upper portion of the fluvial deposits consists of silty sand with alternating layers of clay lenses. The amount of gravel increased with depth; likewise, sand grain-size distribution shifts from fine-grained in the upper part of the fluvial deposits to coarse-grained in the lower part. The fluvial deposits base consists of sand with gravel. Gravel content varied from boring to boring. Two geologic cross sections presented in Figure 5-1 show the lithologic profile of the site.

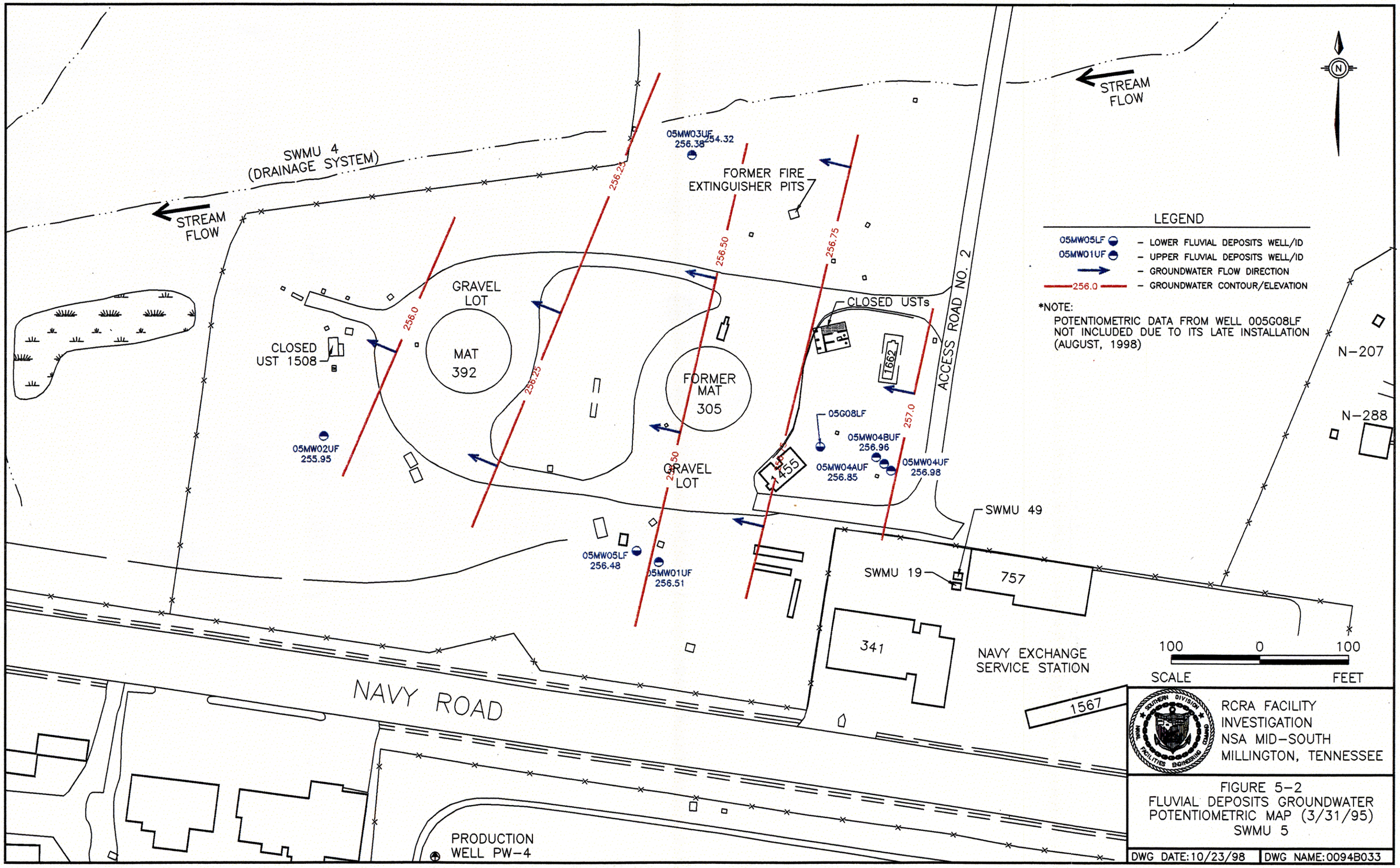
5.3 Site-Specific Hydrogeology

A specific capacity of 0.75 gpm/ft was calculated for well 05MW01UF based on drawdown measured in the well during purging. Using this specific-capacity value and a fluvial deposits aquifer thickness of 25 feet at this location, a hydraulic conductivity (K) was approximated at 12.17 feet per day (ft/day) by the computer program discussed in Section 4.8 (Bradbury and Rothschild, 1985). The aquifer thickness was based on the assumption that the fluvial deposits aquifer is confined at the bottom by the relatively less permeable Cockfield Formation and above by the loess. The input/output data from the analysis are presented in Appendix H.

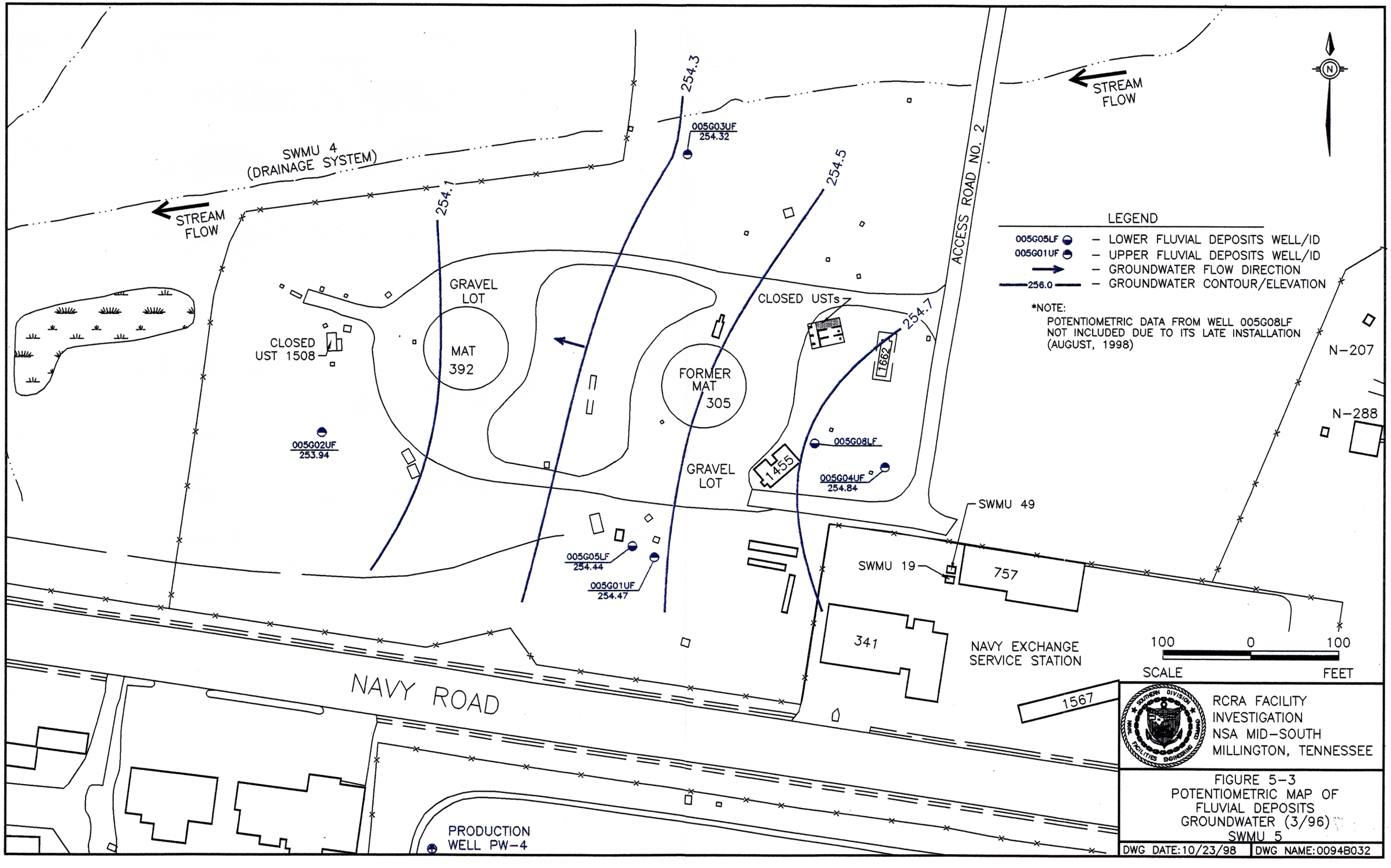
Groundwater level data were collected on March 31, 1995, and on March 3, 1996. These data were used to construct maps of the potentiometric surface for the fluvial deposits from each date, and the loess for the March 1996 data (no sitewide loess water-level data were collected in March 1995). Figures 5-2 and 5-3 show the potentiometric maps for the fluvial deposits for the two data sets. Estimated values for the hydraulic gradient in the fluvial deposits were based on the potentiometric maps. Data from both the March 1995 and 1996 measurements indicate general groundwater movement to the west-northwest (Figures 5-2 and 5-3). The hydraulic gradient for the fluvial deposits was estimated for the March 1995 and March 1996 data at 1.6×10^{-3} and 1.4×10^{-3}, respectively. The calculations are shown below.

Hydraulic Gradient Calculations

March 31, 1995 Data
∇ (05MW04UF - 05MW02UF) = $\frac{256.98 \text{ ft} - 255.95 \text{ ft}}{635 \text{ ft}} = 1.6 \times 10^{-3}$
March 3, 1996 Data
∇ (05MW04UF - 05MW02UF) = $\frac{254.84 \text{ ft} - 253.94 \text{ ft}}{635 \text{ ft}} = 1.4 \times 10^{-3}$


SWMU 4
(DRAINAGE SYSTEM)
STREAM FLOW
STREAM FLOW
05MW03UF
256.38
254.32
FORMER FIRE EXTINGUISHER PITS
256.25
256.50
256.75
GRAVEL LOT
MAT 392
256.0
CLOSED UST 1508
256.25
FORMER MAT 305
CLOSED USTs
1662
ACCESS ROAD NO. 2
05G08LF
05MW04BUF
256.96
257.0
05MW04AUF
256.85
05MW04UF
256.98
1455
05MW02UF
255.95
GRAVEL LOT
256.50
SWMU 49
05MW05LF
256.48
05MW01UF
256.51
SWMU 19
757
341
NAVY EXCHANGE SERVICE STATION
NAVY ROAD
1567
PRODUCTION WELL PW-4
N-207
N-288
N
LEGEND
05MW05LF – LOWER FLUVIAL DEPOSITS WELL/ID
05MW01UF – UPPER FLUVIAL DEPOSITS WELL/ID
– GROUNDWATER FLOW DIRECTION
256.0 – GROUNDWATER CONTOUR/ELEVATION
*NOTE:
POTENTIOMETRIC DATA FROM WELL 005G08LF NOT INCLUDED DUE TO ITS LATE INSTALLATION (AUGUST, 1998)
100 0 100
SCALE FEET
RCRA FACILITY INVESTIGATION
NSA MID-SOUTH
MILLINGTON, TENNESSEE
FIGURE 5-2
FLUVIAL DEPOSITS GROUNDWATER POTENTIOMETRIC MAP (3/31/95)
SWMU 5
DWG DATE:10/23/98
DWG NAME:0094B033

00617FB2Y


SWMU 4
(DRAINAGE SYSTEM)
STREAM FLOW
STREAM FLOW
254.1
254.3
254.5
254.7
005G03UF
254.32
005G02UF
253.94
005G05LF
254.44
005G01UF
254.47
005G08LF
005G04UF
254.84
GRAVEL LOT
MAT 392
CLOSED UST 1508
FORMER MAT 305
CLOSED USTs
GRAVEL LOT
1455
1662
ACCESS ROAD NO. 2
SWMU 49
SWMU 19
757
341
NAVY EXCHANGE SERVICE STATION
1567
N-207
N-288
NAVY ROAD
PRODUCTION WELL PW-4
LEGEND
005G05LF – LOWER FLUVIAL DEPOSITS WELL/ID
005G01UF – UPPER FLUVIAL DEPOSITS WELL/ID
– GROUNDWATER FLOW DIRECTION
256.0 – GROUNDWATER CONTOUR/ELEVATION
*NOTE:
POTENTIOMETRIC DATA FROM WELL 005G08LF NOT INCLUDED DUE TO ITS LATE INSTALLATION (AUGUST, 1998)
100 0 100
SCALE FEET
RCRA FACILITY INVESTIGATION
NSA MID-SOUTH
MILLINGTON, TENNESSEE
FIGURE 5-3
POTENTIOMETRIC MAP OF FLUVIAL DEPOSITS GROUNDWATER (3/96)
SWMU 5
DWG DATE:10/23/98
DWG NAME:0094B032

The horizontal groundwater velocity was estimated for the fluvial deposits using the hydraulic conductivity and estimated gradients. Velocity for the March 1995 data was estimated at 0.069 ft/day and the estimate for the March 1996 data was 0.061 ft/day. The calculations are shown below.

Groundwater Velocity

March 31, 1995 Data
$\frac{12.17 \text{ ft/day } (1.6 \times 10^{-3})}{0.28} = 0.069 \text{ ft/day}$
March 3, 1996 Data
$\frac{12.17 \text{ ft/day } (1.4 \times 10^{-3})}{0.28} = 0.061 \text{ ft/day}$

Horizontal groundwater velocities were calculated using the following derivation of Darcy's law:

$$V = Ki/n$$

where:
- K = hydraulic conductivity from specific-capacity test
- i = groundwater gradient
- n = effective porosity of aquifer matrix

An effective porosity of 28% for the fluvial deposits sand and gravel (Heath, 1989) is assumed.

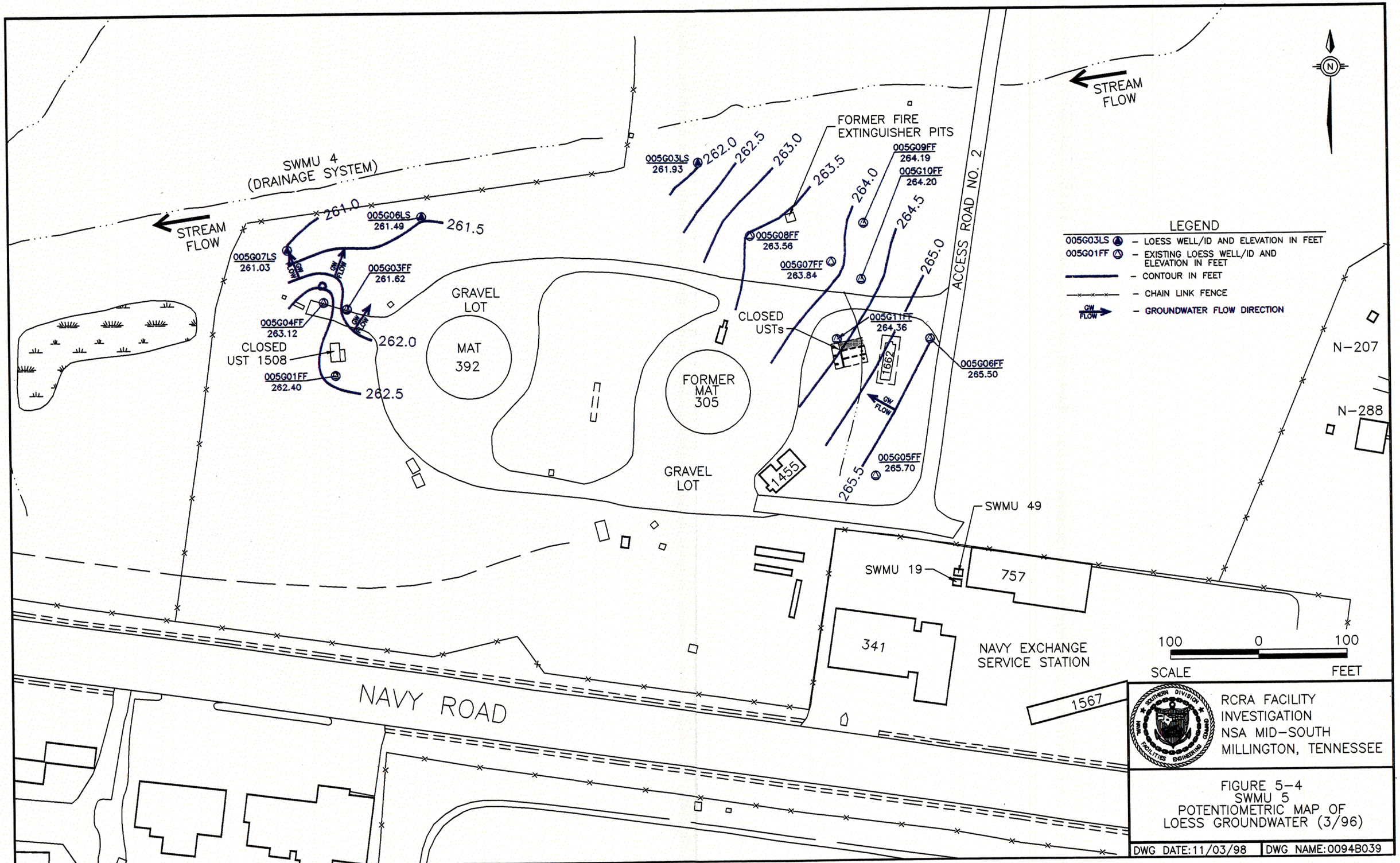
The vertical gradient between the loess and the fluvial deposits was approximated as 0.32. This was calculated by determining the difference in groundwater elevation and dividing by the distance (elevation difference) between the top of the fluvial deposits and the middle of a loess wellscreen at a selected location. The top of the fluvial deposits was used instead of the middle elevation of the fluvial well screen since the groundwater in the fluvial deposits was confined. The positive gradient value indicates downward flow, as shown in the calculations below. Wells 05MW03S

and 05MW03UF were chosen because both were installed during the RFI using rotosonic drilling techniques.

Vertical Hydraulic Gradient Calculations

March 3, 1996 Data
∇ (05MW03S - 05MW03UF) = $\frac{261.93 \text{ ft} - 254.32 \text{ ft}}{24 \text{ ft}}$ = 0.32

Figure 5-4 is a potentiometric map for the loess groundwater zone from data collected on March 3, 1996. Flow is indicated to the northwest at the east side of the site, near the former UST 1489 location, and to the west-northwest on the west end of site, near the former UST 1508 location. The indicated groundwater flow directions are similar to those found in the 1992 UST environmental assessment (E/A&H, 1992).


SWMU 4
(DRAINAGE SYSTEM)
STREAM FLOW
STREAM FLOW
FORMER FIRE EXTINGUISHER PITS
ACCESS ROAD NO. 2
005G03LS
261.93
262.0
262.5
263.0
263.5
264.0
264.5
265.0
005G09FF
264.19
005G10FF
264.20
005G08FF
263.56
005G07FF
263.84
005G06LS
261.49
261.5
261.0
005G07LS
261.03
005G03FF
261.62
005G04FF
263.12
CLOSED UST 1508
005G01FF
262.40
262.0
262.5
GRAVEL LOT
MAT 392
FORMER MAT 305
CLOSED USTs
005G11FF
264.36
1662
005G06FF
265.50
GW FLOW
005G05FF
265.70
265.5
1455
GRAVEL LOT
SWMU 49
SWMU 19
757
341
NAVY EXCHANGE SERVICE STATION
1567
NAVY ROAD
N-207
N-288
LEGEND
005G03LS – LOESS WELL/ID AND ELEVATION IN FEET
005G01FF – EXISTING LOESS WELL/ID AND ELEVATION IN FEET
– CONTOUR IN FEET
– CHAIN LINK FENCE
GW FLOW – GROUNDWATER FLOW DIRECTION
100 0 100
SCALE FEET
RCRA FACILITY INVESTIGATION
NSA MID-SOUTH
MILLINGTON, TENNESSEE
FIGURE 5-4
SWMU 5
POTENTIOMETRIC MAP OF
LOESS GROUNDWATER (3/96)
DWG DATE: 11/03/98
DWG NAME: 0094B039

00617F08Y

6.0 NATURE AND EXTENT OF CONTAMINATION

RBCs and soil screening levels (SSLs) were used as assessment reference values for contaminants detected in soil, while tap water RBCs and MCLs were used as reference values for contaminants detected in groundwater (USEPA Region III Risk-Based Concentration Table [USEPA, 1998a] and *Drinking Water Regulations and Health Advisories* [USEPA, 1996c]). Contaminants detected in surface soil samples were compared to residential and industrial RBC values. This practice is consistent with current human risk models which consider contaminants in the 0 to 1-foot interval (surface soil) to pose the greatest risk to human health. Surface and subsurface soil contaminants were also compared to SSLs provided in the USEPA's *Soil Screening Guidance; Technical Background Document* (USEPA, 1996b). Default SSL values corresponding to a dilution and attenuation factor of 1 have been used as very conservative estimates of the cross-media transfer of contaminants from soil to groundwater. They are conservative because they assume no dilution or attenuation of soil leachate concentrations before reaching groundwater.

The background criteria used for inorganics and dieldrin are discussed briefly in Section 6.1. Section 6.2 summarizes the contaminants detected in soil and whether they exceed their respective RBC and/or SSL values. Section 6.3 similarly discusses groundwater. Contaminants exceeding their screening criteria are summarized in Section 6.4. These contaminants are further evaluated in the human health and ecological risk assessments and fate and transport discussions (Sections 7, 8, and 9).

6.1 Background Criteria

Thirteen background locations were established throughout NSA Mid-South, as shown on Figure 6-1, to assess ambient soil and groundwater quality conditions. Initially five background locations were chosen, then in 1996, eight more locations were selected to gain more data on fluvial deposits groundwater. Reference Concentrations (RCs) for inorganics at NSA Mid-South were established from samples collected at background locations for two soil intervals — surface

and subsurface — and four groundwater intervals — loess, fluvial deposits, alluvial, and Upper Cockfield. The surface soil data consist of samples from all 13 locations, while data for subsurface soil consist of samples from the original five borings. The number of well locations used for the background groundwater data varies by interval: loess groundwater RCs consist of data from four wells; alluvial groundwater RCs consist of data from one well; fluvial deposits groundwater RCs consist of data from nine wells; and Upper Cockfield groundwater RCs consist of data from two wells. Calculations and methods used to establish RCs are outlined in the Technical Memorandum *Reference Concentrations* (E/A&H, 1996).

An RC for dieldrin in surface soil at NSA Mid-South has been established, as outlined in the Technical Memorandum *Surface Soil (0 to 1 foot) Background Dieldrin Concentrations at NSA Memphis* (E/A&H, 1997), which is included as Appendix B. The RC for dieldrin will be used for screening purposes in preparing the site-specific human health risk assessment. Section 7 discusses preparation of the risk assessment.

6.2 Soil Analytical Results

The soil data presented in this section include the following: (1) metals, VOC, SVOC, and pesticide/PCB data from the 1992 UST investigation, (2) FSA data collected during the RFI soil boring/well installation phase, and (3) VOC data from the second DPT investigation in June 1998. Data not presented in this section, but evaluated in the risk assessment, include the 1992 IM investigation (USGS Technical Memorandum, 1992) and benzene, toluene, and xylenes (BTX) soil data collected during the 1992 UST investigation (E/A&H, 1992). Reports from these investigations have been previously submitted; relevant data from each report are in Appendix A.

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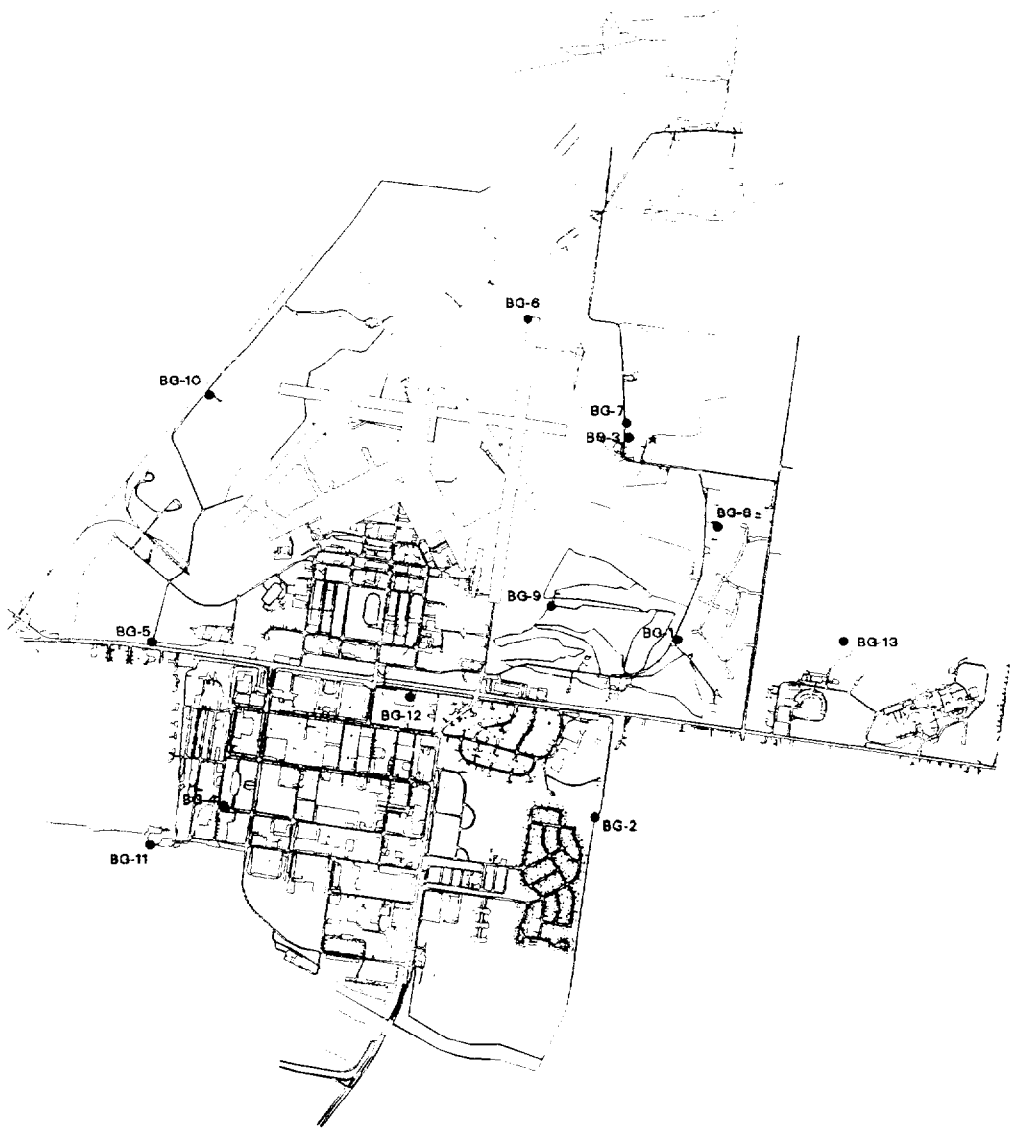

LEGEND

* SOIL BACKGROUND DATA ONLY

BG-2 • BACKGROUND LOCATION 2

0 feet 6000

NOTES:

1. SURFACE SOIL BACKGROUND DATA COLLECTED FROM BACKGROUND LOCATIONS BG-1 THROUGH BG-13.
2. SUBSURFACE SOIL BACKGROUND DATA COLLECTED FROM BACKGROUND LOCATIONS BG-1 THROUGH BG-5.
3. LOESS AND LOWER FLUVIAL DEPOSITS GROUNDWATER DATA COLLECTED FROM BACKGROUND LOCATIONS BG-1, BG-2, BG-4 AND BG-5.
4. UPPER FLUVIAL DEPOSITS GROUNDWATER DATA COLLECTED FROM BACKGROUND LOCATIONS BG-1, BG-2, BG-4, BG-5, BG-8, BG-10, BG-12 AND BG-13.
5. MIDDLE FLUVIAL DEPOSITS GROUNDWATER DATA COLLECTED FROM BACKGROUND LOCATION BG-9.
6. MIDDLE ALLUVIUM GROUNDWATER DATA COLLECTED FROM BACKGROUND LOCATION BG-11.
7. UPPER COCKFIELD GROUNDWATER DATA COLLECTED FROM BACKGROUND LOCATIONS BG-8 AND BG-7.

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MILLINGTON, TENNESSEE

FIGURE 6-1
SOIL & GROUNDWATER
BACKGROUND LOCATIONS

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000086

Table 6-1 lists the number of surface and subsurface soil samples collected during the RFI and UST investigation and the analyses performed. This soil data are presented in summary detection tables for each contaminant group; these tables were generated from the analytical data in Appendix A (1992 UST data) and Appendix F (RFI). Where warranted, figures have been prepared for the contaminant groups illustrating exceedances of RBCs in surface soil and SSLs for contaminant transfer from soil to groundwater. Soil samples collected during the 1992 UST investigation that were analyzed for RFI parameters are presented in this section, while petroleum related parameters (i.e., BTEX or TPH-GRO) from the 1992 UST investigation are included in Appendix A and are not presented in this section.

Table 6-1
Soil Sample Analyses from RFI and 1992 UST Investigation Presented in Report
Surface/Subsurface

Investigation	VOCs	SVOCs	TPH	Metals	Cyanide	Pest. & PCBs	Op. Pest.	Dioxin
1992 UST	1/9	1/7	0/0	2/6	0/0	0/2	0/0	0/0
RFI	6/13	6/12	6/12	6/12	6/12	6/12	6/12	5/0
Total Samples	**7/22**	**7/19**	**6/12**	**8/18**	**6/12**	**6/14**	**6/12**	**5/0**

As discussed in Section 3, three soil removals[1] have taken place since implementation of the SWMU 5 RFI which resulted in removal of several sample locations, specifically soil from UST borings B-08, B-12, B-15, and FFMW08. Even though data from these areas are presented below, removal of soil and contaminants in those areas warrants the exclusion of these samples from the human health risk assessment (Section 7).

[1]Includes removal of the oil-water separator (EnSafe, January 28, 1998), USTs 1490 and 1491 (EnSafe, July 28, 1998), and the VCA associated with the concrete-lined fire-extinguisher pits and Mat 305 (EnSafe, May 26, 1998).

Volatile Organic Compounds

VOCs detected in surface soil were limited to a sample collected near the former concrete-lined fire extinguisher pits during the 1992 UST investigation. Surface soil from boring B-15 contained benzene and methylene chloride at concentrations exceeding the residential RBCs and SSLs. Measured VOC concentrations in surface soil and screening values are listed in Table 6-2. Soil was removed from this area in November 1997 during the VCA.

VOCs detected in subsurface soil are listed in Table 6-3 and include primarily petroleum constituents (BTEX) that were identified during the 1992 UST investigation. BTEX concentrations above the SSLs were identified in five UST samples that were placed near the former USTs and fire Mat 305. As designated in the table, two of these sample locations have been removed. Methylene chloride was also detected in seven samples at concentrations ranging between 1.1 μg/kg and 690 μg/kg, above its 1 μg/kg SSL. The RFI identified VOCs in subsurface soil above the SSL in the sample collected at the southeast corner of the site using DPT methods (location 005SGB01 at a depth of 9 to 10 feet). There concentrations of methylene chloride, TCE, PCE, and 1,2-dichloropropane were detected above the SSLs.

Table 6-2
VOCs in Surface Soil — 1992 UST Investigation Hits Only (μg/kg)

Compound	B-15-2 *	RBC Res.	RBC Ind.	SSLs
Acetone	270 J	7,800,000	200,000,000	800
Benzene	***110***	22	200	2
Methylene Chloride	***120 J***	85	760	1

Notes:
The bottom of the sample interval is denoted by the last two digits of the sample identification.

RBC	—	Residential and industrial risk-based concentrations (USEPA, 1998a).
SSL	—	Soil screening levels protective of groundwater from the *Soil Screening Guidance; Technical Background Document* (USEPA, 1996b).
J	—	Reported concentration is an estimated value.
—	—	Analyte was below the method detection limit.
Bold	—	Exceedance of residential RBC.
Italics	—	Exceedance of SSL.
*	—	Soil at sample location removed during either VCA or tank closure.

Table 6-3
VOCs in Subsurface Soil — SWMU 5
Detections Only (μg/kg)

	RFI Soil Boring/Sample I.D.						UST Samples						
Compound	05SB04/ 005S0004-05	05SB04/ 005S0004-10	DPT 005SGB01-10	B-08-04*	B-08-10*	B-09-04	FFMW-02-06	FFMW-05-08	FFMW-06-06	FFMW-08-04*	FFMW-08-14*	FFMW-11-4	SSLs
Acetone	110 J	10 J	95	—	180	1,500	—	120	17	—	53	—	800
2-Butanone (MEK)	20 J	—	14 J	—	—	—	—	—	—	—	—	—	NA
Ethylbenzene	5 J	—	3.9 J	—	2,600	—	19,000	—	62	4,600	—	20,000	700
Benzene	—	—	1.7 J	—	140	—	4,800 DJ	—	3 J	2,500	—	6,500	2
Toluene	—	—	2.0 J	—	—	—	3,300	—	—	—	—	—	600
Xylenes	—	—	18	1,700	5,000	1,500	97,000	—	5,100 D	21,000	—	75,000	9,000
Methylene Chloride	—	—	1.1 J	—	18	400 J	—	6 J	8 J	—	12 J	690 J	1
Trichloroethylene	—	—	3.4 J	—	—	—	—	—	—	—	—	—	3
Tetrachloroethene	—	—	25	—	—	—	—	—	—	—	—	—	3
1,2-Dichloropropane	—	—	9.5	—	—	—	—	—	—	—	—	—	1
1,1,1-Trichloroethane	—	—	5 J	—	—	—	—	—	—	—	—	—	100
2-Hexanone	—	—	5.6 J	—	—	—	—	—	—	—	—	—	NA

Notes:
The depth of the sample interval varied; however, the bottom of the interval is noted by the last two digits of the sample identification.

SSL — Soil screening levels protective of groundwater from the *Soil Screening Guidance; Technical Background Document* (USEPA, 1996b).
J — Reported concentration is an estimated value.
— — Analyte was below the method detection limit.
Bold — Exceedance of SSL.
* — Soil at sample location removed during either VCA or tank closure.

1000089

Semivolatile Organic Compounds

SVOCs detected in surface and subsurface soil are listed in Tables 6-4 and 6-5. Sample locations and total SVOCs detected in surface soil are shown on Figure 6-2. All surface soil contaminant concentrations were less than their RBCs, except for benzo(a)pyrene, which exceeded its residential RBC of 87 μg/kg in one surface soil sample at RFI boring 05SB07. This sample contained a concentration of 150 μg/kg. Benzo(a)anthracene was also detected above its SSL in this sample. Naphthalene and 2-methylnaphthalene also exceeded their SSLs in two subsurface samples collected during the UST investigation near former USTs 1489, 1490, and 1491 and the former concrete-lined fire extinguisher pits (borings FFMW-11 and B-15 on Figure 3-3).

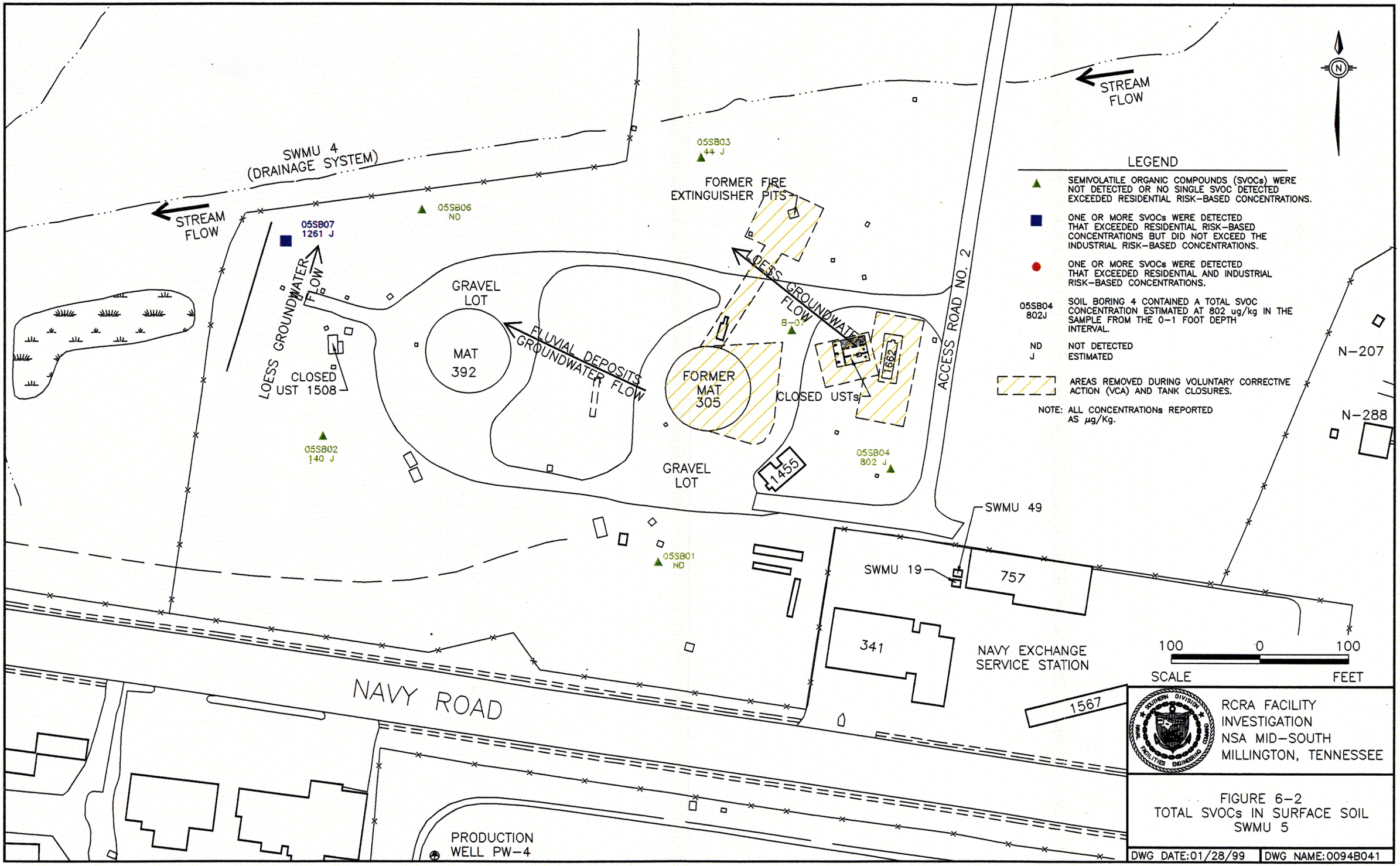
Pesticides/PCBs

Chlorinated pesticides were absent in the two subsurface soil samples collected during the UST investigation; however, they were detected in all surface soil and three subsurface soil samples collected from the six RFI borings. All chlorinated pesticide surface soil concentrations were less than their respective RBCs, except for dieldrin, which was detected at concentrations exceeding its residential RBC (40 μg/kg) at three boring locations. However, dieldrin concentrations were below the 262 μg/kg RC established for surface soil at NSA Mid-South (see Appendix B), except for surface soil from soil boring 05SB04 which contained 290 μg/kg.

Also, dieldrin concentrations in all surface and subsurface soil samples exceeded its SSL of 0.2 μg/kg. Dieldrin was not detected in SWMU 5 groundwater (Section 6.3), indicating it is not leaching from soil. Pesticides detected in surface and subsurface soil are presented in Tables 6-6 and 6-7; total pesticides in surface soil are shown on Figure 6-3. No organophosphorus pesticides were detected in any soil samples collected during the RFI.

PCB Aroclor-1260 was detected in three surface soil samples, but all concentrations were below its 320 μg/kg residential RBC. No SSLs are available for Aroclor-1260.

000030


SWMU 4
(DRAINAGE SYSTEM)
STREAM FLOW
05SB07
1261 J
05SB06
ND
05SB03
44 J
FORMER FIRE EXTINGUISHER PITS
LOESS GROUNDWATER FLOW
GRAVEL LOT
MAT 392
FLUVIAL DEPOSITS GROUNDWATER FLOW
CLOSED UST 1508
FORMER MAT 305
CLOSED USTs
B-07
1662
ACCESS ROAD NO. 2
05SB02
140 J
GRAVEL LOT
1455
05SB04
802 J
SWMU 49
05SB01
ND
SWMU 19
757
341
NAVY EXCHANGE SERVICE STATION
1567
NAVY ROAD
PRODUCTION WELL PW-4
N-207
N-288
STREAM FLOW
N
LEGEND
SEMIVOLATILE ORGANIC COMPOUNDS (SVOCs) WERE NOT DETECTED OR NO SINGLE SVOC DETECTED EXCEEDED RESIDENTIAL RISK-BASED CONCENTRATIONS.
ONE OR MORE SVOCs WERE DETECTED THAT EXCEEDED RESIDENTIAL RISK-BASED CONCENTRATIONS BUT DID NOT EXCEED THE INDUSTRIAL RISK-BASED CONCENTRATIONS.
ONE OR MORE SVOCs WERE DETECTED THAT EXCEEDED RESIDENTIAL AND INDUSTRIAL RISK-BASED CONCENTRATIONS.
05SB04 802J
SOIL BORING 4 CONTAINED A TOTAL SVOC CONCENTRATION ESTIMATED AT 802 ug/kg IN THE SAMPLE FROM THE 0-1 FOOT DEPTH INTERVAL.
ND NOT DETECTED
J ESTIMATED
AREAS REMOVED DURING VOLUNTARY CORRECTIVE ACTION (VCA) AND TANK CLOSURES.
NOTE: ALL CONCENTRATIONs REPORTED AS µg/Kg.
100 0 100
SCALE FEET
RCRA FACILITY INVESTIGATION
NSA MID-SOUTH
MILLINGTON, TENNESSEE
FIGURE 6-2
TOTAL SVOCs IN SURFACE SOIL
SWMU 5
DWG DATE:01/28/99
DWG NAME:0094B041

00617FB3Y

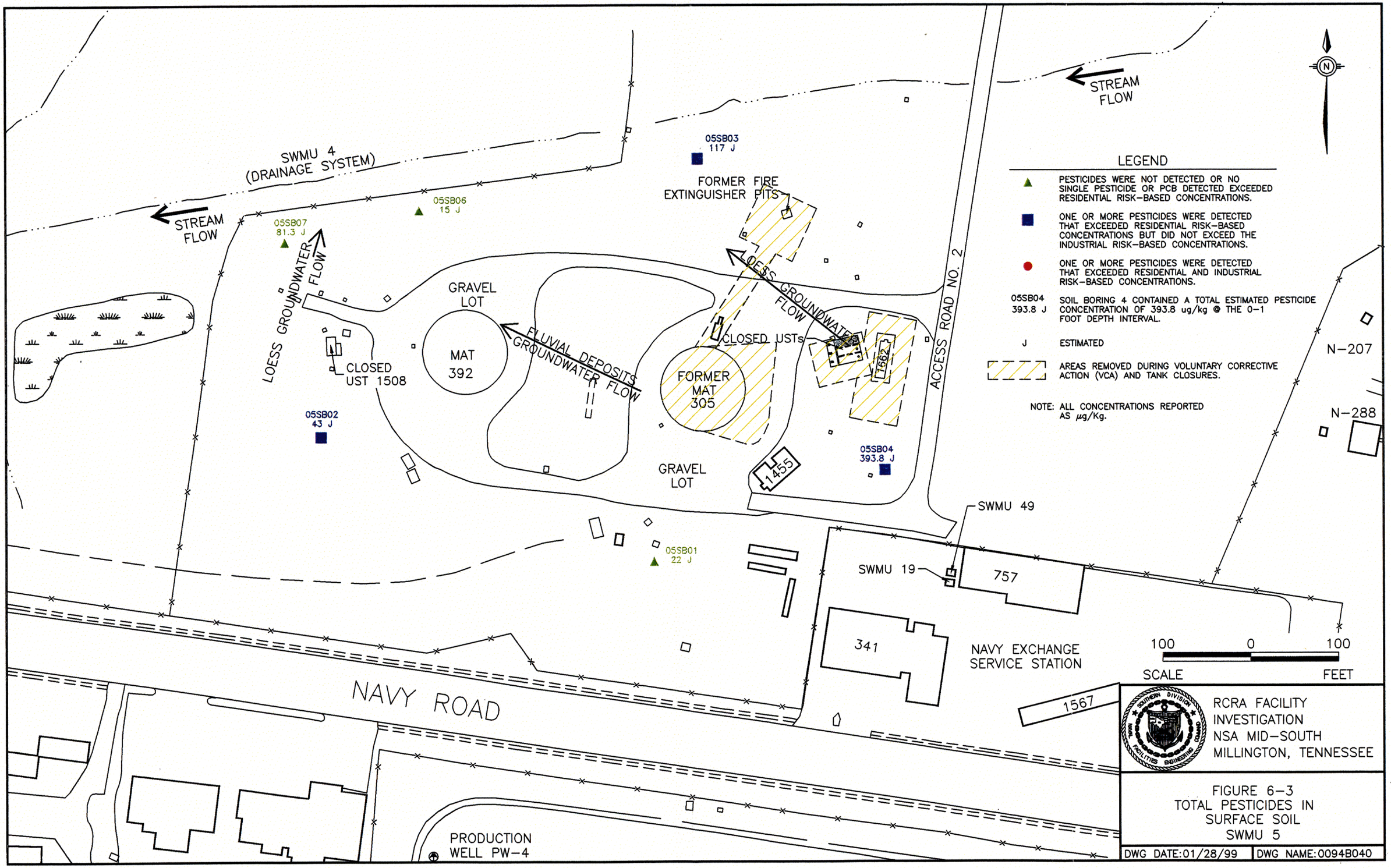

SWMU 4
(DRAINAGE SYSTEM)
STREAM FLOW
05SB07
81.3 J
05SB06
15 J
05SB03
117 J
FORMER FIRE
EXTINGUISHER PITS
LOESS GROUNDWATER FLOW
GRAVEL
LOT
MAT
392
FLUVIAL DEPOSITS
GROUNDWATER FLOW
CLOSED
UST 1508
05SB02
43 J
CLOSED USTs
FORMER
MAT
305
1662
1455
05SB04
393.8 J
GRAVEL
LOT
ACCESS ROAD NO. 2
SWMU 49
05SB01
22 J
SWMU 19
757
341
NAVY EXCHANGE
SERVICE STATION
1567
NAVY ROAD
PRODUCTION
WELL PW-4
N-207
N-288
LEGEND
PESTICIDES WERE NOT DETECTED OR NO SINGLE PESTICIDE OR PCB DETECTED EXCEEDED RESIDENTIAL RISK-BASED CONCENTRATIONS.
ONE OR MORE PESTICIDES WERE DETECTED THAT EXCEEDED RESIDENTIAL RISK-BASED CONCENTRATIONS BUT DID NOT EXCEED THE INDUSTRIAL RISK-BASED CONCENTRATIONS.
ONE OR MORE PESTICIDES WERE DETECTED THAT EXCEEDED RESIDENTIAL AND INDUSTRIAL RISK-BASED CONCENTRATIONS.
05SB04 393.8 J
SOIL BORING 4 CONTAINED A TOTAL ESTIMATED PESTICIDE CONCENTRATION OF 393.8 ug/kg @ THE 0-1 FOOT DEPTH INTERVAL.
J
ESTIMATED
AREAS REMOVED DURING VOLUNTARY CORRECTIVE ACTION (VCA) AND TANK CLOSURES.
NOTE: ALL CONCENTRATIONS REPORTED AS µg/Kg.
100 0 100
SCALE FEET
RCRA FACILITY
INVESTIGATION
NSA MID-SOUTH
MILLINGTON, TENNESSEE
FIGURE 6-3
TOTAL PESTICIDES IN
SURFACE SOIL
SWMU 5
DWG DATE:01/28/99
DWG NAME:0094B040

Table 6-4
Semivolatile Organic Compounds in Surface Soil — SWMU 5
Detections Only (μg/kg)

	RFI Soil Boring/Sample I.D.				UST Sample			
Compound	05SB02/05S0002-01	05SB03/05S0003-01	05SB04/05S0004-01	05SB07/05S0007-01	B-07-2	RBC Ind.	RBC Res.	SSL
Bis(2-ethylhexyl)phthalate	**140 J**	—	—	**67 J**	—	410,000	46,000	11,000
Fluoranthene	—	44 J	150 J	180 J	—	82,000,000	3,100,000	210,000
Pyrene	—	—	120 J	170 J	—	61,000,000	2,300,000	210,000
Phenanthrene	—	—	53 J	—	—	61,000,000[a]	2,300,000[a]	210,000[a]
Benzo(a)anthracene	—	—	60 J	*140 J*	—	7,800	870	80
Chrysene	—	—	77 J	140 J	—	780,000	87,000	8,000
Benzo(b)fluoranthene	—	—	76 J	140 J	—	7,800	870	200
Benzo(k)fluoranthene	—	—	78 J	130 J	—	78,000	8,700	2,000
Benzo(a)pyrene	—	—	81 J	**150 J**	—	780	87	400
Indeno(1,2,3-cd)pyrene	—	—	50 J	67 J	—	7,800	870	700
Benzo(g,h,i)perylene	—	—	57 J	77 J	—	61,000,000[a]	2,300,000[a]	210,000[a]
Dibenzo(a,h)anthracene	—	—	—	—	—	780	87	270,000
Naphthalene	—	—	—	—	3,200 J	82,000,000	1,600,000	4,000
2-Methylnaphthalene	—	—	—	—	2,000 J	82,000,000	1,600,000	4,000[b]

Notes:
RBC — Residential and industrial risk-based concentrations (USEPA, 1998a).
SSL — Soil screening levels protective of groundwater from the *Soil Screening Guidance; Technical Background Document* (USEPA, 1996b).
J — Reported concentration is an estimated value.
— — Analyte was below the method detection limit.
a — Phenanthrene and benzo(g,h,i)perylene do not have established RBC or SSL values. Based on structural and/or toxicological similarities, pyrene values were used for comparison.
b — 2-Methylnaphthalene does not have an established SSL. Based on structural and/or toxicological similarities, naphthalene value used for comparison.
Bold — Exceedance of residential RBC.
Italics — Exceedance of SSL.

000093

Table 6-5
Semivolatile Organic Compounds in Subsurface Soil — SWMU 5
Detections Only (µg/kg)

	RFI Soil Boring/Sample I.D.						UST Samples							
Compound	05SB03/ 05S0003-17	05SB04/ 05S0004-05	05SB06/ 05S0006-07	05SB06/ 05S0006-12	05SB07/ 05S0007-10	05SB07/ 05S0007-12	FFMW-02-06	FFMW-06-04	FFMW 05-06 (6-10')	FFMW-11-3 (3-7')	B-15-2 (2-6')*	B-08-04*	B-09-04	SSL
Bis(2-ethylhexyl)phthalate	51 J	—	57 J	64 J	64 J	96 J	—	180 J	370 J	420 J	—	820 J	320 J	180,000
Naphthalene	—	130 J	—	—	—	—	3,000 J	280 J	—	**4,100**	**6,300 J**	320 J	530 J	4,000
2-Methylnaphthalene	—	150 J	—	—	—	—	3,900 J	100 J	—	**18,000**	**24,000**	2,500	3,000	4,000[a]
Acenaphthene	—	—	—	—	—	—	8,200 E	—	—	440 J	—	41 J	—	29,000
Phenanthrene	—	—	—	—	—	—	1,800	—	—	—	—	—	—	210,000[b]
Fluoranthene	—	—	—	—	—	—	1,400 J	—	—	—	—	—	—	210,000
Pyrene	—	—	—	—	—	—	1,100 J	—	—	—	—	—	—	210,000

Notes:
The depth of the sample interval varied; however, the bottom of the interval is denoted by the last two digits of the sample identification. For the UST investigation samples, the top of the interval is denoted by the last digit of the sample identification.

SSL — Soil screening levels protective of groundwater from the *Soil Screening Guidance; Technical Background Document* (USEPA, 1996b).
— — Dash indicates analyte was below the method detection limit.
J — Reported concentration is an estimated value.
E — Compound exceeded calibration range.
a — 2-Methylnaphthalene does not have an established SSL value. Based on structural and/or toxicological similarities, naphthalene's value was used for comparison.
b — Phenanthrene does not have an established SSL value. Based on structural and/or toxicological similarities, pyrene's value was used for comparison.
Bold — Exceedance of SSL.
* — Soil at sample location removed during either VCA or tank closure.

Table 6-6
Pesticides/PCBs in Surface Soil — SWMU 5
Detections Only (μg/kg)

Compound	Soil Boring Identification/Sample Identification						RBC Ind.	RBC Res.	SSL
	05SB01/005S0001-01	05SB02/005S0002-01	05SB03/005S0003-01	05SB04/005S0004-01	05SB06/005S0006-01	05SB07/005S0007-01			
Dieldrin	*22 J*	*43 J*	*60 JD*	*290 J*	*15 J*	*29*	360	40	0.2
Heptachlor epoxide	—	—	—	2.8 J	—	—	630	70	30
4,4'-DDT	—	—	—	11 J	—	5.3 J	17,000	1,900	2,000
Endrin	—	—	—	—	—	—	610,000	23,000	50
Aroclor-1260	—	—	57 J	90 J	—	47 J	2900	320	NA

Table 6-7
Pesticides/PCBs in Subsurface Soil — SWMU 5
Detections Only (μg/kg)

Compound	Soil Boring Identification/Sample Identification			SSL
	05SB03/005S0003-07	05SB04/005S0004-05	05SB06/005S0006-07	
Dieldrin	*45 J*	*8.3 J*	*103 D*	0.2
Heptachlor epoxide	—	—	12 J	30

Notes (Tables 6-6 and 6-7):
The depth of the sample interval varied; however, the bottom of the interval is denoted by the last two digits of the sample identification.

RBC — Residential and industrial risk-based concentrations (USEPA, 1998a).
SSL — Soil screening levels protective of groundwater from the *Soil Screening Guidance; Technical Background Document* (USEPA, 1996b).
J — Reported concentration is an estimated value.
D — Dilution required.
— — Dash indicates analyte was below the method detection limit.
NA — Not available.
Bold — Exceedance of residential RBC.
Italic — Exceedance of SSL.

000095

Herbicides

Two chlorinated herbicide compounds were detected in soil. MCPA was detected at 19,000 μg/kg in surface soil at boring 05SB01 and in the subsurface at 4,500 μg/kg at the 8-foot depth of boring 05SB02. The concentration of MCPA in surface soil was less than the 39,000 μg/kg residential RBC. The herbicide 2,4,5-T was detected at 4.4 μg/kg at the 8-foot depth of boring 05SB02. No SSLs are available for MCPA or 2,4,5-T.

Total Petroleum Hydrocarbons

The only TPH detection during the RFI was 280 mg/kg at the 5-foot depth of boring 05SB04, which is below the 1,000 mg/kg TDEC cleanup level for TPH in soil. No RBCs or SSLs have been established for TPH.

Metals and Cyanide

Table 6-8 lists the metals detected in surface soil and Tables 6-9 and 6-10 list those detected in subsurface soil during the RFI and UST investigation. No metals in surface soil exceeded their RCs and RBCs. The following metals exceeded their RCs and SSLs in the number of surface and subsurface soil samples indicated:

Metal	Surface	Subsurface
Barium	1	3
Cadmium	6	4
Chromium	0	1
Nickel	0	18
Selenium	3	0

Nickel was not detected in the background samples used to establish the subsurface soil RCs. Cobalt and lead exceeded their RCs in one subsurface soil sample each and lead exceeded its RC in one surface soil sample; SSLs are not available for either metal. Tin was detected in two surface and six subsurface soil samples. Tin was not detected in the background samples nor does tin have an SSL. Cyanide was not detected in SWMU 5 soil samples collected during the RFI.

Table 6-8
Metals in Surface Soil — SWMU 5
Detections Only (mg/kg)
Soil Boring Identification/Sample Identification

	RFI Soil Boring/Sample I.D.						UST Investigation					
Compound	05SB01/ 05S0001-01	05SB02/ 05S0002-01	05SB03/ 05S0003-01	05SB04/ 05S0004-01	05SB06/ 05S0006-01	05SB07/ 05S0007-01	B-07-2	B-15-2*	RC	RBC Res.	RBC Ind.	SSL
Arsenic	7.2	6.7 J	6.6 J	11.0 J	8.3 J	7.7	12.0	1.5	14.6	0.43	3.8	1
Barium	93.5 J	55.5 J	164.0 J	*261.0 J*	192.0 J	181.0	151	183	223.5	5,500	140,000	82
Beryllium	0.56 J	0.43 J	0.86 J	0.81 J	0.72 J	0.64 J	0.72	0.80	1	160	4,100	3
Cadmium	*3.2*	*2.4 J*	*3.0*	*3.4*	*3.2*	*3.0*	—	—	1.5	39	1,000	0.4
Chromium	13.0	12.8	11.1	15.2	20.0	19.2	17.3	12.1	23.9	230	10,000	2
Cobalt	13.3	5.5 J	6.5 J	7.6 J	8.1 J	7.5 J	10.6	—	16.0	4,700	120,000	NA
Copper	14.1	13.3	14.3	16.1	17.4	17.9	17.4	7.2	24.2	3,100	82,000	NA
Lead[b]	11.4 J	12.0 J	16.7 J	22.8 J	16.9 J	*30.7*	14.1	10.4	26.0	400[a]	1,300[a]	NA
Mercury	0.13	—	—	0.14	—	—	0.03	0.04	0.46	NA	NA	NA
Nickel	11.3	11.5	14.4	16.1	14.5	17.3	14.4	11.9	20.6	1,600	41,000	7
Selenium	*0.51 J*	—	—	—	*0.5 J*	—	—	*0.31 B*	ND	390	10,000	0.3
Silver	1.2 J	—	—	—	1.1 J	—	—	—	2.05	390	10,000	2
Thallium	—	—	—	—	—	—	0.28	—	ND	5.5	140	40
Tin	—	—	—	—	—	—	36.4	16.1	ND	47,000	1,200,000	NA
Vanadium	36.0	28.7	23.3	27.3	24.8	26.9	63.5	49.6	45.1	550	14,000	300
Zinc	46.2	44.3	56.9	75.6	63.5	73.1	7.7 B	5.5 B	98	23,000	610,000	620

Notes:

RC — Reference concentrations for surface soil (E/A&H, 1996).
RBC — Residential and industrial risk-based concentrations (USEPA, 1998a).
SSL — Soil screening levels protective of groundwater from the *Soil Screening Guidance; Technical Background Document* (USEPA, 1996b). Lead and tin values exceeded RC only; SSLs do not exist for either metal.
J — Reported concentration is an estimated value.
— — Analyte was below the method detection limit.
NA — Not applicable; SSL value does not exist.
a — USEPA guidance cites 400 mg/kg and 1,300 mg/kg as the residential and industrial soil cleanup concentration for lead (USEPA, 1994b).
Bold — Exceedance of RC and residential RBC.
Italics — Exceedance of residential RC and SSL.
* — Soil at sample location removed during either VCA or tank closure.

260097

Table 6-9
Metals in Subsurface Soil — SWMU 5 RFI
Detections Only (mg/kg)
Soil Boring Identification/Sample Identification

Compound	05SB01/ 005S00 0108	05SB01/ 005S00 0112	05SB02/ 005S00 0208	05SB02/ 005S00 0210	05SB03/ 005S00 0307	05SB03/ 005S00 0317	05SB04/ 005S00 0405	05SB04/ 005S00 0410	05SB06/ 005S00 0607	05SB06/ 005S00 0612	05SB07/ 005S00 0710	05SB07/ 005S00 0712	RC	SSL
Arsenic	10.3	7.8 J	12.2 J	10.1 J	8.1 J	9.5 J	2.7 J	6.5 J	7.5	3.5	11.9	2.6 J	20.3	1
Barium	162 J	123 J	171.0 J	116.0 J	177.0 J	104.0 J	219.0 J	**286.0 J**	228.0	104.0	375.0	106.0	265.1	82
Beryllium	0.51 J	0.4 J	0.55 J	0.44 J	0.9 J	0.53 J	0.77 J	0.56 J	0.88 J	0.47 J	1.1 J	0.45 J	1.00	3
Cadmium	3.1	2.4	**3.7**	2.8	2.3	2.7	3.0	**3.6**	**4.0**	2.8	**8.1 J**	2.3	3.2	0.4
Chromium	12.4	9.2	12.5	10.2	11.1	16.7	17.2	15.1	20.6	17.4	32.8	15.3	28.3	2
Cobalt	7.3 J	6.7 J	9.4 J	7.4 J	6.2 J	7.8 J	6.1 J	13.6	6.9 J	6.9 J	**15.8**	6.8 J	14.4	NA
Copper	16.5	13.8	18.9	16.3	16.2	16.1	18.7	17.6	21.5	13.2	29.6	12.4	32.5	NA
Lead	10.8 J	6.6 J	11.9 J	11.7 J	18.2 J	10.7 J	8. J	8.4 J	11.9	10.4	**26.4**	8.4	19.8	NA
Nickel	**19.0**	**16.1**	**25.0**	**14.8**	**11.4**	**18.4**	**15.1**	**18.9**	**23.8**	**14.6**	**36.0**	**15.7**	ND	7
Vanadium	25.9	16.0	26.2	19.2	20.1	26.1	24.6	25.9	29.6	29.9	46.5	30.1	43.7	300
Zinc	54.6	46.6	64.3	54.0	64.3	60.6	76.9	63.9	84.6	54.0	121.0	45.4	109	620

Notes:
The depth of the sample interval varied; however, the bottom of the interval is denoted by the last two digits of the sample identification.
RC — Reference concentrations for subsurface soil (E/A&H, 1996).
SSL — Soil screening levels protective of groundwater from the *Soil Screening Guidance; Technical Background Document* (USEPA, 1996b). Lead values exceeded RC only; an SSL does not exist for lead.
J — Reported value is an estimated concentration.
NA — Not applicable; SSL value does not exist.
ND — Not detected.
Bold — Exceedance of RC and SSL.

Table 6-10
Metals in Subsurface Soil (1992 UST Investigation) — SWMU 5 (mg/kg)
Detections Only

Compound	FFMW-02-6	FFMW-05-06 (6-10')	FFMW-06-4	FFMW-11-3 (3-7')	B-08-4	B-09-4	RC	SSL
Arsenic	10.5	12.9	2.5	11.3	12.9	7.2	20.3	1
Barium	53	173	**272**	201	173	151	265.1	82
Beryllium	0.73	1.2	0.77	0.75	1.2	0.77	1.00	3
Cadmium	—	0.96	0.96	—	0.96	—	3.2	0.4
Chromium	14.6	16.3	15.3	16.4	16.3	13.4	28.3	2
Cobalt	7.0	14.0	10.7	8.2	14.0	9.2	14.4	NA
Copper	15.1	21.1	10.2	17.9	21.1	10.8	32.5	NA
Lead	9.1	12.5	10.2	10.4	12.5	14.2	19.8	NA
Mercury	0.03	0.03	0.04	0.04	0.03	0.03	0.18	NA
Nickel	**17.4**	**19.5**	**14.4**	**21.4**	**19.5**	**13.0**	ND	7
Selenium	—	—	—	—	—	—	ND	0.3
Thallium	0.27 B	0.26 B	—	0.29 B	0.26 B	—	ND	0.4
Tin	**27.5**	**34.7**	**25.9**	**33.0**	**34.7**	**36.5**	ND	NA
Vanadium	55.2	72.0	58.2	67.5	72.0	41.9	43.7	300
Zinc	3.9 B	6.0 B	6.9 B	—	6.0 B	8.0 B	109	620

Notes:
Sample depths are 2-foot intervals. The top is noted by the last number of the sample identification.
RC — Reference concentrations for subsurface soil (E/A&H, 1996).
SSL — Soil screening levels protective of groundwater from the *Soil Screening Guidance; Technical Background Document* (USEPA, 1996b). Lead and tin values exceeded RC only; SSLs do not exist for either metal.
— — Dash indicates analyte was below the method detection limit.
B — Above instrument detection limit, but below practical quantitation limit.
NA — Not available.
Bold — Exceedance of RC and SSL.

000099

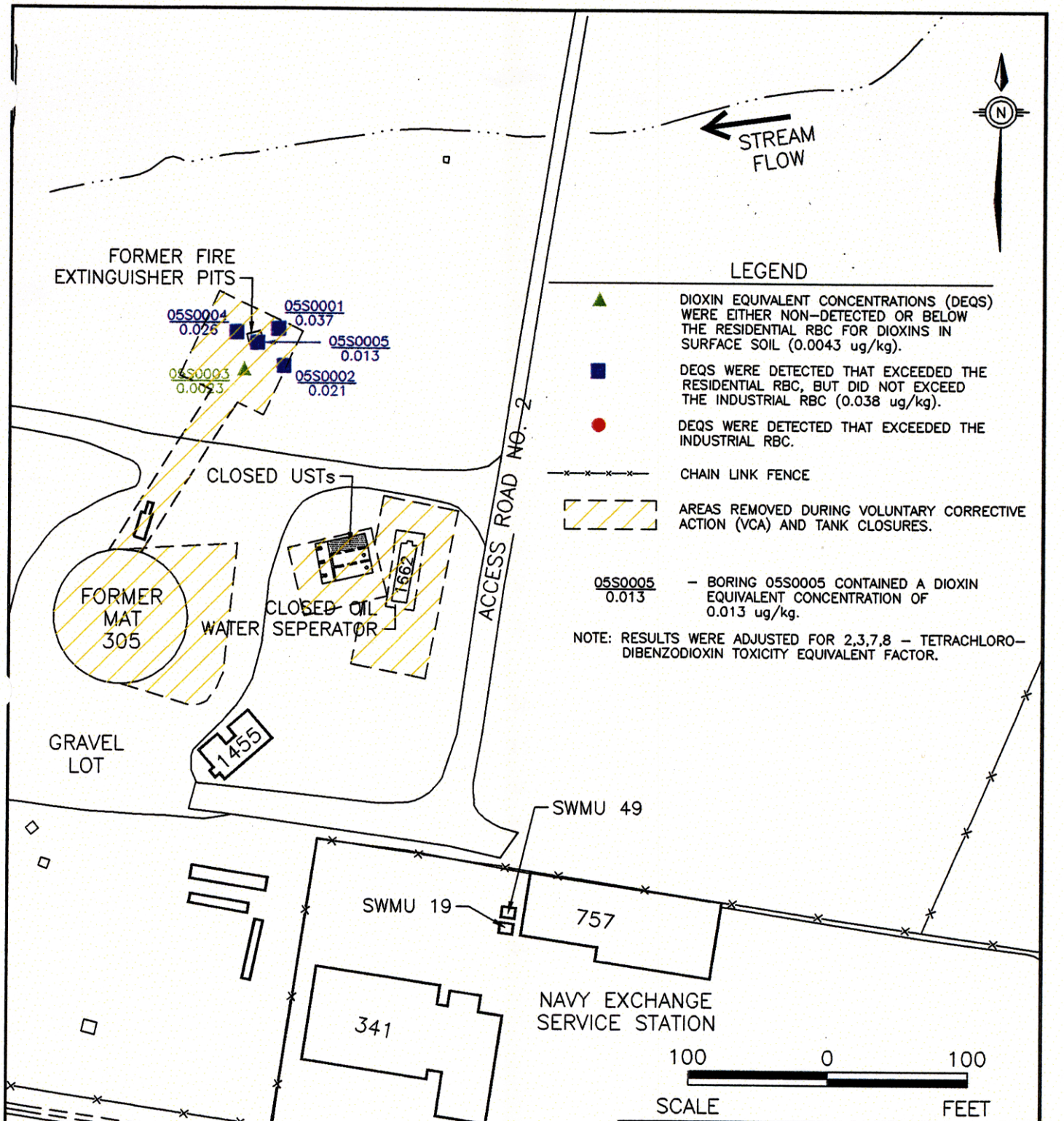
Dioxin

Five surface soil samples were collected on September 27, 1995, from the former concrete-lined pits north of Mat 305 and submitted to the laboratory for dioxin analysis. The results were adjusted for the 2,3,7,8-tetrachlorodibenzodioxin (2,3,7,8-TCDD) toxicity equivalency factor (TEF) as described in the *Supplemental Guidance to RAGS:* USEPA Region IV, Bulletin 1 (USEPA, 1994c). The USEPA considers TCDD TEF in surface soil above 1 μg/kg to be the concentration at which human exposure should be limited (USEPA, 1995a). The TCDD TEF-adjusted dioxin concentrations at SWMU 5 were all less than 1 μg/kg. Four of the five TCDD TEF concentrations exceeded the residential RBC (0.0043 μg/kg), while no samples exceeded the industrial RBC (0.038 μg/kg). SSLs are not available for 2,3,7,8-TCDD. The dioxin analytical results and dioxin equivalent concentrations are summarized in Table 6-11. Sample locations and dioxin equivalent concentrations in surface soil are shown on Figure 6-4.

Summary of Soil-to-Groundwater Cross-Media Transfer

Table 6-12 lists the contaminants exceeding their SSLs and the frequency of exceedances. The following metals were identified in surface and subsurface soil at concentrations exceeding their SSLs and the background RCs: barium, cadmium, chromium, nickel and selenium. Organics exceeding their SSLs include methylene chloride, TCE, PCE, 1,2-dichloropropane, naphthalene, 2-methylnaphthalene, benzo(a)anthracene, and dieldrin. Sample locations where metals exceeded their SSL and RC or where organics exceeded their SSL are shown on Figure 6-5.

000190



00617FB4Y 000101

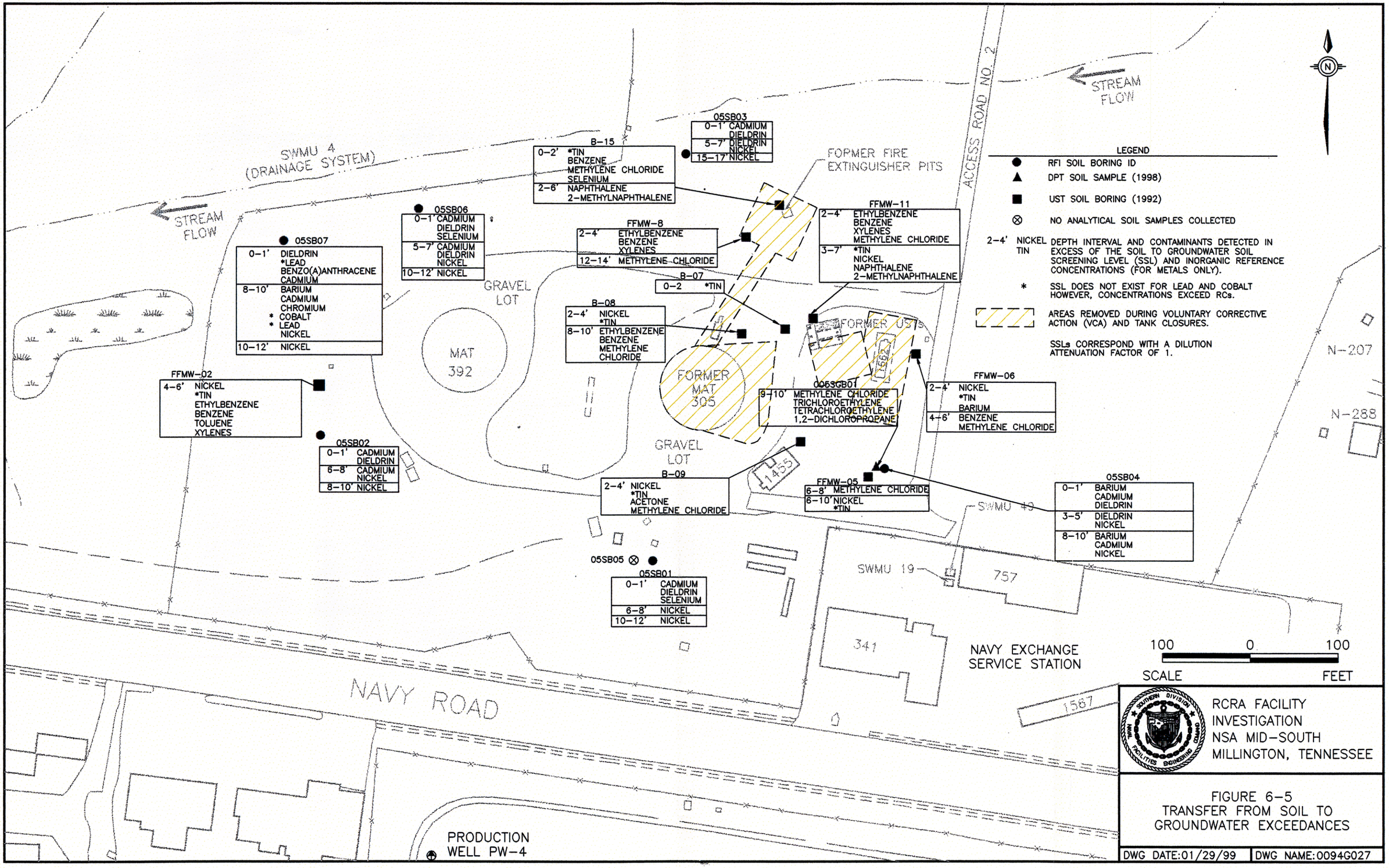

SWMU 4
(DRAINAGE SYSTEM)
STREAM FLOW
STREAM FLOW
ACCESS ROAD NO. 2
FORMER FIRE EXTINGUISHER PITS
B-15
0-2' *TIN
BENZENE
METHYLENE CHLORIDE
SELENIUM
2-6' NAPHTHALENE
2-METHYLNAPHTHALENE
05SB03
0-1' CADMIUM
DIELDRIN
5-7' DIELDRIN
NICKEL
15-17' NICKEL
05SB06
0-1' CADMIUM
DIELDRIN
SELENIUM
5-7' CADMIUM
DIELDRIN
NICKEL
10-12' NICKEL
05SB07
0-1' DIELDRIN
*LEAD
BENZO(A)ANTHRACENE
CADMIUM
8-10' BARIUM
CADMIUM
CHROMIUM
* COBALT
* LEAD
NICKEL
10-12' NICKEL
FFMW-8
2-4' ETHYLBENZENE
BENZENE
XYLENES
12-14' METHYLENE CHLORIDE
FFMW-11
2-4' ETHYLBENZENE
BENZENE
XYLENES
METHYLENE CHLORIDE
3-7' *TIN
NICKEL
NAPHTHALENE
2-METHYLNAPHTHALENE
B-07
0-2 *TIN
GRAVEL LOT
MAT 392
B-08
2-4' NICKEL
*TIN
8-10' ETHYLBENZENE
BENZENE
METHYLENE
CHLORIDE
FORMER MAT 305
FORMER UST
FFMW-02
4-6' NICKEL
*TIN
ETHYLBENZENE
BENZENE
TOLUENE
XYLENES
05SGB01
9-10' METHYLENE CHLORIDE
TRICHLOROETHYLENE
TETRACHLOROETHYLENE
1,2-DICHLOROPROPANE
FFMW-06
2-4' NICKEL
*TIN
BARIUM
4-6' BENZENE
METHYLENE CHLORIDE
05SB02
0-1' CADMIUM
DIELDRIN
6-8' CADMIUM
NICKEL
8-10' NICKEL
GRAVEL LOT
B-09
2-4' NICKEL
*TIN
ACETONE
METHYLENE CHLORIDE
1455
FFMW-05
6-8' METHYLENE CHLORIDE
6-10' NICKEL
*TIN
SWMU 40
05SB04
0-1' BARIUM
CADMIUM
DIELDRIN
3-5' DIELDRIN
NICKEL
8-10' BARIUM
CADMIUM
NICKEL
05SB05
05SB01
0-1' CADMIUM
DIELDRIN
SELENIUM
6-8' NICKEL
10-12' NICKEL
SWMU 19
757
341
NAVY EXCHANGE SERVICE STATION
1567
NAVY ROAD
PRODUCTION WELL PW-4
N-207
N-288
N
LEGEND
RFI SOIL BORING ID
DPT SOIL SAMPLE (1998)
UST SOIL BORING (1992)
NO ANALYTICAL SOIL SAMPLES COLLECTED
2-4' NICKEL TIN DEPTH INTERVAL AND CONTAMINANTS DETECTED IN EXCESS OF THE SOIL TO GROUNDWATER SOIL SCREENING LEVEL (SSL) AND INORGANIC REFERENCE CONCENTRATIONS (FOR METALS ONLY).
* SSL DOES NOT EXIST FOR LEAD AND COBALT HOWEVER, CONCENTRATIONS EXCEED RCs.
AREAS REMOVED DURING VOLUNTARY CORRECTIVE ACTION (VCA) AND TANK CLOSURES.
SSLs CORRESPOND WITH A DILUTION ATTENUATION FACTOR OF 1.
100 0 100
SCALE FEET
RCRA FACILITY INVESTIGATION
NSA MID-SOUTH
MILLINGTON, TENNESSEE
FIGURE 6-5
TRANSFER FROM SOIL TO GROUNDWATER EXCEEDANCES
DWG DATE:01/29/99
DWG NAME:0094G027

Table 6-11
Calculation of Dioxin Equivalent Concentrations in Surface Soil — SWMU 5
Detections Only (μg/kg)

Congeners	005S000101	005S000201	005S000301	005S000401	005S000501	
Reported Concentrations						
1234678-HpCDD	2.5	1.4		1.3	0.83	
1234678-HpCDF				0.41		
OCDD	12	7.4	2.3	8.4	4.6	
Total Hepta-Dioxins	4.4	2.7	0.3	0.65	1.3	
Total Hepta-Furans				0.41		
Total Hexa-Furans		0.19				
Total Penta-Furans	0.24			0.37	0.15	
Total Tetra-Dioxins		0.12			0.11	
Equivalent Concentrations						**TEF**
1234678-HpCDD	0.025	0.014		0.013	0.0083	0.01
1234678-HpCDF				0.0041		0.01
OCDD	0.012	0.0074	0.0023	0.0084	0.0046	0.001
Total Hepta-Dioxins	NA	NA	NA	NA	NA	NA
Total Hepta-Furans				NA		NA
Total Hexa-Furans		NA				NA
Total Penta-Furans	NA	NA		NA	NA	NA
Total Tetra-Dioxins		NA			NA	NA
DEQ	**0.037**	**0.021**	0.0023	**0.026**	**0.013**	

Notes:

NA — Not applicable
TEF — Toxicity Equivalency Factor
DEQ — Dioxin Equivalent Concentration
Bold — Dioxin equivalent concentration exceeds the residential RBC of 0.0043 μg/kg. The industrial RBC is 0.038 μg/kg.

Table 6-12
Soil Samples Exceeding both SSLs and RCs (Metals only)

Metal	Surface Soil Exceedances	Subsurface Soil Exceedances
Barium	1/8	3/18
Cadmium	6/8	4/18
Chromium	0/8	1/18
Nickel	0/8	18/18
Selenium	3/8	0/18
VOCs	**Surface Soil Exceedances**	**Subsurface Soil Exceedances**
Acetone	0/7	1/22
Benzene	1/7	4/22
Toluene	0/7	1/22
Ethylbenzene	0/7	4/22
Xylenes	0/7	3/22
Methylene Chloride	1/7	7/22
Trichloroethylene	0/7	1/22
Tetrachloroethylene	0/7	1/22
1,2-Dichloropropane	0/7	1/22
SVOCs	**Surface Soil Exceedances**	**Subsurface Soil Exceedances**
Naphthalene	0/7	2/19
2-Methylnaphthalene	0/7	2/19
Benzo(a)anthracene	1/7	0/19
Pesticides	**Surface Soil Exceedances**	**Subsurface Soil Exceedances**
Dieldrin	6/6	3/14

000104

6.3 Groundwater Analytical Results

Groundwater results are presented for:

(1) VOC, SVOC, and metal data collected during the 1992 UST investigation (loess groundwater only),

(2) FSA data collected from loess and fluvial deposits wells during the initial RFI sampling event and the first event of long-term monitoring,

(3) VOC data from the four subsequent long-term monitoring events,

(4) VOC data from the June 1998 DPT investigation,

(5) Lead and cadmium data collected from February 1999 resampling of wells 05MW01UF and 05MW02UF, and

(6) VOC data collected from February 1999 replacement well FFMW08 (the original was removed during the VCA).

Summary tables for organic and inorganic constituents in loess and fluvial deposits groundwater samples were generated from the analytical data provided in Appendices A and F. Figures depicting the tap water RBC and/or MCL exceedances for organics and inorganic constituents show maximum concentrations at wells sampled more than one time. Contaminants detected in the loess groundwater are presented first, followed by those detected in the fluvial deposits. Risks to human health and the environment are similarly based on maximum detections for wells with multiple sampling events. Risks are explained in Sections 7 and 8.

000195

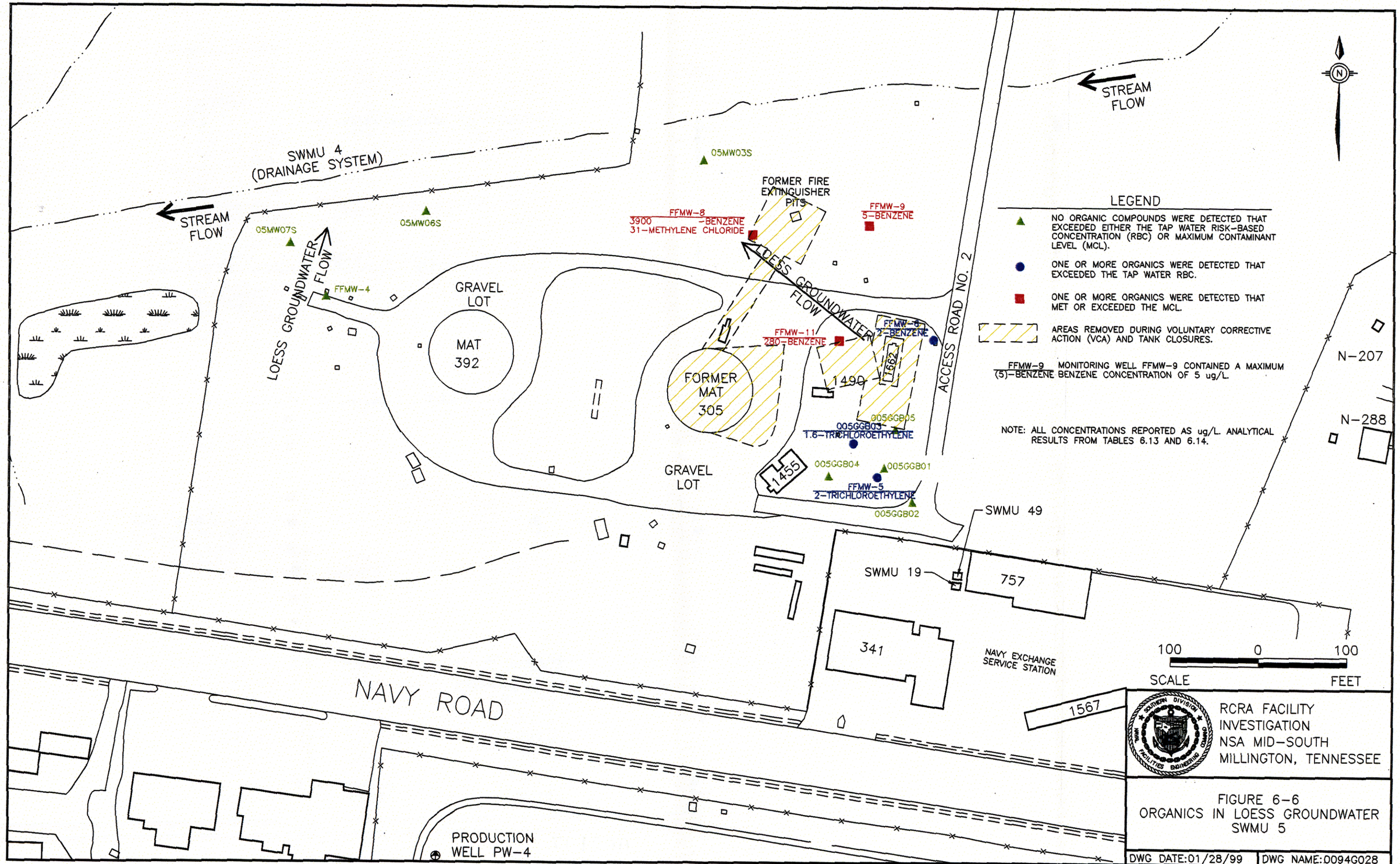
6.3.1 Loess Groundwater

Organic Compounds

The organic compounds detected in loess groundwater during the 1992 UST investigation and the RFI are presented in Tables 6-13 and 6-14. If maximum detections exceeded their tap water RBCs or MCLs, they are shown on Figure 6-6. Most organic detections in loess groundwater were VOCs, with benzene the most prevalent. During the 1992 UST investigation, the highest benzene concentration was identified in well FFMW-8 (1,300 μg/L), north of former Mat 305 near the former fire extinguisher training pits. During the initial RFI sampling (April 1994), benzene concentrations in this well increased to 3,900 μg/L. The MCL and tap water RBC for benzene are 5 μg/L and 0.36 μg/L, respectively. Methylene chloride was also detected in this well at 31 μg/L, which exceeds its tap water RBC (4.1 μg/L) and MCL (5 μg/L). The presumed source of contamination was the fire extinguisher pits, approximately 60 feet northeast of the well. Well FFMW-8 and contaminated soil surrounding it were removed in November 1997 during the SWMU 5 VCA. The well was replaced and sampled in February 1999. No benzene or methylene chloride were detected in the replacement well.

Benzene also exceeded its MCL in loess groundwater near the former USTs (Tanks 1489, 1490, and 1491) that supplied Mat 305. Benzene was detected at 280 μg/L in monitoring well FFMW-11 during the 1992 UST investigation. Benzene was also detected in the loess groundwater in downgradient well FFMW-9 at a concentration equal to its MCL (5 μg/L). Tanks 1490 and 1491 and 1,200 cubic yards of contaminated soil were removed in May 1997. Verification of whether the source of the benzene was removed will be evaluated during the CMS through additional monitoring.

000106


SWMU 4
(DRAINAGE SYSTEM)
STREAM FLOW
STREAM FLOW
05MW03S
05MW06S
05MW07S
FFMW-4
LOESS GROUNDWATER FLOW
LOESS GROUNDWATER FLOW
FORMER FIRE EXTINGUISHER PITS
FFMW-8
3900 -BENZENE
31-METHYLENE CHLORIDE
FFMW-9
5-BENZENE
FFMW-11
280-BENZENE
FFMW-6
2-BENZENE
GRAVEL LOT
MAT 392
FORMER MAT 305
1490
1562
1455
005GGB05
005GGB03
1,6-TRICHLOROETHYLENE
005GGB04
005GGB01
FFMW-5
2-TRICHLOROETHYLENE
005GGB02
GRAVEL LOT
ACCESS ROAD NO. 2
SWMU 49
SWMU 19
757
341
NAVY EXCHANGE SERVICE STATION
1567
NAVY ROAD
PRODUCTION WELL PW-4
N-207
N-288
N
LEGEND
NO ORGANIC COMPOUNDS WERE DETECTED THAT EXCEEDED EITHER THE TAP WATER RISK-BASED CONCENTRATION (RBC) OR MAXIMUM CONTAMINANT LEVEL (MCL).
ONE OR MORE ORGANICS WERE DETECTED THAT EXCEEDED THE TAP WATER RBC.
ONE OR MORE ORGANICS WERE DETECTED THAT MET OR EXCEEDED THE MCL.
AREAS REMOVED DURING VOLUNTARY CORRECTIVE ACTION (VCA) AND TANK CLOSURES.
FFMW-9 (5)-BENZENE MONITORING WELL FFMW-9 CONTAINED A MAXIMUM BENZENE CONCENTRATION OF 5 ug/L.
NOTE: ALL CONCENTRATIONS REPORTED AS ug/L. ANALYTICAL RESULTS FROM TABLES 6.13 AND 6.14.
100 0 100
SCALE FEET
RCRA FACILITY INVESTIGATION
NSA MID-SOUTH
MILLINGTON, TENNESSEE
FIGURE 6-6
ORGANICS IN LOESS GROUNDWATER
SWMU 5
DWG DATE:01/28/99
DWG NAME:0094G028

00617F094

Table 6-13
SWMU 5 — Organics Detected in Loess Groundwater (1992 UST Investigation)
Detections Only (μg/L)

Well ID	Constituent	RBC[a]	MCL[b]	1992
FFMW-5	1,2-Dichloroethene (total)	55	70	5 J
	1,2-Dichlorobenzene	64	600	1 J
FFMW-6	Benzene	0.36	5	**2 J**
	Ethylbenzene	1,300	700	9 J
	Phenol	22,000	DNE	7 J
FFMW-8	Benzene	0.36	5	**1,300 E**
	Ethylbenzene	1,300	700	14
	Xylenes (total)	12,000	10,000	100
	Phenol	22,000	DNE	26
	Naphthalene	1,500	DNE	17
	2-Methylnaphthalene	1,500	DNE	9 J
FFMW-11	Benzene	0.36	5	**280 E**
	Toluene	750	1,000	1 J
	Ethylbenzene	1,300	700	13
	Xylenes	12,000	10,000	83
	Phenol	22,000	DNE	12
	Naphthalene	1,500	DNE	28
	2-Methylnaphthalene	1,500	DNE	21
	Acenaphthene	2,200	DNE	1 J

Notes:

a — Tap water RBC from risk-based concentration table (USEPA, 1998a).
b — MCL from USEPA National Primary Drinking Water Standards (USEPA, 1996c).
J — Reported concentration is an estimated value.
E — Concentration exceeded calibration range.
Bold — Exceeds tap water RBC and/or MCL.
DNE — Does not exist.

Table 6-14
SWMU 5 — Organics Detected in Loess Groundwater During the RFI
Detections Only (μg/L)

Well ID	Constituent	RBC[a]	MCL[b]	Initial[c]	Event 1[d]	Event 2[e]	Event 3[f]	Event 4[g]	Event 5[h]
05MW03S	Naled	73	DNE	2.8 J	—	NS	NS	NS	NS
FFMW-5[g]	1,2-Dichlorobenzene	64	600	6 J	6 J	NS	NS	NS	NS
	1,2-Dichloroethene (total)	55	70	8 J	3 J	NS	1 J	2.6 J	1.4 J
	Chlorobenzene	35	DNE	2 J	—	NS	—	—	—
	Trichloroethylene	1.6	5	**2 J**	1 J	NS	—	—	0.59 J
	Naled	73	DNE	4.3	—	NS	NS	NS	NS
05MW06S	Acetone	3,700	DNE	27	—	NS	NS	—	—
	Naled	73	DNE	3 J	—	NS	NS	NS	NS
	Naphthalene	1,500	DNE	—	3 J	NS	NS	NS	NS
	TPH - DRO	1,000	DNE	NS	170	NS	NS	NS	NS
05MW07S	Naphthalene	1,500	DNE	—	2 J	NS	NS	NS	NS
	TPH - DRO	1,000	DNE	NS	300	NS	NS	NS	NS
	delta-BHC	DNE	DNE	—	0.027 J	NS	NS	NS	NS
FFMW-8[g]	2-Methylnaphthalene	1,500	DNE	100 J	NS	NS	NS	NS	NS
	Acenaphthene	2,200	DNE	3 J	NS	NS	NS	NS	NS
	Benzene	0.36	5	**3,900**	NS	NS	**1,900**	**3,200**	NS
	Ethylbenzene	1,300	700	30 J	NS	NS	—	—	NS
	Methylene chloride	4.1	5	**31 J**	NS	NS	—	—	NS
	Naphthalene	1,500	DNE	120 J	NS	NS	NS	NS	NS
	Phenol	22,000	DNE	98 J	NS	NS	NS	NS	NS
FFMW-9[g]	Benzene	0.36	5	**5 J**	NS	NS	—	—	—
	DPT Data (June 1998) - Detections Only (μg/L)								
005GGB01	1,2-Dichloroethene (total)	55	70	0.78					
005GGB03	Trichloroethylene	1.6	5	**1.6 J**					

Table 6-14
SWMU 5 — Organics Detected in Loess Groundwater During the RFI
Detections Only (μg/L)

Well ID	Constituent	RBC[a]	MCL[b]	Initial[c]	Event 1[d]	Event 2[e]	Event 3[f]	Event 4[g]	Event 5[h]
				FFMW-8 Replacement Well (February 1999)					
FFMW-8	n-Butylbenzene	DNE	61	1.1					
	2-Butanone	DNE	1,900	1.1					
	Isopropylbenzene	DNE	DNE	1.3					
	Naphthalene	DNE	730	4.4					
	n-Propylbenzene	DNE	61	1.7					
	1,2,4-Trimethylbenzene	DNE	12	1.5					

Notes:

a — Tap water RBC from risk-based concentration table (USEPA, 1998a).
b — MCL from USEPA National Primary Drinking Water Standards (USEPA, 1996c).
c — Initial sampling event. Loess RFI monitoring wells (05MW03S, 05MW06S, and 05MW07S) were sampled in March 1995 following installation; all samples were submitted to the laboratory for FSA. Five wells installed as part of the earlier UST investigation (FFMW-4, FFMW-5, FFMW-6, FFMW-8, and FFMW-9) were also sampled, but in April 1995. Results from these wells are included in the initial event.
d — First long-term monitoring event for Assembly A monitoring wells conducted in November/December 1995. Samples collected from loess wells (05MW03S, FFMW-5, 05MW06S, and 05MW07S) were submitted for FSA.
e — Second long-term monitoring event for Assembly A monitoring wells conducted in April 1996. Loess monitoring wells were not sampled during this event.
f — Third long-term monitoring event for Assembly A monitoring wells conducted in August 1996. Loess monitoring wells (FFMW-5, FFMW-8, and FFMW-9) were sampled for VOCs only.
g — Fourth long-term monitoring event for Assembly A monitoring wells conducted in April and May of 1997. Loess monitoring wells (05MW03S, FFMW-5, 05MW06S, 05MW07S, FFMW-8, and FFMW-9) were sampled for VOCs only.
h — Fifth long-term monitoring event for Assembly A monitoring wells conducted in November 1997. Loess monitoring wells (05MW03S, FFMW-5, 05MW06S, 05MW07S, FFMW-9) were sampled for VOCs only during this event.
DNE — Does not exist.
NS — Sample not submitted for analysis of this constituent this sampling event.
— — Not detected.
J — Detected below the method reporting limit; value estimated.
Bold — Exceeds the tap water RBC or MCL.

001110

Other VOCs in loess groundwater that exceeded their tap water RBCs included TCE at 2 μg/L in upgradient well FFMW-5, near the southeast corner of the SWMU. 1,2-dichlorobenzene, 1,2-dichloroethene (total), and chlorobenzene were also detected in well FFMW-5; however, the concentrations were all below their RBCs and MCLs. A focused DPT investigation near well FFMW-5 identified a similarly low TCE concentration (1.6 μg/L at 005GGB03) in one of five loess groundwater samples — concentrations that do not indicate a major source area (dense non-aqueous phase liquids [DNAPLs]). VOCs exceeding their RBCs or MCLs are shown on Figure 6-6.

SVOCs were detected in two loess monitoring wells during the RFI groundwater sampling; however, concentrations were less than their tap water RBCs and MCLs. The 1992 UST investigation identified SVOCs in four wells, but contaminant concentrations were less than their tap water RBCs and MCLs. The SVOCs detected in groundwater from each investigation are presented in Tables 6-13 and 6-14.

The only organophosphorus pesticide detected in SWMU 5 loess groundwater was naled. Concentrations in three wells ranged from 2.8 μg/L to 4.3 μg/L, below the naled tap water RBC (73 μg/L). No MCL has been established for naled. Neither PCBs nor chlorinated pesticides were detected in SWMU 5 loess groundwater. Herbicides were not detected in loess groundwater either.

Metals and Cyanide

1992 UST Investigation: Groundwater samples from four UST loess wells identified several metals — arsenic, beryllium, cadmium, and/or lead[2] — at concentrations exceeding both their RC

[2] An MCL has not been established for lead; however, the USEPA has established a treatment technique action level (TTAL) of 15 μg/L for lead (USEPA, 1996c).

and either their tap water RBC or MCL. Cadmium concentrations ranged between 9.1 and 14.4 μg/L, exceeding its RC (5.9 μg/L) and MCL (5 μg/L) in the four sampled loess wells. Beryllium met its MCL (4 μg/L) and exceeded its RC (1.3 μg/L) in well FFMW-5. Arsenic exceeded its MCL (50 μg/L) and RC (0.73 μg/L) in well FFMW-8 at a concentration of 82.5 μg/L. Arsenic concentrations in the remaining three wells, ranged from 12.9 to 26.2 μg/L, exceeding its tap water RBC (0.045 μg/L). Lead exceeded its RC (17.5 μg/L) and treatment technique action level (15 μg/L) in wells FFMW-5 and FFMW-8 at concentrations of 37.7 μg/L and 26.7 μg/L, respectively. No MCL or tap water RBC has been established for lead. Results of metals analyses from the 1992 UST investigation are presented in Table 6-15 and shown on Figure 6-7.

Cyanide was also detected in groundwater samples from the four wells, but at concentrations below its 200 μg/L MCL and 730 μg/L RBC. Results are listed below in μg/L:

- FFMW-5 40
- FFMW-6 90
- FFMW-8 70
- FFMW-11 20

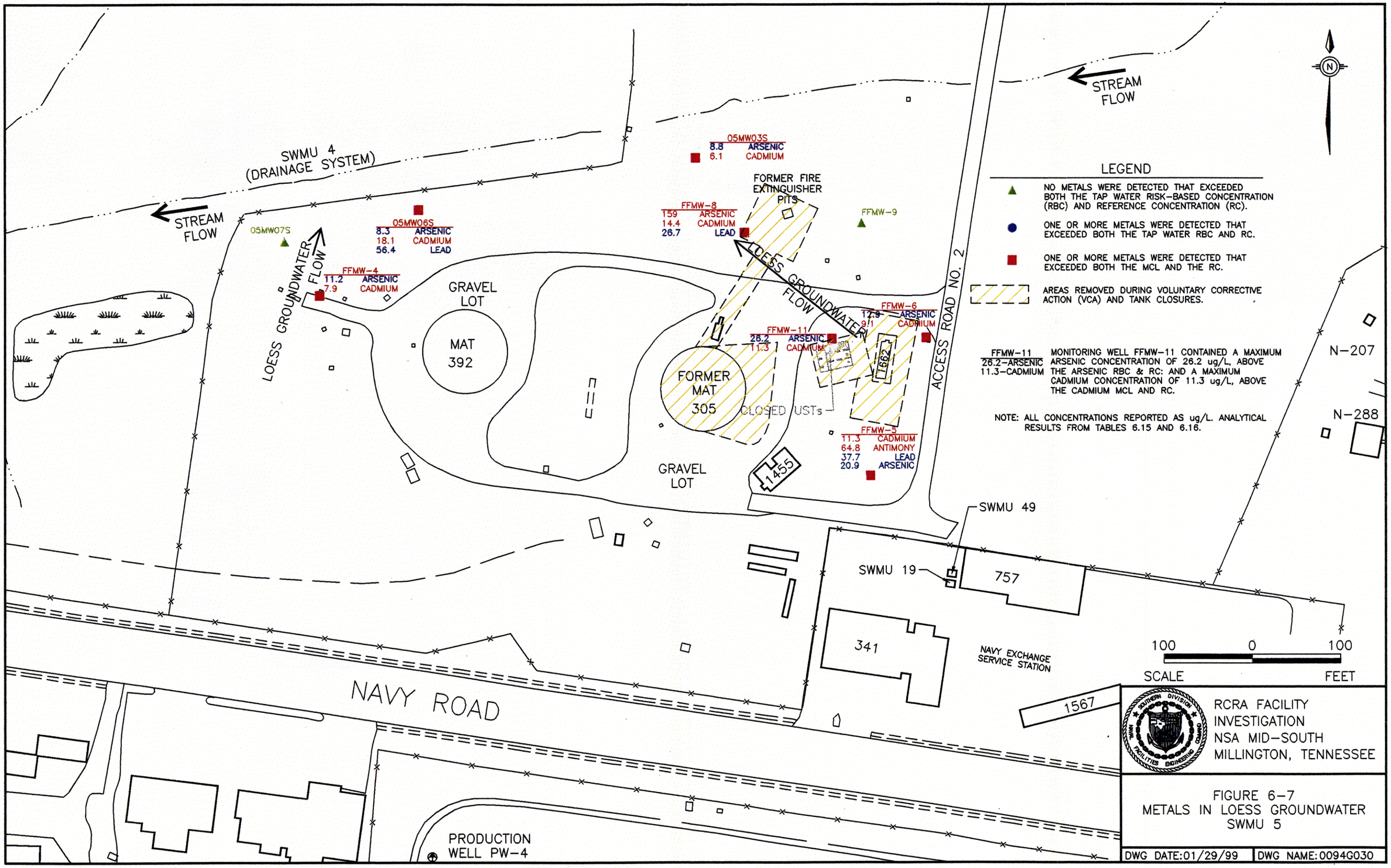
SWMU 5 RFI: Three of the four metals cited above and one additional metal were also identified in loess monitoring wells during the RFI at concentrations exceeding their RC and either the tap water RBC or MCL including the following: antimony, arsenic, cadmium, and lead[3]. However, analytical data presented in Table 6-16 from a second sampling event indicate that these metals are likely the result of turbidity content in the samples due to a significant reduction in concentrations during the second sampling event — these metals were not detected during the second sampling event. Cyanide was not detected in loess groundwater during the RFI. Metals exceeding either the RC, tap water RBC, and/or MCL are shown on Figure 6-7.

Antimony was identified in well FFMW-5 during the initial sampling event at a concentration of 64.8 μg/L, exceeding its tap water RBC (15 μg/L), MCL (6 μg/L), and RC (50.1 μg/L). This was the only antimony detection during the RFI. Antimony was not detected in this well during the second sampling event.

Arsenic exceeded its 50 μg/L MCL and 7.3 μg/L RC in well FFMW-8, which contained 159 μg/L during the initial sampling. Arsenic concentrations in five of the other seven loess wells ranged from 8.3 μg/L to 14.2 μg/L during this sampling event, exceeding the arsenic tap water RBC (0.045 μg/L). Arsenic concentrations were not detected during the second sampling event, in which four of these loess wells were again sampled for metals.

Cadmium exceeded its MCL (5 μg/L) and RC (5.9 μg/L) in five of the sampled wells during the initial sampling event. Results are listed below in μg/L.

- 05MW03S 6.1
- FFMW-4 7.9
- FFMW-5 8.3
- 05MW06S 18.1
- FFMW-8 8.5


SWMU 4
(DRAINAGE SYSTEM)
STREAM FLOW
05MW07S
05MW06S
8.3 ARSENIC
18.1 CADMIUM
56.4 LEAD
FFMW-4
11.2 ARSENIC
7.9 CADMIUM
LOESS GROUNDWATER FLOW
GRAVEL LOT
MAT 392
05MW03S
8.8 ARSENIC
6.1 CADMIUM
FORMER FIRE EXTINGUISHER PITS
FFMW-8
159 ARSENIC
14.4 CADMIUM
26.7 LEAD
FFMW-9
LOESS GROUNDWATER FLOW
FFMW-6
12.9 ARSENIC
9.1 CADMIUM
FFMW-11
26.2 ARSENIC
11.3 CADMIUM
FORMER MAT 305
CLOSED USTs
1662
FFMW-5
11.3 CADMIUM
64.8 ANTIMONY
37.7 LEAD
20.9 ARSENIC
1455
GRAVEL LOT
ACCESS ROAD NO. 2
SWMU 49
SWMU 19
757
341
NAVY EXCHANGE SERVICE STATION
1567
NAVY ROAD
PRODUCTION WELL PW-4
N-207
N-288
STREAM FLOW
N
LEGEND
NO METALS WERE DETECTED THAT EXCEEDED BOTH THE TAP WATER RISK-BASED CONCENTRATION (RBC) AND REFERENCE CONCENTRATION (RC).
ONE OR MORE METALS WERE DETECTED THAT EXCEEDED BOTH THE TAP WATER RBC AND RC.
ONE OR MORE METALS WERE DETECTED THAT EXCEEDED BOTH THE MCL AND THE RC.
AREAS REMOVED DURING VOLUNTARY CORRECTIVE ACTION (VCA) AND TANK CLOSURES.
FFMW-11
26.2-ARSENIC
11.3-CADMIUM
MONITORING WELL FFMW-11 CONTAINED A MAXIMUM ARSENIC CONCENTRATION OF 26.2 ug/L, ABOVE THE ARSENIC RBC & RC: AND A MAXIMUM CADMIUM CONCENTRATION OF 11.3 ug/L, ABOVE THE CADMIUM MCL AND RC.
NOTE: ALL CONCENTRATIONS REPORTED AS ug/L. ANALYTICAL RESULTS FROM TABLES 6.15 AND 6.16.
100 0 100
SCALE FEET
RCRA FACILITY INVESTIGATION
NSA MID-SOUTH
MILLINGTON, TENNESSEE
FIGURE 6-7
METALS IN LOESS GROUNDWATER
SWMU 5
DWG DATE:01/29/99
DWG NAME:0094G030

00617 F10Y

Table 6-15
SWMU 5 — Inorganics Detected in Loess Groundwater During 1992 UST Investigation
Detections only (μg/L)

Well ID	Constituent	RBC[a]	MCL[b]	RC[c]	1992
FFMW-5	Arsenic	0.045	50	7.3	*20.9*
	Barium	2,600	2,000	442	617
	Beryllium	73	4	1.3	4.0 J
	Cadmium	18	5	5.9	**11.3**
	Chromium	110	100	239	92.4
	Cobalt	2,200	DNE	17.8	36.6 J
	Copper	1,500	1,300[d]	38.8	60.1
	Lead	DNE	15[d]	17.5	**37.7**
	Nickel	730	100	173.5	88.4
	Silver	180	DNE	4.5	9.7 J
	Tin	22,000	DNE	ND	381
	Vanadium	260	DNE	40.9	73.6
	Zinc	11,000	DNE	154.6	217
FFMW-6	Arsenic	0.045	50	7.3	*12.9*
	Barium	2,600	2,000	442	183 J
	Beryllium	73	4	1.3	1.7 J
	Cadmium	18	5	5.9	**9.1**
	Chromium	110	100	239	42.2
	Cobalt	2,200	DNE	17.8	22.9 J
	Copper	1,500	1,300[d]	38.8	17.8 J
	Nickel	730	100	173.5	37.9 J
	Silver	180	DNE	4.5	10.6
	Tin	22,000	DNE	ND	317
	Vanadium	260	DNE	40.9	33.3 J
	Zinc	11,000	DNE	154.6	46.0
FFMW-8	Arsenic	0.045	50	7.3	**82.5**
	Barium	2,600	2,000	442	583
	Beryllium	73	4	1.3	3.8 J
	Cadmium	18	5	5.9	**14.4**
	Chromium	110	100	239	70.0
	Cobalt	2,200	DNE	17.8	46.8 J

Table 6-15
SWMU 5 — Inorganics Detected in Loess Groundwater During 1992 UST Investigation
Detections only (μg/L)

Well ID	Constituent	RBC[a]	MCL[b]	RC[c]	1992
FFMW-8	Copper	1,500	1,300[d]	38.8	68.2
	Lead	DNE	15[d]	17.5	**26.7**
	Nickel	730	100	173.5	98.8
	Silver	180	DNE	4.5	14.7
	Tin	22,000	DNE	ND	514
	Vanadium	260	DNE	40.9	81.4
	Zinc	11,000	DNE	154.6	134
FFMW-11	Arsenic	0.045	50	7.3	*26.2*
	Barium	2,600	2,000	442	355
	Beryllium	73	4	1.3	2.3 J
	Cadmium	18	5	5.9	**11.3**
	Chromium	110	100	239	57.6
	Cobalt	2,200	DNE	17.8	29.3
	Copper	1,500	1,300[d]	38.8	44.1
	Lead	DNE	15[d]	17.5	9.9
	Nickel	730	100	173.5	56.0
	Silver	180	DNE	4.5	12.6
	Tin	22,000	DNE	ND	344
	Vanadium	260	DNE	40.9	53.1
	Zinc	11,000	DNE	154.6	92.8

Notes:

a — Tap water RBC from the risk-based concentration table (USEPA, 1998a).
b — MCL from USEPA National Primary Drinking Water Standards (USEPA, 1996c).
c — Background RC. The RC is 2X the mean concentration of the inorganic detected in samples collected from background monitoring wells that are screened in the loess (E/A&H, 1996).
d — Treatment technique action level (USEPA, 1996c).
ND — Analyte not detected in background samples.
NS — Sample not submitted for analysis of this constituent this sampling event.
DNE — Does not exist.
J — Inorganic was detected below the method reporting limit; value estimated.
Bold — Exceeds RC and MCL (TTAL for copper and lead only).
Italic — Exceeds RC and tap water RBC.

000116

Table 6-16
SWMU 5 — Inorganics Detected in Loess Groundwater During the RFI
Hits only (μg/L)

Well ID	Constituent	RBC[a]	MCL[b]	RC[c]	Initial[d]	Event 1
05MW03S	Arsenic	0.045	50	7.32	*8.8 J*	—
	Barium	2,600	2,000	442	394	152 J
	Cadmium	18	5	5.88	**6.1**	—
	Chromium	110	100	239	19.4	16.4
	Cobalt	2,200	DNE	17.8	7.4 J	—
	Copper	1,500	1,300[f]	38.8	26.9	11.8 J
	Lead	DNE	15[f]	17.5	13.4 J	2.2 J
	Nickel	730	100	173.5	37.5 J	—
	Tin	22,000	DNE	ND	—	40.9 J
	Vanadium	260	DNE	40.9	29.3 J	5.2 J
	Zinc	11,000	DNE	154.6	130	—
FFMW-4	Arsenic	0.045	50	7.32	*11.2*	NS
	Barium	2,600	2,000	442	441	NS
	Beryllium	73	4	1.3	2.1 J	NS
	Cadmium	18	5	5.88	**7.9 J**	NS
	Chromium	110	100	239	31	NS
	Cobalt	2,200	DNE	17.8	11.7 J	NS
	Copper	1,500	1,300[f]	38.8	46.7	NS
	Lead	DNE	15[f]	17.5	17.3	NS
	Nickel	730	100	173.5	39.8 J	NS
	Vanadium	260	DNE	40.9	43.2 J	NS
	Zinc	11,000	DNE	154.6	132	NS
FFMW-5	Antimony	15	6	50.1	**64.8**	—
	Arsenic	0.045	50	7.32	*14.2*	—
	Barium	2,600	2,000	442	1,400	142 J
	Beryllium	73	4	1.3	3.7 J	—
	Cadmium	18	5	5.88	**8.3 J**	—
	Chromium	110	100	239	45.4	—
	Cobalt	2,200	DNE	17.8	21.3 J	—
	Copper	1,500	1,300[f]	38.8	71.5	7.1 J
	Lead	DNE	15[f]	17.5	**22.6**	2.9 J

Table 6-16
SWMU 5 — Inorganics Detected in Loess Groundwater During the RFI
Hits only (μg/L)

Well ID	Constituent	RBC[a]	MCL[b]	RC[c]	Initial[d]	Event 1
FFMW-5	Mercury	11	2	0.24	0.63	—
	Nickel	730	100	173.5	69.5	—
	Tin	22,000	DNE	ND	—	63.5 J
	Vanadium	260	DNE	40.9	74.4	—
	Zinc	11,000	DNE	154.6	233	—
	Arsenic	0.045	50	7.32	*8.6 J*	NS
	Barium	2,600	2,000	442	138 J	NS
	Cobalt	2,200	DNE	17.8	3.9 J	NS
	Lead	DNE	15[f]	17.5	2 J	NS
05MW06S	Arsenic	0.045	50	7.32	*8.3 J*	—
	Barium	2,600	2,000	442	714	123 J
	Beryllium	73	4	1.3	2.8 J	—
	Cadmium	18	5	5.88	**18.1**	—
	Chromium	110	100	239	59.9	—
	Cobalt	2,200	DNE	17.8	37.2 J	—
	Copper	1,500	1,300[f]	38.8	89.6	5.2 J
	Lead	DNE	15[f]	17.5	**56.4 J**	—
	Nickel	730	100	173.5	94.2	—
	Tin	22,000	DNE	ND	—	46.2 J
	Vanadium	260	DNE	40.9	102	—
	Zinc	11,000	DNE	154.6	551	—
05MW07S	Arsenic	0.045	50	7.32	2.6 J	—
	Barium	2,600	2,000	442	256	267
	Cadmium	18	5	5.88	—	3.2 J
	Chromium	110	100	239	—	40.2
	Cobalt	2,200	DNE	17.8	—	6.3 J
	Copper	1,500	1,300[f]	38.8	—	20.4 J
	Lead	DNE	15[f]	17.5	—	5.8
	Nickel	730	100	173.5	—	37.3 J
	Tin	22,000	DNE	ND	—	52.1 J
	Vanadium	260	DNE	40.9	4.5 J	12.5 J
	Zinc	11,000	DNE	154.6	53.7	113

000113

Table 6-16
SWMU 5 — Inorganics Detected in Loess Groundwater During the RFI
Hits only (μg/L)

Well ID	Constituent	RBC[a]	MCL[b]	RC[c]	Initial[d]	Event 1
FFMW-8	Arsenic	0.045	50	7.32	**159**	NS
	Barium	2,600	2,000	442	564	NS
	Cadmium	18	5	5.88	**8.5 J**	NS
	Cobalt	2,200	DNE	17.8	7.8 J	NS
	Lead	DNE	15 [f]	17.5	4.5	NS
	Nickel	730	100	173.5	56.4	NS
	Zinc	11,000	DNE	154.6	26.7	NS
FFMW-9	Arsenic	0.045	50	7.32	2.7 J	NS
	Barium	2,600	2,000	442	407	NS
	Beryllium	73	4	1.3	1.4 J	NS
	Cobalt	2,200	DNE	17.8	4.2 J	NS
	Lead	DNE	15[f]	17.5	4.6	NS
	Mercury	11	2	0.24	0.23	NS
	Nickel	730	100	173.5	27.8 J	NS
	Vanadium	260	DNE	40.9	4.8 J	NS
	Zinc	11,000	DNE	154.6	61.5	NS

Notes:

a — Tap water RBC from the risk-based concentration table (USEPA, 1998a).
b — MCL from USEPA National Primary Drinking Water Standards (USEPA, 1996c).
c — Background RC. The RC is 2X the mean concentration of the inorganic detected in samples collected from background monitoring wells screened in the loess and fluvial deposits (E/A&H, 1996).
d — Initial sampling event. Loess RFI monitoring wells (05MW03S, 05MW06S, and 05MW07S) were sampled in March 1995 following installation; all samples were submitted to the laboratory for FSA. Five wells installed as part of the earlier UST investigation (FFMW-4, FFMW-5, FFMW-6, FFMW-8, and FFMW-9) were also sampled, but in April 1995. Results from these wells are included in the initial event.
e — First long-term monitoring event for Assembly A monitoring wells conducted in November/December 1995. Samples collected from loess wells (05MW03S, FFMW-5, 05MW06S, and 05MW07S) were submitted for FSA.
f — Treatment technique action level (USEPA, 1996c).
ND — Inorganic was not detected in background wells.
NS — Sample not submitted for analysis of this inorganic during this sampling event.
DNE — Does not exist.
— — Inorganic analyzed for, but not detected.
J — Inorganic was detected below the method reporting limit; value estimated.
Bold — Exceeds RC and MCL.
Italic — Exceeds tap water RBC and RC.

Cadmium was not detected in wells 05MW03S, FFMW-5, and 05MW06S, which were sampled during the second sampling event. Wells FFMW-4 and FFMW-8 were not sampled during the second sampling event.

Lead exceeded its treatment technique action level (TTAL [15 μg/L]) and RC (17.5 μg/L) in wells FFMW-5 and 05MW06S where 22.6 μg/L and 56.4 μg/L were detected. Lead concentrations in these wells were not detected or were below the RC and TTAL during the second sampling event.

6.3.2 Fluvial Deposits Groundwater

Organics

Organics detected in the fluvial deposits are listed in Table 6-17; those that exceeded the MCLs or tap water RBCs are shown on Figure 6-8. Most organic detections were VOCs: 2-butanone, chloromethane, carbon tetrachloride, chloroform, methylene chloride, 1,1,1-trichloroethane, and TCE. Three paired upper fluvial deposits wells at the southeast corner of the SWMU contained carbon tetrachloride. In samples from two wells, collected during Event 3, carbon tetrachloride exceeded its MCL (5 μg/L) and its tap water RBC (0.16 μg/L). The third sample was collected during Event 5. Carbon tetrachloride results are listed below in μg/L:

Well	Concentration
05MW04AUF	6
05MW04BUF	10
05MW04UF	3

Revision 1 of this report suggested that possible sources of the carbon tetrachloride were SWMUs 19 and 49 at the Navy Exchange service station, adjacent to the SWMU 5 well cluster and hydraulically upgradient of it. The carbon tetrachloride detected at SWMU 5 was not thought to be the result of former SWMU 5 site activities due to its absence in loess soil or loess

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00617F11Y

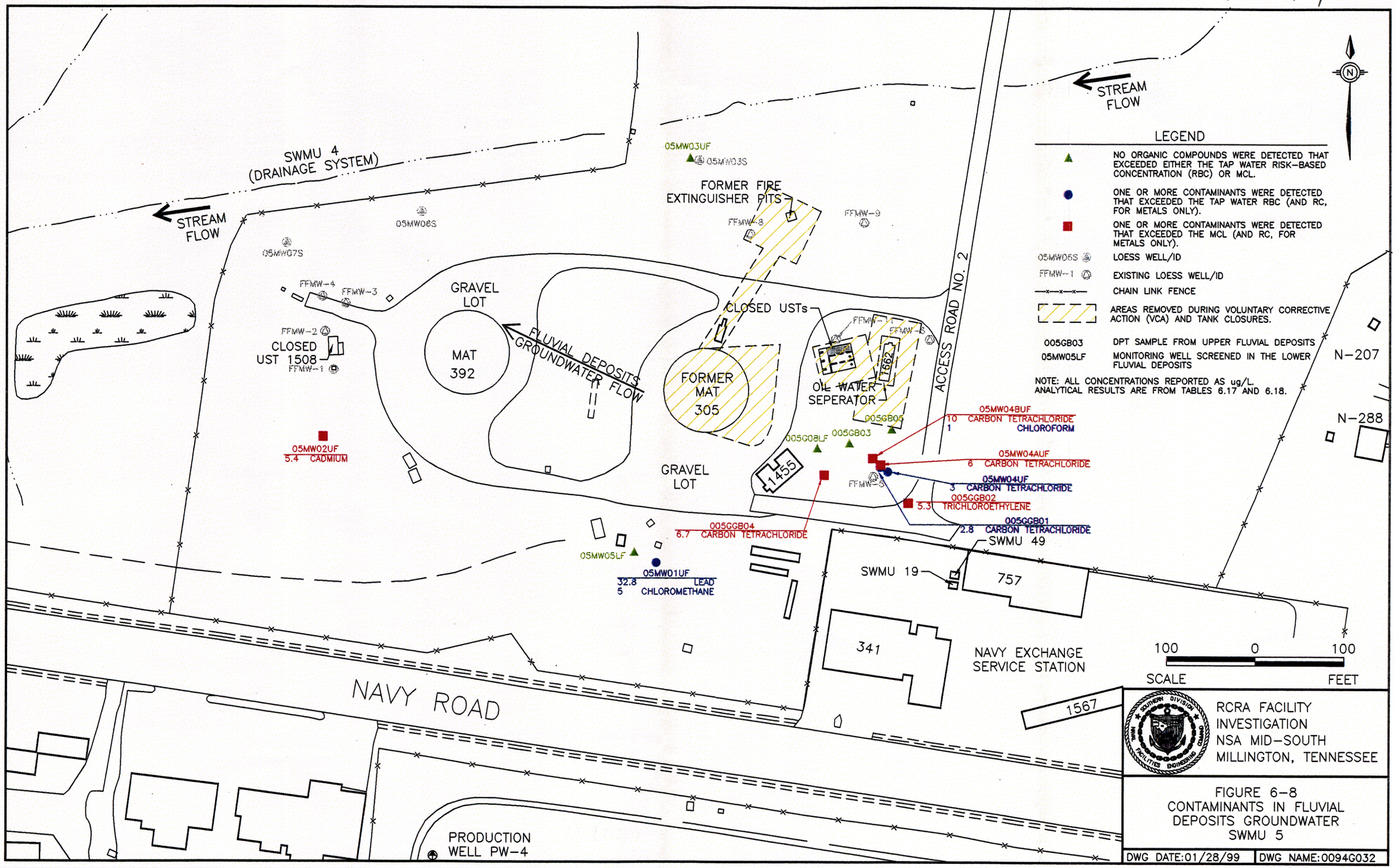
SWMU 4
(DRAINAGE SYSTEM)
STREAM FLOW
STREAM FLOW
05MW03UF
05MW03S
FORMER FIRE EXTINGUISHER PITS
FFMW-8
FFMW-9
05MW06S
05MW07S
FFMW-4
FFMW-3
GRAVEL LOT
CLOSED USTs
FFMW-2
CLOSED UST 1508
FFMW-1
MAT 392
FLUVIAL DEPOSITS GROUNDWATER FLOW
FORMER MAT 305
FFMW-7
FFMW-6
1662
OIL WATER SEPERATOR
ACCESS ROAD NO. 2
005GB05
005GB03
005GG8LF
05MW04BUF
10 CARBON TETRACHLORIDE
1 CHLOROFORM
05MW04AUF
6 CARBON TETRACHLORIDE
05MW04UF
3 CARBON TETRACHLORIDE
005GGB02
5.3 TRICHLOROETHYLENE
005GGB01
2.8 CARBON TETRACHLORIDE
05MW02UF
5.4 CADMIUM
GRAVEL LOT
1455
FFMW-5
005GGB04
6.7 CARBON TETRACHLORIDE
05MW05LF
05MW01UF
32.8 LEAD
5 CHLOROMETHANE
SWMU 49
SWMU 19
757
341
NAVY EXCHANGE SERVICE STATION
N-207
N-288
100 0 100
SCALE FEET
1567
NAVY ROAD
PRODUCTION WELL PW-4
LEGEND
NO ORGANIC COMPOUNDS WERE DETECTED THAT EXCEEDED EITHER THE TAP WATER RISK-BASED CONCENTRATION (RBC) OR MCL.
ONE OR MORE CONTAMINANTS WERE DETECTED THAT EXCEEDED THE TAP WATER RBC (AND RC, FOR METALS ONLY).
ONE OR MORE CONTAMINANTS WERE DETECTED THAT EXCEEDED THE MCL (AND RC, FOR METALS ONLY).
05MW06S LOESS WELL/ID
FFMW-1 EXISTING LOESS WELL/ID
CHAIN LINK FENCE
AREAS REMOVED DURING VOLUNTARY CORRECTIVE ACTION (VCA) AND TANK CLOSURES.
005GB03 DPT SAMPLE FROM UPPER FLUVIAL DEPOSITS
05MW05LF MONITORING WELL SCREENED IN THE LOWER FLUVIAL DEPOSITS
NOTE: ALL CONCENTRATIONS REPORTED AS ug/L.
ANALYTICAL RESULTS ARE FROM TABLES 6.17 AND 6.18.
RCRA FACILITY INVESTIGATION
NSA MID-SOUTH
MILLINGTON, TENNESSEE
FIGURE 6-8
CONTAMINANTS IN FLUVIAL DEPOSITS GROUNDWATER
SWMU 5
DWG DATE:01/28/99
DWG NAME:0094G032

Table 6-17
SWMU 5 — Organics Detected in Fluvial Deposits Groundwater
Detections Only (μg/L)

Well ID	Constituent	RBC[a]	MCL[b]	Initial[c]	Event 1[d]	Event 2[e]	Event 3[f]	Event 4[g]	Event 5[h]
05MW01UF	2-Butanone (MEK)	1,900	DNE	—	—	11	—	—	—
	Acetone	3,700	DNE	—	3 J	—	—	—	—
	Chloromethane	1.4	DNE	—	—	5 J	—	—	—
05MW02UF	2-Butanone (MEK)	1,900	DNE	—	27	—	—	—	—
05MW04UF	Acetone	3,700	DNE	—	54	—	—	—	—
	Carbon tetrachloride	0.16	5	—	—	—	1 J	1.2 J	3 J
05MW04AUF	Carbon tetrachloride	0.16	5	3 J	5 J	4 J	6 J	NS	NS
	BEHP	4.8	DNE	3 J	NS	NS	NS	NS	NS
05MW04BUF	Carbon tetrachloride	0.16	5	4 J	5 J	4 J	10 J	NS	NS
	Chloroform	0.15	100	—	—	—	1 J	NS	NS
	Nitrobenzene	3.4	DNE	1 J	NS	NS	NS	NS	NS
DPT Data (June 1998) Detections Only (μg/L)									
005GGB02	Methylene chloride	4.1	5	1.6 J					
	1,1,1-Trichloroethane	540	200	0.79 J					
	Trichloroethylene	1.6	5	5.3					
005GGB04	Carbon tetrachloride	0.16	5	6.7					

Notes:

a — Tap water RBC from the risk-based concentration table (USEPA, 1998a).
b — MCL from USEPA National Primary Drinking Water Standards (USEPA, 1996c).
c — Initial sampling event. All fluvial deposits monitoring wells (six upper and one lower fluvial deposits wells) were sampled in March 1995 following installation; all samples were submitted to the laboratory for FSA.
d — First long-term monitoring event for Assembly A monitoring wells conducted in November/December 1995; all fluvial deposits wells sampled for VOCs only.
e — Second long-term monitoring event for Assembly A monitoring wells conducted in April 1996; all fluvial deposits well sampled for VOCs only.
f — Third long-term monitoring event for Assembly A monitoring wells conducted in August 1996; all fluvial deposits wells sampled for VOCs only.
g — Fourth long-term monitoring event for Assembly A monitoring wells conducted in April and May of 1997. Samples from all fluvial deposits wells, except for 005G04AUF and 005G04BUF, were submitted for VOC analysis only.
h — Fifth long-term monitoring event for Assembly A monitoring wells conducted in November 1997. Samples from all fluvial wells, except for 005G04AUF and 005G04BUF, were submitted for VOC analysis only.
DNE — Does not exist.
NS — Sample not submitted for anlysis of this constituent this sampling event.
J — Compound was detected below the method reporting limit; value estimated.
Bold — Exceeds either tap water RBC or MCL.
— — Below the method detection limit.

Monitoring wells 05MW03UF and 05MW05LF were sampled during the six sampling events above; however, no organic compounds were detected.

000122

groundwater. SWMU 49 was an accumulation point for used automobile batteries, waste paints, containerized waste mineral spirits, and tires. SWMU 19, immediately adjacent to SWMU 49, contained a 280-gallon underground tank (Tank 1648) used to store waste automotive oil and hydraulic fluid generated by automotive repair activities at the Navy Exchange service station. The 280-gallon tank, SWMU 19, was removed in March 1996, along with 20 cubic yards of contaminated soil. Confirmation samples collected from the bottom of the excavation did not contain chlorinated hydrocarbons (EnSafe, January 28, 1998). SWMUs 19 and 49 were investigated in January 1998 through a Confirmatory Sampling Investigation (CSI) which resulted in the collection of eight groundwater samples from upper fluvial deposits locations surrounding the SWMUs (shown earlier on Figure 3-4). Chlorinated hydrocarbons were not detected in the groundwater samples, indicating that those detected downgradient at SWMU 5 did not likely originate from SWMUs 19 and 49 (EnSafe, May 29, 1998).

Because it did not appear that the chlorinated hydrocarbons had originated from SWMUs 19 and 49, a DPT investigation was conducted at SWMU 5 in June 1998 to further evaluate the extent and possible sources of the contaminants detected at the SWMU's southeast corner. During this investigation, carbon tetrachloride was identified in two of the five samples from the upper fluvial deposits groundwater. However, the concentrations of 2.8 μg/L and 6.7 μg/L did not indicate a source area. In one of the five DPT groundwater samples, TCE was detected at a concentration of 5.3 μg/L, which exceeded its 5 μg/L MCL.

To evaluate whether higher concentrations of chlorinated hydrocarbons were present at the lower fluvial deposits' base, lower fluvial deposits monitoring well 005G08LF was installed in August 1998, approximately 50 feet downgradient of well cluster 05MW04. In this well, carbon tetrachloride and other chlorinated hydrocarbons detected in the upper part of the fluvial deposits were not present. The BCT concluded that the chlorinated hydrocarbons had been adequately

000123

defined based on their absence in this well and the relatively low concentrations identified during the earlier focused DPT investigations.

SVOCs in the fluvial deposits consisted of BEHP and nitrobenzene; both compounds were detected in separate wells at concentrations below their tap water RBCs. MCLs have not been established for these compounds.

Pesticides (organophosphorus and chlorinated), herbicides, or **PCBs** were not detected in the fluvial deposits groundwater.

Inorganics

Two fluvial deposits wells contained metals in excess of its respective RC and MCL (Figure 6-8). Cadmium was detected in excess of its RC (3.9 μg/L) and MCL (5 μg/L) in well 05MW02UF at 5.4 μg/L. Lead was detected in well 05MW01UF at a concentration of 32.8 μg/L, which exceeds its RC (6.6 μg/L) and TTAL (15 μg/L). Cadmium and lead were not detected in the resampling of these wells in February 1999. However, a relatively high detection limit (28 μg/L) was used by the laboratory for the lead analysis (the lead TTAL is 15 μg/L). Wells 05MW01UF and 05MW02UF will be further monitored as part of the CMS (using a lower lead detection limit) to verify the presence or absence of these metals. No cyanide was detected in fluvial deposits groundwater. Table 6-18 presents the metals concentrations in SWMU 5 fluvial deposits wells.

Table 6-18
SWMU 5 — Inorganics Detected in Fluvial Deposits Groundwater
Detections only (μg/L)

Well ID	Constituent	RBC[a]	MCL[b]	RC[c]	Initial[d]	Feb. 1999
05MW01UF	Barium	2,600	2,000	232	48.6 J	
	Lead	DNE	15[e]	6.6	**32.8 J**	ND (28 U)
	Zinc	11,000	DNE	39.8	6.4 J	
05MW02UF	Barium	2,600	2,000	232	112 J	
	Cadmium	18	5	3.9	**5.4 J**	ND (1.8 U)
05MW03UF	Barium	2,600	2,000	232	61.4 J	
05MW04UF	Barium	2,600	2,000	232	50.8 J	
05MW04AUF	Barium	2,600	2,000	232	76.8 J	
	Cobalt	2,200	DNE	16.2	8.7 J	
05MW04BUF	Barium	2,600	2,000	232	82.1 J	
	Cobalt	2,200	DNE	16.2	9.4 J	
05MW05LF	Barium	2,600	2,000	232	214	
	Cobalt	2,200	DNE	16.2	6.9 J	
	Copper	1,500	1,300[e]	5.6	6 J	
	Lead	DNE	15[e]	6.6	5.4 J	
	Zinc	11,000	DNE	39.8	12.5 J	

Notes:

a — Tap water RBC from risk-based concentration table (USEPA, 1998a).
b — MCL from USEPA National Primary Drinking Water Standards (USEPA, 1996c).
c — Background RC. The RC is 2X the mean concentration of a constituent detected in samples collected from background monitoring wells screened in the fluvial deposits (E/A&H, 1996).
d — Initial sampling event in March 1995, following monitoring well installation. Only time fluvial deposits monitoring wells were sampled for metals.
e — Treatment technique action level (USEPA, 1996c).
DNE — Does not exist.
J — Metal was detected below the method reporting limit; value estimated.
U — Metal was below the instrument detection limit.
Bold — Exceeds RC and MCL.
ND — Not detected

000125

Comparison of Analytical Results from the Well Cluster at Boring 05SB04

Three wells were located at boring 05SB04 in the upper fluvial deposits to evaluate alternative drilling and well installation methods through shallow contamination zones[3]. Well 05MW04UF was installed using the standard rotasonic method for the initial Assembly A drilling, which consisted of permanent casing installed with a rotary rig followed by rotasonic drilling and well installation through the inside of the casing (described in Section 4.4.1). Experimental well 05MW04AUF was installed by pushing a permanent ungrouted surface casing through the loess (approximately 30 feet thick), followed by rotasonic drilling and well completion inside the casing. Experimental well 05MW04BUF was installed using the standard rotasonic method without installing a permanent surface casing.

Groundwater analytical results from the three wells were very similar, with the notable exception that carbon tetrachloride detections in wells 05MW04AUF and 05MW04BUF were higher than in 05MW04UF. The variation in concentrations is likely due to the spatial distribution of the contaminants in the fluvial deposits and not due to "carry down" of contaminants during drilling experimental wells 05MW04AUF and 05MW04BUF. Carbon tetrachloride was not detected in the overlying soil or loess groundwater. Bis(2-ethylhexyl)phthalate (BEHP) was in one well (05MW04AUF) and nitrobenzene was in another (05MW04BUF), but both were absent in 05MW04UF. BEHP and nitrobenzene concentrations were below the RBCs. Based on the BCT's review of the data generated from these three monitoring wells, it was decided that surface casings were not necessary for subsequent rotasonic drilling into the fluvial deposits.

[3] The 1992 UST investigation identified 1,2-dichloroethene and 1,2-dichlorobenzene in loess groundwater at well FFMW-5 (see Table 6-14), adjacent to the well cluster.

000126

6.4 Nature and Extent Summary

Soil

VOCs detected in surface soil at concentrations exceeding their RBCs include benzene and methylene chloride in a single surface soil sample from the area of the former fire extinguisher pits. Soil from this area was removed with the fire extinguisher pits during the earlier described VCA. SVOCs in surface soil were less than their RBCs, except for benzo(a)pyrene. The residential RBC for benzo(a)pyrene was exceeded in two surface soil samples, one from boring 05SB04 southeast of Mat 305 and one from boring 05SB07 northwest of Mat 392. However, groundwater samples from the corresponding monitoring wells contained no SVOCs exceeding their tap water RBCs or MCLs, indicating that SVOCs in soil were not leaching into groundwater. All herbicides in soil were less than their RBCs.

Dieldrin was the only pesticide in soil that exceeded its RBC value. Three surface soil samples contained dieldrin above its residential RBC of 40 μg/kg; however, only surface soil from boring 05SB04 contained dieldrin (290 μg/kg) above the 262 μg/kg RC established for surface soil at NSA Mid-South (E/A&H, 1997).

Aroclor-1260 was detected in three surface soil samples. However, its highest detection of 233 μg/kg was below its residential RBC value of 320 μg/kg.

Five surface soil samples were submitted for dioxin analysis from the former concrete-lined fire fighter extinguisher pit area. Four of the five samples contained dioxin-equivalent concentrations ranging from 0.013 to 0.037 μg/kg, which exceeded the residential RBC of 0.0043, but not the industrial RBC of 0.038 μg/kg.

No metals exceeded their RC and RBC in surface soil.

000127

Soil-to-Groundwater Cross-Media Transfer

Organics that exceeded their SSL are acetone, benzene, ethylbenzene, toluene, xylenes, methylene chloride, trichloroethylene, tetrachloroethylene, 1,2-dichloropropane, naphthalene, 2-ethylnaphthalene, benzo(a)anthracene, and dieldrin. Metals in surface and subsurface soil at concentrations exceeding their SSL and background RC are barium, cadmium, chromium, selenium, and nickel. Table 6-12 (shown previously) lists the metals exceeding their SSL and the frequency of exceedances. Sample locations and contaminants that exceeded their SSL and RC (for inorganics) were shown previously on Figure 6-5.

Groundwater

Loess Groundwater

VOCs and metals were identified in loess groundwater at concentrations exceeding regulatory screening values. The highest VOC concentrations were in loess well FFMW-8, which indicated a benzene concentration of 3,900 μg/L, exceeding its tap water RBC (0.36 μg/L) and MCL (5 μg/L), and a methylene chloride concentration of 31 μg/L, exceeding its tap water RBC (4.1 μg/L) and MCL (5 μg/L). However, removal of the fire extinguisher pits and surrounding contaminated soil during the VCA indicate removal of the source area for these contaminants, as benzene and methylene chloride were absent in the FFMW-8 replacement well. FFMW-5 indicated TCE (2 μg/L) exceeding its tap water RBC (1.6 μg/L), but not its MCL (5 μg/L). Loess wells FFMW-11 and FFMW-9 indicated benzene (280 μg/L and 5 μg/L respectively) exceeding or meeting its MCL (5 μg/L) and exceeding its tap water RBC (0.36 μg/L).

The initial RFI sampling event identified the following metals in loess wells at concentrations exceeding their MCLs and RCs: antimony (FFMW-5), arsenic (FFMW-8 and FFMW-4), and cadmium (05MW03S, FFMW-4, FFMW-5, FFMW-6, 05MW06S, and FFMW-8). However, analytical data from a second sampling event indicated that these metals were likely the result of

turbidity content in the samples due to a significant reduction in concentrations during the second sampling event — these metals were not detected during the second sampling event. Each metal is discussed below by well.

- In a groundwater sample from loess well FFMW-4, arsenic exceeded the RC and tap water RBC, but not the MCL. Cadmium also exceeded its RC and MCL in this well. Results are listed below in μg/L:

	Arsenic	**Cadmium**
FFMW-4	11.2	7.9
RC	7.3	5.9
Tap Water RBC	0.045	18
MCL	50	5

- Groundwater from loess well FFMW-5 contained antimony (64.8 μg/L) exceeding its RC (50.1 μg/L), tap water RBC (15 μg/L), and MCL (6 μg/L). However, during the second sampling of this well (Event 1 of long-term monitoring), antimony was not detected. In well FFMW-5's initial sampling, cadmium exceeded its RC and MCL and arsenic exceeded its RBC. Cadmium and arsenic were not detected during the second sampling event, possibly suggesting false positives associated with turbidity during the initial sampling event. During the 1992 UST investigation, arsenic, cadmium, and lead exceeded their regulatory screening values and RCs in this well.

- A groundwater sample from loess well FFMW-8 indicated arsenic (159 μg/L) exceeding its RC, tap water RBC, and MCL, and cadmium (8.5 μg/L) exceeding its RC and MCL. Earlier sampling of this well during the 1992 UST investigation identified concentrations of the following exceeding their regulatory screening criteria: arsenic (82.5 μg/L), cadmium (14.4 μg/L), and lead (26.7 μg/L).

000129

- A groundwater sample from loess well 05MW03S indicated cadmium (6.1 μg/L) exceeding its RC and MCL, but not its tap water RBC, and arsenic (8.8 μg/L) exceeding its RC and tap water RBC, but not its MCL. Arsenic and cadmium were not detected during the second sampling event of this well (Event 1 of long-term monitoring).

- Groundwater from loess well 05MW06S indicated arsenic (8.3 μg/L) exceeding its RC and tap water RBC, but not its MCL, cadmium (18.1 μg/L) exceeding its RC, tap water RBC, and MCL, and lead (56.4 μg/L) exceeding its RC and TTAL. During the second sampling event, these metals were not detected.

- A groundwater sample from loess well FFMW-6 indicated arsenic (8.6 μg/L) exceeding its RC and tap water RBC, but not its MCL. A sample from this well during the 1992 UST investigation indicated a similar arsenic concentration (12.9 μg/L) as well as a cadmium concentration (9.1 μg/L) above its MCL (5 μg/L) and RC (5.9 μg/L).

- During the UST investigation groundwater from FFMW-11 indicated arsenic (26.2 μg/L) exceeding its tap water RBC (0.045 μg/L) and RC (7.3 μg/L), and cadmium (11.3 μg/L) above its MCL (5 μg/L) and RC (5.9 μg/L). Benzene was also detected in this well at 280 μg/L, which exceeds its tap water RBC (0.36 μg/L) and MCL (5 μg/L).

Fluvial Deposits Groundwater

VOCs and one metal were identified in groundwater samples from the fluvial deposits monitoring wells. The following VOCs were detected at concentrations exceeding either their tap water RBC or MCL: carbon tetrachloride, chloromethane, and chloroform. However, chloromethane and chloroform were not consistently detected. Chloromethane was detected in one of six sampling events. It exceeded its tap water RBC (1.4 μg/L) at well 05MW01UF (5 μg/L were detected during Event 2 of long term monitoring). An MCL has not been established for chloromethane.

Chloroform, detected in one of four sampling events, exceeded its tap water RBC (0.15 μg/L) at well 05MW04BUF with 1 μg/L; however, the detected concentration was below the 100 μg/L MCL.

Conversely, carbon tetrachloride has persisted in the upper fluvial well cluster 05MW04UF, 05MW04AUF, and 05MW04BUF with concentrations reaching 10 μg/L, exceeding the tap water RBC (0.16 μg/L) and MCL (5 μg/L). In an effort to identify the extent and possible source areas of the carbon tetrachloride, a June 1998 DPT investigation encircled the well with sample locations from soil and groundwater (both loess and fluvial deposits). Carbon tetrachloride and TCE both exceeded their MCLs (maximums of 6.7 μg/L and 5.3 μg/L) in the upper fluvial deposits groundwater; however, the data do not suggest a source area and indicate that contaminants are limited spatially to the immediate area of the well cluster. Lower fluvial well 005G08LF, situated down gradient from the focused study area to evaluate the presence of chlorinated hydrocarbons at the base of the fluvial deposits, indicated chlorinated hydrocarbons were absent in groundwater there.

A cadmium concentration of 5.4 μg/L was detected at well 05MW02UF, exceeding its RC (3.9 μg/L) and MCL (5 μg/L). Lead was detected in well 05MW01UF at a concentration 32.8 μg/L, which exceeds its RC (6.6 μg/L) and TTAL (15 μg/L). However, resampling of both wells in February 1999 indicated lead and cadmium were absent.

000131

7.0 HUMAN HEALTH RISK ASSESSMENT

A baseline risk assessment (BRA) analyzes the potential adverse effects on actual or hypothetical human and ecological receptors arising from exposures to hazardous substances released from a site, assuming no remedial actions are taken to reduce the extent of environmental contamination. The information below documents the SWMU 5 RFI results and other information used to make SWMU 5 risk management decisions.

Most BRAs are divided into two parts: one assesses human health risk and the other assesses ecological risk. This section focuses on human health risk at SWMU 5 at NSA Mid-South while Section 8 assesses ecological risk. The methods used in the human health risk assessment (HHRA) are discussed in EnSafe's February 4, 1997, Technical Memorandum, *Revision 1: General Human Health Risk Assessment (HHRA) Approach for NSA Memphis*, (E/A&H, 1997) included in Appendix I.

7.1 Site Background and Investigative Approach

SWMU 5, the Aircraft Fire Fighting Training Facility (AFFTF) on Dakar Street on the NSA Mid-South Northside, is bounded to the south by Navy Road and the Navy Exchange service station, to the east by a wooded area and the Carrier Deck Fire Fighting Training Facility, and to the north and west by a drainage ditch (SWMU 4). A site and vicinity map of SWMU 5 is in Figure 1-1.

The AFFTF contained two circular fire mats until November 1997 when the east fire mat was removed during the VCA. During training operations, mock cockpits were sprayed with jet fuel and ignited. Firefighters extinguished blazes with high-pressure water or foam sprays. Several spills and releases (Section 1) and the data from previous investigations (Section 3) resulted in SWMU 5, which was active from 1949 to 1996, being considered an RFI site.

Level III and Level IV QA/QC data validation was performed as detailed in the DQOs and outlined in the *Comprehensive RFI Work Plan*. CLP-type deliverables and reporting requirements were obtained to facilitate data validation. Appendix IX metals were included in the analyte list and TPH was analyzed using USEPA Method 418.1. Specific analytes are listed in Section 4 and RFI soil boring locations are shown in Figure 4-1 (boring designations 05SB01 through 05SB07). Groundwater sample locations are shown in Figure 4-2 and discussed in Section 4.2. The nature and extent of contaminants reported in soil and groundwater are discussed in Section 6 of this RFI.

Soil Investigations

The 1992 USGS IM investigation studied the AFFTF and drainage ditch network around a proposed fire fighting training mat north of the present facility. Ten soil borings were completed in the proposed area and 12 sediment samples were collected from the drainage ditch network. Samples were analyzed for VOCs, SVOCs, TPH, cyanide, pesticides/PCBs, and Appendix IX metals. TPH and individual petroleum contaminants were detected in only one boring, approximately 100 feet north of Mat 305, and near boring and well FFMW-8. TPH was also detected in several ditch sediment samples. Low concentrations of dieldrin were detected in surface soil samples and ditch sediment samples; its presence has been attributed to aerial application during the 1950s and 1960s by the USDA to control the spread of the white-fringed beetle. Dieldrin at NSA Mid-South is discussed in Appendix B.

Surface soil (0 to 1 foot) was sampled at six locations for the RFI. IM and UST investigation data were included in this HHRA because limited surface soil data were available from the RFI investigation and surface soil data from these investigations were collected from an area not sampled during the RFI. These data, collected from soil 0 to 2 feet deep at seven IM and two UST investigation sampling locations, were combined with the RFI surface soil data. Although the use of data from the 0 to 2 foot depth deviates from Region 4 guidance, these data were used to supplement the data set for the site. Consequently, 14 total surface soil samples were assumed to

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represent SWMU 5. Table 7-1 lists by sample designation chemicals reported in surface soil for the combined data set.

Subsurface soil was sampled at seven locations for the RFI, 15 locations for the UST investigations and six locations for the IM investigation. The sample depths for samples collected varied for each investigation. However, there were no sample data collected beyond 13 foot bls interval. Table 7-2 lists by sample designation the chemicals reported in subsurface soil for the combined data set.

Groundwater Investigations

Four loess wells were sampled during the 1992 UST investigation for VOCs. Three of the UST wells (FFMW-5, FFMW-6, and FFMW-8), five additional loess wells, and seven fluvial deposits monitoring wells (location 05MW04 had three co-located wells) were sampled during the initial RFI sampling effort. In June 1998, five loess and five fluvial deposits monitoring wells were sampled during the DPT investigation. Because monitoring wells were sampled multiple times, the maximum detected concentration from each well was reported. Tables 7-3 and 7-4 summarize the chemicals detected in loess and fluvial deposits groundwater, respectively.

The second sampling event at FFMW-5 yielded more recent data and identified more organic and inorganic compounds. Subsequent groundwater sampling events are discussed in Section 6.

In February 1999 replacement well FFMW-8 (the original well FFMW-8 was removed during the VCA) was sampled and groundwater was analyzed for VOCs. During this sampling event monitoring wells 05MW01UF and 05MW02UF were sampled and groundwater was analyzed for cadmium and lead. Because this data was obtained after the HHRA was completed, it was not addressed quantitatively. However, the results of the data is discussed in Section 7.6 (Uncertainty Analysis).

Table 7.1
Chemicals Reported in SWMU 5 Surface Soil for UST, IM, RFI Sampling Events
NSA Mid-South SWMU 5
Memphis, Tennessee

	RFI Surface Soil (0-1') Sample Designation						IM Surface Soil (0-2') Sample Designation						UST Surface Soil (0-2') Sample Designation
Chemical	005S000101	005S000201	005S000301	005S000401	005S000601	005S000701	IM-B-1-0	IM-B-2-0	IM-B-3-0	IM-B-5-0	IM-B-6-0	IM-B-7-0	B-07-2
4,4'-DDT	ND	ND	ND	0.011	ND	5.3	ND	ND	ND	ND	ND	ND	NA
Aroclor-1260	ND	ND	0.057	0.09	ND	47	ND	ND	ND	ND	ND	ND	NA
Acetone	ND	ND	ND	ND	ND	ND	4.6	ND	ND	ND	0.3	ND	NA
* Arsenic	7.2	6.7	6.6	11	8.3	7.7	ND	ND	ND	5.7	3.7	5.9	12
* Barium	93.5	55.5	164	261	192	181	154	273	146	194	273	148	151
Benzo(a)anthracene	ND	ND	ND	0.06	ND	140	ND	ND	ND	ND	ND	ND	ND
Benzo(a)pyrene	ND	ND	ND	0.081	ND	150	ND	ND	ND	ND	ND	ND	ND
Benzo(b)fluoranthene	ND	ND	ND	0.08	ND	140	ND	ND	ND	ND	ND	ND	ND
Benzo(g,h,i)perylene	ND	ND	ND	0.057	ND	0.08	ND	ND	ND	ND	ND	ND	ND
Benzo(k)fluoranthene	ND	ND	ND	0.078	ND	130	ND	ND	ND	ND	ND	ND	ND
Benzene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	2500
* Beryllium	0.56	0.43	0.86	0.81	0.72	0.64	0.51	1	0.5	0.7	0.8	0.6	0.72
* Cadmium	3.2	2.4	3	3.4	3.2	3	0.6	ND	0.9	ND	0.8	1	ND
* Chromium	13	12.8	11.1	15.2	20	19.2	12	10.3	14.5	9.6	12.3	10.7	ND
Chrysene	ND	ND	ND	0.077	ND	0.14	ND	ND	ND	ND	ND	ND	ND
* Cobalt	13.3	5.5	6.5	7.6	8.1	7.5	6.6	7.3	5.5	6.8	7.4	4.5	10.6
* Copper	14.1	13.3	14.3	16.1	17.4	17.9	17.8	11.3	12.8	11.1	12.7	10.7	17.4
Dieldrin	0.022	0.043	0.1	0.29	0.015	0.029	0.3	0.8	1	0.1	0.2	0.5	NA
Fluoranthene	ND	ND	0.044	0.15	ND	0.18	ND	ND	ND	ND	ND	ND	ND
Heptachlor epoxide	ND	ND	ND	0.0028	ND	ND	ND	ND	ND	ND	ND	ND	NA
Indeno(1,2,3-cd)pyrene	ND	ND	ND	0.05	ND	0.07	ND	ND	ND	ND	ND	ND	ND
* Lead	11.4	12	16.7	22.8	16.9	30.7	6.2	19	19.3	14.4	12.3	22.6	ND
MCPA	19	ND	ND	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA
* Mercury	0.13	ND	ND	0.14	ND	ND	ND	ND	ND	ND	ND	ND	ND
* Nickel	11.3	11.5	14.4	16.1	14.5	17.3	14.0	17.2	12.8	13.8	22.5	11.1	14.4
Phenanthrene	ND	ND	ND	0.05	ND	ND	ND	ND	ND	ND	ND	ND	ND
Pyrene	ND	ND	ND	0.12	ND	0.17	ND	ND	ND	ND	ND	ND	ND
* Selenium	0.51	ND	ND	ND	0.5	ND	ND	ND	ND	ND	ND	ND	ND
* Silver	1.2	ND	ND	ND	1.1	ND	1.1	1.2	ND	1	ND	ND	ND
Thallium	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.28
Tin	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	7.7
* Vanadium	36	28.7	23.3	27.3	24.8	26.9	18.4	21.5	15.9	19.7	19.6	18.1	36.4
* Zinc	46.2	44.3	56.9	75.6	63.5	73.1	46.5	47.9	53.4	44.5	58.4	50.9	63.5
bis(2-Ethylhexyl)phthalate (BEHP)	ND	0.014	ND	ND	ND	0.07	ND	ND	ND	ND	ND	ND	ND

Notes:

ND = Chemical analyzed for but not detected at specified detection limit.
NA = Chemical not analyzed for this sample
* = Inorganics reported in milligrams per kilogram; organic compounds were reported in micrograms per kilogram

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Chemicals Reported in Subsurface Soil for UST, IM, and RFI Sampling Events
NSA Mid-South SWMU 5
Memphis, Tennessee

	UST INVESTIGATION DATA												
Parameter	B-04-8	B-07-8	B-09-4	MW-02-6	MW-05-6	MW-05-8	MW-06-4	MW-06-6	MW-06-8	MW-07-4	MW-07-6	MW-11-3	MW-11-4
1,1,1-Trichloroethane	NA	NA	ND	ND	NA	ND	ND	ND	NA	NA	ND	ND	ND
1,2-Dichloropropane	NA	NA	ND	ND	NA	ND	ND	ND	NA	NA	ND	ND	ND
2,4,5-T	NA	NA	NA	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA
2-Butanone (MEK)	NA	NA	ND	ND	NA	ND	ND	ND	NA	NA	ND	ND	ND
2-Hexanone	NA	NA	ND	ND	NA	ND	ND	ND	NA	NA	ND	ND	ND
2-Methylnaphthalene	NA	NA	3	3.9	ND	NA	0.1	NA	NA	NA	ND	18	NA
Acenaphthene	NA	NA	ND	ND	ND	NA	ND	NA	NA	NA	ND	0.44	NA
Acetone	NA	NA	15	ND	NA	0.12	ND	0.017	NA	NA	ND	ND	ND
Aldrin	NA	NA	NA	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA
Arsenic	NA	NA	7.2	10.5	14.7	NA	2.5	NA	NA	NA	ND	11.3	NA
Barium	NA	NA	151	153	312	NA	272	NA	NA	NA	ND	201	NA
Benzene	ND	2.8	ND	4.8	ND	ND	ND	0.003	ND	0.5	ND	ND	6.5
Beryllium	NA	NA	0.77	0.73	0.74	NA	0.77	NA	NA	NA	NA	0.750	NA
Cadmium	NA	NA	ND	ND	ND	NA	0.96	NA	NA	NA	NA	ND	NA
Chromium	NA	NA	13.4	14.6	16.5	NA	15.3	NA	NA	NA	NA	16.400	NA
Cobalt	NA	NA	9.2	7	14.5	NA	10.7	NA	NA	NA	NA	8.200	NA
Copper	NA	NA	10.8	15.1	12.7	NA	10.2	NA	NA	NA	NA	17.900	NA
Dieldrin	NA	NA	NA	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA
Ethylbenzene	ND	ND	ND	19	NA	ND	ND	0.062	ND	ND	ND	ND	20
Fluoranthene	NA	NA	ND	1.4	ND	NA	ND	NA	NA	NA	NA	ND	NA
Heptachlor epoxide	NA	NA	ND	ND	NA	NA	ND	NA	NA	NA	NA	NA	NA
Lead	NA	NA	14.2	9.1	11.7	NA	10.2	NA	NA	NA	NA	10.4	NA
MCPA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Mercury	NA	NA	0.03	0.03	0.04	NA	0.04	NA	NA	NA	NA	0.040	NA
Methylene chloride	NA	NA	0.4	ND	NA	0.006	ND	0.008	NA	NA	NA	ND	0.69
Naphthalene	NA	NA	0.53	3	ND	NA	0.28	NA	NA	NA	NA	4.1	NA
Nickel	NA	NA	13	17.4	27	NA	14.4	NA	NA	NA	NA	21.4	NA
Phenanthrene	NA	NA	ND	1.8	ND	NA	ND	NA	NA	NA	NA	ND	NA
Pyrene	NA	NA	ND	1.1	ND	NA	ND	NA	NA	NA	NA	ND	NA
Selenium	NA	NA	ND	ND	ND	NA	0.26	NA	NA	NA	NA	ND	NA
Silver	NA	NA	ND	ND	ND	NA	ND	NA	NA	NA	NA	ND	NA
Tetrachloroethene	NA	NA	ND	ND	NA	ND	ND	ND	NA	NA	NA	ND	ND
Thallium	NA	NA	ND	0.27	0.27	NA	ND	NA	NA	NA	NA	0.29	NA
Tin	NA	NA	8	3.9	4.1	NA	6.9	NA	NA	NA	NA	5.5	NA
Toluene	ND	2.4	ND	1.6	NA	ND	ND	0.2	ND	0.8	ND	ND	4.5
Trichloroethene	NA	NA	ND	ND	NA	ND	ND	ND	NA	NA	NA	ND	ND
Vanadium	NA	NA	36.5	27.5	34.5	NA	25.9	NA	NA	NA	NA	33	NA
Xylene (Total)	6.7	7.7	1.5	26	NA	ND	ND	5.1	0.4	17	0.2	ND	120
Zinc	NA	ND	41.9	55.2	67.6	NA	58.2	NA	ND	ND	ND	67.5	NA
bis(2-Ethylhexyl)phthalate	NA	NA	0.32	ND	0.37	NA	0.18	NA	NA	NA	NA	0.420	NA

Notes:
ND = Parameter analyzed for but not detected at specified quantitation limit.
NA = Parameter not analyzed for this sample.
All units are milligrams per kilogram.

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Table 7.2
Chemicals Reported in Subsurface Soil for UST, IM, and RFI Sampling Events
NSA Mid-South SWMU 5
Memphis, Tennessee

	RFI DATA												
Parameter	005S000108	005SGB0110	005S000112	005S000208	005S000210	005S000307	005S000317	005S000405	005S000410	005S000607	005S000612	005S000710	005S000712
1,1,1-Trichloroethane	ND	0.005	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,2-Dichloropropane	ND	0.01	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,4,5-T	ND	ND	ND	0.004	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-Butanone (MEK)	ND	0.014	ND	ND	ND	ND	ND	0.02	ND	ND	ND	ND	ND
2-Hexanone	ND	0.006	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-Methylnaphthalene	ND	ND	ND	ND	ND	ND	ND	0.15	ND	ND	ND	ND	ND
Acenaphthene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Acetone	ND	0.095	ND	ND	ND	ND	ND	0.11	0.01	ND	ND	ND	ND
Aldrin	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Arsenic	10.3	ND	7.8	12.2	10.1	8.1	9.5	2.7	6.5	7.5	3.5	11.9	2.6
Barium	162	ND	123	171	116	177	104	219	286	228	104	375	106
Benzene	ND	0.002	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Beryllium	0.510	ND	0.400	0.550	0.44	0.9	0.53	0.77	0.56	0.88	0.47	1.1	0.45
Cadmium	3.1	ND	2.4	3.7	2.8	2.3	2.7	3	3.6	4	2.8	8.1	2.3
Chromium	12.400	ND	9.200	12.500	10.2	11.1	16.7	17.2	15.1	20.6	17.4	32.8	15.3
Cobalt	7.300	ND	6.700	9.400	7.4	6.2	7.8	6.1	13.6	6.9	6.9	15.8	6.8
Copper	16.500	ND	13.800	18.900	16.3	16.2	16.1	18.7	17.6	21.5	13.2	29.6	12.4
Dieldrin	ND	ND	ND	ND	ND	0.045	ND	0.008	ND	0.103	ND	ND	ND
Ethylbenzene	ND	0.004	ND	ND	ND	ND	ND	0.005	ND	ND	ND	ND	ND
Fluoranthene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Heptachlor epoxide	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.012	ND	ND	ND
Lead	10.800	ND	6.600	11.900	11.7	18.2	10.7	8	8.4	11.9	10.4	26.4	8.4
MCPA	ND	ND	ND	4.500	ND	ND	ND	ND	ND	ND	ND	ND	ND
Mercury	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Methylene chloride	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Naphthalene	ND	ND	ND	ND	ND	ND	ND	0.13	ND	ND	ND	ND	ND
Nickel	19.000	ND	16.100	25.000	14.8	11.4	18.4	15.1	18.9	23.8	14.6	36	15.7
Phenanthrene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Pyrene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Selenium	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Silver	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Tetrachloroethene	ND	0.025	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Thallium	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Tin	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Toluene	ND	0.002	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Trichloroethene	ND	0.003	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Vanadium	25.900	ND	16.000	26.200	19.2	20.1	26.1	24.6	25.9	29.6	29.9	46.5	30.1
Xylene (Total)	ND	0.018	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Zinc	54.600	ND	46.600	64.300	54	64.3	60.6	76.9	63.9	84.6	54	121	45.4
bis(2-Ethylhexyl)phthalate	ND	ND	ND	ND	ND	ND	0.051	ND	ND	0.057	0.064	0.064	0.096

Notes:
ND = Parameter analyzed for but not detected at specified quantitation limit
NA = Parameter not analyzed for this sample.
All units are milligrams per kilogram.

Ta... 7.2
Chemicals Reported in Subsurface Soil for UST, IM, and RFI Sampling Events
NSA Mid-South SWMU 5
Memphis, Tennessee

Parameter	INTERIM MEASURES INVESTIGATION DATA										
	IM-B-11-6	IM-B-1-4	IM-B-2-10	IM-B-2-5	IM-B-3-10	IM-B-3-5	IM-B-5-10	IM-B-5-5	IM-B-6-10	IM-B-6-5	IM-B-7-5
1,1,1-Trichloroethane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,2-Dichloropropane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,4,5-T	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-Butanone (MEK)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-Hexanone	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-Methylnaphthalene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Acenaphthene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Acetone	0.35	ND	ND	ND	ND	ND	ND	ND	ND	0.22	0.96
Aldrin	0.01	0.01	0.01	ND	0.01	ND	0.01	ND	0.01	ND	ND
Arsenic	0.57	0.57	9.7	1.8	6	4.6	6.8	1.5	1.5	4.1	ND
Barium	58.4	173	152	158	76.1	276	178	153	92.5	175	125
Benzene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Beryllium	0.27	0.66	0.36	0.57	0.27	0.49	0.38	0.54	0.38	0.59	0.47
Cadmium	ND	ND	ND	ND	ND	0.78	ND	ND	ND	ND	ND
Chromium	6.4	12	9.4	11.8	8.6	9.8	9.2	11.4	10.4	12.2	11.2
Cobalt	4.9	2.5	5	2.3	3.8	7.8	8.8	4	3.2	5.4	2.5
Copper	7.7	11.2	11.3	10.4	9.7	12.9	11.8	10.7	8.6	13.1	8.8
Dieldrin	ND	ND	ND	0.07	ND	ND	ND	0.04	ND	0.07	0.1
Ethylbenzene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Fluoranthene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Heptachlor epoxide	ND	ND	ND	ND	ND	0.01	ND	ND	ND	ND	ND
Lead	6.2	7.3	6.2	6.2	5.2	6.3	7.8	10.6	3.9	14.8	7.4
MCPA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Mercury	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Methylene chloride	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Naphthalene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Nickel	8.9	12.6	17.3	12.9	11.7	22.9	16.5	11.4	11.6	13.5	13.8
Phenanthrene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Pyrene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Selenium	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Silver	ND	ND	ND	ND	ND	1.2	ND	ND	ND	ND	ND
Tetrachloroethene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Thallium	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Tin	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Toluene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Trichloroethene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Vanadium	10.6	8.6	14.5	12.0	11.5	17.9	16.4	12.0	10.8	14.7	12
Xylene (Total)	ND	0.52	ND	ND	ND	ND	ND	ND	ND	ND	ND
Zinc	31.4	61.3	47.9	53.3	33.8	53.2	44.2	53.2	47.3	58.8	47.8
bis(2-Ethylhexyl)phthalate	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

Notes:
ND = Parameter analyzed for but not detected at specified quantitation limit.
NA = Parameter not analyzed for this sample.
All units are milligrams per kilogram.

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Table 7.3
Chemicals Reported in Loess Groundwater for UST, RFI, and DPT Sampling Events
NSA Mid-South SWMU 5
Memphis, Tennessee

Sample	Chemical	UST	RFI and Subsequent Long-term Sampling Events						DPT	Sample Location
			Initial	Event 1	Event 2	Event 3	Event 4	Event 5		Max
05MW03LS	Arsenic	NS	8.8	ND	NS	NS	NS	NS	NS	8.8
	Barium	NS	394	152	NS	NS	NS	NS	NS	394
	Cadmium	NS	6.1	ND	NS	NS	NS	NS	NS	6.1
	Chromium	NS	19.4	16.4	NS	NS	NS	NS	NS	19.4
	Cobalt	NS	7.4	ND	NS	NS	NS	NS	NS	7.4
	Copper	NS	26.9	11.8	NS	NS	NS	NS	NS	26.9
	Lead	NS	13.4	2.2	NS	NS	NS	NS	NS	13.4
	Naled	NS	2.8	ND	NS	NS	NS	NS	NS	2.8
	Nickel	NS	37.5	ND	NS	NS	NS	NS	NS	37.5
	Tin	NS	ND	40.9	NS	NS	NS	NS	NS	40.9
	Vanadium	NS	29.3	5.2	NS	NS	NS	NS	NS	29.3
	Zinc	NS	130	ND	NS	NS	NS	NS	NS	130
FFMW-4	Arsenic	NS	11.2	NS	NS	NS	NS	NS	NS	11.2
	Barium	NS	441	NS	NS	NS	NS	NS	NS	441
	Beryllium	NS	2.1	NS	NS	NS	NS	NS	NS	2.1
	Cadmium	NS	7.9	NS	NS	NS	NS	NS	NS	7.9
	Chromium	NS	31	NS	NS	NS	NS	NS	NS	31
	Cobalt	NS	11.7	NS	NS	NS	NS	NS	NS	11.7
	Copper	NS	46.7	NS	NS	NS	NS	NS	NS	46.7
	Lead	NS	17.3	NS	NS	NS	NS	NS	NS	17.3
	Nickel	NS	39.8	NS	NS	NS	NS	NS	NS	39.8
	Vanadium	NS	43.2	NS	NS	NS	NS	NS	NS	43.2
	Zinc	NS	132	NS	NS	NS	NS	NS	NS	132
FFMW-5	1,2-Dichlorobenzene	NS	6	6	NS	NS	NS	NS	NS	6
	1,2-Dichloroethene (total)	NS	8	3	NS	1	2.6	1.4	NS	8
	Antimony	ND	64.8	ND	NS	NS	NS	NS	NS	64.8
	Arsenic	20.9	14.2	ND	NS	NS	NS	NS	NS	20.9
	Barium	617	1400	142	NS	NS	NS	NS	NS	1400
	Beryllium	4	3.7	ND	NS	NS	NS	NS	NS	4
	Cadmium	11.3	8.3	ND	NS	NS	NS	NS	NS	11.3
	Chromium	92.4	45.4	ND	NS	NS	NS	NS	NS	92.4
	Chlorobenzene	NS	2	ND	NS	ND	ND	ND	NS	2
	Cobalt	36.6	21.3	ND	NS	NS	NS	NS	NS	36.6
	Copper	60.1	71.5	7.1	NS	NS	NS	NS	NS	71.5
	Lead	37.7	22.6	2.9	NS	NS	NS	NS	NS	37.7
	Mercury	ND	0.63	ND	NS	NS	NS	NS	NS	0.63
	Naled	NS	4.3	ND	NS	NS	NS	NS	NS	4.3
	Nickel	88.4	69.5	ND	NS	NS	NS	NS	NS	88.4
	Silver	9.7	ND	ND	NS	NS	NS	NS	NS	9.7
	Tin	381	ND	63.5	NS	NS	NS	NS	NS	381
	Trichloroethene	NS	2	1	NS	ND	ND	0.59	NS	2
	Vanadium	73.6	74.4	ND	NS	NS	NS	NS	NS	74.4
	Zinc	217	233	ND	NS	NS	NS	NS	NS	233
FFMW-6	Acetone	NS	27	ND	NS	NS	ND	ND	NS	27
	Arsenic	12.9	8.6	NS	NS	NS	NS	NS	NS	12.9
	Barium	183	138	NS	NS	NS	NS	NS	NS	183
	Cadmium	9.1	ND	NS	NS	NS	NS	NS	NS	9.1
	Chromium	42.2	ND	NS	NS	NS	NS	NS	NS	42.2
	Cobalt	22.9	3.9	NS	NS	NS	NS	NS	NS	22.9
	Copper	17.8	ND	NS	NS	NS	NS	NS	NS	17.8
	Lead	ND	2	NS	NS	NS	NS	NS	NS	2
	Naled	NS	3	ND	NS	NS	NS	NS	NS	3
	Naphthalene	NS	ND	3	NS	NS	NS	NS	NS	3
	Nickel	37.9	ND	NS	NS	NS	NS	NS	NS	37.9
	Silver	10.6	ND	NS	NS	NS	NS	NS	NS	10.6
	Tin	317	ND	NS	NS	NS	NS	NS	NS	317
	Vanadium	33.3	ND	NS	NS	NS	NS	NS	NS	33.3
	Zinc	46	ND	NS	NS	NS	NS	NS	NS	46
05MW06LS	Arsenic	NS	8.3	ND	NS	NS	NS	NS	NS	8.3
	Barium	NS	714	123	NS	NS	NS	NS	NS	714
	Beryllium	NS	2.8	ND	NS	NS	NS	NS	NS	2.8
	Cadmium	NS	18.1	ND	NS	NS	NS	NS	NS	18.1
	Chromium	NS	59.9	ND	NS	NS	NS	NS	NS	59.9
	Cobalt	NS	37.2	ND	NS	NS	NS	NS	NS	37.2
	Copper	NS	89.6	5.2	NS	NS	NS	NS	NS	89.6
	Lead	NS	56.4	ND	NS	NS	NS	NS	NS	56.4
	Nickel	NS	94.2	ND	NS	NS	NS	NS	NS	94.2
	Tin	NS	ND	46.2	NS	NS	NS	NS	NS	46.2
	Vanadium	NS	102	ND	NS	NS	NS	NS	NS	102
	Zinc	NS	551	ND	NS	NS	NS	NS	NS	551

Table 7.3
Chemicals Reported in Loess Groundwater for UST, RFI, and DPT Sampling Events
NSA Mid-South SWMU 5
Memphis, Tennessee

Sample	Chemical	UST	RFI and Subsequent Long-term Sampling Events Initial	Event 1	Event 2	Event 3	Event 4	Event 5	DPT	Sample Location Max
05MW07LS	Arsenic	NS	2.6	ND	NS	NS	NS	NS	NS	2.6
	Barium	NS	256	267	NS	NS	NS	NS	NS	267
	Cadmium	NS	ND	3.2	NS	NS	NS	NS	NS	3.2
	Chromium	NS	ND	40.2	NS	NS	NS	NS	NS	40.2
	Cobalt	NS	ND	6.3	NS	NS	NS	NS	NS	6.3
	Copper	NS	ND	20.4	NS	NS	NS	NS	NS	20.4
	delta-BHC	NS	ND	0.027	NS	NS	NS	NS	NS	0.027
	Lead	NS	ND	5.8	NS	NS	NS	NS	NS	5.8
	Naphthalene	NS	ND	2	NS	NS	NS	NS	NS	2
	Nickel	NS	ND	37.3	NS	NS	NS	NS	NS	37.3
	Tin	NS	ND	52.1	NS	NS	NS	NS	NS	52.1
	Vanadium	NS	4.5	12.5	NS	NS	NS	NS	NS	12.5
	Zinc	NS	53.7	113	NS	NS	NS	NS	NS	113
	2-Methylnaphthalene	NS	100	NS	NS	NS	NS	NS	NS	100
	Acenaphthene	NS	3	NS	NS	NS	NS	NS	NS	3
FFMW-8	Arsenic	82.5	159	NS	NS	NS	NS	NS	NS	159
	Barium	3.8	564	NS	NS	NS	NS	NS	NS	564
	Benzene	NS	3,900	NS	NS	1900	3200	NS	NS	3900
	Cadmium	14.4	8.5	NS	NS	NS	NS	NS	NS	14.4
	Chromium	70	ND	NS	NS	NS	NS	NS	NS	70
	Cobalt	46.8	7.8	NS	NS	NS	NS	NS	NS	46.8
	Copper	68.2	ND	NS	NS	NS	NS	NS	NS	68.2
	Ethylbenzene	NS	30	NS	NS	ND	ND	NS	NS	30
	Lead	26.7	4.5	NS	NS	NS	NS	NS	NS	26.7
	Methylene chloride	NS	31	NS	NS	ND	ND	NS	NS	31
	Naphthalene	120	NS	NS	NS	NS	NS	NS	NS	120
	Nickel	98.8	56.4	NS	NS	NS	NS	NS	NS	98.8
	Phenol	NS	98	NS	NS	NS	NS	NS	NS	98
	Silver	14.7	ND	NS	NS	NS	NS	NS	NS	14.7
	Tin	514	ND	NS	NS	NS	NS	NS	NS	514
	Vanadium	81.4	ND	NS	NS	NS	NS	NS	NS	81.4
	Zinc	ND	26.7	NS	NS	NS	NS	NS	NS	26.7
FFMW-9	Arsenic	NS	2.7	NS	NS	NS	NS	NS	NS	2.7
(05MW09FF)	Barium	NS	407	NS	NS	NS	NS	NS	NS	407
	Benzene	NS	5	NS	NS	ND	ND	NS	NS	5
	Beryllium	NS	1.4	NS	NS	NS	NS	NS	NS	1.4
	Cobalt	NS	4.2	NS	NS	NS	NS	NS	NS	4.2
	Lead	NS	4.6	NS	NS	NS	NS	NS	NS	4.6
	Mercury	NS	0.23	NS	NS	NS	NS	NS	NS	0.23
	Nickel	NS	27.8	NS	NS	NS	NS	NS	NS	27.8
	Vanadium	NS	4.8	NS	NS	NS	NS	NS	NS	4.8
	Zinc	NS	61.5	NS	NS	NS	NS	NS	NS	61.5
FFMW-11	Benzene	280	NS	NS	NS	NS	NS	NS	NS	280
	Toluene	1	NS	NS	NS	NS	NS	NS	NS	1
	Ethylbenzene	13	NS	NS	NS	NS	NS	NS	NS	13
	Xylenes	83	NS	NS	NS	NS	NS	NS	NS	83
	Phenol	12	NS	NS	NS	NS	NS	NS	NS	12
	Naphthalene	28	NS	NS	NS	NS	NS	NS	NS	28
	2-Methylnaphthalene	21	NS	NS	NS	NS	NS	NS	NS	21
	Acenaphthene	1	NS	NS	NS	NS	NS	NS	NS	1
005GGB01	Methylene chloride	NS	NS	NS	NS	NS	NS	NS	0.74	0.74
	1,2-Dichloroethene (Total)	NS	NS	NS	NS	NS	NS	NS	0.78	0.78
005GGB02	Methylene chloride	NS	NS	NS	NS	NS	NS	NS	0.78	0.78
005GGB03	Methylene chloride	NS	NS	NS	NS	NS	NS	NS	1.8	1.8
	Trichloroethene	NS	NS	NS	NS	NS	NS	NS	1.6	1.6
005GGB04	Carbon tetrachloride	NS	NS	NS	NS	NS	NS	NS	6.7	6.7

Notes:
Units are micrograms per liter (ug/L)
NS = Sample not analyzed during this sampling event
ND = Chemical not detected during this sampling event

Table 7.4
Chemicals Reported in Fluvial Deposits Groundwater for RFI and DPT Sampling Events
NSA Mid-South SWMU 5
Memphis, Tennessee

Sample	Chemical	RFI and Subsequent Long-term Sampling Events							
		Initial	Event 1	Event 2	Event 3	Event 4	Event 5	DPT	Max
05MW01UF	Cadmium*	ND	ND	ND	ND	ND	ND	NS	ND
	Nitrobenzene	ND	ND	ND	ND	ND	ND	NS	ND
	2-Butanone	ND	ND	11	ND	ND	ND	NS	11
	Acetone	ND	3	ND	ND	ND	ND	NS	3
	Chloroform	ND	ND	ND	ND	ND	ND	NS	ND
	Chloromethane	ND	ND	5	ND	ND	ND	NS	5
	bis(2-Ethylhexyl)phthalate	ND	ND	ND	ND	ND	ND	NS	ND
	Methylene chloride	ND	ND	ND	ND	ND	ND	NS	ND
	1,1,1-Trichloroethane	ND	ND	ND	ND	ND	ND	NS	ND
	Trichloroethene	ND	ND	ND	ND	ND	ND	NS	ND
	Carbon tetrachloride	ND	ND	ND	ND	ND	ND	NS	ND
05MW02UF	Cadmium*	5.4	ND	ND	ND	ND	ND	NS	5.4
	Nitrobenzene	ND	ND	ND	ND	ND	ND	NS	ND
	2-Butanone	ND	27	ND	ND	ND	ND	NS	27
	Acetone	ND	ND	ND	ND	ND	ND	NS	ND
	Chloroform	ND	ND	ND	ND	ND	ND	NS	ND
	Chloromethane	ND	ND	ND	ND	ND	ND	NS	ND
	bis(2-Ethylhexyl)phthalate	ND	ND	ND	ND	ND	ND	NS	ND
	Methylene chloride	ND	ND	ND	ND	ND	ND	NS	ND
	1,1,1-Trichloroethane	ND	ND	ND	ND	ND	ND	NS	ND
	Trichloroethene	ND	ND	ND	ND	ND	ND	NS	ND
	Carbon tetrachloride	ND	ND	ND	ND	ND	ND	NS	ND
05MW04UF	Cadmium*	ND	ND	ND	ND	ND	ND	NS	ND
	Nitrobenzene	ND	ND	ND	ND	ND	ND	NS	ND
	2-Butanone	ND	ND	ND	ND	ND	ND	NS	ND
	Acetone	ND	54	ND	ND	ND	ND	NS	54
	Chloroform	ND	ND	ND	ND	ND	ND	NS	ND
	Chloromethane	ND	ND	ND	ND	ND	ND	NS	ND
	bis(2-Ethylhexyl)phthalate	ND	ND	ND	ND	ND	ND	NS	ND
	Methylene chloride	ND	ND	ND	ND	ND	ND	NS	ND
	1,1,1-Trichloroethane	ND	ND	ND	ND	ND	ND	NS	ND
	Trichloroethene	ND	ND	ND	ND	ND	ND	NS	ND
	Carbon tetrachloride	ND	ND	ND	1	1.2	3	NS	3
05MW04AUF	Cadmium*	ND	ND	ND	ND	ND	ND	NS	ND
	Nitrobenzene	ND	ND	ND	ND	ND	ND	NS	ND
	2-Butanone	ND	ND	ND	ND	ND	ND	NS	ND
	Acetone	ND	ND	ND	ND	ND	ND	NS	ND
	Chloroform	ND	ND	ND	ND	ND	ND	NS	ND
	Chloromethane	ND	ND	ND	ND	ND	ND	NS	ND
	bis(2-Ethylhexyl)phthalate	3	NS	NS	NS	NS	NS	NS	3
	Methylene chloride	ND	ND	ND	ND	ND	ND	NS	ND
	1,1,1-Trichloroethane	ND	ND	ND	ND	ND	ND	NS	ND
	Trichloroethene	ND	ND	ND	ND	ND	ND	NS	ND
	Carbon tetrachloride	3	5	4	6	NS	NS	NS	6
05MW04BUF	Cadmium*	ND	ND	ND	ND	ND	ND	NS	ND
	Nitrobenzene	1	NS	NS	NS	NS	NS	NS	1
	2-Butanone	ND	ND	ND	ND	ND	ND	NS	ND
	Acetone	ND	ND	ND	ND	ND	ND	NS	ND
	Chloroform	ND	ND	ND	1	ND	ND	NS	1
	Chloromethane	ND	ND	ND	ND	ND	ND	NS	ND
	bis(2-Ethylhexyl)phthalate	ND	ND	ND	ND	ND	ND	NS	ND
	Methylene chloride	ND	ND	ND	ND	ND	ND	NS	ND
	1,1,1-Trichloroethane	ND	ND	ND	ND	ND	ND	NS	ND
	Trichloroethene	ND	ND	ND	ND	ND	ND	NS	ND
	Carbon tetrachloride	4	5	4	10	ND	ND	NS	10

Table 7.4
Chemicals Reported in Fluvial Deposits Groundwater for RFI and DPT Sampling Events
NSA Mid-South SWMU 5
Memphis, Tennessee

Sample	Chemical	RFI and Subsequent Long-term Sampling Events						DPT	Max
		Initial	Event 1	Event 2	Event 3	Event 4	Event 5		
005GGB01 (DPT)	Cadmium[a]	NS	NS	NS	NS	NS	NS	NS	NS
	Nitrobenzene	NS	NS	NS	NS	NS	NS	ND	NS
	2-Butanone	NS	NS	NS	NS	NS	NS	ND	ND
	Acetone	NS	NS	NS	NS	NS	NS	ND	ND
	Chloroform	NS	NS	NS	NS	NS	NS	ND	ND
	Chloromethane	NS	NS	NS	NS	NS	NS	ND	ND
	bis(2-Ethylhexyl)phthalate	NS	NS	NS	NS	NS	NS	ND	ND
	Methylene chloride	NS	NS	NS	NS	NS	NS	0.74	0.74
	1,1,1-Trichloroethane	NS	NS	NS	NS	NS	NS	ND	ND
	Trichloroethene	NS	NS	NS	NS	NS	NS	ND	ND
	Carbon tetrachloride	NS	NS	NS	NS	NS	NS	2.8	2.8
005GGB02 (DPT)	Cadmium[a]	NS	NS	NS	NS	NS	NS	NS	NS
	Nitrobenzene	NS	NS	NS	NS	NS	NS	ND	ND
	2-Butanone	NS	NS	NS	NS	NS	NS	ND	ND
	Acetone	NS	NS	NS	NS	NS	NS	ND	ND
	Chloroform	NS	NS	NS	NS	NS	NS	ND	ND
	Chloromethane	NS	NS	NS	NS	NS	NS	ND	ND
	bis(2-Ethylhexyl)phthalate	NS	NS	NS	NS	NS	NS	ND	ND
	Methylene chloride	NS	NS	NS	NS	NS	NS	1.6	1.6
	1,1,1-Trichloroethane	NS	NS	NS	NS	NS	NS	0.79	0.79
	Trichloroethene	NS	NS	NS	NS	NS	NS	5.3	5.3
	Carbon tetrachloride	NS	NS	NS	NS	NS	NS	ND	ND
005GGB03 (DPT)	Cadmium[a]	NS	NS	NS	NS	NS	NS	NS	NS
	Nitrobenzene	NS	NS	NS	NS	NS	NS	ND	ND
	2-Butanone	NS	NS	NS	NS	NS	NS	ND	ND
	Acetone	NS	NS	NS	NS	NS	NS	ND	ND
	Chloroform	NS	NS	NS	NS	NS	NS	ND	ND
	Chloromethane	NS	NS	NS	NS	NS	NS	ND	ND
	bis(2-Ethylhexyl)phthalate	NS	NS	NS	NS	NS	NS	ND	ND
	Methylene chloride	NS	NS	NS	NS	NS	NS	1.6	1.6
	1,1,1-Trichloroethane	NS	NS	NS	NS	NS	NS	ND	ND
	Trichloroethene	NS	NS	NS	NS	NS	NS	ND	ND
	Carbon tetrachloride	NS	NS	NS	NS	NS	NS	ND	ND
005GGB04 (DPT)	Cadmium[a]	NS	NS	NS	NS	NS	NS	NS	NS
	Nitrobenzene	NS	NS	NS	NS	NS	NS	ND	ND
	2-Butanone	NS	NS	NS	NS	NS	NS	ND	ND
	Acetone	NS	NS	NS	NS	NS	NS	ND	ND
	Chloroform	NS	NS	NS	NS	NS	NS	ND	ND
	Chloromethane	NS	NS	NS	NS	NS	NS	ND	ND
	bis(2-Ethylhexyl)phthalate	NS	NS	NS	NS	NS	NS	ND	ND
	Methylene chloride	NS	NS	NS	NS	NS	NS	ND	ND
	1,1,1-Trichloroethane	NS	NS	NS	NS	NS	NS	ND	ND
	Trichloroethene	NS	NS	NS	NS	NS	NS	ND	ND
	Carbon tetrachloride	NS	NS	NS	NS	NS	NS	6.7	6.7

Notes:

a = Reported in units of milligram per kilogram; all other data reported in units of microgram per kilogram.
ND = Target analyte not detected at the specified quanititation.
NS = Sample not analyzed for this sampling event.

RFI samples were submitted to NET for analysis. Analytical results are provided in Appendix F. Tables 7-5 through 7-7 list surface soil, subsurface soil, and groundwater sample designations and indicate which soil data were included from the UST, IM, and RFI investigations. Benzo(a)pyrene equivalent concentrations (BEQ) for carcinogenic polycyclic aromatic hydrocarbons are presented in Table 7-8.

7.2 Chemicals of Potential Concern Identification

Chemicals of potential concern (COPC) were selected by comparing the maximum detected concentration of all detected compounds or elements to their appropriate RBC, surrogate screening concentration (as necessary), and reference background concentration (when applicable). RBCs were obtained from USEPA *Risk Based Screening Concentration Table,* (USEPA, 1998). Groundwater results were compared to tap water screening values; surface soil results to residential soil RBCs; and subsurface soil to industrial soil screening values. RBCs were adjusted to reflect a target HQ of 0.1 for noncarcinogens in accordance with *USEPA Region 4 Supplemental Guidance to RAGS Bulletin 1* (USEPA, November 1995). Any metal concentrations that exceeded their RBC were then compared to its respective RC as presented in E/A&H's August 27, 1996 *Reference Concentration* technical memorandum. Dieldrin concentrations that exceeded their RBCs were compared to the RC established for dieldrin at NSA Mid-South (E/A&H, 1996). Detected concentrations that exceeded the RBC and RC were then retained as COPCs. The COPC selection process is detailed in Appendix I. The results of the screening evaluations are presented on a medium-specific basis in Tables 7-9, 7-10, 7-11, and 7-12 for surface soil, subsurface soil, loess groundwater, and fluvial deposits groundwater, respectively. Table 7-13 summarizes COPCs identified at SWMU 5.

Table 7-5
Surface Soil Sample Identifications and Sample Depth Interval

Sample ID	Depth Interval (in feet)	BTX	H	M	O	P	SV	V
05SB0101	0 to 1		X	X	X	X	X	X
05SB0201	0 to 1		X	X	X	X	X	X
05SB0301	0 to 1		X	X	X	X	X	X
05SB0401	0 to 1		X	X	X	X	X	X
05SB0601	0 to 1		X	X	X	X	X	X
05SB0701	0 to 1		X	X	X	X	X	X
IM-B-1-0	0 to 2			X		X	X	X
IM-B-2-0	0 to 2			X		X	X	X
IM-B-3-0	0 to 2			X		X	X	X
IM-B-5-0	0 to 2			X		X	X	X
IM-B-6-0	0 to 2			X		X	X	X
IM-B-7-0	0 to 2			X		X	X	X
B-07-2	0 to 2	X		X			X	
FFMW-10-2	0 to 2	X						

Notes:
All 0 to 2-foot sample interval data were obtained from the 1992 IM and UST investigations. All remaining samples were collected during the RFI.

BTX — Benzene, toluene, and xylene
H — Chlorinated herbicides
M — Metals
O — Organophosphorus pesticides
P — Chlorinated pesticides and polychlorinated biphenyls
SV — SVOCs
V — VOCs
X — Samples were analyzed for analytical group indicated.

Table 7-6
Subsurface Soil Sample Identifications and Sample Depth Interval

Sample ID	Depth Interval (in feet)	M	SV	V	P	O	H	BTX
005S000108	a	X	X	X	X	X	X	
005S000112	a	X	X	X	X	X	X	
005S000208	a	X	X	X	X	X	X	
005S000210	a	X	X	X	X	X	X	
005S000307	a	X	X	X	X	X	X	
005S000317	a	X	X	X	X	X	X	
005S000405	a	X	X	X	X	X	X	
005S000410	a	X	X	X	X	X	X	
005S000607	a	X	X	X	X	X	X	
005S000612	a	X	X	X	X	X	X	
005S000710	a	X	X	X	X	X	X	
005S000712	a	X	X	X	X	X	X	
005SGB0110	a			X				
B-03-8	8 to 10							X
B-04-10	10 to 12							X
B-04-12	12 to 14							X
B-04-8	8 to 10							X
B-07-8	8 to 10							X
B-09-4	4 to 6	X	X	X				
B-09-9	9 to 11							X
B-16-10	10 to 12							X
IM-B-1-16	16 to 18	X	X	X	X			
IM-B-1-4	4 to 6	X	X	X	X			
IM-B-2-10	10 to 12	X	X	X	X			
IM-B-2-5	5 to 7	X	X	X	X			
IM-B-3-10	10 to 12	X	X	X	X			
IM-B-3-5	5 to 7	X	X	X	X			
IM-B-5-10	10 to 12	X	X	X	X			
IM-B-5-5	5 to 7	X	X	X	X			

000145

Table 7-6
Subsurface Soil Sample Identifications and Sample Depth Interval

Sample ID	Depth Interval (in feet)	M	SV	V	P	O	H	BTX
IM-B-6-10	10 to 12	X	X	X	X			
IM-B-6-5	5 to 7	X	X	X	X			
IM-B-7-5	5 to 7	X	X	X	X			
FFMW-01-9	9 to 11							X
FFMW-02-10	10 to 12							X
FFMW-02-6	6 to 8	X	X	X	X			
FFMW-03-10	10 to 12							X
FFMW-04-8	8 to 10							X
FFMW-05-6	6 to 10	X	X					
FFMW-05-8	8 to 10			X				X
FFMW-06-10	10 to 12							X
FFMW-06-4	4 to 8	X	X					
FFMW-06-6	6 to 8			X				
FFMW-06-8	8 to 10							X
FFMW-07-4	4 to 6							X
FFMW-07-6	6 to 8							X
FFMW-07-8	8 to 10							X
FFMW-09-8	8 to 10							X
FFMW-10-10	10 to 12							X
FFMW-10-6	6 to 8							X
FFMW-11-11	11 to 13							X
FFMW-11-3	3 to 7	X	X	X				
FFMW-11-4	4 to 6			X				

Notes:
a — The depth of the sample interval varied; however, the bottom of the interval is denoted by the last two digits of the sample identification.
M — Metals
SV — SVOCs
V — VOCs
P — Chlorinated pesticides and polychlorinated biphenyls
O — Organophosphorus pesticides
H — Chlorinated herbicides
BTX — Samples were analyzed for benzene, toluene, and total xylene
X — Samples were analyzed for analytical group indicated.

Table 7-7
Loess and Fluvial Deposits Groundwater Sample Identifications

RFI Sample ID	1992 UST Investigation ID	1998 DPT Investigation ID	Groundwater	H	M	O	P	SV	V
05GMW030A	NA	NA	S [a]	X	X	X	X	X	X
05GFF040B	FFMW-04	NA	S [b]		X				X
05GFF050A	FFMW-05	NA	S [a]	X	X	X	X	X	X
05GFF050B	FFMW-05	NA	S [b]		X			X	X
05GMW060A	NA	NA	S [a]	X	X	X	X	X	X
05GFF060B	FFMW-06	NA	S [b]		X			X	X
05GMW070A	NA	NA	S [a]	X	X	X	X	X	X
05GFF080B	FFMW-08	NA	S [b]		X			X	X
05GFF090B	FFMW-09	NA	S [b]		X			X	X
NA	FFMW-11	NA	S		X			X	X
NA	NA	005GGB0112	S						X
NA	NA	005GGB0212	S						X
NA	NA	005GGB0312	S						X
NA	NA	005GGB0412	S						X
NA	NA	005GGB0512	S						X
05GMW01UF	NA	NA	UF [a]	X	X	X	X	X	X
05GMW02UF	NA	NA	UF [a]	X	X	X	X	X	X
05GMW03UF	NA	NA	UF [a]	X	X	X	X	X	X
05GMW04UF	NA	NA	UF [a]	X	X	X	X	X	X
05GMW04AUF	NA	NA	UF [a]	X	X	X	X	X	X
05GMW04BUF	NA	NA	UF [a]	X	X	X	X	X	X
05GMW05LF	NA	NA	LF [a]	X	X	X	X	X	X
NA	NA	005GGB0147	UF						X
NA	NA	005GGB0248	UF						X
NA	NA	005GGB0347	UF						X
NA	NA	005GGB0447	UF						X
NA	NA	005GGB0547	UF						X

Notes:
NA — Not applicable
S — Loess groundwater
a — Sample collected 3/95 (last two digits of corrected sample ID designated with "0A")
b — Sample collected 4/95 (last two digits of corrected sample ID designated with "0B")
H — Chlorinated herbicides
M — Metals
O — Organophosphorus pesticides
P — Chlorinated pesticides and polychlorinated biphenyls
SV — SVOCs
V — VOCs
X — Samples were analyzed for analytical group indicated.
UF — Upper fluvial deposits groundwater
LF — Lower fluvial deposits groundwater
Samples 05MW04UF, 05MW04AUF, and 05MW04BUF were co-located at location 05MW04.

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Table 7.6
BEQ Concentrations in Surface Soil
NSA Mid-South SWMU 5
Memphis, Tennessee

Chemical		05S000101	05S000201	05S000301	05S000401	05S000601	05S000701	IM-B-1-0	IM-B-2-0	IM-B-3-0	IM-B-5-0	IM-B-6-0	IM-B-7-0	B-07-2	FFMW-10-2
Reported Concentrations															
Benzo(a)anthracene		ND	ND	ND	60	ND	140	ND	ND	ND	ND	ND	ND	ND	ND
Benzo(a)pyrene		ND	ND	ND	81	ND	150	ND	ND	ND	ND	ND	ND	ND	ND
Benzo(b)fluoranthene		ND	ND	ND	76	ND	140	ND	ND	ND	ND	ND	ND	ND	ND
Benzo(k)fluoranthene		ND	ND	ND	78	ND	130	ND	ND	ND	ND	ND	ND	ND	ND
Chrysene		ND	ND	ND	77	ND	140	ND	ND	ND	ND	ND	ND	ND	ND
Dibenz(a,h)anthracene		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Indeno(1,2,3-cd)pyrene		ND	ND	ND	50	ND	67	ND	ND	ND	ND	ND	ND	ND	ND
Equivalent Concentrations	TEF														
Benzo(a)anthracene	0.1	ND	ND	ND	6	ND	14	ND	ND	ND	ND	ND	ND	ND	ND
Benzo(a)pyrene	1	ND	ND	ND	81	ND	150	ND	ND	ND	ND	ND	ND	ND	ND
Benzo(b)fluoranthene	0.1	ND	ND	ND	7.6	ND	14	ND	ND	ND	ND	ND	ND	ND	ND
Benzo(k)fluoranthene	0.01	ND	ND	ND	0.78	ND	1.3	ND	ND	ND	ND	ND	ND	ND	ND
Chrysene	0.001	ND	ND	ND	0.077	ND	0.14	ND	ND	ND	ND	ND	ND	ND	ND
Dibenz(a,h)anthracene	1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Indeno(1,2,3-cd)pyrene	0.1	ND	ND	ND	5	ND	6.7	ND	ND	ND	ND	ND	ND	ND	ND
BEQ[a]					100.46		186.14								

Notes:

BEQ = Benzo(a)pyrene equivalent concentration
ND = Not detected at specified quantitation limit
TEF = Toxicity Equivalence Factor
a = All units are microgram per kilogram (ug/kg)

Table 7.9
Selection of Chemicals of Potential Concern for SWMU 5 Surface Soil
NSA Mid-South
Millington, Tennessee

Parameter	Frequency of Detection	Default Concentration[a] (mg/kg)	Range of Detected Concentrations (mg/kg)	Mean of Hits (mg/kg)	Screening Value[b] (mg/kg)	Source	Reference Concentration[c] (mg/kg)	Notes
4,4'-DDT	2 /12		0.0053 - 0.011	0.0082	1.88 C	RBCr		2
Acetone	2 /12		0.34 - 4.6	2.47	782 N	RBCr		2
Aroclor 1260	3 /12		0.047 - 0.09	0.0647	0.319 C	RBCr		2
Arsenic	10 /13		3.7 - 12	7.48	0.426 C	RBCr	14.6	1
Barium	13 /13		55.5 - 273	176	548 N	RBCr	223	2
Benzene	2 /14		0.2 - 2.5	1.35	22.0 C	RBCr		2
Benzo(a)anthracene	2 /13	0.03	0.06 - 0.14	0.1	0.87 C	RBCr		2
* Benzo(a)pyrene[d]	2 /13	0.041	0.081 - 0.15	0.116	0.087 C	RBCr		1, 2
Benzo(b)fluoranthene	2 /13	0.038	0.076 - 0.14	0.108	0.87 C	RBCr		2
Benzo(g,h,i)perylene	2 /13		0.057 - 0.077	0.067	235 N	RBCr		2
Benzo(k)fluoranthene	2 /13	0.039	0.078 - 0.13	0.104	8.75 C	RBCr		2
Beryllium	13 /13		0.43 - 0.95	0.675	16 N	RBCr	1	
Cadmium[e]	10 /12		0.61 - 3.4	2.14	4 N	RBCr	1.54	2
Chromium	12 /13		9.6 - 20	13.7	23 N	RBCr	23.9	
Chrysene	3 /13	0.0385	0.077 - 8.2	2.81	87.5 C	RBCr		2
Cobalt	13 /13		4.5 - 13.3	7.48	469 N	RBCr	16.0	
Copper	13 /13		10.7 - 17.9	14.4	313 N	RBCr	24.2	
* Dieldrin	12 /12	0.0015	0.015 - 1.0	0.282	0.040 C	RBCr	0.262	1, 2
Fluoranthene	3 /13		0.044 - 0.18	0.125	313 N	RBCr		2
Heptachlor epoxide	1 /12		0.0028 - 0.0028	0.0028	0.070 C	RBCr		2
Indeno(1,2,3-cd)pyrene	2 /13	0.025	0.05 - 0.067	0.059	0.87 C	RBCr		2
Lead	12 /13		6.2 - 30.7	16.8	400 N	OSWER	26.0	2
* MCPA	1 /6	0.047	19 - 19	19	4 N	RBCr		1, 2
Mercury	2 /13		0.13 - 0.14	0.135	NA	RBCr	0.46	
Nickel	13 /13		11.1 - 22.5	14.7	156 N	RBCr	20.6	2
Phenanthrene[f]	1 /13		0.053 - 0.053	0.053	235 N	RBCr		2
Pyrene	2 /13		0.12 - 0.17	0.145	235 N	RBCr		2
Selenium	3 /13		0.5 - 0.51	0.505	39 N	RBCr	BDL	
Silver	5 /13		1 - 1.2	1.1	39 N	RBCr	2.05	
Thallium	1 /13		0.28 - 0.28	0.2800	1 N	RBCr		2
Tin	1 /13		7.7 - 7.7	7.7	4693 N	RBCr	33.6	
Toluene	1 /14		4.5 - 4.5	4.5	1564 N	RBCr		2
Vanadium	13 /13		15.9 - 36.4	24.4	55 N	RBCr	45.1	
Zinc	13 /13		44.3 - 75.6	55.7	2346 N	RBCr	98	
bis(2-Ethylhexyl)phthalate[e]	2 /12		0.067 - 0.14	0.104	45.6 C	RBCr	-	2

NOTES:

a = The lesser of one-half the quantitation limit or one-half the lowest reported detection was used as the default concentration (listed in the table above) for all nondetects (where applicable).
b = Screening values for noncarcinogens have been adjusted from a target hazard quotient of 1.0 to 0.1.
c = Calculated using 2x the mean background concentration as recommended by USEPA Region 4 in Supplemental Guidance to RAGS: Region 4 Bulletin No.1, November 1995.
d = Benzo(a)pyrene (BEQ) was reported at two sample locations only — soil borings 4 and 7 of the RFI data. BEQ concentrations for locations 4 and 7 were determined to be 0.101 and 0.186 mg/kg, respectively.
e = Cadmium and bis(2-ethylhexyl)phthalate were not reported for UST sample B-07-2; therefore, only 12 samples analyzed for these two analytes.
f = Screening values are not available for phenanthrene and benzo(g,h,i)perylene; therefore, the screening value for pyrene was used as a surrogate.
mg/kg = Milligrams per kilogram
N = Noncarcinogen
C = Carcinogen
RBCr = Residential soil ingestion risk based concentration, (USEPA, 1998)
OSWER = Office of Solid Waste and Emergency Response Directive 9355.4-12, (USEPA, 1994).
NA = Not applicable
* = Retained as a chemical of potential concern
BDL = Below detection limit
1 = Maximum detected concentration exceeds the residential risk based screening value.
2 = Maximum detected concentration exceeds the background reference concentration (RC) or a RC is not applicable.

Table 7.10
Selection of Chemicals of Potential Concern for SWMU 5 Subsurface Soil
NSA Mid-South
Memphis, Tennessee

Chemical	Frequency of Detection[a]	Range of Detected Concentrations (mg/kg)	Mean of Hits (mg/kg)	Screening Value[b] (mg/kg)	Source	Reference Concentration[c] (mg/kg)	Notes
1,1,1-Trichloroethane	1 /29	0.005 - 0.005	0.005	4088 N	RBCi	NA	2
1,2-Dichloropropane	1 /29	0.0095 - 0.0095	0.0095	84 C	RBCi	NA	2
2,4,5-T	1 /13	0.0044 - 0.0044	0.0044	2044 N	RBCi	NA	2
2-Butanone (MEK)	2 /29	0.014 - 0.02	0.017	122640 N	RBCi	NA	2
2-Hexanone	1 /29	0.0056 - 0.0056	0.0056	8176 N	RBCi	NA	2
2-Methylnaphthalene	7 /29	0.1 - 24	7.3	4088 N	RBCi	NA	2
Acenaphthene	1 /29	0.44 - 0.44	0.44	12264 N	RBCi	NA	2
Acetone	11 /29	0.01 - 15.00	2.18	20440 N	RBCi	NA	2
Aldrin	6 /25	0.01 - 0.01	0.01	0.34 C	RBCi	NA	2
Arsenic	29 /29	0.57 - 14.7	6.69	3.82 C	RBCi	20.3	1
Barium	29 /29	58.4 - 375	179	14308 N	RBCi	265	2
Benzene	9 /50	0.0017 - 6.5	1.70	197 C	RBCi	NA	2
Beryllium	29 /29	0.27 - 1.1	0.62	410 N	RBCi	1.00	2
Cadmium	14 /29	0.78 - 8.1	2.90	102 N	RBCi	3.24	2
Cadmium	14 /29	0.78 - 8.1	2.90	204 N	RBCi	3.24	2
Chromium	29 /29	6.4 - 32.8	13.8	613 N	RBCi	28.3	2
Cobalt	29 /29	2.3 - 15.8	7.77	12264 N	RBCi	14.4	2
Copper	29 /29	7.2 - 29.6	13.6	8176 N	RBCi	32.5	
Dieldrin	7 /25	0.0083 - 0.103	0.062	0.36 C	RBCi	NA	2
Ethylbenzene	8 /33	0.0039 - 20	5.34	20440 N	RBCi	NA	2
Fluoranthene	1 /29	1.4 - 1.4	1.4	8176 N	RBCi	NA	2
Heptachlor epoxide	2 /25	0.01 - 0.012	0.011	0.63 C	RBCi	NA	2
Lead	29 /29	3.9 - 26.4	10.5	NA	RBCi	19.8	2
MCPA	1 /13	4.5 - 4.5	4.5	102 N	RBCi	NA	2
Mercury	7 /29	0.03 - 0.04	0.036	NA	RBCi	0.176	
Methylene chloride	6 /29	0.006 - 0.69	0.178	763 C	RBCi	NA	2
Naphthalene	7 /29	0.13 - 6.3	2.53	4088 N	RBCi	NA	2
Nickel	29 /29	8.9 - 36	16.6	4088 N	RBCi	BDL	
Phenanthrene[d]	1 /29	1.8 - 1.8	1.8	6132 N	RBCi	NA	2
Pyrene	1 /29	1.1 - 1.1	1.1	6132 N	RBCi	NA	2
Selenium	2 /29	0.26 - 0.31	0.285	1022 N	RBCi	BDL	
Silver	1 /29	1.2 - 1.2	1.2	1022 N	RBCi	BDL	
Tetrachloroethene	1 /29	0.025 - 0.025	0.025	110 C	RBCi	NA	2
Thallium	4 /29	0.27 - 0.29	0.277	14 N	RBCi	BDL	
Tin	7 /29	3.9 - 8	6.15	122640 N	RBCi	BDL	
Toluene	9 /49	0.002 - 4.5	1.7447	40880 N	RBCi	NA	2
Trichloroethene	1 /29	0.0034 - 0.0034	0.0034	520 C	RBCi	NA	2
Vanadium	29 /29	8.6 - 46.5	23.4	1431 N	RBCi	43.7	2
Xylene (Total)	15 /49	0.018 - 120	19.2	408800 N	RBCi	NA	2
Zinc	29 /29	31.4 - 121	57.3	61320 N	RBCi	109	2
bis(2-Ethylhexyl)phthalate (BEHP)	10 /29	0.051 - 2	0.464	409 C	RBCi	NA	2

Notes:

a = Variances in the frequencies of detection for each analyte depend on sampling event. Tables 7.2 and 7.6 outline which samples were analyzed for each fraction.
b = Screening values for noncarcinogens have been adjusted from a target hazard quotient of 1.0 to 0.1.
c = Calculated using 2x the mean background concentration as recommended by USEPA Region 4 in Supplemental Guidance to RAGS: Region 4 Bulletin No.1, (USEPA, 1995).
d = A screening value is not available for phenanthrene; therefore, the screening value for pyrene was used as a surrogate.
mg/kg = milligrams per kilogram
N = noncarcinogen
C = carcinogen
RBCi = Industrial soil ingestion risk based concentration screening value, (USEPA, 1998)
NA = Not applicable
BDL = Analyte was not detected at the specified detection limit.
1 = Maximum detected concentration exceeds the industrial risk-based screening value.
2 = Maximum detected concentration exceeds the background reference concentration or an RC is not applicable

Table 7.11
Selection of Chemicals of Potential Concern for SWMU 5 Loess Groundwater
NSA Mid-South
Millington, Tennessee

Parameter	Frequency of Detection[a]	Default Concentration[b] (ug/l)	Range of Detected Concentrations (ug/l)	Mean of Hits (ug/l)	Screening Value[c] (ug/l)	Source	Reference Concentration[d] (ug/l)	Notes
1,1,1-Trichloroethane	1 /14		0.79 - 0.79	0.79	54.1 N	RBCr	NA	2
1,2-Dichlorobenzene	1 /8		7 - 7	7	64.41 N	RBCr	NA	2
* 1,2-Dichloroethene (Total)	2 /14	0.39	0.78 - 8	4.39	5.48 N	RBCr	NA	1, 2
* 2-Methylnaphthalene	1 /8		100 - 100	100	12.2 N	RBCr	NA	1, 2
Acenaphthene	1 /8		3 - 3	3	219 N	RBCr	NA	2
Acetone	2 /14		27 - 38	32.5	365 N	RBCr	NA	2
* Antimony	1 /9	32.4	64.8 - 64.8	64.8	1.5 N	RBCr	50.1	1, 2
* Arsenic	8 /9	1	2.6 - 159	26.9	0.045 C	RBCr	7.32	1, 2
* Barium	8 /9	128	256 - 909	539	256 N	RBCr	442	1, 2
* Benzene	2 /14	2.5	5 - 3900	1953	0.36 C	RBCr	NA	1, 2
Beryllium	4 /9	0.5	1.4 - 2.8	2.5	7.3 N	RBCr	1.3	2
bis(2-Ethylhexyl)phthalate	1 /8		2 - 2	2	4.8 C	RBCr	NA	2
* Cadmium	5 /9	1.5	6.1 - 18.1	9.78	1.8 N	RBCr	5.88	1, 2
* Carbon tetrachloride	1 /14		6.7 - 6.7	6.7	0.16 C	RBCr	NA	1, 2
Chlorobenzene	1 /14		3 - 3	3	34.8 N	RBCr	NA	2
Chromium	4 /9		8.5 - 59.9	38.9	11.0 N	RBCr	239	1
Cobalt	7 /9		4.2 - 19.6	13.4	219 N	RBCr	17.8	2
Copper	4 /9		26.9 - 89.6	58.7	146 N	RBCr	38.8	2
Ethylbenzene	1 /14		30 - 30	30	134 N	RBCr	NA	2
* Lead	7 /9	1	4.5 - 29.2	17.3	15 N	TTAL	17.5	1, 2
Mercury	2 /9		0.23 - 0.63	0.43	NA	RBCr	0.24	2
* Methylene chloride	1 /9	5	31 - 31	31	4.1 C	RBCr	NA	1, 2
Naled	3 /4		2.8 - 4.3	3.37	7.3 N	RBCr	NA	2
* Naphthalene	1 /8		120 - 120	120	73 N	RBCr	NA	1, 2
Nickel	6 /9		27.8 - 94.2	54.2	73 N	RBCr	173.5	1
Phenol	1 /8		98 - 98	98	2190 N	RBCr	NA	2
* Trichloroethene	2 /14	0.5	1 - 2	1.5	1.6 C	RBCr	NA	1, 2
* Vanadium	6 /9	2	4.5 - 102	43.0	25.6 N	RBCr	40.9	1, 2
Zinc	7 /9		26.7 - 551	170	1095 N	RBCr	154.6	2

NOTES:

a = Variances in the frequencies of detection for each analyte depend on sampling event. Table 7.7 outlines which samples were analyzed for each fraction.

b = The lesser of one-half the quantitation limit or one-half the lowest reported hit was used as the default concentration (listed in the table above) for all non-detects.

c = RBC values for non-carcinogens have been adjusted from a target hazard quotient of 1.0 to 0.1

d = Calculated using 2x the mean background concentration as recommended by USEPA Region 4 in Supplemental Guidance to RAGS: Region 4 Bulletin No.1, (USEPA, 1995)

N = Noncarcinogen

C = Carcinogen

RBCr = Tap water risk based concentration screening value, (USEPA, 1998)

NA = Not Applicable

* Retained as a chemical of potential concern

TTAL = Treatment Technique Action Level (USEPA, 1996)

1 = Maximum detected concentration exceeds the residential risk-based screening value or TTAL.

Table 7.12
Selection of Chemicals of Potential Concern for SWMU 5 Fluvial Deposits Groundwater
NSA Mid-South
Millington, Tennessee

Parameter	Frequency of Detection[a]	Default Concentration[b] (ug/l)	Range of Detected Concentrations (ug/l)	Mean of Hits (ug/l)	Screening Value[c] (ug/l)	Source	Reference Concentration[d] (ug/l)	Notes
1,1,1-Trichloroethane	1 /13		0.79 - 0.79	0.79	54.1 N	RBCr	NA	2
2-Butanone	2 /13		11 - 27	19	191 N	RBCr	NA	2
Acetone	2 /13		3 - 54	28.5	365 N	RBCr	NA	2
Barium	7 /7		48.6 - 214	101	256 N	RBCr	232	
bis(2-Ethylhexyl)phthalate	1 /7		3 - 3	3	4.78 C	RBCr	NA	2
* Cadmium	1 /7	1.1	5.4 - 5.4	5.4	1.83 N	RBCr	3.9	1, 2
* Carbon tetrachloride	5 /13	1.5	2.8 - 10	5.7	0.16 C	RBCr	NA	1, 2
* Chloroform	1 /13	0.5	1 - 1	1	0.15 C	RBCr	NA	1, 2
* Chloromethane	1 /13	2.5	5 - 5	5	1.49 C	RBCr	NA	1, 2
Cobalt	3 /7		6.9 - 8.7	8.3	219 N	RBCr	16.2	
Copper	1 /7		6 - 6	6	146 N	RBCr	5.6	2
* Lead	2 /7	1	5.4 - 32.8	12.7	15 N	TTAL	6.6	1, 2
Methylene chloride	3 /13		0.74 - 1.6	1.3	4.10 C	RBCr	NA	2
* Nitrobenzene	1 /7	0.5	1 - 1	1	0.35 N	RBCr	NA	1, 2
* Trichloroethene	1 /13	2.65	5.3 - 5.3	5.3	1.55 C	RBCr	NA	1, 2
Zinc	2 /7		6.4 - 12.5	9.45	1095 N	RBCr	39.8	

NOTES:

a = Variances in the frequencies of detection for each analyte depend on sampling event. Table 7.7 outlines which samples were analyzed for each fraction.

b = The lesser of one-half the quantitation limit or one-half the lowest reported hit was used as the default concentration (listed in the table above) for all non-detects.

c = RBC values for non-carcinogens have been adjusted from a target hazard quotient of 1.0 to 0.1.

d = Calculated using 2x the mean background concentration as recommended by USEPA Region 4 in Supplemental Guidance to RAGS: Region 4 Bulletin No.1, (USEPA, 1995).

N = Noncarcinogen

C = Carcinogen

RBCr = Tap water risk based concentration screening value, (USEPA, 1998).

NA = Not Applicable

* Retained as a chemical of potential concern

TTAL = Treatment Technique Action Level (USEPA, 1996).

1 = Maximum detected concentration exceeds the residential risk-based screening value.

2 = Maximum detected concentration exceeds reference concentration (2X the background mean), or an RC was not applicable.

Table 7-13
Summary of Chemicals of Potential Concern

Chemical	Media		
1,2-Dichloroethene (total)		L	
2-Methylnaphthalene		L	
Antimony		L	
Arsenic		L	
Barium		L	
Benzene		L	
BEQ	S		
Cadmium		L	F
Carbon tetrachloride		L	F
Chloroform			F
Chloromethane			F
Dieldrin	S		
Lead		L	F
MCPA	S		
Methylene chloride		L	
Naphthalene		L	
Nitrobenzene			F
Trichloroethene		L	F
Vanadium		L	

Notes:
BEQ — Benzo(a)pyrene equivalent concentration
MCPA — 2-Methyl-4-chlorophenoxyacetic acid
L — Identified as a COPC in loess groundwater
S — Identified as a COPC in surface soil
F — Identified as a COPC in fluvial deposits groundwater

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7.2.1 Soil

Surface Soil

Based on the screening comparisons described in Appendix I and data presented in Table 7-9, this HHRA focuses on the following surface soil COPCs: dieldrin, MCPA, and the calculated BEQ comprising the carcinogenic polyaromatic hydrocarbons: chrysene, benzo(a)pyrene, benzo(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, and indeno(123-cd)pyrene. Components of BEQ not identified as COPCs in Table 7-9 are assumed to be present in site samples, as indicated in Appendix. Dibenz(a,h)anthracene was not reported in any surface soil samples and is not included in the BEQ calculation, as shown in Table 7-8.

Subsurface Soil

Based on the screening comparisons and data presented in Table 7-10, no COPCs were identified. Subsurface soil will not be addressed in subsequent sections of this HHRA.

7.2.2 Groundwater

SWMU 5 groundwater will be deed restricted to prevent use of loess or fluvial deposits groundwater. The discussion below documents information risk managers use in risk management decisions regarding SWMU 5.

Loess Groundwater

All loess groundwater data were combined into one data set, and the maximum reported concentration for each chemical was used in the screening comparisons. Based on the guidelines presented in Appendix I and data presented in Table 7-11, the COPCs identified in loess groundwater are: antimony, arsenic, barium, cadmium, lead, vanadium, 1,2-dichloroethene (total), 2-methylnaphthalene, carbon tetrachloride, naphthalene, trichloroethene, methylene chloride, and benzene.

Fluvial Deposits Groundwater

All fluvial deposits groundwater data were combined into one data set, and the maximum reported concentration for each chemical was used in the screening comparisons. Fluvial deposits groundwater COPCs are identified in Table 7-12 as cadmium, lead, nitrobenzene, chloroform, chloromethane, trichloroethene, and carbon tetrachloride.

7.3 Exposure Assessment

7.3.1 Exposure Setting and Land Use

The AFFTF was active from 1949 to 1996 and contained two circular fire mats. Both mats, Mat 305 to the east and Mat 392 to the west, were 75-foot diameter, double-bermed concrete pads with mock aircraft cockpits used in fire fighting and pilot rescue drills. The jet fuel used to ignite the fires was electrically pumped on demand from USTs via underground piping to the cockpits. Wastewater, foam, and fuel collected in drains in the mats were piped underground to an oil-water separator/fuel recycling system east of Mat 305. Separated fuel was then piped back to Mat 305 on demand. Jet fuel was supplied to the east mat by three former USTs, which have since been removed. The west mat was serviced by one 5,000-gallon JP-5 UST before it was decommissioned and removed.

Three small concrete-lined pits, approximately 160 feet north of the east mat, were used for hand-held fire extinguisher practice. Drain pipes from these pits lead to adjacent drainage ditches (SWMU 4). No chemicals of concern (COCs) were identified in an RFI for the drainage ditches at NSA Mid-South, which included SWMU 4.

JP-5 is the most recent fuel type used at the AFFTF. JP-4 and waste fuels such as de-planed aircraft fuels were previously used. The RFA reported that waste fuel was commonly mixed with waste solvents such as naphtha, xylene, methyl ethyl ketone, toluene, and benzene.

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The oil-water separator/fuel recycling system was installed in 1977. Before that, the water-fuel-foam mixture from training activities was routinely discharged to the ditch system leading to the SWMU 4 drainage ditch. Occasionally, the waste liquid in the separator overflowed onsite. Shortly after the separator was installed, unburned fuel exploded several times in the drain line leading to the separator. In 1986, the oil-water separator overflowed, releasing approximately 500 gallons. In 1989, several ruptures in the drain line from the fire mats were identified and repaired in place.

Tank-tightness tests conducted on the USTs on July 2, 1991, indicated that the west tank (UST 1508) and one of three east tanks (UST 1489) were leaking. Consequently, both tanks were removed from service. The amount of fuel released from the leaking USTs was unknown.

Two spills of JP-5 fuel from the Carrier Deck Fire Fighting Training Facility, about 1,000 feet east of the site, may have affected the AFFTF. The first spill occurred on April 9, 1993; the second followed several weeks later. Overflow from the oil-water separator at the carrier deck entered the sanitary sewer, surfaced near the Navy Exchange service station, then reached the southeast corner of the AFFTF.

Currently the site Ownership of the AFFTF is projected to change from the Navy to the City of Millington; however, future land use at SWMU 5 is projected to commercial property.

7.3.2 Potentially Exposed Populations

This section describes who may be exposed to COPCs in environmental media at SWMU 5 currently or in the future. The discussion below documents information risk managers use in risk management decisions regarding SWMU 5 throughout the decision-making process.

Hypothetically exposed populations assumed to contact SWMU 5 media are site residents, site workers, construction workers, and site trespassers. Site residents are assumed to use the onsite underlying aquifers as a source of drinking water irrespective of naturally poor water quality. In accordance with RAGS and Appendix I, a residential scenario includes exposure during childhood and adulthood, and assumes exposure for 350 days per year for at least 30 years.

Site workers are assumed to contact the affected area for eight hours each day, 250 days per year for 25 years. Current site workers' exposure would be less than that assumed for the hypothetical future site worker because of their limited soil contact and the fact that SWMU 5 groundwater is not used as drinking or process water. Currently exposed individuals are maintenance workers. Maintenance worker exposure would be less than the hypothetical future worker assumed in this HHRA because maintenance workers would be less frequently exposed than USEPA's standard default site worker *and* for fewer years, either acutely or subchronically. Default site worker assumptions are based on chronic exposure, as are the corresponding chemical and toxicological data used to estimate risk. Table 7-14 lists the exposure parameters for this receptor. Consequently, future worker assessment is considered to be protective of both current and future land use for site workers.

In accordance with the agreement made among USEPA, TDEC, and the Navy on April 22, 1997, a future construction worker has been incorporated into this HHRA. A three year exposure duration was assumed with an exposure frequency of 120 days per year. Incidental ingestion rates for construction workers' exposure to soil would be expected to be higher than default site workers (e.g., 50 mg per day). To account for a high ingestion rate during a portion of the construction project, and a lower ingestion rate toward the end of the project, the averages used were six months at 480 mg per day and 30 months at 150 mg per day. Consequently an average of 200 mg per day is used as the construction worker ingestion rate.

Table 7-14
Parameters Used to Estimate CDI

Pathway Parameters	Resident Adult	Resident Child	Trespassing Adolescent (age 7-16)	Construction Worker	Adult Worker	Units
Ingestion Rate (soil/sediment) (IR_s)	100[a]	200[a]	100[a]	200[b]	50[a]	mg/day
Ingestion Rate (groundwater) (IR_w)	2[a]	1[a]	NA	1	1	L/day
Skin Surface Area (SSA)	4,100[a]	2,900	4,100[a]	4,100[b]	4,100[b]	cm^2/event
Soil to Skin Adherence Factor (ADH)	1	1	1	1	1	unitless
Absorption Factor [c] (ABS)	0.01 (organics) 0.001 (inorganics)	0.01 (organics) 0.001 (inorganics)	0.01 (organics) 0.001 (inorganics)	0.01 (organics) 0.001 (inorganics)	0.01 (organics) 0.001 (inorganics)	unitless
Oral Absorption Efficiency [c] (OAE)	0.2 (inorganics) 0.8 (VOCs) 0.5 (others)	0.2 (inorganics) 0.8 (VOCs) 0.5 (others)	0.2 (inorganics) 0.8 (VOCs) 0.5 (others)	0.2 (inorganics) 0.8 (VOCs) 0.5 (others)	0.2 (inorganics) 0.8 (VOCs) 0.5 (others)	unitless
Exposure Frequency (EF)	350[d]	350[d]	52[e]	120[b]	250[d]	days/year
Exposure Duration (ED)	24[f]	6[f]	10[g]	3[b]	25[f]	years
Conversion Factor (C)	1E-6	1E-6	1E-6	1E-6	1E-6	kg/mg
Body Weight (BW)	70[a]	15[a]	45[a]	70[a]	70[a]	kg
Averaging Time, Noncancer (AT_n)	8,760[h]	2,190[h]	3,650[h]	1095[h]	9125[h]	days
Averaging Time, Cancer (AT_c)	25,550	25,550	25,550	25,550	25,550	days

Notes:

a — *Risk Assessment Guidance for Superfund Vol. I, Human Health Evaluation Manual (Part A) (USEPA, 1989a)*
b — Construction worker IR, EF, and ED values recommended by TDEC, USEPA Region 4, and Navy April 1997 (USEPA, 1995).
c — *Supplemental Guidance to RAGS Bulletins 2 and 3, Exposure Assessment and Toxicity Assessment (USEPA, 1995).*
d — *Risk Assessment Guidance for Superfund Vol. 1: Human Health Evaluation Manual Supplemental Guidance, Standard Default Exposure Factors, Interim Final*, OSWER Directive: 9285.6-3.EPA/600/8-89/043 (USEPA, 1991b).
e — Assuming one day per week exposure.
f — *Risk Assessment Guidance for Superfund: Vol. I — Human Health Evaluation Manual (Part B, Development of Risk-Based Preliminary Remediation Goals)*, OSWER Directive 9285.7-01B *USEPA (1991a).*
g — Assuming trespassing occurs during the 10-year adolescent/teenage period.
h — Calculated as the product of ED (years) x 365 days/year.
i — Calculated as the product of 70 years (assumed lifetime) x 365 days per year.
NA — Not applicable.

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Because groundwater is unlikely to be used as a drinking water source and soil exposure would likely be less frequent than that assumed for site residents, risk estimates were calculated for an adolescent trespasser, assuming exposure to SWMU 5 soil for 52 days per year for 10 years. The hypothetical future site trespasser scenario is assessed to account for a maximally exposed adolescent using the site for hiking and/or exploring. RAGS and Appendix I detail all exposure assumptions made for this HHRA.

7.3.3 Exposure Pathways

The hypothetical site resident, site worker, construction worker, and site trespasser scenarios assume continuous exposure to surface soil conditions. Incidental ingestion and dermal contact are the primary exposure pathways assessed in this HHRA. SWMU 5 is partially paved, and inhaling COPCs entrained in dust typically contributes several orders of magnitude less than incidental ingestion and dermal contact, based on the particulate emission factor recommended by USEPA. Consequently, fugitive dust exposure was not estimated.

As summarized in the Environmental Assessment Report, a water well survey conducted by the Memphis and Shelby County Health Department does not indicate loess or fluvial deposits groundwater use for domestic or agricultural purposes within a mile of the site. Active public water supply wells in the area draw from deeper aquifers hydraulically separated from these upper groundwater zones by the Jackson-upper Claiborne confining unit clays. The domestic wells closest to SWMU 5 are two NSA Mid-South supply wells 2,700 feet northeast and 1,600 feet southeast of the site, which draw from the Memphis and Fort Pillow aquifers, respectively, and a city of Millington supply well 3,800 feet west of the site, which is screened in the Memphis aquifer (E/A&H, 1992).

Background groundwater samples were analyzed for primary and secondary drinking water standards and the data indicate the loess groundwater would not be a viable drinking water source

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(E/A&H, 1992). Groundwater sampled and target analytes are detailed in Section 4. Turbidity, detergents, iron, and manganese reportedly exceed the drinking water standards, limiting the potential for a complete exposure pathway.

In accordance with recommendations of the BCT and TDEC's policy assuming all groundwater is potentially drinking water, loess and fluvial deposits groundwater are assumed to be used as drinking water sources. Exposure estimates for each water-bearing zone included ingestion, and inhalation of COPCs identified in both loess and fluvial deposits groundwater.

SWMU 5 is considered a single exposure unit area, and uniform exposure is assumed for all sample locations. Table 7-14 justifies exposure pathways assessed in this HHRA.

Soil

In general, soil-related pathways include incidental ingestion and dermal contact. Land use scenarios include hypothetical adult and child site residents, site workers, construction workers, and adolescent trespassers. In addition, the scenarios presented in Table 7-15 assume continuous exposure to current surface and subsurface soil conditions.

Groundwater

For groundwater, the ingestion, inhalation of VOCs while showering exposure pathways are evaluated for hypothetical site residents, site workers, and construction workers. Uniform exposure is assumed for all sample locations.

Table 7-15
Exposure Pathways Summary and Justification

Medium and Exposure Pathway	Pathway Selected for Evaluation?	Reason for Selection or Exclusion
Current/Future Site Workers and Future Construction Workers		
Air-Inhalation of gaseous contaminants emanating from soil	No	No significant VOC concentrations were detected in surface soil at SWMU 5.
Air-Inhalation of chemicals entrained in fugitive dust	No	Most of SWMU 5 is paved, covered with gravel, or vegetated, preventing fugitive dust generation. This exposure pathway would contribute orders of magnitude less than other direct exposure pathways.
Soil-Incidental ingestion	Yes	Current/future site workers and construction workers could be exposed to soil at SWMU 5.
Soil-Dermal contact	Yes	Current/future site workers and construction workers could be exposed to soil at SWMU 5.
Groundwater-Ingestion of contaminants during potable or general use	Yes	Groundwater is not currently a source of potable or general use water at SWMU 5. However, TDEC requires groundwater to be assessed assuming it will be a drinking water source.
Groundwater-Inhalation of volatilized groundwater contaminants	Yes	Groundwater is not currently a source of potable or general use water at SWMU 5. However, TDEC requires groundwater to be assessed assuming it will be a drinking water source.
Current/Future Adolescent Site Trespassers		
Air-Inhalation of gaseous contaminants emanating from soil	No	No significant VOC concentrations were detected in SWMU 5 surface soil.
Air-Inhalation of chemicals entrained in fugitive dust	No	Most of SWMU 5 is paved, covered with gravel, or vegetated, preventing fugitive dust generation. This exposure pathway would contribute orders of magnitude less than other direct exposure pathways.
Soil-Incidental ingestion	Yes	Trespassers could be exposed to site soil at SWMU 5.
Soil-Dermal contact	Yes	Trespassers could be exposed to site soil at SWMU 5.
Groundwater-Ingestion of contaminants during potable or general use	No	Groundwater is not currently a source of potable or general use water at SWMU 5.
Groundwater-Inhalation of volatilized groundwater contaminants	No	Groundwater is not currently a source of potable or nonresidential water at SWMU 5.

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Table 7-15
Exposure Pathways Summary and Justification

Medium and Exposure Pathway	Pathway Selected for Evaluation?	Reason for Selection or Exclusion
Future Site Residents (Child and Adult)		
Air-Inhalation of gaseous contaminants emanating from soil	No	No significant VOC concentrations were detected in surface soil at SWMU 5.
Air-Inhalation of chemicals entrained in fugitive dust	No	Most of SWMU 5 is paved, covered with gravel, or vegetated, which prevents fugitive dust generation. This exposure pathway would contribute orders of magnitude less than other direct exposure pathways.
Soil-Incidental ingestion	Yes	Current soil conditions were assessed for the hypothetical residential scenarios. However, any future construction activities would likely result in conditions different from those assumed in this HHRA.
Groundwater-Ingestion of contaminants during potable or general use	Yes	The loess and fluvial deposits water-bearing zone could be used as a potable water source. This assumption was based on TDEC's requirements for assuming all groundwater is potential drinking water.
Groundwater-Inhalation of volatilized contaminants during domestic use	Yes	The loess and fluvial deposits water-bearing zones could be used as a potable water source. VOCs were reported in both fluvial deposits and loess groundwater. This assumption was based on TDEC's requirements for assuming all groundwater is potential drinking water.
Wild game or domestic animals-Ingestion of tissue impacted by media contamination	No	The potential for significant exposure via this pathway is low relative to that of other exposure pathways assessed.
Fruits and vegetables-Ingestion of plant tissues grown in media	No	The potential for significant exposure via this pathway is low relative to that of other exposure pathways assessed.

7.3.4 Exposure Point Concentrations

EPCs are determined in accordance with RAGS and Appendix I.

Surface Soil

The upper confidence limits (UCLs) calculated for dieldrin and the carcinogenic PAHs in surface soil (Table 7-16) are greater than the maximum reported concentration, so the maximum concentrations are used as the EPC. MCPA, which was only analyzed in six samples did not have an UCL calculated and the maximum reported concentration is used as the EPC for this compound (Table 7-16).

Groundwater

No plumes were defined based on the concentrations reported, so the arithmetic mean concentration recommended in USEPA's Supplemental Guidance to RAGS Bulletins could not be used as the groundwater EPC. Because fewer than 10 loess or 10 fluvial deposits groundwater samples were analyzed for each parameter, UCLs were not calculated for the groundwater COPCs, and the maximum reported concentrations were used to estimate exposure. Maximum concentrations reported in loess and fluvial deposits groundwater are presented in Tables 7-11 and 7-12, respectively. Assuming an individual would be exposed to the maximum reported concentration for each groundwater COPC creates a theoretical hot spot. The nature and extent of contamination is described in Section 6.

7.3.5 Quantification of Exposure

Exposure is quantified in accordance with RAGS as discussed in Appendix I. Intake calculations are incorporated into risk estimates, and chronic daily intake (CDI) is not presented separately. However, to aid the reader in understanding intake parameters that were used to estimate CDI, these parameters are summarized in Table 7-14.

Table 7.16
Statistical Analysis of COPCs in Surface Soil
NSA Mid-South SWMU5
Millington, Tennessee

COPC	Natural Log Transformed n	mean	SD	H-stat	UCL (mg/kg)	MAX (mg/kg)	EPC (mg/kg)	FI/FC (unitless)	TEF (unitless)	EPC (mg/kg)	Rationale for Selection
* MCPA	6	NA	NA	NA	NA	19	19	0.2	NA	3.8	Max used
Dieldrin	12	4.992	1.428	3.662	1.848	0.09	1.848	1	NA	1.848	UCL used
Benzo(a)anthracene	13	-1.606	0.415	2.043	0.2824	0.14	0.14	0.2	0.1	0.0028	Max used
Benzo(a)pyrene	13	-1.612	0.331	1.967	0.266	0.15	0.15	0.2	1	0.03	Max used
Benzo(b)fluoranthrene	13	-1.578	0.353	1.98	0.2691	0.14	0.14	0.2	0.1	0.0028	Max used
Benzo(k)fluoranthene	13	-1.591	0.355	1.981	0.2684	0.13	0.13	0.2	0.01	0.00026	Max used
Chrysene	13	-1.595	1.077	2.998	1.234	0.14	0.14	0.2	0.001	0.000028	Max used
Indeno(1,2,3-cd)pyrene	13	-1.459	0.554	2.211	0.3134	0.067	0.067	0.2	0.1	0.00134	Max used

NOTES:

mean = arithmetic mean of the logtransformed data
n = number of samples analyzed
SD = standard deviation for a sample of data
H-stat = "H" statistic from Gilbert 1987; cuboidal interpolation was used to determine the value in accordance with USEPA Supplemental Guidance to RAGS, Calculating the Concentration Term
NA = not applicable
EPC = exposure point concentration
UCL = 95 percentile upper confidence level mean
MAX = maximum reported concentration
FI/FC = 20% of the total site area was assumed for COPCs reported in only one sample
TEF = toxicity equivalence factor
MCPA = 2-methyl-4-chlorophenoxyacetic acid
BEQ = benzo(a)pyrene equivalent concentration, based on hits only
* = The maximum reported concentration was used as EPC for MCPA and BEQ because these compounds were reported in two or less of 13 samples.

The fraction ingested and fraction consumed (FI/FC) is computed by estimating the maximum affected area and dividing that area by the approximate total site area. These computations are conservative to account for uncertainty about contaminant distributions. The FI/FC factors modify the exposure unit area concentrations to more closely approximate actual exposure conditions.

To clarify the spatial distribution of estimated risks, three steps were followed:

- risk was estimated based on the maximum reported concentrations
- risk was estimated based on FI/FC
- point risk was estimated for hot spots

Of the three COPCs identified in surface soil at SWMU 5, dieldrin warrants 95th percentile upper confidence limit (UCL) calculation based on its spatial distribution (reported at 12 of 13 sample locations). The maximum reported concentration of MCPA is used as the EPC since only RFI samples (six samples) were analyzed for MCPA. Carcinogenic PAHs were reported in less than 20% of surface soil samples (two of 13 samples). Consequently, a UCL would be primarily influenced by reported nondetects, possibly skewing the data to overestimate risk at locations reported as nondetects, while underestimating risk at locations where PAHs were reported. The maximum concentrations reported for individual PAHs were used to estimate the EPC (i.e., BEQ).

EPCs for MCPA and PAHs were adjusted based on their spatial distribution. Based on the frequency of detection, a multiplier of 0.2 was applied to the EPCs for MCPA and BEQ to account for an individual exposed to the entire SWMU 5 area. Assuming these concentrations are present at 20% of SWMU 5 is conservative, based on the limited data set. The actual site area contaminated with either MCPA or PAHs may be less. However, this fraction was selected to account for areas not sampled and possible variability inherent in soil samples. This adjustment could underestimate exposure at the locations where MCPA and BEQ were reported at

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concentrations greater than the adjusted EPC. Consequently, MCPA and PAHs are assessed as hot spots using unadjusted EPCs in Section 7.6, and dieldrin is included where appropriate.

Groundwater

Although 14 loess groundwater samples were collected, all samples were not analyzed for each analytical parameter. Consequently, the UCL did not apply and the maximum reported concentrations reported in Table 7-11 are used as the EPC. Similarly, 10 fluvial deposits groundwater locations were sampled (three samples were collected at location 05MW04) and the maximum reported concentrations shown in Table 7-12 are used as EPCs.

7.4 Toxicity Assessment

Toxicity assessment terms and methods are discussed in Appendix I. In accordance with RAGS, toxicological profiles for SWMU 5 COPCs are presented below.

Most information for the brief profiles below was obtained from the Integrated Risk Information System (IRIS), the Health Effects Assessment Summary Table (HEAST), and the National Center for Environmental Assessment (NCEA). The profiles summarize the adverse effects of COPCs and the amount associated with them. Table 7-17 summarizes toxicity reference information for all COPCs.

Antimony belongs to the same periodic group as arsenic. This element is absorbed slowly through the gastrointestinal tract. Another target is the blood, where antimony concentrates. Because of widespread industrial use, the primary exposure route for antimony to the general population is food. Antimony is also a common air pollutant from industrial emissions. The critical effect of antimony in experimental animals is a reduction of longevity. An oral reference dose (RfD) of 0.0004 mg/kg-day has been established by USEPA (Klaassen et al., 1986). Information is unavailable regarding the carcinogenicity of antimony.

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Table 7.17
Toxicological Reference Information
for Chemicals of Potential Concern
SWMU 5
NSA Mid-South RFI

	Non-Carcinogenic Toxicity Data							Carcinogenic Toxicity Data					
Chemical	Oral Reference Dose (mg/kg-day)		Confidence Level	Critical Effect	Oral Uncertainty Factor	Inhalation Reference Dose (mg/kg-day)		Inhalation Uncertainty Factor	Oral Slope Factor (kg-day/mg)		Inhalation Slope Factor (kg-day/mg)		Weight of Evidence	Tumor Type
2-Methynaphthalene	0.02	a		kidney and liver toxicity		ND		NA	ND		ND		NA	
Antimony	0.0004	a	L	whole body/blood increased mortality	1000	ND		ND	ND		ND		D	
Arsenic	0.0003	a	M	hyperpigmentation	3	ND		ND	1.5	a	15.1	a	A	various
Barium	0.07	a	M	increased blood pressure	3	ND		ND	ND		ND		D	
Benzene	ND		NA		NA	0.00171	e	NA	0.029	a	0.029	a	A	leukemia
Benzo(a)pyrene Equivalents (BEQ)	ND		NA		NA	ND		ND	7.3	a	ND		B2	mutagen
Cadmium (food)	0.001	a	H	proteinuria	10	ND		ND	ND		6.3	a	B1	lung
Cadmium (water)	0.0005	a	H	proteinuria	10	ND		ND	ND		6.3	a	B1	lung
Carbon tetrachloride	0.0007	a	M	liver lesions	1000	0.000571	e	NA	0.13	a	0.0525	a	B2	liver tumors
Chloroform	0.01	a				0.000086	a		0.006100	a	0.081	a		
Chloromethane	ND		NA		NA	ND		NA	0.013	a	0.006	a		
1,2-Dichloroethene (total)	0.009	b			ND	ND		ND	ND		ND		D	
Dieldrin	0.00005	a	M	liver lesions	100	ND		ND	16	a	ND		B2	hepatocarcinoma
Lead	ND		NA		NA	ND		ND	ND		ND		B2	various
MCPA	0.0005	a	M	kidney and liver toxicity	3000	ND		ND	ND		ND		D	
Methylene chloride	0.06	a	M	liver toxicity	100	0.8571	b	ND	0.0075	a	0.00164	a	B2	various neoplasms and sarcomas
Naphthalene	0.02			kidney and liver toxicity		0.0009			ND		ND		NA	
Nitrobenzene	0.0005	a	L	liver and kidney lesions	10000	0.0006	c	ND	ND		ND		D	
Trichloethene	0.006	e		liver toxicity	ND	ND		ND	0.011	w	0.006	e	B2	liver tumors
Vanadium	0.007	a		unclear	100	ND		ND	ND		ND		D	

Notes:

a = Integrated Risk Information System (IRIS)
b = Health Effects Assessment Summary Tables (HEAST)
c = HEAST alternative method
e = EPA NCEA - Cincinnati (provisional)
w = Withdrawn from IRIS/HEAST
NA = Not applicable or not available
ND = Not determined due to lack of information
L = Low confidence
M = Medium confidence
H = High confidence

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Arsenic exposure via the ingestion route darkens and hardens the skin of chronically exposed humans. Inhalation exposure to arsenic causes neurological deficits, anemia, and cardiovascular effects. USEPA set 0.3 μg/kg-day as the oral RfD for arsenic based on a no-observed-adverse effects-level (NOAEL) of 0.8 μg/kg-day in a human exposure study. Arsenic's effect on the nervous and cardiovascular systems is primarily associated with acute exposure to higher concentrations. Exposure to arsenic-containing materials has been shown to cause cancer in humans. Inhaling these materials can lead to increased lung cancer risk, and ingesting these materials is associated with increased skin cancer rates. Arsenic has been classified as a Group A carcinogen by USEPA, with an slope factor (SF) of 1.5 kg-day/mg. Human milk contains about 3 μg/L arsenic (Klaassen et al., 1986).

Barium is used in various alloys, paints, soap, and manufacturing processes. Barium sulfate aids X-ray diagnosis. This element is relatively abundant in nature and is found in plant and animal tissue such as Brazil nuts, which contain 3 to 4 milligrams (mg) per gram. The fatal absorbed dose of barium is approximately 1,000 mg (for humans). Major toxic effects of this element are muscle stimulation, and heart and central nervous system (CNS) effects. USEPA determined the oral and inhalation RfDs to be 0.07 and 1.43E-4 mg/kg-day, respectively (Dreisbach et al., 1987; Klaassen et al., 1986).

Benzene is found in gasoline and has been used as a solvent in coal tar naphtha, rubber, and plastic cement. USEPA lists benzene as a group A carcinogen. In large doses, benzene depresses the CNS, and chronic exposure depresses bone marrow. The oral SF for benzene was set by USEPA as 2.9E-2 kg-day/mg; an oral RfD has not been set.

Cadmium can upset the stomach, leading to vomiting and diarrhea in acute oral exposure. Acute inhalation of cadmium-containing dust can irritate the lungs. Chronic exposure to cadmium, either via inhalation or ingestion, caused kidney damage (including kidney stones), emphysema, and high

blood pressure. Other tissues reportedly injured by cadmium exposure in animals and humans include the lungs, testes, liver, immune system, blood, and the nervous system. An oral RfD of 0.001 mg/kg-day has been determined by USEPA for cadmium in food, based on human diet studies involving chronic exposure in which significant increased protein was found in the urine. A separate oral RfD for cadmium in water has been determined by USEPA to be 0.0005 mg/kg-ay. Cadmium has been classified by USEPA as a group B1 carcinogen by the inhalation route, based on limited evidence from epidemiological studies in which an excess risk of lung cancer was observed in cadmium smelter workers. There is sufficient evidence of increased risk of lung cancer in rats and mice exposed to cadmium via inhalation. Seven studies in which cadmium was administered orally to rats and mice have shown no evidence of carcinogenic response following exposure via this route (Klaassen et al., 1986).

Carbon tetrachloride is used as a solvent and intermediate in many industrial processes. The adult fatal dose by ingestion or inhalation is 3 to 5 milliliters and the exposure limit is 5 ppm (National Institute for Occupational Safety and Health 2 ppm) or 30 mg/m^3 (1.5 grams evaporated in a room 10-foot by 10-foot by 8-foot = 10 ppm). Carbon tetrachloride depresses and injures almost all cells of the body, including those of the CNS, liver, kidney, and blood vessels. Toxicity appears to result from the intracellular breakdown of carbon tetrachloride to more toxic intermediates, including epoxides, particularly in the liver. The heart muscle may be depressed and ventricular arrhythmias may occur. Concomitant ethanol ingestion increases the effect of carbon tetrachloride on all organs. For acute poisoning from inhalation, skin absorption, or ingestion, the immediate effects are abdominal pain, nausea, vomiting, dizziness, and confusion, progressing to unconsciousness, respiratory slowing, slowed or irregular pulse, and falling blood pressure. Coma, liver damage, jaundice, or kidney damage may appear independently, or all may occur in the same individual at different times. These same symptoms may occur after repeated exposures to low concentrations, but in less severe form. USEPA has identified carbon tetrachloride as a group B2 carcinogen. Carbon tetrachloride has an oral RfD of

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7E-04 mg/kg-day, an oral SF of 1.30E-01 kg-day/mg, and an inhalation SF of 5.25E-02 kg-day/mg calculated using an inhalation unit risk of 1.5E-5 ug/m^3 (IRIS, 1999). NCEA has issued a provisional value for an inhalation RFD of 5.71E-04 mg/kg-day as well. A federal MCL has been established for carbon tetrachloride at 0.005 milligrams per liter (mg/L) (USEPA, 1996b).

Chloroform, a halogenated hydrocarbon, has been used as a fumigant and an additive to suppress the fire hazard of carbon disulfide. It also has a low capacity for insect control. Volatile and gaseous anesthetics such as chloroform are sometimes used to produce general anesthesia. This contaminant is the primary chlorinated hydrocarbon produced during chlorination of drinking water, and is commonly present at low concentrations in most drinking water supplies. This compound depresses all CNS functions from the cortex to the medulla. Additional target organs include the liver, heart, and kidney. Chloroform exposure to the heart sensitizes the muscle to arrhythmias, as do many halogenated hydrocarbons. This action could interfere with digitalis glycosides or a pacemaker in the form of premature or uncontrolled beats. Chloroform is a class B2 carcinogen, and USEPA set the oral slope factor and inhalation slope factor to 0.0061 and 0.0805 (mg/kg-day)$^{-1}$, respectively. The RfDo is 0.01 mg/kg-day (Dreisbach, et al., 1987).

Chloromethane is a clear, colorless gas that has a faintly sweet, nonirritating odor at high concentrations in the air. A naturally occurring chemical, it is produced in large amounts in the oceans and by some plants and rotting wood, and by burning such materials as grass, wood, charcoal, and coal. Chloromethane is also produced industrially, but most of it is destroyed during use. It is used mainly to produce other chemicals such as silicones (72%), agricultural chemicals (8%), quaternary amines, and butyl rubber.

1,2-Dichloroethene is a halogenated hydrocarbon associated with toxicity to the mucous membrane, skin, lung, cornea (irritation), and liver. This compound is less toxic than its

alkane counterparts, and is a breakdown product of trichloroethene (TCE) and an intermediate in the dechlorination of TCE to vinyl chloride. 1,2-Dichloroethene is neither mutagenic nor carcinogenic. There is no USEPA carcinogenicity listing for this compound (Dreisbach et al., 1987). However, the oral reference dose has been set to 0.01 mg/kg-day for the cis-isomer, and at 0.02 mg/kg-day for the trans-isomer by USEPA (HEAST, 1996, and IRIS, 1997).

Dieldrin is a polycyclic chlorinated pesticide. Short-term exposure to high doses of dieldrin causes tremors and convulsions. Chronic exposure can cause emotional and neuromuscular disturbances. Exposed individuals revert to normal approximately one week after the dieldrin source is removed. Dieldrin is classified as a B2 carcinogen by USEPA; the oral SF, inhalation SF, and oral RfD were set to 16 kg-day/mg, 16.1 kg-day/mg, and 0.00005 mg/kg-day, respectively (Dreisbach et al., 1987).

Lead has been classified as a group B2 carcinogen by USEPA based on sufficient animal evidence and inadequate human evidence. Ten rat bioassays and one mouse assay have shown statistically significant increases in renal tumors with dietary and subcutaneous exposure to several soluble lead salts. Animal assays provide reproducible laboratory results, in multiple rat strains, with some evidence of multiple tumor sites. Short-term studies show that lead affects gene expression. Lead can accumulate in bone marrow, and effects have been observed in the CNS, blood, and mental development of children. Once lead accumulates in the body, other influences cause the actual levels in the blood to fluctuate — sometimes the lead is attached to binding sites; sometimes lead is free flowing. This fluctuation and lack of previous lead exposure data are two of the reasons lead effects are difficult to predict (Klaassen et al., 1986). No RfD or SF has been set by USEPA. However, an action level of 400 mg/kg for soil has been proposed by USEPA that is considered to be protective of child residents. USEPA has recommended a 1,000 to 1,300 mg/kg cleanup standard for industrial properties. USEPA's Office of Water has established a lead treatment technique action level of 15 μg/L.

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2-Methyl-4-chlorophenoxyacetic acid (MCPA) is a hormone-type herbicide, structurally similar to 2,4-D and often combined with it. A lethal dose to 50% of the population (LD_{50}) was determined for quail of 377 mg/kg, with a lethal concentration to 50% of the population (LC_{50}) for trout at 117 mg/L (Farm Chemicals Handbook, 1990). MCPA is generally toxic to the liver and kidneys. Specific toxic effects noted in IRIS elicited from oral administration of MCPA to dogs and rats include: alterations in clinical chemistries (e.g., kidneys: urea, potassium, and creatinine; liver: bilirubin, GPT, GOT, triglycerides, and cholesterol) associated with concomitant liver weight changes and histopathology changes (e.g., kidney: increased kidney pigment deposition in proximal tubular epithelium; liver: change in the nature/coloration of gall fluid) (IRIS, 1997). The lower exposure limit (LEL) for systemic toxicity is 0.75 mg/kg-day, and the no-observed-effects-level (NOEL) for systemic toxicity is 0.15 mg/kg-day. USEPA determined the oral RfD to be 5E-4 mg/kg-day, with a medium confidence rating and an uncertainty factor of 300 (IRIS, 1997).

Methylene chloride, a common industrial solvent, has been used in the post-harvest fumigation of strawberries and commodity fumigation of grains, with ethylene for degreening citrus fruits. This compound causes CNS depression and lung and liver damage. The potential exists for synergistic hepatotoxic effects during corresponding exposure to enzyme inducers such as alcohols and ketones (Dreisbach et al., 1987). Methylene chloride is a USEPA class B2 carcinogen, and the oral and inhalation SFs have been set by USEPA at 0.0075 and 0.00164 kg-day/mg, respectively. As listed in IRIS, the classification is based on inadequate human data, but sufficient evidence of carcinogenicity in animals, such as increased incidence of hepatocellular neoplasms and alveolar/bronchiolar neoplasms in male and female mice, and increased incidence of benign mammary tumors in both sexes of rats, salivary gland sarcomas in male rats, and leukemia in female rats. This classification is supported by some positive genotoxicity data, although results in mammalian systems are generally negative. The oral and inhalation RfDs are 0.06 and 0.857 mg/kg-day, respectively. As listed in IRIS, the critical effect of this chemical is liver

toxicity. The uncertainty factor was determined to be 100 and the modifying factor was determined to be 1 (IRIS, 1997).

Naphthalene and ***2-methylnaphthalene*** cause hemolysis with subsequent blocking of renal tubules by precipitated hemoglobin. Hepatic necrosis has been reported. Hemolysis only occurs in individuals with a hereditary deficiency of glucose-6-phosphate dehydrogenase in the red cells (primarily black males), which results in a low level of reduced glutathione and increased susceptibility to hemolysis by naphthalene metabolites. These chemicals are most dangerous in children up to age 6, in whom absorption occurs rapidly. The oral RfD for naphthalene is 4E-02 mg/kg-day (USEPA, 1996).

Nitrobenzene is an oily yellow or pale brown liquid with an almond-like odor used in the manufacture of dyes, drugs, pesticides, and synthetic rubber (ATSDR, 1990). Direct contact of small amounts of nitrobenzene with the skin or eyes may cause mild irritation. Case studies of repeated exposure to nitrobenzene via inhalation and the oral route indicated that methemoglobinemia is the major adverse effect in humans. This condition affects the ability of the blood to carry oxygen. Following such exposure, the skin may turn bluish, accompanied by nausea, vomiting, and shortness of breath. Effects such as headaches, irritability, dizziness, weakness, and drowsiness may also occur. If the exposure level is extremely high, nitrobenzene can cause coma and possibly death, unless prompt medical treatment is received. No studies were located regarding the carcinogenic effects in humans or animals from inhalation, oral, or dermal exposure to nitrobenzene. Nitrobenzene has been classified by USEPA as a Group D compound, i.e., not classifiable as to its carcinogenicity because of lack of data (IRIS, 1997). The oral RfD for nitrobenzene is 5E-04 mg/kg-day (IRIS, 1997) and the inhalation RFD for nitrobenzene is 5.71E-04 mg/kg-day (HEAST, 1996).

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Carcinogenic PAHs include the following COPCs and toxicity equivalence factors (TEFs):

Carcinogenic PAH	TEF
Benzo(a)anthracene	0.1
Benzo(b)fluoranthene	0.1
Dibenz(a,h)anthracene	1.0
Benzo(k)fluoranthene	0.01
Benzo(a)pyrene	1.0
Indeno(1,2,3-cd)pyrene	0.1
Chrysene	0.001

All the carcinogenic PAHs listed above are classified by USEPA as B2 carcinogens. Their carcinogenicity is addressed relative to that of benzo(a)pyrene, which has an oral slope factor of 7.3 kg-day/mg using TEFs set by USEPA. Some PAHs are toxic to the liver, kidney, and blood. However, the toxic effects of the PAHs above have not been well established. There are no RfDs for the PAHs above because of a lack of data. Most carcinogenic PAHs have been classified as such due to animal studies using large doses of purified PAHs. There is some doubt as to the validity of these listings, and the SFs listed in USEPA's RBC table are provisional. However, these PAHs are carcinogens when the exposure involves a mixture of other carcinogenic substances, such as coal tar, soots, cigarette smoke, etc. (Klaassen et al., 1986).

Other PAHs — those not classified by USEPA as carcinogens — are toxic to the liver, kidney, and blood. This group of PAHs includes compounds such as pyrene, acenaphthene, acenaphthylene, benzo(g,h,i)perylene, and phenanthrene. USEPA has determined oral RfDs for only two of these compounds: pyrene (0.03 mg/kg-day) and acenaphthene (0.06 mg/kg-day). The RfD for pyrene is adopted as a surrogate oral RfD for phenanthrene and benzo(g,h,i)perylene.

Trichloroethene (TCE) is a mobile, volatile liquid with the characteristic odor of chloroform. TCE is a strong skin and eye irritant that is relatively less toxic if ingested. Inhaling high concentrations causes narcosis and anesthesia (Dreisbach et al., 1987). This compound targets the liver and other organs. TCE is a B2 carcinogen, and the oral and inhalation SFs have been assigned provisional values by USEPA's NCEA to 0.011 and 0.006 kg-day/mg, respectively. The provisional oral RfD also set by NCEA is 0.006 mg/kg-day (NCEA, 1992).

Vanadium is poorly absorbed through the skin and gastrointestinal mucosa (i.e., via oral ingestion), and is a ubiquitous element. It is also a by-product of petroleum refining. Vanadium is soluble in fats and oils. Municipal water supplies contain 0.001 to 0.006 mg/L (Klaassen et al., 1986). The target organ is unclear, and the primary focus of toxicological information is inhalation of vanadium dust, an exposure pathway not addressed in this risk assessment. Typical mineral supplements contain approximately 0.010 mg in a daily dose. The oral RfD set by USEPA is 0.007 mg/kg-day (IRIS, 1997).

7.5 Risk Characterization

Exposure to SWMU 5 media was assessed using three scenarios: residential, industrial (site worker and construction worker), and trespasser. For the residential and industrial scenarios, five exposure pathways were evaluated: incidental surface soil ingestion, dermal contact with surface soil, and ingestion of groundwater, and inhalation of VOCs volatilized from groundwater. Site trespassers were assessed assuming soil exposure only (incidental ingestion and dermal contact with surface soil).

TDEC assumes that all groundwater is potential drinking water. Consequently, loess and fluvial deposits groundwater exposure pathways were evaluated assuming that site groundwater will be used for potable, domestic, and/or process water and that an unfiltered well, drawing from the corresponding water-bearing zone, will be installed. However, the trespasser scenario does not include groundwater exposure pathways. Tables 7-18 and 7-19 present surface soil risk estimates for the incidental ingestion and dermal contact exposure pathways, respectively.

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Table 7.18
Risk Estimates
Incidental Ingestion of Surface Soil
NSA Mid-South SWMU 5
Memphis, Tennessee

				Site Resident			*Site Worker*		*Construction Worker*		*Site Trespasser*	
				Adult	*Child*	*LWA*	*Adult*		*Adult*		*Adolescent*	
Chemical	**EPC (mg/kg)**	**Oral RfD (mg/kg-day)**	**Oral SF (kg-day/mg)**	**HQ**	**HQ**	**ILCR**	**HQ**	**ILCR**	**HQ**	**ILCR**	**HQ**	**ILCR**
BEQ	0.0372	NA	7.3	NA	NA	4.3E-07	NA	4.8E-08	NA	1.1E-08	NA	1.2E-08
Dieldrin	1.848	0.00005	16	0.051	0.47	4.6E-05	0.018	5.2E-06	3.5E-02	1.2E-06	0.012	1.3E-06
MCPA	3.8	0.0005	NA	0.010	0.097	NA	0.004	NA	7.1E-03	NA	0.002	NA
Cumulative HI or ILCR				0.06	0.6	5.E-05	0.02	5.E-06	0.04	1.E-06	0.014	1.E-06

Notes:

EPC = Exposure point concentration
RfD = Reference Dose
SF = Slope Factor
HQ = Hazard quotient
ILCR = Incremental excess lifetime cancer risk
HI = Hazard index
NA = Not applicable
LWA = Lifetime weighted average
mg/kg = milligram per kilogram

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Table 7.19
Risk Estimates
Dermal Contact With Surface Soil
NSA Mid-South SWMU 5
Memphis, Tennessee

						Site Resident			*Site Worker*		*Construction Worker*		*Site Trespasser*	
						Adult	*Child*	*LWA*	*Adult*		*Adult*		*Adolescent*	
Chemical	EPC (mg/kg)	Inorganic	DAF	Dermal RfD (mg/kg-day)	Dermal SF (kg-day/mg)	HQ	HQ	ILCR	HQ	ILCR	HQ	ILCR	HQ	ILCR
BEQ	0.0372	no	0.5	NA	14.6	NA	NA	1.9E-07	NA	7.8E-08	NA	4.5E-09	NA	1.0E-08
Dieldrin	1.848	no	0.5	0.000025	32	0.042	0.14	2.1E-05	0.030	8.5E-06	1.4E-02	4.9E-07	0.0096	1.1E-06
MCPA	3.8	no	0.5	0.00025	NA	0.009	0.03	NA	0.006	NA	2.9E-03	NA	0.0020	NA
Cumulative HI or ILCR						0.05	0.2	2.E-05	0.04	9.E-06	0.02	5.E-07	0.012	1.E-06

Notes:

EPC = Exposure point concentration
Inorganic = In accordance with RAGS, dermal absorption factors of 0.01 and 0.001 were used to account for the fraction crossing the skin barrier for organics and inorganics, respectively; dermal intake was estimated in accordance with RAGS and *General Human Health Risk Assessment Approach for NSA Memphis* (E/A&H, 1997).
DAF = Dermal adjustment factor, used to account for gastrointestinal absorbtion efficiency in accordance with RAGS
RfD = Reference Dose
SF = Slope Factor
HQ = Hazard quotient
ILCR = Incremental excess lifetime cancer risk
HI = Hazard index
NA = Not applicable
LWA = Lifetime weighted average
mg/kg = milligram per kilogram

Tables 7-20 and 7-21 present ingestion and inhalation risk estimates for loess groundwater, respectively, while Tables 7-22 and 7-23 present ingestion and inhalation risk estimates for fluvial deposits groundwater.

7.5.1 Hypothetical Site Residents

In accordance with RAGS, risk to site residents was evaluated for carcinogens using the lifetime weighted average estimates of daily intake. As previously discussed, three exposure pathways were evaluated for the residential scenario: incidental surface soil ingestion, dermal contact with surface soil, and ingestion of groundwater. In addition, inhalation of VOCs was evaluated because VOCs were identified as groundwater COPCs. Noncarcinogenic risk or hazard was estimated separately to address child and adult exposure. As shown in Figure 7-1, the sum of soil and loess groundwater risk estimates is 7E-3, with groundwater contributing more than 95% of the risk. Also shown in Figure 7-1, soil and fluvial deposits risk estimates total 1E-4.

Similarly, groundwater hazard estimates contribute more than 95% of the total Hazard Index (HI). HI estimates for the sum of soil and loess groundwater adult and child residents are 84 and 197, respectively, as shown in Figure 7-2. Figure 7-2 also shows HI estimates for soil and fluvial deposits groundwater, which are 1 and 4 for adult and child residents, respectively.

Soil

As shown on Figure 7-1, the sum soil Incremental Lifetime Excess Cancer Risk (ILCR) estimate for site residents is 7E-5. The ingestion ILCR estimate for surface soil is 5E-5, while the dermal pathway ILCR is 1E-5, as shown in Tables 7-18 and 7-19, respectively. Dieldrin is the primary contributor to the ingestion and dermal contact pathways, with BEQ contributing less than 1E-6 to each exposure pathway.

Figure 7-2 shows the sum of soil HI estimates for adult and child residents to be 0.1 and 0.7, respectively. As shown in Tables 7-18 and 7-19, the incidental soil ingestion HI estimates for adult and child residents are 0.06 and 0.6, respectively. Dermal contact HI estimates are 0.05 and 0.2, respectively. Dieldrin is the primary contributor to soil HI, with MCPA as a secondary contributor.

Groundwater

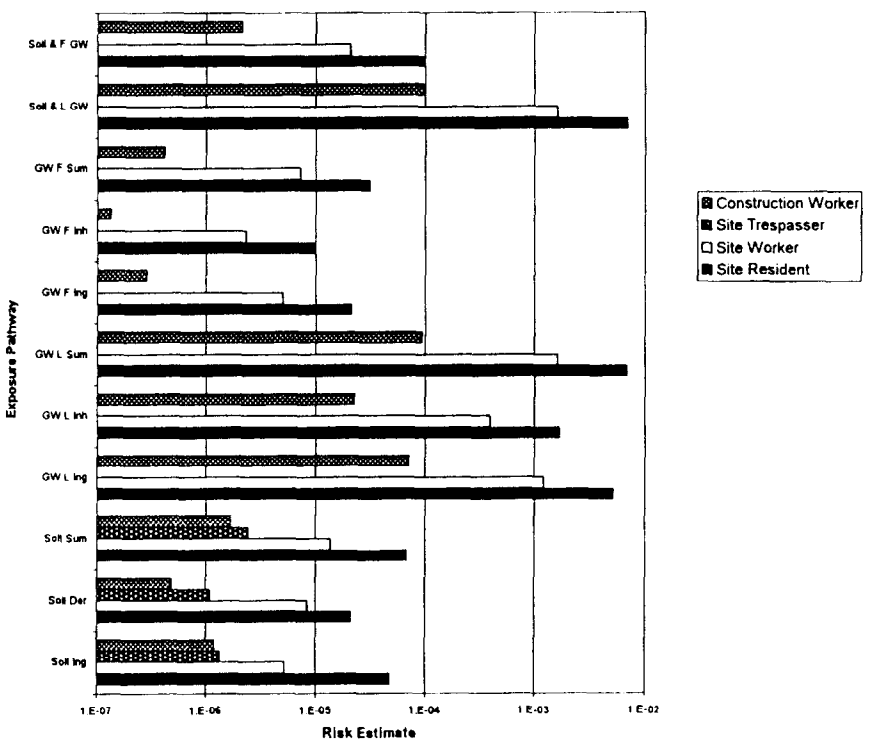
Loess

The sum loess groundwater ILCR estimate for the site resident receptor is 7E-3, as shown in Figure 7-1. For the ingestion and inhalation pathways, the lifetime weighted average ILCR estimates are 5E-3 and 2E-3, respectively, as shown in Tables 7-20 and 7-21. Arsenic and benzene are the primary contributors to ILCR estimates.

Sum adult and child HI estimates for loess groundwater exposure pathways are 84 and 196, respectively. Ingestion HI estimates for the adult and child are 21 and 50, while inhalation HI estimates are 63 and 147. Arsenic, antimony, and cadmium are primary contributors to ingestion HI, with vanadium and barium as secondary contributors. Benzene accounts for more than 95% of the inhalation pathway HI estimates.

The maximum lead concentration reported in loess groundwater was used as the EPC when using USEPA's IEUBK Lead Model (Version 0.99d) and the maximum lead concentration reported in soil was also used in the model to account for incidental soil and dust ingestion. Model defaults remained unchanged for the remaining input parameters. This characterization is based on USEPA's IEUBK lead model default settings and the assumption that a child would ingest loess groundwater and site soil from the age of zero to 84 months. USEPA's policy is to identify lead as a COC if the model calculates more than a 5% probability of a blood lead level greater than or equal to 0.01 milligrams per deciliter (mg/dl). As shown in Figure 7-3, the probability USEPA's model calculated a blood lead level above 0.01 mg/dl is below USEPA's acceptable limit of 5%. Consequently, lead is not a COC in loess groundwater.

Figure 7-1 Risk Summary



Notes:

Abbreviation	Exposure Medium	Exposure Pathway
Soil Ing	Surface Soil	Incidental Ingestion
Soil Der		Dermal Contact
Soil Sum		Sum (of all applicable soil pathways)
GW L Ing	Loess Groundwater	Ingestion
GW L Inh		Inhalation
GW L Sum		Sum
GW F Ing	Fluvial Deposits Groundwater	Ingestion
GW F Inh		Inhalation
GW F Sum		Sum
Soil & L GW	Soil & Loess Groundwater	Sum
Soil & F GW	Soil & Fluvial Deposits Groundwater	Sum

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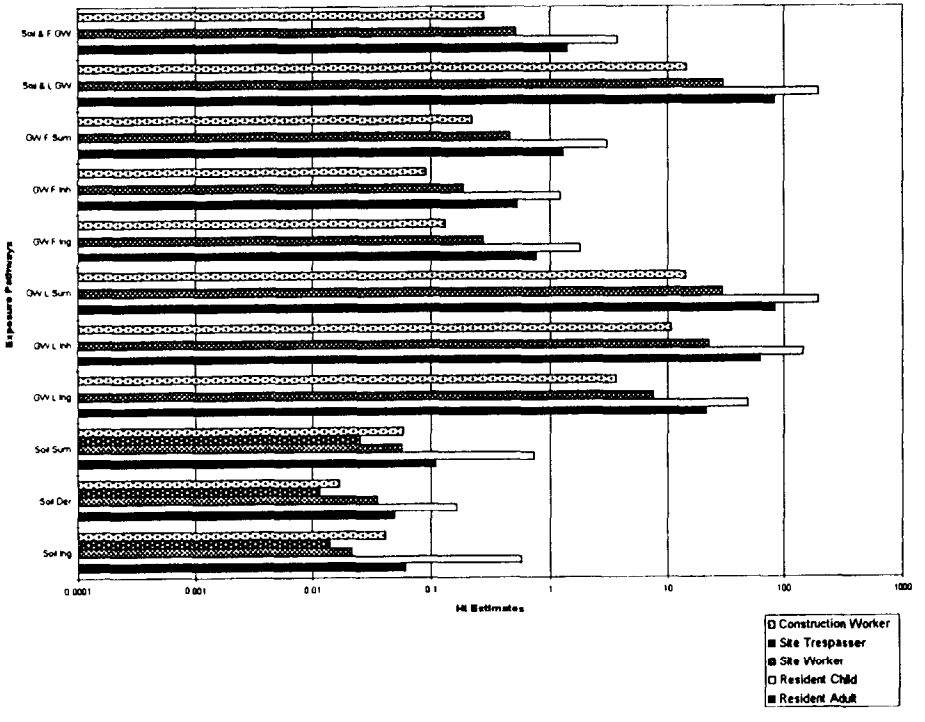
Figure 7-2 HI Summary



Notes:

Abbreviation	Exposure Medium	Exposure Pathway
Soil Ing	Soil	Incidental Ingestion
Soil Der		Dermal Contact
Soil Sum		Sum (of all applicable soil pathways)
GW L Ing	Loess Groundwater	Ingestion
GW L Inh		Inhalation
GW L Sum		Sum
GW F Ing	Fluvial Deposits Groundwater	Ingestion
GW F Inh		Inhalation
GW F Sum		Sum
Soil & L GW	Soil & Loess Groundwater	Sum
Soil & F GW	Soil & Fluvial Deposits Groundwater	Sum

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Figure 7-3

Model Output for Loess Groundwater and Surface Soil
USEPA LEAD MODEL Version 0.99d

AIR CONCENTRATION: 0.100 μg Pb/m^3 DEFAULT
Indoor AIR Pb Conc: 30.0 percent of outdoor.
Other AIR Parameters:

Age	Time Outdoors (hr)	Vent. Rate (m^3/day)	Lung Abs. (%)
0-1	1.0	2.0	32.0
1-2	2.0	3.0	32.0
2-3	3.0	5.0	32.0
3-4	4.0	5.0	32.0
4-5	4.0	5.0	32.0
5-6	4.0	7.0	32.0
6-7	4.0	7.0	32.0

DIET: DEFAULT

DRINKING WATER Conc: 29.20 μg Pb/L
WATER Consumption: DEFAULT

SOIL & DUST:
Soil: constant conc.
Dust: constant conc.

Age	Soil (μg Pb/g)	House Dust (μg Pb/g)
0-1	30.7	30.7
1-2	30.7	30.7
2-3	30.7	30.7
3-4	30.7	30.7
4-5	30.7	30.7
5-6	30.7	30.7
6-7	30.7	30.7

Additional Dust Sources: None DEFAULT

PAINT Intake: 0.00 μg Pb/day DEFAULT

MATERNAL CONTRIBUTION: Infant Model
Maternal Blood Conc: 2.50 μg Pb/dl

Figure 7-3 (continued)

Model Output for Loess Groundwater and Surface Soil
USEPA LEAD MODEL Version 0.99d

CALCULATED BLOOD Pb and Pb UPTAKES:

YEAR	Blood Level (μg/dl)	Total Uptake (μg/day)	Soil+Dust Uptake (μg/day)
0.5-1:	3.3	6.06	0.73
1-2:	4.2	10.46	1.13
2-3:	4.1	11.18	1.14
3-4:	4.0	11.33	1.16
4-5:	3.8	11.31	0.87
5-6:	3.6	11.87	0.78
6-7:	3.5	12.31	0.74

YEAR	Diet Uptake (μg/day)	Water Uptake (μg/day)	Paint Uptake (μg/day)	Air Uptake (μg/day)
0.5-1:	2.58	2.73	0.00	0.02
1-2:	2.64	6.66	0.00	0.03
2-3:	2.99	6.99	0.00	0.06
3-4:	2.90	7.19	0.00	0.07
4-5:	2.82	7.55	0.00	0.07
5-6:	2.99	8.00	0.00	0.09
6-7:	3.31	8.16	0.00	0.09

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Table 7.20
Risk Estimates
Ingestion of Loess Groundwater
NSA Mid-South SWMU 5
Memphis, Tennessee

				Site Resident			*Site Worker*		*Construction Worker*	
				Adult	*Child*	*LWA*	*Adult*		*Adult*	
Chemical	**EPC (mg/L)**	**Oral RfD (mg/kg-day)**	**Oral SF (kg-day/mg)**	**HQ**	**HQ**	**ILCR**	**HQ**	**ILCR**	**HQ**	**ILCR**
Antimony	0.0648	0.0004	NA	4.4	10.4	NA	1.58	NA	0.76	NA
Arsenic	0.159	0.0003	1.5	14.5	33.9	3.6E-03	5.18	8.3E-04	2.49	4.8E-05
Barium	0.909	0.07	NA	0.36	0.83	NA	0.13	NA	0.06	NA
Benzene	3.9	NA	0.029	NA	NA	1.7E-03	NA	3.9E-04	NA	2.3E-05
Cadmium	0.0181	0.0005	NA	1.0	2.3	NA	0.35	NA	0.17	NA
Carbon tetrachloride	0.0067	0.0007	0.13	0.3	0.6	1.3E-05	0.09	3.0E-06	0.04	1.8E-07
1,2-Dichloroethene (total)	0.008	0.009	NA	0.024	0.057	NA	0.0087	NA	0.0042	NA
2-Methylnaphthalene	0.1	0.02	NA	0.137	0.320	NA	0.0489	NA	0.0235	NA
Methylene chloride	0.031	0.06	0.0075	0.014	0.033	3.5E-06	0.005	8.1E-07	0.0024	4.7E-08
Naphthalene	0.12	0.02	NA	0.2	0.4	NA	0.06	NA	0.03	NA
Trichloroethene	0.002	0.006	0.011	0.009	0.02	3.3E-07	0.003	7.7E-08	0.0016	4.4E-09
Vanadium	0.102	0.007	NA	0.40	0.9	NA	0.14	NA	0.068	NA
Cumulative HI or ILCR				21	50	5.E-03	7.6	1.E-03	3.7	7.E-05

Table 7.21
Risk Estimates
Inhalation of Chemicals Volatilized While Showering With Loess Groundwater
NSA Mid-South SWMU 5
Memphis, Tennessee

				Site Resident			*Site Worker*		*Construction Worker*	
				Adult	*Child*	*LWA*	*Adult*		*Adult*	
Chemical	**EPC (mg/L)**	**Inhalation RfD (mg/kg-day)**	**Inhalation SF (kg-day/mg)**	**HQ**	**HQ**	**ILCR**	**HQ**	**ILCR**	**HQ**	**ILCR**
Benzene	3.9	0.00171	0.029	62	146	1.7E-03	22	3.9E-04	11	2.3E-05
Carbon tetrachloride	0.0067	5.71E-04	0.0525	0.32	0.75	5.2E-06	0.11	1.2E-06	0.055	7.1E-08
1,2-Dichloroethene (total)	0.008	0.009	NA	0.024	0.057	NA	0.009	NA	0.0042	NA
Methylene chloride	0.031	0.857	0.00164	0.0010	0.0023	7.6E-07	0.0004	1.8E-07	0.00017	1.0E-08
Trichloroethene	0.002	0.006	0.006	0.009	0.021	1.8E-07	0.003	4.2E-08	0.0016	2.4E-09
Cumulative HI or ILCR				63	147	2.E-03	22	4.E-04	11	2.E-05

Notes:

EPC = Exposure point concentration
RfD = Reference Dose; the oral RfD was applied when no inhalation RfD was available
SF = Slope Factor
HQ = Hazard quotient
ILCR = Incremental excess lifetime cancer risk
HI = Hazard index
NA = Not applicable
LWA = Lifetime weighted average
mg/L = milligram per liter

Table 7.22
Risk Estimates
Ingestion of Fluvial Deposits Groundwater
NSA Mid-South SWMU 5
Memphis, Tennessee

				Site Resident			*Site Worker*		*Construction Worker*	
				Adult	*Child*	*LWA*	*Adult*		*Adult*	
Chemical	**EPC (mg/L)**	**Oral RfD (mg/kg-day)**	**Oral SF (kg-day/mg)**	**HQ**	**HQ**	**ILCR**	**HQ**	**ILCR**	**HQ**	**ILCR**
Cadmium	0.0054	5.00E-04	NA	0.30	0.69	NA	0.11	NA	0.05	NA
Nitrobenzene	0.001	5.00E-04	NA	0.05	0.13	NA	0.02	NA	0.0094	NA
Chloroform	0.001	1.00E-02	0.0061	0.003	0.006	9.1E-08	0.001	2.1E-08	0.00047	1.2E-09
Chloromethane	0.005	NA	0.013	NA	NA	9.7E-07	NA	2.3E-07	NA	1.3E-08
Trichloroethene	0.0053	6.00E-03	0.011	0.02	0.06	8.7E-07	0.009	2.0E-07	0.0041	1.2E-08
Carbon tetrachloride	0.01	7.00E-04	0.13	0.39	0.91	1.9E-05	0.14	4.5E-06	0.067	2.6E-07
Cumulative HI or ILCR				0.8	2	2.E-05	0.3	5.E-06	0.1	3.E-07

Table 7.23
Risk Estimates
Inhalation of Chemicals Volatilized While Showering With Loess Groundwater
NSA Mid-South SWMU 5
Memphis, Tennessee

				Site Resident			*Site Worker*		*Construction Worker*	
				Adult	*Child*	*LWA*	*Adult*		*Adult*	
Chemical	**EPC (mg/L)**	**Inhalation RfD (mg/kg-day)**	**Inhalation SF (kg-day/mg)**	**HQ**	**HQ**	**ILCR**	**HQ**	**ILCR**	**HQ**	**ILCR**
Nitrobenzene	0.001	0.000571	NA	0.048	0.112	NA	0.017	NA	0.0082	NA
Chloroform	0.001	0.01	0.0805	0.003	0.006	1.2E-06	0.001	2.8E-07	0.0005	1.6E-08
Chloromethane	0.005	NA	0.0063	NA	NA	4.7E-07	NA	1.1E-07	NA	6.3E-09
Trichloroethene	0.0053	0.006	0.006	0.024	0.056	4.7E-07	0.009	1.1E-07	0.0041	6.4E-09
Carbon tetrachloride	0.01	0.0006	0.0525	0.46	1.07	7.8E-06	0.163	1.8E-06	0.078	1.1E-07
Cumulative HI or ILCR				0.5	1.2	1.E-05	0.19	2.E-06	0.09	1.E-07

Notes:

EPC = Exposure point concentration
RfD = Reference Dose; the oral RfD was applied when no inhalation RfD was available
SF = Slope Factor
HQ = Hazard quotient
ILCR = Incremental excess lifetime cancer risk
HI = Hazard index
NA = Not applicable
LWA = Lifetime weighted average
mg/L = milligram per liter

Fluvial Deposits

Tables 7-22 and 7-23 present risk estimates for fluvial deposits groundwater. As shown in Figure 7-1, the sum of fluvial deposits groundwater ILCR estimate is 3E-5 for the site resident receptor. For the ingestion and inhalation pathways, ILCR estimates are 2E-5 and 1E-5, respectively. Carbon tetrachloride and chloroform are the primary contributors to the inhalation ILCR, while carbon tetrachloride is the only contributor to the ingestion ILCR. Adult and child HI estimates are 1.3 and 3.2, respectively. Cadmium and carbon tetrachloride are the primary contributors to HI, with nitrobenzene as a secondary contributor.

The maximum lead concentration reported in fluvial deposits groundwater was used as the EPC when using USEPA's **IEUBK** Lead Model, and the maximum lead concentration reported in soil was also used in the model to account for incidental soil and dust ingestion. Model defaults remained unchanged for the remaining input parameters. This characterization is based on USEPA's IEUBK lead model default settings and the assumption that a child would ingest fluvial deposits groundwater and site soil from the age of zero to 84 months. USEPA identifies lead as a COC if the model calculates more than a 5% probability of a blood lead level greater than or equal to 0.01 milligram per deciliter (mg/dl). As shown in Figure 7-4, the probability USEPA's model calculated a blood lead level above 0.01 mg/dl is below USEPA's acceptable limit of 5%. Consequently, lead is not a COC in fluvial deposits groundwater.

7.5.2 Hypothetical Site Workers

Risk to site workers was evaluated in accordance with RAGS assuming a standard default worker scenario. As previously discussed, three exposure pathways were evaluated for the site worker scenario: incidental surface soil ingestion, dermal contact with surface soil, and ingestion of groundwater. In addition, inhalation of VOCs was evaluated for loess groundwater, because VOCs were identified as loess groundwater COPCs. As shown in Figure 7-2, the sum of soil and loess groundwater risk estimates is 2E-3, with groundwater contributing more than 95% of the risk. The sum of soil and fluvial deposits groundwater risk estimates is 1E-5, mostly from soil risk.

Figure 7-2 shows the soil and loess groundwater HI estimate of 30 for site workers with groundwater contributing more than 95% of the risk, while the sum soil and fluvial deposits HI estimate is 0.5.

Soil

As shown on Figure 7-1, the sum soil ILCR estimate for site workers is 1E-5. The ingestion ILCR estimate for surface soil is 5E-6, while the dermal pathway ILCR is 9E-6, as shown in Tables 7-18 and 7-19, respectively. Dieldrin is the primary risk contributor to both pathways.

As shown on Figure 7-2, the sum HI estimate for surface soil pathways is 0.06. Tables 7-18 and 7-19 show that incidental soil ingestion and dermal contact HI estimates for site workers are 0.02 and 0.04, respectively. Dieldrin and MCPA are the only contributors to soil HI estimates.

Groundwater

Loess

The sum loess groundwater ILCR estimate for the site worker receptor is 2E-3, as shown in Figure 7-1. For the ingestion and inhalation pathways, ILCR estimates are 1E-3 and 4E-4, respectively, as shown in Tables 7-20 and 7-21. Arsenic and benzene are primary contributors to ILCR estimates, with carbon tetrachloride and methylene chloride as secondary contributors.

Cumulative HI estimates for ingestion and inhalation loess groundwater exposure pathways are 7 and 22, as shown in Tables 7-20 and 7-21. Arsenic and antimony are primary contributors to the estimated ingestion HI, while benzene is the primary contributor to the inhalation pathway HI estimate.

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Figure 7-4

Model Output for Fluvial Deposits Groundwater and Surface Soil
USEPA LEAD MODEL Version 0.99d

AIR CONCENTRATION: 0.100 μg Pb/m^3 DEFAULT
Indoor AIR Pb Conc: 30.0 percent of outdoor.
Other AIR Parameters:

Age	Time Outdoors (hr)	Vent. Rate (m^3/day)	Lung Abs. (%)
0-1	1.0	2.0	32.0
1-2	2.0	3.0	32.0
2-3	3.0	5.0	32.0
3-4	4.0	5.0	32.0
4-5	4.0	5.0	32.0
5-6	4.0	7.0	32.0
6-7	4.0	7.0	32.0

DIET: DEFAULT

DRINKING WATER Conc: 32.80 μg Pb/L
WATER Consumption: DEFAULT

SOIL & DUST:
Soil: constant conc.
Dust: constant conc.

Age	Soil (μg Pb/g)	House Dust (μg Pb/g)
0-1	30.7	30.7
1-2	30.7	30.7
2-3	30.7	30.7
3-4	30.7	30.7
4-5	30.7	30.7
5-6	30.7	30.7
6-7	30.7	30.7

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Figure 7-4 (continued)

Model Output for Fluvial Deposits Groundwater and Surface Soil
USEPA LEAD MODEL Version 0.99d

Additional Dust Sources: None DEFAULT

PAINT Intake: 0.00 μg Pb/day DEFAULT

MATERNAL CONTRIBUTION: Infant Model
Maternal Blood Conc: 2.50 μg Pb/dl
CALCULATED BLOOD Pb and Pb UPTAKES:

YEAR	Blood Level (μg/dl)	Total Uptake (μg/day)	Soil+Dust Uptake (μg/day)
0.5-1:	3.5	6.37	0.73
1-2:	4.5	11.21	1.13
2-3:	4.4	11.97	1.14
3-4:	4.2	12.15	1.15
4-5:	4.0	12.18	0.86
5-6:	3.9	12.79	0.78
6-7:	3.7	13.25	0.74

YEAR	Diet Uptake (μg/day)	Water Uptake (μg/day)	Paint Uptake (μg/day)	Air Uptake (μg/day)
0.5-1:	2.57	3.05	0.00	0.02
1-2:	2.62	7.43	0.00	0.03
2-3:	2.97	7.80	0.00	0.06
3-4:	2.89	8.05	0.00	0.07
4-5:	2.81	8.44	0.00	0.07
5-6:	2.98	8.94	0.00	0.09
6-7:	3.30	9.12	0.00	0.09

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Fluvial Deposits

The sum of the fluvial deposits groundwater ILCR estimate is 7E-6 for the site worker receptor, as shown on Figure 7-1. Carbon tetrachloride is the only contributor to ILCR. Ingestion and inhalation HI estimates are 0.3 and 0.18 **(0.19)**, respectively. Carbon tetrachloride and cadmium are the primary contributors to ingestion HI. Carbon tetrachloride is the primary contributor to the inhalation HI, as shown in Tables 7-22 and 7-23.

7.5.3 Current Site Workers

Neither loess nor fluvial deposits groundwater are currently used as a potable water source for NSA Mid-South. In the absence of a completed exposure pathway, no threat to human health is posed by reported groundwater contamination, and the future site worker scenario would be protective of current site workers, as previously discussed.

7.5.4 Hypothetical Construction Workers

Risk to construction workers was evaluated in accordance with RAGS using exposure parameters agreed upon by USEPA Region 4, TDEC, and the Navy. Five exposure pathways were evaluated for the construction worker scenario: incidental surface soil ingestion, dermal contact with surface soil, ingestion of groundwater, and inhalation of volatiles from groundwater while showering. In addition, inhalation of VOCs was evaluated for groundwater because VOCs were identified as groundwater COPCs. As shown in Figure 7-2, the sum of surface soil risk estimates is 2E-6.

Figure 7-2 shows the surface soil HI estimate of 0.04 for construction workers. There are no COPCs with an HQ greater than 0.1.

Soil

As shown on Figure 7-1, the sum of surface soil ILCR estimates for construction workers is 2E-6. Tables 7-18 and 7-19, present ILCR estimates of 1E-6 and 5E-7 for incidental ingestion and

dermal contact, respectively. Dieldrin is the primary contributor for the ingestion pathway. No COPCs had an ILCR greater than 1E-6 for the inhalation pathway.

As shown on Figure 7-2, the sum HI estimate for the surface soil pathway is 0.06. Tables 7-18 and 7-19 show that incidental surface soil ingestion and dermal contact HI estimates for construction workers are 0.04 and 0.02. Dieldrin and MCPA are the only contributors to surface soil HI estimates.

Groundwater

Loess

The sum loess groundwater ILCR estimate for the construction worker receptor is 9E-5, as shown in Figure 7-1. For the ingestion and inhalation pathways, ILCR estimates are 7E-5 and 2E-5, as shown in Tables 7-20 and 7-21. Arsenic and benzene are primary contributors to ILCR estimates.

Sum HI estimates for ingestion and inhalation loess groundwater exposure pathways are 4 and 11, as shown in Tables 7-20 and 7-21. Arsenic and antimony are primary contributors to ingestion HI, while benzene is the primary contributor to the inhalation pathway HI estimate.

Fluvial Deposits

The sum fluvial deposits groundwater ILCR estimate is 4E-7 for the construction worker receptor, as shown on Figure 7-1. Ingestion and inhalation HI estimates are 0.1 and 0.09, respectively, as shown in Tables 7-22 and 7-23.

7.5.5 Hypothetical Site Trespassers

Risk to site trespassers was evaluated in accordance with the scenario suggested by USEPA Region 4 in Supplemental Guidance to RAGS Bulletin 3, *Exposure Assessment* (USEPA, 1995b). As previously discussed, site trespassers were assessed assuming soil exposure because the

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groundwater pathway is not complete. Surface soil exposure pathways are incidental ingestion and dermal contact.

As shown on Figure 7-1, the sum of soil ILCR estimate for site trespassers is 2E-6. The ingestion and dermal pathway ILCR estimates for surface soil are 1E-6, as shown in Tables 7-18 and 7-19, respectively. Dieldrin is the primary contributor to both pathways, with the carcinogenic PAHs as a secondary contributor.

Figure 7-2 shows the HI for surface soil pathways, 0.03. Incidental soil ingestion and dermal contact HI estimates for site trespassers are 0.014 and 0.012, respectively, as shown in Tables 7-8 and 7-19. Dieldrin is the primary contributor to soil HI.

7.5.6 Identification of Chemicals of Concern

In accordance with RAGS and as outlined in Appendix I, COCs were identified based on cumulative (all pathway) risk and hazard projected for this site. USEPA has established a generally acceptable risk range of 1E-4 to 1E-6, and an HI threshold of 1 (unity). In this HHRA, a COC was considered to be any chemical contributing to land use scenario with a cumulative risk level of 1E-4 or greater and/or a cumulative HI above 1, where an individual chemical's ILCR exceeds 1E-6 or HQ exceeds 0.1. The COC selection method provides a more comprehensive evaluation of chemicals contributing to carcinogenic risk or noncarcinogenic hazard during the remedial goal options (RGO) development process.

Based on this method, COCs were identified in loess and fluvial deposits groundwater. The list of COCs follows and is annotated to indicate the COC and corresponding exposure scenario and medium:

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Loess Groundwater

- Antimony [resident, site worker]
- Arsenic [resident, site worker]
- Barium [resident, site worker]
- Benzene [resident, site worker]
- Cadmium [resident, site worker]
- Carbon tetrachloride [resident, site worker]
- Methylene chloride [resident]
- 2-Methylnaphthalene [resident]
- Naphthalene [resident]
- Vanadium [resident, site worker]

Fluvial Deposits Groundwater

- Cadmium [resident, site worker]
- Nitrobenzene [resident]
- Carbon tetrachloride [resident, site worker]
- Chloroform [resident]

Although dieldrin risk estimates exceed the 1E-6 risk threshold in soil, COCs were not identified in surface soil. Groundwater accounts for most of the risk posed by SWMU 5 media. If risk to groundwater were eliminated through remediation or institutional controls, hypothetical exposure to surface soil is not expected to pose sufficient risk alone.

7.6 Uncertainty Analysis

This section discusses the uncertainty inherent in the risk assessment process in addition to medium-specific and exposure pathway-specific influences. Risk assessment sections are discussed separately below, and specific examples of uncertainty sources are included where appropriate.

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7.6.1 General

Uncertainty and variability are factors in each step of the exposure and toxicity assessment procedures presented in the preceding sections. Overall, uncertainties associated with the initial stages of the risk assessment process become magnified when they are combined with other uncertainties. It is not possible to eliminate all uncertainties; however, recognizing the uncertainties is fundamental to understanding and subsequently using risk assessment results.

This section presents the uncertainty of site-, medium-, and pathway-specific variables introduced as part of the risk assessment process, in addition to other variables influencing the uncertainty of the calculated ILCR and HQs/HIs.

Assumptions for the risk assessment process are based on population studies and USEPA guidance. This guidance divides the assumptions into two basic categories: the upper bound (90th to 95th percentile) and the mean or 50th percentile central tendency (CT) exposure assumptions. As discussed in Appendix I, the reasonable maximum exposure (RME) is based on the upper-bound assumptions, and CT exposure is based on mean assumptions. Therefore, exposure estimated using RME exposure assumptions are expected to result in an overestimate of risks potentially used by the site. The following paragraphs discuss sources of uncertainty pertinent to each exposure pathway evaluated.

7.6.2 Quality of Data

Data collected during the investigation of NSA Mid-South are summarized in Appendix F. Data from the IM and RFI were evaluated to verify that the QC requirements of the data set have been met and to characterize the weakness of questionable data. The validation report for the RFI data is presented in Appendix F. Although the IM data were evaluated, there was no validation report submitted with this data. The UST subsurface soil data were not evaluated in accordance with *USEPA Contract Laboratory Program National Functional Guidelines for Organic and Inorganic*

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Data Review (USEPA, 1994 a,b). However, a cursory data review (i.e., review of surrogates, matrix spike, matrix spike duplicates, and blanks) suggests that blank contamination is the only quality control parameter that may be an issue. Because the data was used without blank evaluation, the data represent the most conservative concentrations. During screening the data were compared to RBCs and RCs (metals only) and no COPCs were identified. Because no COPCs were identified, and the data represents the most conservative concentrations, the lack of data evaluation is inconsequential.

Most analytical data for environmental samples have inherent variability. This is a function of the sample matrix, the precision and accuracy of sampling and analysis, sample preparation, and the analytical methods used. Although data are typically considered to be exact values, they are in reality the laboratory's best estimate within a range defined by method control limits. As a result, reported concentrations for any chemical can vary and can underestimate or overestimate actual concentrations as detailed in E/A&H's data validation report.

Uncertainty in samples collected could bias exposure estimates. Although concentrations across SWMU 5 could be higher or lower than those reported, samples were collected from locations most likely to be impacted. Because of the biased sampling design, it is more likely that the reported concentrations are overestimates of concentrations that are potentially present at the site.

7.6.3 Identification of COPCs

In accordance with RAGS, and as discussed in Appendix I, screening values were used to focus the HHRA on exposure scenarios of concern and COPCs that individually exceed a carcinogenic risk of 1E-6 or an HQ of 0.1.

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Exposure Media and Pathways

The exposure pathways considered in the Exposure Assessment Section of this HHRA are extremely conservative. As discussed previously, loess and fluvial deposits groundwater are not currently used as drinking water, and drinking water is obtained from a much deeper aquifer. However, a comparison was made using the most conservative screening value provided by USEPA for each exposure pathway, (i.e., assuming residential land use) in accordance with USEPA's Supplemental Guidance to RAGS Bulletin 1, *Data Collection and Evaluation* (USEPA, 1995b).

Although the screening method is conservative, inhalation exposure is not incorporated into the soil screening values calculated by USEPA Region III. If these pathways were the primary concern rather than ingestion, the screening method could eliminate contaminants that should be considered as COPCs.

Consequently, VOC concentrations reported in surface soil were compared to USEPA's SSLs, which would be protective of VOCs in soil being released and inhaled by site residents. Acetone was the only VOC in surface soil reported at a maximum concentration of 4.6 mg/kg. USEPA determined the soil-to-air screening value for acetone to be 62,000 mg/kg. Consequently, acetone was eliminated as a COPC and risk was not underestimated for VOCs reported in surface soil.

Comparison to Reference Concentrations (Background)

Because the intent of the HHRA is to estimate the incremental health risks posed by COPCs, site data were subsequently compared to RCs for NSA Mid-South. Additional uncertainty is introduced by comparing site data to nonspecific screening reference data. Although the background concentrations are specific to NSA Mid-South, they are not SWMU-specific. However, because metals are naturally occurring and the samples were collected from areas of similar soil-type, the use of non-specific background soil data was deemed appropriate. The

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limited number of background samples and sample locations increases the uncertainty because a larger data set more adequately accounts for natural variability in media composition.

The technical memorandum — *Surface Soil (0 to 1 Foot) Background Dieldrin Concentrations at NSA Memphis* (E/A&H, 1997) has been included in this RFI as Appendix B. In summary, the memorandum stated that dieldrin was detected at NSA Mid-South at relatively insignificant concentrations. Dieldrin, which was used extensively in the 1950s and 1960s, was applied as a pesticide at NSA Mid-South during that time period. Dieldrin was also used in the pest-control trade with chlordane for general subterranean termite control. The range of dieldrin concentrations reported for SWMU 5 is 0.015 to 1.0 mg/kg, with an arithmetic mean concentration of 0.3 mg/kg. The average background dieldrin concentration reported in the memorandum is 0.131 mg/kg. Two-times the average background dieldrin concentration equals 0.262 mg/kg, which is similar to the mean reported in SWMU 5 surface soil. Therefore, the background dieldrin concentration should be considered when making risk-management decisions.

Elimination of Essential Nutrients

In accordance with RAGS, the following nutrients were eliminated from the SWMU 5 BRA: calcium, sodium, potassium, and magnesium. Toxicity from overexposure to these nutrients is possible only if human receptors are exposed to extremely high doses. USEPA generally recommends eliminating these compounds from formal risk assessment. Because no screening comparison was performed, the HIs calculated in this HHRA could be positively influenced by the nutrient concentrations detected onsite. Therefore, the HIs may underestimate potential nutrient contributions to the HIs.

Based on Region 4 guidance, the RfD for iron is based on inadvertent iron consumption of beer brewed in iron vessels. As a result, iron was eliminated as a COPC.

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7.6.4 Quantification of Exposure

Quantification of exposure involves calculation of the estimated chemical intake likely to be experienced by receptors in each of the scenarios identified for evaluation. Exposure equations are developed to determine chemical intake expressed as milligram of chemical per kilogram of body weight per day . These equations incorporate rates of contact with contaminated media, duration and frequency of exposure to the contaminated medium, exposure point concentrations of each COPC for each medium, and other exposure factors unique to each exposure scenario, in estimating chronic intakes. Estimated chemical intakes using these types of equations can be highly uncertain. The following sections discuss the uncertainties associated with exposure quantification.

Characterization of Exposure Setting

The potential for high bias is introduced through the exposure setting and pathway selection due to the highly conservative assumptions (future residential use) recommended by USEPA Region 4 when assessing potential future and current exposure scenarios. The exposure assumptions made in the site worker scenario are highly conservative and are expected to overestimate exposure. Current site workers are not exposed to site groundwater, because it is not a potable water source. Current site workers are infrequently exposed to surface soil when walking across or during maintenance activities at the site. Site workers would not be expected to work onsite in contact with affected media for eight hours per day, 250 days per year, as assumed in the exposure assessment. In all likelihood, a landfill will not be developed for residential use at SWMU 5. Mowing grass 52 days per year would result in one-fifth the projected risk/hazard for site workers, if that activity took eight hours.

Fire fighter training activities were suspended as a current use of the site and future training activities are not anticipated at the site. These plans show the zone as commercial use with limited open areas. Significant grading and fill would be required to render it suitable for development

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of any kind. Surface soil conditions would change — the soil could be covered with landscaping soil, a paved driveway, or it could be left uncovered and disturbed. However, exposure to current surface soil conditions would not be likely under a true future residential scenario. Construction workers would be exposed to the media assessed in this BRA, and the current site worker scenario is a generally conservative estimate of their exposure and resulting risk/hazard. These factors indicate that exposure pathways assessed in this BRA would generally overestimate the risk and hazard posed to current/future site workers, trespassers, and future site residents.

Determination of Exposure Point Concentrations

Based on the guidance provided by USEPA, EPCs are used to estimate exposure. USEPA's *Supplemental Guidance to RAGS: Calculating the Concentration Term* (USEPA, 1992a) outlines a statistical estimation of EPC. These calculated concentrations represent the 95th percentile UCLs on the arithmetic mean which are based on the certain assumptions. USEPA assumes that most (if not all) environmental data are lognormally distributed. This assumption can lead to over- or underestimation of the concentration term because many environmental data are neither normally nor lognormally distributed.

The UCL calculation includes a statistical value, the **H-statistic**, which is based on the number of samples analyzed for each COPC and the standard deviation of the results. To obtain this number, a table must be referenced, and the value must be interpolated (an estimation) from the table. Although the statistic appears to be nonlinear, linearity was assumed to facilitate interpolation of the statistic for each COPC addressed in this HHRA.

Linear interpolation is a good estimate of the **H-statistic**; however, the UCL formula and **H** are natural log values. The effect of multiplying natural log numbers is not equivalent to multiplying untransformed values. When data are log-transformed, adding two numbers is the equivalent of multiplying the two numbers if they were not transformed. The effect of multiplying a number

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while in log form is exponential; here, **H** is applied as a multiplier. In summary, using this method to calculate the EPC generally overestimates concentrations that are representative of a site under investigation.

The data sets in NSA Mid-South risk assessments are generally small, but when appropriate, UCLs were calculated. Data sets often contain many assumed values. A few high detections and many nondetected values would increase the standard deviation, ultimately increasing the UCL above the maximum reported concentration. Conversely, a few concentrations reported near or slightly below the standard quantitation limit and many nondetected values could lower the UCL. To minimize this uncertainty, when data sets had fewer than 10 total samples for a specific medium, the maximum concentrations detected were used as the EPC. This approach is consistent with current USEPA guidance.

Uncertainty is associated with EPCs also stems from using maximum concentrations for the groundwater EPC. Because fewer than 10 groundwater sample locations per analytical parameter were used to assess this site, the maximum reported concentration was used to estimate exposure for the COCs identified during risk characterization. USEPA does not recommend using maximum concentrations to estimate exposure because exposure to the maximum concentration of every chemical detected across the site overestimates exposure (a theoretical hot spot having the maximum concentrations detected in all samples collected).

As reviewed above, summation of risk based on maximum concentrations can overestimate exposure, especially for low detection frequency or spatially segregated COPCs. This concept is further discussed below, and a factor for FI/FC was used to provide exposure estimates which more accurately assess the entire SWMU 5 exposure area.

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Frequency of Detection and Spatial Distribution

Soil

Using the maximum concentration detected as EPC may not be appropriate when the EPC is assumed to be uniformly distributed. It is not feasible for a receptor to be simultaneously exposed to maximum concentrations of all the COPCs that are distributed at various locations throughout SWMU 5. The use of the maximum concentration is questionable for these contaminants, and the calculated risk and hazard could be skewed upward or downward due to the low frequency of detection. In addition, significant uncertainty exists with respect to low sample density areas. Because the RFI focused on identified problem areas at individual SWMUs, contaminated areas could exist which were not delineated.

In some instances, it is possible to define "hot spots" or affected areas within the investigation area. A hot spot is an isolated area containing higher concentrations relative to the entire exposure area. In accordance with Supplemental Guidance to RAGS, exposure may be quantified in such an area by using an FI/FC factor based on the percentage of the total exposure area encompassed by the hot spot. This term was used to modify the maximum reported concentration to derive the EPC for MCPA and PAHs, which were detected at limited sample locations (MCPA frequency 1 of 6 and PAHs frequency 2 of 13). The FI/FC is discussed in Section 7.3, while the extent of contamination is discussed in Section 6.

Applying FI/FC reduces exposure. Consequently, Tables 7-24 through 7-27 were developed to account for possible hot spots at locations 05SB01 and 05SB07. No hot spots are evident, based on the surface soil risk estimates presented for these sample locations. Hot spots would be identified at SWMU 5 when the soil risk or hazard estimate exceeded USEPA's acceptable levels, such as ILCR of 1E-4 or an HI of 1.

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Table 7.24
Point Risk Estimates
Incidental Ingestion of Surface Soil Sample 005SB01
NSA Mid-South SWMU 5
Memphis, Tennessee

				Site Resident			Site Worker		Construction Worker		Site Trespasser	
				Adult	Child	LWA	Adult		Adult		Adolescent	
Chemical	EPC (mg/kg)	Oral RfD (mg/kg-day)	Oral SF (kg-day/mg)	HQ	HQ	ILCR	HQ	ILCR	HQ	ILCR	HQ	ILCR
BEQ	ND	NA	7.3	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dieldrin	0.022	5.00E-05	16	0.001	0.01	5.5E-07	0.0002	6.2E-08	0.00041	1.4E-08	0.00014	1.6E-08
MCPA	19	0.0005	NA	0.052	0.49	NA	0.019	NA	0.0357	NA	0.012	NA
Cumulative HI or ILCR				0.05	0.5	6.E-07	0.02	6.E-08	0.04	1.E-08	0.01	2.E-08

Table 7.25
Point Risk Estimates
Dermal Contact With Surface Soil Sample 005SB01
NSA Mid-South SWMU 5
Memphis, Tennessee

				Site Resident			Site Worker		Construction Worker		Site Trespasser	
				Adult	Child	LWA	Adult		Adult		Adolescent	
Chemical	EPC (mg/kg)	Dermal RfD (mg/kg-day)	Dermal SF (kg-day/mg)	HQ	HQ	ILCR	HQ	ILCR	HQ	ILCR	HQ	ILCR
BEQ	ND	NA	14.6	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dieldrin	0.022	0.000025	32	0.0005	0.0016	2.5E-07	0.0004	1.0E-07	0.0002	5.8E-09	0.00011	1.3E-08
MCPA	19	0.00025	NA	0.0427	0.14	NA	0.030	NA	0.0146	NA	0.0099	NA
Cumulative HI or ILCR				0.04	0.1	2.E-07	0.03	1.E-07	0.01	6.E-09	0.01	1.E-08

Notes:

EPC = Exposure point concentration
RfD = Reference Dose
SF = Slope Factor
HQ = Hazard quotient
ILCR = Incremental excess lifetime cancer risk
HI = Hazard index
DAF = Dermal adjustment factor, used to account for gastrointestinal absorbtion efficiency in accordance with RAGS
Inorganic = In accordance with RAGS, dermal absorption factors of 0.01 and 0.001 were used to account for the fraction crossing the skin barrier for organics and inorganics, respectively; dermal intake was estimated in accordance with RAGS and and General Human Health Risk Assessment Approach for NSA Memphis (E/A
NA = Not applicable
ND = Not detected
LWA = Lifetime weighted average

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Table 7.26
Point Risk Estimates
Incidental Ingestion of Surface Soil Sample 005SB07
NSA Mid-South SWMU 5
Memphis, Tennessee

				Site Resident			*Site Worker*		*Construction Worker*		*Site Trespasser*	
				Adult	*Child*	*LWA*	*Adult*		*Adult*		*Adolescent*	
Chemical	**EPC (mg/kg)**	**Oral RfD (mg/kg-day)**	**Oral SF (kg-day/mg)**	**HQ**	**HQ**	**ILCR**	**HQ**	**ILCR**	**HQ**	**ILCR**	**HQ**	**ILCR**
BEQ	0.186	NA	7.3	NA	NA	2.1E-06	NA	2.4E-07	NA	5.5E-08	NA	6.1E-08
Dieldrin	0.029	5.00E-05	16	0.0008	0.0074	7.3E-07	0.0003	8.1E-08	1.7E-09	1.9E-08	0.00018	2.1E-08
MCPA	ND	0.0005	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Cumulative HI or ILCR				0.0008	0.007	3.E-06	0.0003	3.E-07	1.7E-09	7.E-08	0.0002	8.E-08

Table 7.27
Point Risk Estimates
Dermal Contact With Surface Soil Sample 005SB07
NSA Mid-South SWMU 5
Memphis, Tennessee

				Site Resident			*Site Worker*		*Construction Worker*		*Site Trespasser*	
				Adult	*Child*	*LWA*	*Adult*		*Adult*		*Adolescent*	
Chemical	**EPC (mg/kg)**	**Dermal RfD (mg/kg-day)**	**Dermal SF (kg-day/mg)**	**HQ**	**HQ**	**ILCR**	**HQ**	**ILCR**	**HQ**	**ILCR**	**HQ**	**ILCR**
BEQ	0.186	NA	14.6	NA	NA	9.5E-07	NA	3.9E-07	NA	2.2E-08	NA	5.0E-08
Dieldrin	0.029	0.000025	32	0.0007	0.0021	3.3E-07	0.0005	1.3E-07	0.00022	7.7E-09	0.00015	1.7E-08
MCPA	ND	0.00025	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Cumulative HI or ILCR				0.0007	0.002	1.E-06	0.0005	5.E-07	0.00022	3.E-08	0.0002	7.E-08

Notes:

EPC = Exposure point concentration
RfD = Reference Dose
SF = Slope Factor
HQ = Hazard quotient
ILCR = Incremental excess lifetime cancer risk
HI = Hazard index
DAF = Dermal adjustment factor, used to account for gastrointestinal absorbtion efficiency in accordance with RAGS
Inorganic = In accordance with RAGS, dermal absorption factors of 0.01 and 0.001 were used to account for the fraction crossing the skin barrier for organics and inorganics, respectively; dermal intake was estimated in accordance with RAGS and E/A&H's Technical Memorandum
NA = Not applicable
ND = Not detected
LWA = Lifetime weighted average

Groundwater

Loess Groundwater: Arsenic was reported in eight of twelve loess groundwater samples at concentrations ranging from 0.0026 to 0.159 mg/L. The maximum concentration reported was in the sample from well FFMW-8 (0.159 mg/L). Although this concentration exceeds the MCL of 0.05 mg/L for arsenic, the results from the remaining seven wells were generally one to two orders of magnitude less than this concentration. In addition, the arithmetic mean of reported arsenic concentrations (0.027 mg/L) is less than the MCL (0.05 mg/L). Arsenic contributed the majority of the ILCR and HI estimated for the residential exposure scenario.

Benzene was reported in samples from two wells in the northeast quadrant of SWMU 5: 3.9 mg/L in well FFMW-8 and 0.005 mg/L in well FFMW-9. Benzene was not reported in surface soil or fluvial deposits groundwater. However, benzene was detected in well FFMW-8 during the 1992 UST investigation. Methylene chloride reported in samples from well FFMW-8 (0.031 mg/L) could be a laboratory artifact. As discussed in Section 6, VOCs in loess groundwater are apparently limited to the northeast quadrant of SWMU 5 — specifically, monitoring well FFMW-8. Data collected from the newly installed FFMW-8 monitoring well during the February 1999 sampling event did not have detections of benzene or methylene chloride. However, there were detections of the following compounds at concentrations below their respective tap-water RBCs:

Chemical	Detected Concentration[a]	Tap-Water RBC[a, b]
n-butylbenzene	1.07	60.8
tert-butylbenzene	1.06	60.8
isopropylbenzene	1.31	NA
naphthalene	4.44	730
n-propylbenzene	1.68	60.8
1,2,4-trimethylbenzene	1.54	12.3

Note:
a — All units are microgram per liter (μg/L).

These sample results suggest that the source of benzene and methylene chloride in loess groundwater was removed during the VCA and may no longer be present in loess groundwater at concentrations above RBCs. However, further monitoring of this well would be necessary to verify this assumption. The lack of sufficient information regarding current concentrations of benzene and methylene chloride in loess groundwater represents a data gap.

Antimony, although a major contributor to the ingestion HI, was reported in only one of eight samples at well FFMW-5, located in the southeast quadrant of SWMU 5.

Cadmium, barium, and vanadium were detected in samples from at least five of eight monitoring wells at SWMU 5. Barium concentrations, ranging from 0.256 to 0.909 mg/L, do not exceed the corresponding MCL of 2 mg/L. Cadmium concentrations, ranging from 0.0016 to 0.0181 mg/L, exceeds the MCL of 0.005 mg/L at five locations. There is no MCL available for vanadium. However vanadium, with concentrations ranging from 0.0045 to 0.102 mg/L, exceeded its RC of 0.0409 mg/L at only two monitoring well locations.

In summary, chemicals identified in this assessment that contribute significantly to risk and hazard appear to be focused in the eastern portion of SWMU 5. Although data from previous sampling events indicate well FFMW-8 appears to be a VOC hot spot, recent analytical data suggest benzene and methylene chloride concentrations are might be greatly reduced. The mean arsenic concentration is less than the corresponding MCL and antimony was reported at only one sample location. The extent of benzene, antimony, and arsenic impacts is limited.

Fluvial Deposits Groundwater: As previously discussed in Section 4, samples 05MW04UF, 05MW04AUF, and 05MW04BUF were co-located and installed using different techniques, which could be the source of data variability. Carbon tetrachloride was reported in samples from two of the three co-located fluvial deposits monitoring wells 05MW04AUF and 05MW04BUF at

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concentrations exceeding the RBC of 0.00016 mg/L. Also, cadmium was reported at concentrations exceeding its corresponding RBC in the wells mentioned above and in well 05MW02UF. Cadmium was not detected in 05MW02UF samples collected in February 1999, suggesting cadmium may no longer be present at concentrations exceeding its RBC. Nitrobenzene, reported in well 05MW04BUF, was not reported in either of the other co-located wells. All COPCs reported in fluvial deposits groundwater appear to be hydraulically upgradient of SWMU 5.

7.6.5 Toxicity Assessment Information

There is a generally recognized uncertainty in human risk values developed from experimental data primarily due to the uncertainty of data extrapolation in the areas of: (1) high- to low-dose exposure and (2) animal data to human experience. The site-specific uncertainty is mainly in the degree of accuracy of the exposure assumptions. Most of the assumptions used in this and any risk assessment have not been verified. For example, the degree of chemical absorption from the gut or through the skin or the amount of soil contact is not known with certainty.

The uncertainty of toxicological values available from the IRIS and HEAST databases (provided by USEPA) are summarized in Table 7-17 (previously presented). The uncertainty factors assigned to these values account for acute to chronic dose extrapolation, study inadequacies, and sensitive subpopulations, among other factors. Although uncertainty factors for a specific compound may be 1,000 or higher, these safety factors are applied by USEPA to conservatively bias the overall assessment of risk/hazard toward human health concerns. In the presence of such uncertainty, USEPA and the risk assessor are obligated to make conservative assumptions so the chance is very small for the actual health risk to be greater than what is determined through the risk assessment process. On the other hand, the process is not to yield overly conservative risk values that have no basis in actual conditions. This balance was kept in mind while developing exposure assumptions and pathways and while interpreting data and guidance for this HHRA.

Evaluation of Chemicals for Which No Toxicity Values Are Available

In addition to the typical uncertainties inherent in toxicity values, some parameters do not have corresponding RBCs due to the lack of approved toxicological data. When appropriate surrogate compounds could be determined for those chemicals that do not have published toxicological values, surrogate RBCs were used for screening. This does not indicate that chemicals lacking approved toxicological values, such as lead, pose no risk or hazard. Calcium, sodium, potassium, magnesium, and iron were eliminated based on their low potential for toxicity and because they are essential nutrients. Therefore, these chemicals were not assessed further in this HHRA.

7.6.6 Quantification of Risk/Hazard

This section discusses uncertainty sources identified in the quantification of risk and hazard that are not covered in preceding discussions. Each exposure medium addressed in the formal risk assessment process is discussed briefly.

Soil

Of the chemicals present in site samples (CPSSs) that were screened from formal assessment, none was reported at a concentration close to its corresponding RBC (i.e., a 10% difference with respect to the RBC). This minimizes the likelihood of potentially significant cumulative risk/hazard with respect to the eliminated CPSSs. Arsenic exceeded its corresponding RBC, but this element was excluded based on the comparison to its RC.

BEQ was identified as a COPC in SWMU 5 surface soil. BEQ is a generic term describing the benzo(a)pyrene equivalent concentration of seven carcinogenic PAHs: benzo(a)pyrene, benzo(a)anthracene, dibenz(a,h)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, indeno(123-cd)pyrene, and chrysene. Because the mechanism of action is similar for the seven carcinogenic PAHs, all carcinogenic PAHs detected were included as COPCs and were used to

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calculate BEQ, as shown in Table 7-8. It should be noted, however, that benzo(a)pyrene is the only carcinogenic PAH exceeding the corresponding soil screening value.

Groundwater

Groundwater is currently not used as a potable water source onsite or in the surrounding area, since municipal water is readily available. As previously mentioned, it is highly unlikely that the site will be developed as a residential area or that a potable-use well would be installed onsite. Also, it is likely that dissolved solids and low yield would preclude the loess zone from being an acceptable potable water source, if residences were constructed onsite and an unfiltered well was installed.

Of the CPSSs that were screened from formal assessment, none was reported in either loess or fluvial deposits groundwater at concentrations close to the corresponding RBCs (a 10% difference with respect to the RBC). This minimizes the likelihood of potentially significant cumulative risk/hazard with respect to the eliminated CPSSs.

Loess Groundwater

1,2-Dichloroethene, 2-methylnaphthalene, antimony, arsenic, barium, benzene, cadmium, carbon tetrachloride, lead, methylene chloride, naphthalene, trichloroethene, and vanadium were the COPCs selected for loess groundwater. Chromium, lead, and nickel were reported at concentrations exceeding corresponding RBCs in loess groundwater, but these elements were eliminated based on comparisons to reference background concentrations. Antimony, arsenic, benzene, cadmium, carbon tetrachloride, 2-methylnaphthalene, methylene chloride, naphthalene, and vanadium were selected as COCs for loess groundwater. However, vanadium and methylene chloride were not reported at concentrations exceeding RBCs in later sampling events and arsenic was detected at concentrations below its MCL. Consequently, some uncertainty exists with respect to their presence as COCs.

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Antimony and benzene were reported at concentrations exceeding both the RBC and the MCL. If deed restrictions were in place to prevent the use of loess groundwater, this medium would not represent a viable exposure pathway.

Fluvial Deposits Groundwater

Cadmium, carbon tetrachloride, chloroform, chloromethane, lead, nitrobenzene, trichloroethene were the COPCs selected for fluvial deposits groundwater. Cadmium, nitrobenzene, and carbon tetrachloride were selected as COCs for fluvial deposits groundwater. Cadmium and carbon tetrachloride were reported at concentrations exceeding the corresponding MCL. If deed restrictions were in place to prevent the use of fluvial deposits groundwater, this medium would not represent a viable exposure pathway.

Where chronic RME estimates of risk/hazard suggest a potential threat would be posed to human health, CT analysis was performed. The CT risk descriptor is the arithmetic mean or median risk calculated using average values (50th percentile) for all the exposure factors. CT exposure scenarios were constructed according to standard CT exposure assumptions provided in *Superfund's Standard Default Exposure Factors for the Central Tendency and Reasonable Maximum Exposure-Draft* (USEPA, 1993). CT analysis was performed for loess and fluvial deposits groundwater. Exposure durations for adults and children were changed from 24 and six years and an ILCR was calculated for each receptor using nine years as the exposure duration for each receptor. The adult ingestion rate was changed from 2 to 1.4 liters per day (L/day), while the ingestion rate for children remained 1 L/day. The exposure frequency was changed from 350 days/yr to 234 days/yr, and a factor of 0.75 was used to adjust the ingestion rate to reflect other sources of drinking water. The exposure frequency of site workers was reduced from 250 to 219 days/yr, and the exposure duration was reduced from 25 to five years. CT risk estimates for loess and fluvial deposits groundwater are shown in Tables 7-28 through 7-31.

Table 7.28
Central Tendency Risk Estimates
Ingestion of Loess Groundwater
NSA Mid-South SWMU 5
Memphis, Tennessee

				Site Resident				*Site Worker*	
				Adult	*Child*	*Adult*	*Child*	*Adult*	
Chemical	EPC (mg/L)	Oral RfD (mg/kg-day)	Oral SF (kg-day/mg)	HQ	HQ	ILCR	ILCR	HQ	ILCR
Antimony	0.0648	0.0004	NA	2.00	23.4	NA	NA	1.46	NA
Arsenic	0.159	0.0003	1.5	6.55	76.5	2.9E-04	2.2E-04	4.77	1.5E-04
Barium	0.909	0.07	NA	0.16	1.9	NA	NA	0.12	NA
Benzene	3.9	NA	0.029	NA	NA	1.4E-04	1.0E-04	NA	7.3E-05
Cadmium	0.0181	0.0005	NA	0.45	5.2	NA	NA	0.33	NA
Carbon tetrachloride	0.0067	0.0007	0.13	0.12	1.4	1.1E-06	8.0E-07	0.09	5.6E-07
1,2-Dichloroethene (total)	0.008	0.009	NA	0.01	0.1	NA	NA	0.01	NA
2-Methylnaphthalene	0.1	0.02	NA	0.06	0.7	NA	NA	0.05	NA
Methylene chloride	0.031	0.06	0.0075	0.01	0.1	2.9E-07	2.1E-07	0.00	1.5E-07
Naphthalene	0.12	0.02	NA	0.07	0.9	NA	NA	0.05	NA
Trichloroethene	0.002	0.006	0.011	0.00	0.0	2.7E-08	2.0E-08	0.003	1.4E-08
Vanadium	0.102	0.007	NA	0.18	2.1	NA	NA	0.13	NA
Cumulative HI or ILCR				10	112	4.E-04	3.E-04	7	2.E-04

Table 7.29
Central Tendency Risk Estimates
Inhalation of Chemicals Volatilized While Showering With Loess Groundwater
NSA Mid-South SWMU 5
Memphis, Tennessee

				Site Resident				*Site Worker*	
				Adult	*Child*	*Adult*	*Child*	*Adult*	
Chemical	EPC (mg/L)	Inhalation RfD (mg/kg-day)	Inhalation SF (kg-day/mg)	HQ	HQ		ILCR	HQ	ILCR
Benzene	3.9	0.00171	0.029	21.9	73.11	1.4E-04	1.0E-04	20.5	7.3E-05
Carbon tetrachloride	0.0067	0.000571	0.0525	0.11	0.38	4.3E-07	3.2E-07	0.11	2.3E-07
1,2-Dichloroethene (total)	0.008	0.009	NA	0.0085	0.028	NA	NA	0.008	NA
Methylene chloride	0.031	0.857	0.00164	0.00035	0.0012	6.3E-08	4.7E-08	0.00033	3.3E-08
Trichloroethene	0.002	0.006	0.006	0.0032	0.011	1.5E-08	1.1E-08	0.003	7.7E-09
Cumulative HI or ILCR				22	74	1.E-04	1.E-04	21	7.E-05

Notes:

EPC = Exposure point concentration
RfD = Reference Dose; the oral RfD was applied when no inhalation RfD was available.
SF = Slope Factor
HQ = Hazard quotient
ILCR = Incremental excess lifetime cancer risk
HI = Hazard index
NA = Not applicable
LWA = Lifetime weighted average

Table 7.30
Central Tendency Risk Estimates
Ingestion of Fluvial Deposits Groundwater
NSA Mid-South SWMU 5
Memphis, Tennessee

				Site Resident				*Site Worker*	
				Adult	*Child*	*Adult*	*Child*	*Adult*	
Chemical	**EPC (mg/L)**	**Oral RfD (mg/kg-day)**	**Oral SF (kg-day/mg)**	**HQ**	**HQ**	**ILCR**	**ILCR**	**HQ**	**ILCR**
Cadmium	0.0054	0.0005	NA	0.10	0.35	NA	NA	0.097	NA
Nitrobenzene	0.001	0.0005	NA	0.019	0.064	NA	NA	0.018	NA
Chloroform	0.001	0.01	0.0061	0.001	0.0032	7.5E-09	2.5E-08	0.0009	3.9E-09
Chloromethane	0.005	NA	0.013	NA	NA	8.0E-08	2.7E-07	NA	4.2E-08
Trichloroethene	0.0053	0.006	0.011	0.0085	0.028	7.2E-08	2.4E-07	0.0080	3.7E-08
Carbon tetrachloride	0.01	0.0007	0.13	0.137	0.46	1.6E-06	5.4E-06	0.13	8.4E-07
Cumulative HI or ILCR				0.3	0.9	2.E-06	6.E-06	0.3	9.E-07

Table 7.31
Central Tendency Risk Estimates
Inhalation of Chemicals Volatilized While Showering With Loess Groundwater
NSA Mid-South SWMU 5
Memphis, Tennessee

				Site Resident				*Site Worker*	
				Adult	*Child*		*LWA*	*Adult*	
Chemical	**EPC (mg/L)**	**Inhalation RfD (mg/kg-day)**	**Inhalation SF (kg-day/mg)**	**HQ**	**HQ**		**ILCR**	**HQ**	**ILCR**
Nitrobenzene	0.001	0.0006	NA	0.02	0.06	NA	NA	0.016	NA
Chloroform	0.001	0.0100	0.0061	0.001	0.003	7.5E-09	5.6E-09	0.001	3.9E-09
Chloromethane	0.005	NA	0.013	NA	NA	8.0E-08	6.0E-08	NA	4.2E-08
Trichloroethene	0.0053	0.006	0.011	0.008	0.028	7.2E-08	5.3E-08	0.008	3.7E-08
Carbon tetrachloride	0.01	0.0006	0.0525	0.160	0.534	6.5E-07	4.8E-07	0.150	3.4E-07
Cumulative HI or ILCR				0.19	0.6		6.E-07	0.17	4.E-07

Notes:

EPC = Exposure point concentration
RfD = Reference Dose; the oral RfD was applied when no inhalation RfD was available.
SF = Slope Factor
HQ = Hazard quotient
ILCR = Incremental excess lifetime cancer risk
HI = Hazard index
NA = Not applicable
LWA = Lifetime weighted average

A comparison of the CT risk estimates presented in Tables 7-28 through 7-31 to the RME risk estimates presented in Tables 7-20 to 7-23 indicates that the risks and hazards are unacceptable for both CT and RME estimates.

7.7 Risk Summary

Based on risk estimates above 1E-6 and a HI greater than 1.0, 12 chemicals were identified as possible COCs:

- Antimony
- Arsenic
- Barium
- Benzene
- Cadmium
- Methylene chloride
- 2-Methylnaphthalene
- Naphthalene
- Vanadium
- Nitrobenzene
- Carbon tetrachloride
- Chloroform

Health risks potentially posed by contaminants at NSA Mid-South SWMU 5 were assessed using four RME exposure scenarios: the hypothetical site worker, the hypothetical construction worker, the child trespasser scenario, and the hypothetical future site resident scenario. The exposure media assessed consisted of surface soil, loess groundwater, and fluvial deposits groundwater. In surface soil, the incidental ingestion and dermal contact pathways were assessed. For groundwater ingestion and inhalation of VOCs while showering were assessed. Risk estimates for SWMU 5 media are shown in Table 7-32.

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Table 7.32
Summary Risk Estimates
All Exposure Pathways
NSA Mid-South SWMU 5
Memphis, Tennessee

		Site Resident			*Site Worker*		*Construction Worker*		*Site Trespasser*	
		Adult	*Child*	*LWA*	*Adult*		*Adult*		*Adolescent*	
Medium	Exposure Pathway	HI	HI	ILCR	HI	ILCR	HI	ILCR	HI	ILCR
Surface Soil	Incidental Ingestion	0.06	0.57	5.E-05	0.02	5.E-06	0.04	1.E-06	0.014	1.E-06
	Dermal Contact	0.05	0.16	2.E-05	0.04	9.E-06	0.02	5.E-07	0.012	1.E-06
	Sum	0.1	0.7	7.E-05	0.06	1.E-05	0.06	2.E-06	0.03	2.E-06
Loess Groundwater	Ingestion	21	50	5.E-03	8	1.E-03	4	7.E-05	NA	NA
	Inhalation	63	147	2.E-03	22	4.E-04	11	2.E-05	NA	NA
	Sum	84	196	7.E-03	30	2.E-03	14	9.E-05	NA	NA
Soil & Loess Groundwater	Sum	84	197	7.E-03	30	2.E-03	14	1.E-04	0.03	2.E-06
Fluvial Deposits Groundwater	Ingestion	0 8	2	2.E-05	0.3	5.E-06	0.1	3.E-07	NA	NA
	Inhalation	0.5	1.2	1.E-05	0.19	2.E-06	0.09	1.E-07	NA	NA
	Sum	1.30	3	3.E-05	0.5	7.E-06	0.2	4.E-07	NA	NA
Soil & Fluvial Deposits Groundwater	Sum	1	4	1.E-04	0.5	2.E-05	0.3	2.E-06	0.03	2.E-06

Notes:

ILCR = Incremental excess lifetime cancer risk
HI = Hazard index
NA = Not applicable
LWA = Lifetime weighted average

In summary, groundwater exposure is the primary medium of concern. As discussed in the HHRA, SWMU 5 is zoned for commercial use, which precludes residential development. In addition, if the zoning were changed and residences were developed, municipal water would likely be used rather than installing unfiltered wells which was assumed in this HHRA. Should unfiltered wells be installed, they would have to be screened in the fluvial deposits which reliably yield sufficient water.

If receptors are not exposed to groundwater, no COCs would be identified based on risk estimates for surface soil exposure.

7.8 Remedial Goal Options

RGOs are concentrations computed for COCs to equate with specific risk goals that may be established for a particular site. As previously discussed, COCs are identified as any COPC that significantly contributes to a scenario of concern. A pathway having a combined ILCR greater than 1E-4 or an HI greater than 1 is defined as a scenario of concern, and an individual chemical contributing either 1E-6 ILCR or 0.1 HI to one exposure pathway is considered to significantly contribute to the scenario ILCR or HI. Based on this method, COCs required calculation of RGOs; they are listed in Section 7.5, Risk Characterization. Inclusion in the RGO table does not necessarily indicate that remedial action will be required to address a specific chemical. Instead, RGOs are provided to facilitate risk-management decisions.

In accordance with USEPA Supplemental RGO Guidance, RGOs were calculated at 1E-6, 1E-5, and 1E-4 risk levels for carcinogenic COCs and HQ goals of 0.1, 1.0, and 3.0 for noncarcinogenic COCs. RGOs for carcinogens were exposure scenario-specific and were based on the lifetime weighted average for hypothetical future site residents. Calculation of noncarcinogenic RGOs was based on the hypothetical child resident, as noted in the corresponding tables. Tables 7-33 and 7-34 present the loess groundwater RGOs for the hypothetical future site resident and site worker exposure scenarios, respectively. Tables 7-35 and 7-36 present the fluvial deposits groundwater RGOs for the hypothetical future site resident and site worker exposure scenarios, respectively.

Table 7.33
Loess Groundwater Remedial Goal Options
Calculated Based on the RME Scenario
Site Residents: Ingestion, Inhalation, and Dermal Contact Exposure Pathways
NSA Mid-South SWMU 5
Memphis, Tennessee

				Site Resident						
				*RGO***						
Chemical	**MCL (mg/L)**	**EPC (mg/L)**	**HI**	**HI = 0.1**	**HI = 1.0**	**HI = 3.0**	**ILCR**	**ILCR = 1E-6**	**ILCR = 1E-5**	**ILCR = 1E-4**
Antimony	0.006	0.0648	10.4	0.00063	0.0063	0.019	NA	NA	NA	NA
Arsenic	0.05	0.159	33.9	0.00047	0.0047	0.014	3.6E-03	0.000045	0.00045	0.0045
Barium	2	0.909	0.8	0.11	1.1	3.3	NA	NA	NA	NA
Benzene	0.005	3.9	146	0.0027	0.027	0.080	3.4E-03	0.00116	0.0116	0.116
Cadmium	0.005	0.0181	2.3	0.00078	0.0078	0.023	NA	NA	NA	NA
Carbon tetrachloride	0.005	0.0067	0.6	0.00110	0.0110	0.033	NA	NA	NA	NA
1,2-Dichloroethene (total)	0.07*	0.008	0.11	0.00704	0.0704	0.211	1.7E-03	4.7E-06	4.7E-05	4.7E-04
2-Methylnaphthalene	NA	0.1	0.32	0.03107	0.3107	0.932	NA	NA	NA	NA
Methylene chloride	0.005	0.031	0.0353	0.08775	0.8775	2.633	NA	NA	NA	NA
Naphthalene	0.005	0.12	0.38	0.031	0.31	0.94	4.2E-06	0.0284	0.284	2.842
Trichloroethene	0.005	0.002	147	0.0000	0.000	0.00	5.1E-07	0.0039	0.039	0.39
Vanadium	NA	0.102	0.9	0.011	0.110	0.33	NA	NA	NA	NA

Table 7.34
Loess Groundwater Remedial Goal Options
Calculated Based on the RME Scenario
Site Worker: Ingestion, Inhalation, and Dermal Contact Exposure Pathways
NSA Mid-South SWMU 5
Memphis, Tennessee

				Site Worker						
				*RGO***						
Chemical	**MCL (mg/L)**	**EPC (mg/L)**	**HI**	**HI = 0.1**	**HI = 1.0**	**HI = 3.0**	**ILCR**	**ILCR = 1E-6**	**ILCR = 1E-5**	**ILCR = 1E-4**
Antimony	0.006	0.0648	1.6	0.0041	0.041	0.12	NA	NA	NA	NA
Arsenic	0.05	0.159	5.2	0.0031	0.031	0.092	8.3E-04	0.00019	0.0019	0.019
Barium	2	0.909	0.13	0.72	7.2	21.5	NA	NA	NA	NA
Benzene	0.005	3.9	22.3	0.017	0.17	0.52	7.9E-04	0.0049	0.049	0.49
Cadmium	0.005	0.0181	0.4	0.0051	0.051	0.15	NA	NA	NA	NA
Carbon tetrachloride	0.005	0.0067	0.21	0.0032	0.032	0.10	3.0E-06	0.0022	0.022	0.22
1,2-Dichloroethene (total)	0.07*	0.008	0.017	0.046	0.46	1.38	NA	NA	NA	NA
2-Methylnaphthalene	NA	0.1	0.049	0.203	2.03	6.09	NA	NA	NA	NA
Methylene chloride	0.005	0.031	0.0054	0.573	5.73	17.20	9.9E-07	0.031	0.31	3.1
Naphthalene	NA	0.12	0.06	0.204	2.04	6.13	NA	NA	NA	NA
Trichloroethene	0.005	0.002	0.007	0.031	0.31	0.92	1.2E-07	0.017	0.17	1.7
Vanadium	NA	0.102	0.14	0.072	0.72	2.1	NA	NA	NA	NA

Notes:

EPC = Exposure point concentration
ILCR = Incremental excess lifetime cancer risk
HI = Hazard index
NA = Not applicable
RGO = Remedial Goal Option, calculated in accordance with RAGS, based on the child receptor for site residents
MCL = Maximum Contaminant Level, excerpted from USEPA's Drinking Water Regulations and Health Advisories, October, 1996.
* = The most conservative MCL is presented, the MCL for cis-1,2-dichloroethene is 0.07, while the MCL for the trans isomer is 0.1.
** = All HI and ILCR RGO units are mg/L

Table 7.35
Fluvial Deposits Groundwater Remedial Goal Options
Calculated Based on the RME Scenario
Site Residents: Ingestion, Inhalation, and Dermal Contact Exposure Pathways
NSA Mid-South SWMU 5
Memphis, Tennessee

				Site Resident						
				*RGO**						
Chemical	**MCL (mg/L)**	**EPC (mg/L)**	**HI**	**HI = 0.1**	**HI = 1.0**	**HI = 3.0**	**ILCR**	**ILCR = 1E-6**	**ILCR = 1E-5**	**ILCR = 1E-4**
Cadmium	0.005	0.0054	0.7	0.0008	0.008	0.023	NA	NA	NA	NA
Nitrobenzene	NA	0.001	0.2	0.0004	0.004	0.013	NA	NA	NA	NA
Chloroform	0.1	0.001	0.0128	0.0078	0.078	0.235	1.3E-06	0.00077	0.0077	0.077
Chloromethane	NA	0.005	NA	NA	NA	NA	1.4E-06	0.00348	0.0348	0.348
Trichloroethene	0.005	0.0053	0.113	0.0047	0.047	0.141	1.3E-06	0.00395	0.0395	0.395
Carbon tetrachloride	0.005	0.01	1.98	0.00051	0.0051	0.015	2.7E-05	0.00037	0.0037	0.037

Table 7.36
Fluvial Deposits Groundwater Remedial Goal Options
Calculated Based on the RME Scenario
Site Worker: Ingestion, Inhalation, and Dermal Contact Exposure Pathways
NSA Mid-South SWMU 5
Memphis, Tennessee

				Site Worker						
				*RGO**						
Chemical	**MCL (mg/L)**	**EPC (mg/L)**	**HI**	**HI = 0.1**	**HI = 1.0**	**HI = 3.0**	**ILCR**	**ILCR = 1E-6**	**ILCR = 1E-5**	**ILCR = 1E-4**
Cadmium	0.005	0.0054	0.11	0.0051	0.051	0.15	NA	NA	NA	NA
Nitrobenzene	NA	0.001	0.04	0.0027	0.027	0.082	NA	NA	NA	NA
Chloroform	0.1	0.001	0.0020	0.0511	0.511	1.534	3.0E-07	0.0033	0.033	0.33
Chloromethane	NA	0.005	NA	NA	NA	NA	3.4E-07	0.0148	0.148	1.48
Trichloroethene	0.005	0.0053	0.02	0.0307	0.307	0.920	3.1E-07	0.0169	0.169	1.69
Carbon tetrachloride	0.005	0.01	0.30	0.0033	0.033	0.099	6.4E-06	0.0016	0.016	0.16

Notes:

EPC = Exposure point concentration
ILCR = Incremental excess lifetime cancer risk
HI = Hazard index
NA = Not applicable
RGO = Remedial Goal Option, calculated in accordance with RAGS, based on the child receptor for site residents
MCL = Maximum Contaminant Level, excerpted from USEPA's Drinking Water Regulations and Health Advisories, October, 1996
* = All HI and ILCR RGO units are mg/L

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8.0 ECOLOGICAL RISK ASSESSMENT

8.1 Introduction

The ecological risk assessment (ERA) evaluates the actual or potential effects to ecological receptors due to contamination of the SWMU 5 terrestrial ecosystem. This assessment considers surface soil contaminant concentrations and distributions, media-specific physicochemical conditions, and exposure pathways that could result in unacceptable levels of exposure to ecological receptors. The approach to this assessment is based on the following USEPA documents: *Guidelines for Ecological Risk Assessment* (USEPA, 1998b), *Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments* (USEPA, 1997), *Supplemental Guidance to RAGs: Region IV Bulletin — Ecological Risk Assessment* (USEPA, 1995c), *Framework for Ecological Risk Assessment* (USEPA, 1992b), and *Risk Assessment Guidance for Superfund Volume II — Environmental Evaluation Manual* (USEPA, 1989).

8.2 Problem Formulation

Site Description

As described in Section 2, SWMU 5 in a large open field where a pair of large concrete mats used for fire fighting training were located. To the east of the site is a small wooded area and the north and southern boundaries are roadways. In the spring of 1998, the Millington Airport Authority cleared and grubbed an expansive area south of the main runway to maintain the runway protection zone, including portions of SWMU 5 and the woodlands to the west of the site. These areas were grubbed, leveled, sodded, and will be maintained as a mowed lawn. Furthermore, as part of the remedial activities at SWMU 5, a large pit was excavated and filled with clean soil, making any existing, pre-removal surface soil data from the filled area obsolete and unusable for assessing ecological risk from site-related constituents.

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Ecosystem at Risk

With the site's open field and the clearing of surrounding areas, no quality habitat is considered to be present at SWMU 5. The grass fields could be used by terrestrial receptors, such as passerine birds and/or small mammals, as foraging areas, but their occurrence would most likely be transient or opportunistic. With the long-term maintenance of this area as a mowed grass field, it is unlikely that future, quality habitat will be established at SWMU 5, thus eliminating the presence of significant ecological receptors and thus prolonged exposure to site constituents.

Threatened and Endangered Species

According to U.S. Fish and Wildlife threatened and endangered species survey conducted in 1997, no federal listed species occur at NSA Mid-South. One state-listed species, the walnut tree or butternut tree (*Juglans cinerea*) was found at the northwest end of the clear zone of the main runway and is not associated with SWMU 5.

8.3 Characterization of Ecological Risk

Due to current site conditions, no further action is recommended for SWMU 5 based on ecological risk since exposure potential for site receptors is very low. In a October 28, 1997, NSA Mid-South BCT meeting, it was decided that sites affected by the Millington Airport Authority's clearing would not undergo a complete ecological risk assessment since habitats and surface soils associated with these areas either will or have been significantly disturbed and are unable to support sensitive ecological receptors. The quality of the existing (and likely future) habitat was substantially diminished after the area surrounding the site was leveled; therefore, the exposure pathways from site contaminants to terrestrial receptors is considered incomplete and no ecological risk is predicted.

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9.0 CONTAMINANT FATE AND TRANSPORT

In previous sections, physical characteristics of the study area and distributions of contaminants in each environmental medium were presented. In this section, that information is used to discuss the fate and transport of contaminants in each medium. This section consists of four parts:

- Source definition, specifically for the contaminants detected during the investigation, and the COCs for each medium, are discussed in Section 9.1.

- Potential migration routes are discussed for each medium in Section 9.2.

- Contaminant persistence in soil, surface water, sediment, and groundwater is considered in Section 9.3. For each class of compounds, the general fate and transport characteristics of the relevant contaminants are summarized since their chemical and physical properties affect contaminant migration and fate.

- Hydrogeologic factors affecting contaminant migration are presented in Section 9.4 with a discussion of potential receptors.

9.1 Source Definition

SWMU 5, the AFFTF, has been in operation since 1949 and consisted of two bermed concrete mats (Mat 392 and Mat 305) approximately 75 feet in diameter with a mock aircraft cockpit in the center of each pad. Jet fuel (JP-5), supplied via underground lines to the mock cockpits, was ignited to simulate fire/rescue situations. Firefighters extinguished the flames with water and foam. Unused fuel and wastewater collected by drains in the mat were piped underground to an oil-water separator (OWS 1662) that recovered and recycled the unused fuel. Wastewater was discharged to the sanitary sewer system. Prior to the current system's use, unused fuel was allowed to evaporate from the fire mats or discharged to the system of ditches leading to the

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SWMU 4 drainage ditch system. Several fuel releases have occurred over the life of SWMU 5. OWS 1662 and Mat 305 were removed in August and December 1997, respectively.

In Section 6, the nature and extent of contamination were described for all compounds detected at SWMU 5. This section focuses on the primary contaminants detected in various media and compounds that were detected at concentrations exceeding their SSLs. SSLs are maximum chemical concentrations in soil that represent a level of contamination below which human exposure pathways (air or groundwater) are considered to be protected. This section limits discussion to compounds exceeding either SSLs, RBCs, or RCs.

COCs identified in surface soil (0 to 1 foot bls) include the VOCs benzene and methylene chloride, the SVOCs benzo(a)pyrene and benzo(a)anthracene, the pesticide dieldrin, and the inorganics barium, cadmium, nickel, selenium. Inorganics that exceeded their SSL in surface soil, but not their RC are arsenic, chromium, and nickel, which are considered to be naturally occurring. Inorganics that exceeded their SSL and RC are barium, cadmium, and selenium. They are included in this fate and transport discussion. COCs identified in subsurface soil (below 1 foot bls) are the VOCs benzene, ethylbenzene, methylene chloride, toluene, trichloroethene, tetrachloroethene, 1,2-dichloropropane, and xylenes, the SVOC naphthalene, the pesticide dieldrin, and the inorganics barium, cadmium, chromium, and nickel.

In loess groundwater, methylene chloride was detected in a sample from original well FFMW-8 (FFMW-8 was removed during the VCA and then replaced after the excavation was complete) at an estimated concentration of 31 μg/L. Benzene was detected in samples from former well FFMW-8 at 3,900 μg/L, 1,900 μg/L, and 3,200 μg/L during the initial, 3rd and 4th events, respectively, and from well FFMW-9 during the initial event at an estimated concentration of 5 μg/L. However, recent sampling (February 1999) of replacement well FFMW-8 indicated a non-detect concentration for benzene. Four metals (antimony, arsenic, cadmium, and lead) were

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detected in loess groundwater samples at concentrations exceeding their RC and either their tap water RBC or MCL, or a combination of both.

In fluvial deposits groundwater, carbon tetrachloride and chloromethane were detected at concentrations exceeding tap water RBCs. Specifically, carbon tetrachloride was identified in samples from two wells, 05MW04AUF and 05MW04BUF, at estimated concentrations of 3 μg/L and 4 μg/L, respectively. Concentrations of carbon tetrachloride in well 05MW04AUF have increased to 6 μg/L since the initial event. In well 05MW04BUF they have increased to 10 μg/L. These maximum concentrations exceed the MCL (5 μg/L) for carbon tetrachloride. Trichloroethene was detected at a concentration of 5.3 μg/L in DPT point 005GGB02. This concentration exceeds the RBC and MCL for trichloroethene. Cadmium was detected in fluvial deposits groundwater samples at concentrations exceeding its RC and MCL, and lead was detected at a concentration exceeding its TTAL in one well. However, results from the February 1999 sampling event indicated non-detect concentrations for cadmium and lead in these upper fluvial wells.

Although recent sampling has indicated much lower concentrations for benzene, lead, and cadmium, the fate and transport of these compounds will still be discussed since this is data from only one additional sampling event. Two additional quarters of monitoring will verify whether these contaminants are actually absent.

Table 9-1 summarizes COCs for SWMU 5 that will be discussed further in this section.

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Table 9-1
COCs for SWMU 5

Environmental Medium	COCs
Surface Soil	The VOCs benzene and methylene chloride, the SVOCs benzo(a)pyrene and benzo(a)anthracene, the pesticide dieldrin, and the inorganics barium, cadmium, and selenium.
Subsurface Soil	The VOCs benzene, ethylbenzene, methylene chloride, toluene, trichloroethene, tetrachloroethene, 1,2-dichloropropane, and xylene, the SVOC naphthalene, the pesticide dieldrin, and the inorganics barium, cadmium, chromium, and nickel.
Loess Groundwater	The VOCs methylene chloride and benzene, and the inorganics antimony, arsenic, cadmium, and lead.
Fluvial Deposits Groundwater	The VOCs carbon tetrachloride, chloromethane, trichloroethene, and the inorganics cadium and lead.

9.2 Potential Routes of Migration

This section delineates potential contaminant migration routes within SWMU 5 and from it. Potential migration pathways at SWMU 5 are considered for each of the four available media:

- Air emissions, specifically the dispersion of VOCs from soil and surface water bodies (Section 9.2.1)

- Soil, primarily the potential leaching of contaminants from soil to underlying groundwater and nearby surface water, and the potential erosion of surface soil into adjacent surface water (Section 9.2.2)

- Surface water and sediment, including transport of surface water and sediment downstream, and the potential transport of contaminants to groundwater via infiltration from lakes or streams (Section 9.2.3)

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- Groundwater, including potential migration to NSA Mid-South drinking water wells, and potential transport of contaminants to surface water via discharge of groundwater to lakes or streams (9.2.4)

9.2.1 Air Emissions

Volatile contaminants in surface soil and surface water have the potential to migrate to the air by volatilization. To evaluate the potential for soil-to-air migration of volatile contaminants, a screening approach is used to focus on chemicals that have the greatest potential to volatilize in sufficient quantities to create a human health threat in ambient air. The screening process consists of taking the maximum concentration of volatile COCs found in surface soil and comparing them to soil-to-air screening levels as presented in the *Risk-Based Concentration Tables,* (USEPA, 1998a). None of the contaminants detected in surface soil exceeded its respective soil-to-air SSL, therefore, transport of contaminants by air emissions is not included as a route of migration.

9.2.2 Soil

Near-surface and subsurface soil is contaminated with VOCs, SVOCs, pesticides, and inorganics (see Table 9-1). The geographic distribution of these contaminants was described in Section 9.1. The potential fate and transport of these contaminants in soil are discussed further in Section 9.4.

9.2.3 Surface Water and Sediment

No surface water has been identified at SWMU 5; therefore, surface water and sediment are not included as possible routes of migration for contaminants.

9.2.4 Groundwater

VOCs and metals were detected in loess and fluvial deposits groundwater. The geographic distribution of these contaminants is described in Section 9.1.

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Potential pathways for migration of COCs in groundwater are:

- Advective transport to water supply wells
- Advective transport to the underlying Memphis Sand Aquifer
- Intermedia contaminant transfer from groundwater to surface water bodies
- Intermedia contaminant transfer from groundwater to subsurface soil through the volatilization of VOCs

The potential fate and migration of contaminants are discussed in Section 9.4.

9.3 Contaminant Persistence

Persistence measures how long a given chemical will exist in a specific medium. Contaminant persistence in environmental media is a function of physical and chemical properties of a given class of compounds, the specific chemicals within each class found in the environment, and properties of the medium of concern.

Persistence of primary contaminants detected in SWMU 5 soil and groundwater is discussed below. Relevant classes of compounds are VOCs, SVOCs, inorganics, and pesticides.

9.3.1 Chemical and Physical Properties

Chemical and physical properties are discussed below along with a description of the significance of each property to volatilization, sorption, diffusion, dispersion, biodegradation, and other attenuation processes. Table 9-2 is an overview of chemical property behavior. Each is briefly discussed below.

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Table 9-2
Chemical Properties

Chemical Property	Critical Value	High (>)	Low (<)
Vapor pressure	10^{-6} mm Hg	volatile	nonvolatile
Density[a]	0.75 to 1.25 g/cm^3	> 1 g/cm^3 sink/fall	< 1 g/cm^3 float/rise
Solubility[a]	0 to 100 mg/L	leaches from soil, mobile in water, does not volatilize readily, degrades	absorbs to soil, volatilizes, does not degrade
Henry's law constant	$5x10^{-3}$ to $5x10^{-6}$ atm-m^3/mole	high volatilization	low volatilization
Half-life	biologically dependent	does not degrade readily	degrades readily
Log octonal/water coefficient[a]	2 to 10	remains in soil	move and diffuses in water

Notes:

a	—	Determinations of critical ranges were based on literature review and professional judgment.
mm Hg	—	millimeters mercury
g/cm^3	—	grams per cubic centimeter
atm-m^3/mole	—	atmospheres-cubic meter per mole

Chemical and physical properties relevant to the evaluation of fate and transport of organic contaminants include water solubility, vapor pressure, Henry's law constant, specific gravity, organic carbon partition coefficient, and half life. Water solubility, adsorption coefficient, and reduction-oxidation (redox) processes are properties of interest for inorganic contaminants.

Water Solubility

The solubility of a chemical in water is the maximum amount that will dissolve at a specified temperature. Chemicals with high solubility are relatively mobile in water and are more likely to leach from soil. These chemicals tend to have low volatilization potential but may be biodegradable. Chemicals with low water solubility are more apt to adsorb on soil and are not readily biodegradable.

Vapor Pressure

The vapor pressure of a liquid or solid is the pressure of the gas in equilibrium with respect to the liquid or solid at a given temperature. It represents a compound's tendency to evaporate. From soil, the vapor pressure determines the volatilization of a chemical to the atmosphere. A chemical with a vapor pressure less than 10^{-6} millimeters of mercury (mm Hg) will tend to associate with particulate matter, whereas a chemical with higher vapor pressure tends to associate with the vapor phase. Compounds with high water solubilities show little volatilization from water or moist soil unless they have a high vapor pressure.

Henry's Law Constant

Henry's law states that the amount (i.e., mole fraction) of a slightly soluble gas dissolved in a liquid is proportional to the partial pressure of the gas. The Henry's law constant, with units of atmospheres-cubic meter per mole (atm-m^3/mole), describes a linear relationship between vapor pressure and water solubility and measures a chemical's ability to move from water or soil to air. The following describes the relative volatilization that can be expected from a chemical, based on the Henry's law constant:

- Greater than 10^{-3} — ready volatilization
- 10^{-3} to 10^{-5} — moderate volatilization
- Less than 10^{-5} — limited volatilization

Specific Gravity

Specific gravity is the dimensionless ratio of a fluid's density to a standard reference density. For liquids and solids, the reference is the density of pure water, 1 gram per cubic centimeter (g/cm^3). A substance with a specific gravity less than water tends to float; conversely, compounds with densities greater than water tend to sink. Typically, the specific gravity of a compound impacts its ability to vertically penetrate within the zone of saturation when the compound is a free-phase

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liquid (free product). The vertical migration of dissolved-phase compounds within the zone of saturation is not as greatly influenced by density differences. Therefore, the vertical penetration of dissolved-phase compounds tends to be more associated with site-specific characteristics such as hydrogeologic considerations. Specific gravity can be used to estimate the potential vertical extent of the immiscible portion of a chemical in water.

Organic Carbon Partition Coefficient

The organic carbon partition coefficient (K_{oc}) measures the degree to which an organic substance will preferentially sorb to organic carbon. The typical range of K_{oc} values is from 1 to 10^7 milliliters per gram (ml/g), with higher values indicating a greater tendency to remain sorbed. Chemicals moving through the subsurface will alternately sorb to or desorb from available organic matter in the soil matrix; therefore, the organic content of the soil is critical to predicting the state of contaminants in a soil matrix. The higher the K_{oc} values, the lower the mobility in the subsurface due to the tendency of a chemical to sorb to the organic carbon fraction (f_{oc}) of soil.

Distribution Coefficient

The distribution coefficient (K_d) validly represents the partitioning between liquid and solids. The larger the K_d value, the greater the sorption to the solid phase. A K_d value may be estimated from the K_{oc} of the chemical and the f_{oc} in the soil:

$$K_d = K_{oc} f_{oc}$$

Retardation Factor

During transport processes, some degree of contaminant mass transfer by adsorption from the pore water to the solid part of the porous medium will retard the advance rate of the contaminant front. The retardation of the contaminant front relative to the bulk mass of water is described by the following equation:

$$R = 1 + \frac{p_b}{n} K_d$$

where:

R = retardation factor, dimensionless
p_b = bulk mass density of the porous medium, g/cm^3
n = porosity, fraction
K_d = distribution coefficient (solid-liquid partition coefficient), ml/g

A retardation factor of 10 would imply that the contaminant plume moves 10 times slower than the local groundwater velocity.

Half-Life

Half-life is the time required for a substance's concentration to decrease from its initial level by 50%. The apparent decrease may be caused by various processes, including biodegradation. The half-life values listed for the contaminants at SWMU 5 may not be representative of conditions at SWMU 5 and are presented to indicate the chemical's persistence in the subsurface.

Oxidation and Reduction Processes

Redox reactions involve the transfer of electrons from one compound to another. Specifically, one reactant is oxidized, and the other is reduced. The terms *pe* and *Eh* are used to characterize redox conditions. Graphs that show the equilibrium occurrence of ions or minerals as domains relative to pe or Eh are known as pe-Eh diagrams. These diagrams help describe the state of inorganics in the subsurface (i.e., whether it remains in a solid [immobile] state or is in an aqueous state [mobile]).

9.3.2 Volatile Organic Compounds

Based on their physical and chemical characteristics, VOCs can be expected to be mobile in the environment with potential to volatilize to the atmosphere, leach to groundwater, discharge to surface water, and to move with groundwater flow in the zone of saturation as a dissolved phase. Relative to other compound classes, VOCs have low molecular weight and high water solubility, vapor pressure, and Henry's law constant, along with a corresponding low K_{oc}. Relative to chemicals in other classes, many VOCs tend to have relatively short half-lives in groundwater. VOCs have a limited tendency to adsorb to soil and can be expected to be moderately to highly mobile in the environment.

9.3.2.1 VOCs in Soil

Eight VOC COCs are identified in soil at SWMU 5. Benzene and methylene chloride in surface and subsurface soil, and ethylbenzene, toluene, trichloroethene, tetrachloroethene, xylenes, and 1,2-dichloropropane are in subsurface soil only. Characteristics of these VOCs are discussed briefly below and presented in Table 9-3.

Table 9-3
Properties of Benzene, Ethylbenzene, Xylenes, Methylene Chloride, Tetrachloroethene, Toluene, Trichloroethene, and 1,2-Dichloropropane

	Benzene	Ethyl Benzene	Xylenes	Methylene Chloride
Molecular weight[a]	78.11	106.17	106.17	84.94
Vapor pressure[a,b]	95 mm Hg	7.1 mm Hg	8.7 mm Hg	434.9 mm Hg
Solubility in water[a,b]	1,800 mg/L	150 mg/L	200 mg/L	13,000 mg/L
Specific gravity[a]	0.87 g/ml	0.87 g/ml	0.88 g/ml	1.3266 g/ml
K_{oc}[b,c]	50	187	234	230
Henry's law constant[b,c]	5.4×10^{-3} atm-m^3/mole	6.6×10^{-3} atm-m^3/mole	7.1×10^{-3} atm-m^3/mole	2.68×10^{-3} atm-m^3/mole
SSL transfers from soil to air (mg/kg)[c]	0.5	260	320	7
SSL transfers from soil to groundwater (mg/kg)[c]	0.002	0.7	9	0.001

Table 9-3
Properties of Benzene, Ethylbenzene, Xylenes, Methylene Chloride, Tetrachloroethene, Toluene, Trichloroethene, and 1,2-Dichloropropane

	Tetrachloroethene	Toluene	Trichloroethene	1,2-Dichloropropane
Molecular weight[a]	165.83	92.14	131.39	112.99
Vapor pressure[a,b]	14 mm Hg	22 mm Hg	58 mm Hg	49.67 mm Hg
Solubility in water[a,b]	150 mg/L	520 mg/L	1,100 mg/L	2,740 mg/L
Specific gravity[a]	1.60 g/ml	0.87 g/ml	1.50 g/ml	1.22 g/ml
K_{oc}[b,c]	264	129	87	47
Henry's law constant[b,c]	1.53×10^{-2} atm-m^3/mole	6.7×10^{-3} atm-m^3/mole	9.1×10^{-3} atm-m^3/mole	2.07×10^{-3} atm-m^3/mole
SSL transfers from soil to air (mg/kg)[e]	11	520	3	no data
SSL transfers from soil to groundwater (mg/kg)[e]	0.003	0.6	0.003	0.001

Notes:
a — Merck & Co., *The Merck Index*, Merck & Co., Rahway, New Jersey, 1983.
Lide, *CRC Handbook of Chemistry and Physics*, CRC Press, Boca Raton, Florida, 1994.
USEPA, *Treatability Database*, USEPA Risk Reduction Engineering Laboratory, Cincinnati, Ohio, 1992c.
Resource Consultants, *Chemtox Release K*, 1985-1995.
b — Howard, *Fate and Exposure Data*, Lewis Publishers, Chelsea, Michigan, 1993.
c — Knox, Sabatini, Canter, *Subsurface Transport and Fate Processes*, Lewis Publishers, Chelsea, Michigan, 1993.
d — Howard, *Handbook of Environmental Degradation Rates*, Lewis Publishers, Chelsea, Michigan, 1991.
e — Soil screening levels from risk-based concentrations table (USEPA, 1998a)

Benzene

Benzene is a colorless to light yellow, mobile, nonpolar liquid of highly refractive nature with an aromatic odor. Its primary use is to manufacture ethylbenzene for styrene monomer, dodecylbenzene for detergents, cyclohexane for nylon, phenol, nitrobenzene for aniline, maleic anhydride, chlorobenzene, diphenyl, benzene hexachloride, and benzene-sulfonic acid as a solvent. Benzene is most commonly found in the environment as the result of gasoline-associated releases. Benzene, if released in small quantities to soil, is expected to evaporate into the atmosphere from near-surface soil due to its moderate to high vapor pressure. It will adsorb to soil, especially soil with organic carbon content. It is slightly soluble in water. Biodegradation of benzene in soil and groundwater can be high depending on site-specific factors such as the presence of the appropriate micro-biota, oxygen, and other nutrients. It is a confirmed human carcinogen, a human poison

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by inhalation, moderately toxic by ingestion, and a severe eye and moderate skin irritant. Laboratory measurements indicate teratogenic and reproductive effects. It has a specific gravity less than that of water, indicating that as a free-phase liquid in the environment, benzene will float. Benzene's chemical and physical properties are summarized in Table 9-3.

Ethylbenzene

Like benzene, ethylbenzene's presence in soil and groundwater may be attributed to its use in gasoline. When released to soil, ethylbenzene is expected to evaporate into the atmosphere from near-surface soil due to its moderate to high vapor pressure. Biodegradation of ethylbenzene in soil and groundwater can be high depending on site-specific factors such as the presence of the appropriate micro-biota, oxygen, and other nutrients. It has a specific gravity less than that of water, indicating that it will float as a free-phase liquid in the environment. Ethylbenzene's chemical and physical properties are summarized in Table 9-3.

Methylene Chloride

Methylene chloride is a chlorinated solvent. It is a clear, colorless mobile liquid with a characteristic penetrating ether-like odor. It is used as a paint remover, solvent degreaser, plastics processor, blowing agent in foams, solvent for cellulose acetate, aerosol propellant, and as a solvent extractor, which is why this compound is commonly identified as a laboratory artifact. Methylene chloride is expected to evaporate into the atmosphere from near-surface soil due to its high vapor pressure. It is poorly adsorbed to soil, especially soil with low f_{oc}. It is slightly soluble in water and will tend to remain in a separate phase from water. Methylene chloride in soil and groundwater biodegrades under certain conditions. It is toxic, narcotic, and a suspected human carcinogen. It has a specific gravity greater than water, indicating that as a free-phase liquid in the environment, methylene chloride will generally tend to sink. Methylene chloride's chemical and physical properties are presented in Table 9-3.

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Toluene

Toluene is released into the environment principally from the storage, transport, and disposal of fuels and oils. If toluene is released to soil, it will be lost by evaporation from near-surface soil and by leaching to the groundwater. Biodegradation occurs both in soil and groundwater, but this process is apt to be slow, especially at high concentrations. Based on organic-carbon partition values, toluene will be expected to exhibit very high to moderate mobility in soil. Toluene's chemical and physical properties are presented in Table 9-3.

Trichloroethene

Spills or releases of trichloroethene to soil will evaporate rapidly due to its reasonably high vapor pressure. It will also leach into groundwater rapidly. Trichloroethene biodegrades very slowly in water under most conditions. Cis- and trans-1,2-dichloroethylene are typically detected near trichloroethene contamination sites, which suggests biodegradation. The relatively low adsorption coefficient of trichloroethene to a number of soil types indicates ready transport through soil and low potential adsorption to sediments. The relatively high Henry's law constant indicates rapid evaporation from water. Relatively high vapor pressure indicates rapid evaporation from near-surface soil and other surfaces. Trichloroethene's chemical and physical properties are presented in Table 9-3.

Tetrachloroethene

Tetrachloroethene is likely to enter the environment by fugitive air emissions from dry cleaning and metal degreasing industries and by accidental spills or releases. If released to soil, it will be subject to evaporation into the atmosphere and to leaching to the groundwater. Biodegradation may be an important process in anaerobic soils. Slow biodegradation may occur in groundwtaer where acclimated populations of microorganisms exist. Tetrachloroethene's chemical and physical properties are presented in Table 9-3.

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1,2-Dichloropropane

1,2-dichloropropane is typically released into soil during its use as a soil fumigant and in wastewater during its production and use as a chemical intermediate, solvent, and metal degreasing agent. If released to soil, 1,2-dichloropropane will be primarily lost by volatilization. Some may leach into the groundwater. Having a high Henry's law constant, 1,2-dichloropropane volatilizes very rapidly, with diffusion through the liquid phase controlling the rate of evaporation. 1,2-dichloropropane's chemical and physical properties are presented in Table 9-3.

Xylenes (total)

Industrial sources of xylenes include petroleum refining, coal tar and coal gas distillation, and its use as a solvent. Discharges and spills on land and in water usually result from its use in diesel fuel and gasoline. The dominant removal process in water is by volatilization. Xylenes are moderately mobile in soil and may leach to groundwater. Xylenes chemical and physical properties are presented in Table 9-3.

9.3.2.2 VOCs in Groundwater

Three VOC COCs are chlorinated solvents with densities greater than water. These types of chlorinated solvents as free-phase compounds exhibit unique chemical, physical, and biological characteristics (obtained from Pankow and Cherry, 1996) that influence the ability of the chlorinated solvents to migrate within an environmental medium. The influence of these general characteristics are lessened when a chlorinated solvent is present in the environment as dissolved phase instead of in a free phase.

- Density — The **high densities** of chlorinated solvents (1.2 to 1.7 g/cm^3) relative to that of water (1 g/cm^3) mean that if a sufficient volume of a chlorinated solvent is spilled, liquid solvent under the force of gravity may be able to penetrate the subsurface media and/or groundwater.

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- Viscosity — The relatively **low viscosities** of the chlorinated solvents allow relatively rapid downward movement in the subsurface. Chlorinated solvent mobility in the subsurface increases with increasing density/viscosity ratios (USEPA, 1993).

- Interfacial Tension — The **low interfacial tension** between a liquid chlorinated solvent phase and water allows a liquid chlorinated solvent to enter small fractures and pore spaces, facilitating penetration into the subsurface. Low interfacial tension also contributes to the low retention capacities of soil.

- Solubility — The **low *absolute* solubilities** of chlorinated solvents in water (typically on the order of hundreds of mg/L) mean that when a significant quantity of such a compound is spilled on the ground surface, liquid solvent can migrate as a free phase in the subsurface and persist as a separate phase for significant periods of time. The **high *relative* solubilities** of the chlorinated solvents in regard to established groundwater standards protective of human health mean that a solvent release can cause continued groundwater contamination at concentrations which are low (i.e., parts per billion levels), but still greater than current groundwater standards.

- Partitioning — The **low partitioning to soil** exhibited by the chlorinated solvents means that soil and rock tend not to bind these constituents strongly, resulting in limited to no contaminant retention by the soil particles.

- Volatility — The **high volatilities** of the chlorinated solvents provide a false sense of security when a release occurs because it is often assumed that most of the release volatilizes to the atmosphere before it can enter the subsurface environment. However, after a chlorinated solvent has been released, downward penetration is often immediate due to the characteristics outlined above. Any volatilization that occurs during the migration

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process increases the migratory potential and complexity by creating a vapor-phase plume. Once in the subsurface, the vapor plume can migrate in directions other than that of the liquid mass. Once the chlorinated solvents reach the saturated zone, the high volatility of the compounds have little effect on removing solvent mass because vapor transport across the capillary fringe can be exceedingly slow (McCarthy and Johnson, 1992).

Five VOC COCs are identified in SWMU 5 groundwater. Methylene chloride and benzene were identified in the loess groundwater, and carbon tetrachloride, chloromethane, and trichloroethene were identified in the fluvial deposits groundwater. As discussed earlier, February 1999 sampling indicated a non-detect concentration for benzene in replacement well FFMW08, which previously had a concentration of 3,900 μg/L. Fate and tranport of benzene will still be discussed, since only one additional sampling event revealed a non-detect concentration. Carbon tetrachloride, and chloromethane are discussed briefly below. Benzene, methylene chloride, and trichloroethene were discussed previously.

Carbon Tetrachloride

Carbon tetrachloride is a chlorinated hydrocarbon solvent. It is a colorless, distinctively sweet liquid. It is used as a refrigerant, metal degreaser, agricultural fumigant, chlorinating organic compound, production of semiconductors, and solvent (e.g., fats, oils, rubber). Carbon tetrachloride will evaporate into the atmosphere from near-surface soil due to its moderate vapor pressure. However, vapors are 5.3 times heavier than air, so any vaporization may result in the migration of the constituent through the air and the potential impact of surface soil or water bodies in areas where the migrated vapors settle. Adsorption potential is limited; however, it will adsorb to soil with high f_{oc}. It is practically insoluble in water. Carbon tetrachloride in soil and groundwater is biodegradable under certain conditions. However, the compound is persistent in the environment. Carbon tetrachloride is a confirmed human carcinogen, a human poison by inhalation, moderately toxic by ingestion, and a severe eye and moderate skin irritant. Laboratory measurements indicate teratogenic and reproductive effects. It has a specific gravity much greater

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than that of water, so as a free-phase liquid in the environment carbon tetrachloride will sink. Carbon tetrachloride's chemical and physical properties are presented in Table 9-4.

Table 9-4
Properties of Carbon Tetrachloride and Chloromethane

	Carbon Tetrachloride	Chloromethane
Molecular weight[a]	153.82	50.49
Vapor pressure[a,b]	90 mm Hg	3,800 mm Hg
Solubility in water[a,b]	1,160 mg/L	7,300 mg/L
Specific gravity[a]	1.59 g/ml	0.92 g/ml
K_{oc}[b,c]	440	25
Henry's law constant[b,c]	3.04×10^{-2} atm-m^3/mole	8.82×10^{-3} atm-m^3/mole
SSL transfers from soil to air (mg/kg)[e]	0.2	No data
SSL transfers from soil to groundwater (mg/kg)[e]	0.003	No data

Notes:
a — Merck & Co., *The Merck Index*, Merck & Co., Rahway, New Jersey, 1983.
Lide, *CRC Handbook of Chemistry and Physics*, CRC Press, Boca Raton, Florida, 1994.
USEPA, *Treatability Database*, USEPA Risk Reduction Engineering Laboratory, Cincinnati, Ohio, 1992c.
Resource Consultants, *Chemtox Release K*, 1985-1995.
b — Howard, *Fate and Exposure Data*, Lewis Publishers, Chelsea, Michigan, 1993.
c — Knox, Sabatini, Canter, *Subsurface Transport and Fate Processes*, Lewis Publishers, Chelsea, Michigan, 1993.
d — Howard, *Handbook of Environmental Degradation Rates*, Lewis Publishers, Chelsea, Michigan, 1991.
e — Soil screening levels from risk-based concentrations table (USEPA, 1998a).

Chloromethane

Typically used as a refrigerant, chloromethane (methyl chloride) is slightly soluble in water and is miscible with chloroform. With a very high vapor pressure, chloroform is very volatile and tends to associate with the vapor phase rather than to particulates.

9.3.3 Semivolatile Organic Compounds

SVOCs generally have higher molecular weights and lower solubilities, vapor pressures, and Henry's law constants than VOCs. Because of higher K_{oc}, SVOCs tend to sorb to solids and are relatively immobile in the environment. These characteristics lead to a likelihood of greater persistence but lower mobility of SVOCs in the environment than VOCs.

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9.3.3.1 SVOCs in Soil

Three SVOCs were identified as COCs at SWMU 5, benzo(a)anthracene and benzo(a)pyrene in surface soil and naphthalene in subsurface soil. Each SVOC exceeded its soil-to-groundwater SSL. Characteristics of these SVOCs are discussed briefly below and presented in Table 9-5. No SVOCs were determined to be COCs in groundwater at SWMU 5.

Table 9-5
Properties of Benzo(a)anthracene, Benzo(a)pyrene, and Naphthalene

	Benzo(a)anthracene	Benzo(a)pyrene	Naphthalene
Molecular weight[a]	228.3	253.32	128.18
Vapor pPressure[a,b]	5×10^{-9} mm Hg	5.6×10^{-9} mm Hg	5.4×10^{-2} mm Hg
Solubility in water[a,b]	0.012 mg/L	0.0039 mg/L	30 mg/L
Specific gravity[a]	1.27 g/ml	1.4 g/ml	1.10 g/ml
K_{oc}[b,c]	1.38×10^6	1.77×10^6	792
Henry's law constant[b,c]	2.3×10^{-6} atm-m^3/mole	2.4×10^{-6} atm-m^3/mole	4.6×10^{-4} atm-m^3/mole
SSL transfers from soil to air (mg/kg)[d]	27	11	180
SSL transfers from soil to groundwater (mg/kg)[e]	0.08	0.4	4

Notes:
a — Merck & Co., *The Merck Index*, Merck & Co., Rahway, New Jersey, 1983.
Lide, *CRC Handbook of Chemistry and Physics*, CRC Press, Boca Raton, Florida, 1994.
USEPA, *Treatability Database*, USEPA Risk Reduction Engineering Laboratory, Cincinnati, Ohio, 1992c.
Resource Consultants, *Chemtox Release K*, 1985-1995.
b — Howard, *Fate and Exposure Data*, Lewis Publishers, Chelsea, Michigan, 1993.
c — Knox, Sabatini, Canter, *Subsurface Transport and Fate Processes*, Lewis Publishers, Chelsea, Michigan, 1993.
d — Howard, *Handbook of Environmental Degradation Rates*, Lewis Publishers, Chelsea, Michigan, 1991.
e — Soil screening levels from risk-based concentrations table (USEPA, 1998a).

Benzo(a)anthracene

Industrial occurrences of benzo(a)anthracene include: coal mining, timber products processing, petroleum refining, foundries, coil coating, and iron and steel manufacturing. The presence of benzo(a)anthracene at SWMU 5 may be associated with fuel once stored in underground storage tanks or from an underground oil-water separator. The principal transport process is adsorption; volatilization is not an important process. Metabolization and microbial degradation are its principal fate processes.

Benzo(a)pyrene

Industrial occurrences of benzo(a)pyrene are similar in description to benzo(a)anthracene, and the presence of benzo(a)pyrene can also be attributed with fuel storage. The principal transport process is adsorption, volatilization is not an important process, and microbial degradation may be the principal fate process for benzo(a)pyrene.

Naphthalene

Naphthalene may enter the subsurface from discharges on land and into water from spills during the storage, transport, and disposal of fuel oil, coal tar, etc. Releases into water are lost due to volatilization, adsorption, and biodegradation. Naphthalene adsorbs moderately to soil and undergoes biodegradation. The sorption onto soil will be low to moderate depending on the organic carbon content of the soil. Naphthalene's chemical and physical properties are presented in Table 9-5.

9.3.3.2 SVOCs in Groundwater

No SVOCs were identified as COCs in groundwater at SWMU 5.

9.3.4 Inorganics

Unlike organic compounds, inorganic compounds do not degrade in the environment, but they may change chemical form. The sources of trace metals are associated with both natural processes of chemical weathering, soil leaching, and human activity. They are generally considered indefinitely persistent. Metals may interact with soil or other solids by ion exchange, adsorption, precipitation, or complexation. These processes are affected by pH, composition, leachate, or groundwater redox processes, and the type and amount of organic matter, minerals, and clay present. Extreme pe and Eh (redox) conditions can significantly increase the solubility and mobility of metals. Therefore, the availability of the metal in the medium, the composition of

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groundwater, and the adsorption capacity of the soil determine the fate and transport of the metal in the environment.

9.3.4.1 Inorganics in Soil

Inorganics identified as COCs at SWMU 5 were identified in surface and subsurface soil. Barium and cadmium exceeded both their soil-to-groundwater SSL and RC in surface soil and subsurface soil, chromium, and nickel exceeded their soil-to-groundwater SSL and RC in subsurface soil only, and selenium exceeded its soil-to-groundwater SSL and RC in surface soil only. The chemical and physical properties of these COCs are discussed briefly below and presented in Table 9-6.

Table 9-6
Properties of Barium, Cadmium, Chromium, Nickel, and Selenium

	Barium	Cadmium	Chromium
Molecular weight[a]	137.33	112.41	52
Solubility in water[a,b]	insoluble	insoluble	insoluble
Specific gravity[a]	3.5	8.64	8.64
SSL transfers from soil to air (mg/kg)[e]	350,000	920	no data
SSL transfers from soil to groundwater (mg/kg)[e]	82	0.4	2

	Nickel	Selenium
Molecular weight[a]	58.71	78.96
Solubility in water[a,b]	insoluble	insoluble
Specific gravity[a]	8.9	4.28
SSL transfers from soil to air (mg/kg)[e]	6900	no data
SSL transfers from soil to groundwater (mg/kg)[e]	7	0.3

Notes:

a — Merck & Co., *The Merck Index*, Merck & Co., Rahway, New Jersey, 1983.
Lide, *CRC Handbook of Chemistry and Physics*, CRC Press, Boca Raton, Florida, 1994.
USEPA, *Treatability Database*, USEPA Risk Reduction Engineering Laboratory, Cincinnati, Ohio, 1992c.
Resource Consultants, *Chemtox Release K*, 1985-1995.

b — Howard, *Fate and Exposure Data*, Lewis Publishers, Chelsea, Michigan, 1993.

c — Knox, Sabatini, Canter, *Subsurface Transport and Fate Processes*, Lewis Publishers, Chelsea, Michigan, 1993.

d — Howard, *Handbook of Environmental Degradation Rates*, Lewis Publishers, Chelsea, Michigan, 1991.

e — Soil screening levels from risk-based concentrations table (USEPA, 1998a).

Barium

Barium, one of the alkaline earth metals, resembles calcium chemically and, when pure, barium is silvery white like lead. It occurs naturally in low concentrations in most surface waters (2 μg/L to 230 μg/L) and in many treated drinking waters (1 μg/L to 172 μg/L) (Viessman and Hammer, 1985). The common mineral form is barium sulfate, which has a low solubility. It oxidizes easily and is decomposed by water or alcohol. Barium's chemical and physical properties are presented in Table 9-6.

Cadmium

Almost all cadmium is obtained as a by-product in the treatment of zinc, copper, and lead ores and it is similar in many respects to zinc. Cadmium is used extensively in electroplating. It is also used in many types of solder, for nickel-cadmium batteries, and as a barrier to control atomic fission. Cadmium exists in an aqueous phase in the +2 valence state, and in insoluble forms over a redox range of -0.5 to 0.75 at a pH greater than 8. Cadmium will also precipitate in the presence of phosphate, arsenate, chromate and other anions, although solubility will vary with pH and other chemical factors. Cadmium's chemical and physical properties are presented in Table 9-6.

Chromium

Chromium is usually produced by reducing the oxide with aluminum. Chromium is used to harden steel, to manufacture stainless steel, and to form many alloys. Chromium compounds are used in the textile industry, and by the aircraft industry and others to anodize aluminum. Chromium's chemical and physical properties are presented in Table 9-6.

Nickel

Nickel is primarily used in plating of various alloys, and is used to manufacture stainless steels, nickel-chrome resistance wire, and alloys for electronic and space applications. Nickel is naturally occurring in the environment. Nickel's chemical and physical properties are summarized in Table 9-6.

Selenium

Selenium occurs in nature usually in the sulfide ores of the heavy metals; it is present in small quantities in pyrite and in some minerals. It is used as an ingredient of toning baths in photography, as a pigment in some glasses, and as a vulcanizing agent in processing rubber. Selenium is insoluble in water and alcohol, and very slightly soluble in carbon disulfide. Selenium's chemical and physical properties are shown in Table 9-6.

9.3.4.2 Inorganics in Groundwater

Four inorganics were identified as COCs in groundwater at SWMU 5. Cadmium and lead in both loess and fluvial deposits groundwater, and antimony and arsenic in loess groundwater only. As discussed earlier, February 1999 sampling indicated non-detect concentrations for both lead and cadmium in upper fluvial wells. Lead exceeded its TTAL and cadmium its MCL during previous sampling events in upper fluvial groundwater. Fate and transport for these two inorganics are still discussed since the additional data is from only one additional sampling event. Additional sampling events are proposed to verify whether or not these compounds are actually absent or not. The chemical and physical properties of antimony, arsenic, and lead are discussed briefly below and presented in Table 9-7; cadmium was discussed previously.

Table 9-7
Properties of Arsenic, Antimony, and Lead

	Arsenic	Antimony	Lead
Molecular weight[a]	74.92	121.75	207.2
Solubility in H_2O (mg/L)[a,b]	insoluble	insoluble	insoluble
Specific gravity[a]	5.724	6.684	11.34
SSL transfers from soil to air (mg/kg)[c]	380	no data	no data
SSL transfers from soil to groundwater (mg/kg)[c]	1	0.3	no data

Notes:

a — Merck & Co., *The Merck Index*, Merck & Co., Rahway, New Jersey, 1983.
Lide, *CRC Handbook of Chemistry and Physics*, CRC Press, Boca Raton, Florida, 1994.
USEPA, *Treatability Database*, USEPA Risk Reduction Engineering Laboratory, Cincinnati, Ohio, 1992c.
Resource Consultants, *Chemtox Release K*, 1985-1995.

b — Howard, *Fate and Exposure Data*, Lewis Publishers, Chelsea, Michigan, 1993.

c — Soil Screening levels from risk-based concentration table (USEPA, 1998a).

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Antimony

Antimony occurs naturally in the environment as a component of certain minerals. As antimony oxide, it is added to various materials as a flame retardant. Antimony may occur in the aquatic environment from natural weathering of mineral formations, from mining and manufacturing effluents, and from municipal waste. Over a broad range of redox conditions (Eh -0.5 to 0.05), most antimony would be expected to exist in soluble forms if pH is less than approximately 7.5. Antimony is highly persistent in water with a half-life of longer than 200 days. Antimony is typically insoluble in water. Antimony's chemical and physical properties are presented in Table 9-7.

Arsenic

Arsenic is a naturally occurring element often found in association with copper or lead. Arsenic is widely distributed in waters of the United States in low concentrations ranging from a trace amount to approximately 1,100 μg/L in surface waters with isolated instances of higher concentrations in well waters (Viessman and Hammer, 1985). Its primary use is in pesticides and as a plant defoliant. Most arsenic compounds are white or colorless compounds. In the environment, arsenic can exist in several oxidation states. Under oxidizing conditions, the arsenate (V) form is the stable oxidation state, which gives way to the arsenite (III) form under transitional conditions and As (I) or elemental arsenic under reducing conditions. Under reducing conditions in the presence of sulfur, the relatively insoluble sulfides As_2S_3 and AsS are formed. The As_2O_3 oxides have limited stability under transitional Eh conditions below a pH of approximately 8. Under oxidizing conditions, arsenic acid (H_3AsO_4) and its ionization products ($H_2AsO_4^{-1}$, $HAsO_4^{-2}$, AsO_4^{-3}) are important for arsenic transport over a wide range of pH. Therefore, arsenic can become mobile under oxidizing conditions if a significant source is present. Based on the physical characteristics of SWMU 5, arsenic is not expected to be significantly mobile. Specifically, arsenic is expected to be affected by cation exchange and adsorb to soil particles or mineral grains. In addition, the relatively neutral pH should generally prevent most

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inorganics, including arsenic, from migrating significant distances. Arsenic's chemical and physical properties are presented in Table 9-7.

Lead

Lead is a naturally occurring element that is widely dispersed in sedimentary rocks, or as a discrete mineral. Commercial uses for lead include solder, vehicle batteries, gasoline additive, and in alloys. In the environment, lead is adsorbed to soil particles and mobility is very low. The aqueous speciation of lead is mainly as Pb^{-2} which is readily adsorbed by clay minerals. Lead mobility is very low in groundwater, and under reducing conditions, lead will become even less mobile as insoluble lead sulfide forms. The chemical and physical properties of lead are presented in Table 9-7.

Metals have fairly limited mobility in groundwater because of cation exchange or sorption on the surface of mineral grains. They can also form precipitates of varying solubility under specific Eh-pH conditions. Metals are mobile in groundwater if soluble ions exist and the soil has a low cation exchange capacity (CEC). They can also be mobile if they are chelated or if they are attached to a mobile colloid. Conditions that promote mobility include an acidic, sandy soil with low organic and clay content. Discharge of a metal in an acidic solution would keep the metal soluble and promote mobility.

Although relatively low turbidity was observed during the sampling event, the sorption of metals onto mobile sediments may be a transport mechanism for metals in groundwater at SWMU 5. Typical groundwater pH values ranged from 6 to 7 in both the loess and fluvial deposits. In general, pHs less than 2 to 4 are conducive for most metals to become mobile. The only inorganic with some degree of mobility in this setting is arsenic. Adsorption of arsenic compounds is not expected to be significant unless aluminum, manganese, and/or iron minerals are present in the soil or aquifer sediments. Barium will be nearly insoluble in the groundwater

environment. Barium was detected in surface and subsurface soil samples at concentrations exceeding SSLs. The barium ion predicted to be predominant in the aqueous phase is Ba^{+2}. Beryllium will become moderately mobile when oxidizing conditions in the groundwater system form aqueous complexes. Cadmium exists in aqueous solution in the +2 valence state. The aqueous speciation of lead is mainly as Pb^{+2}, which is readily adsorbed by clay minerals. Under reducing conditions, lead will become even less mobile as insoluble lead sulfide forms.

9.3.5 Pesticides

Pesticides have moderate molecular weights along with generally high densities, high K_{oc} values, and generally low solubilities, low vapor pressures, and low Henry's law constants. Typical fate and transport characteristics include a tendency to sorb to soil particles; they tend to be hydrophobic (avoid water), are immobile in the environment, and tend to degrade relatively slowly. Overall, pesticides are anticipated to be immobile and persistent in the environment, not readily diffusing into groundwater.

9.3.5.1 Pesticides in Soil

The only pesticide identified as a COC at SWMU 5 is dieldrin. Dieldrin has been used extensively in the past as an insecticide and for termite control, although it is no longer registered for general use. The presence of dieldrin has been attributed to aerial applications at NSA Mid-South during the 1950s and 1960s. Dieldrin is extremely persistent in the environment, and a release to soil may persist for more than seven years, reaching the air either through slow evaporation or adsorption on dust particles and subsequent suspension in air. It is not expected to leach into groundwater, and will reach surface water mostly through agricultural runoff. If dieldrin reaches surface waters, it will adsorb strongly to sediments. Biodegradation is not an important process. Adsorption is a major factor in limiting dieldrin movement. Chemical and physical properties of dieldrin are summarized in Table 9-8.

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Table 9-8
Properties of Dieldrin

Molecular weight[a]	380.91
Vapor pressure (mm Hg)[a,b]	1.80×10^{-7}
Solubility in water (mg/L)[a,b]	0.2
Specific gravity[a]	1.8
K_{oc} (L/kg)[a,c]	1.34×10^{4}
Henry's law constant (atm-m^3/mole at 20°C)[b,c]	2×10^{-5}
SSL transfers from soil to air (mg/kg)[e]	2
SSL transfers from soil to groundwater (mg/kg)[e]	0.0002

Notes:

a — Merck & Co., *The Merck Index*, Merck & Co., Rahway, New Jersey, 1983.
Lide, *CRC Handbook of Chemistry and Physics*, CRC Press, Boca Raton, Florida, 1994.
USEPA, *Treatability Database*, USEPA Risk Reduction Engineering Laboratory, Cincinnati, Ohio, 1992c.
Resource Consultants, *Chemtox Release K*, 1985-1995.

b — Howard, *Fate and Exposure Data*, Lewis Publishers, Chelsea, Michigan, 1993.

c — Knox, Sabatini, Canter, *Subsurface Transport and Fate Processes*, Lewis Publishers, Chelsea, Michigan, 1993.

d — Howard, *Handbook of Environmental Degradation Rates*, Lewis Publishers, Chelsea, Michigan, 1991.

e — Soil Screening levels from risk-based concentration table (USEPA, 1998a).

Dieldrin was only detected in surface and subsurface soil. Although it exceeded its soil-to-groundwater SSL, it has not been detected in groundwater at SWMU 5. Concentrations of dieldrin in surface soil ranged from 15 to 928 μg/kg, and concentrations in subsurface soil ranged from 8.3 to 103 μg/kg. The number of detections was greater in surface soil than in subsurface soil, leading to the conclusion that dieldrin is not likely to migrate vertically through the soil and reach groundwater.

9.3.5.2 Pesticides in Groundwater

Pesticides were not identified as COCs in groundwater at SWMU 5.

9.4 Contaminant Migration

The transport of dissolved contaminants in the environment is controlled by advection, diffusion, and dispersion. Other parameters which control transport include solubility and sorption; both were described earlier. The principal component of migration is advection, which is the movement of dissolved contaminants with groundwater flow. The remaining two processes, diffusion and dispersion, are both physical and chemical processes affected by site-specific variables such as groundwater velocity, formation heterogeneity, and the retardation factor of the chemical.

9.4.1 Factors Affecting Contaminant Migration

The movement of groundwater particles and/or contaminant plumes is typically from areas of high hydrostatic pressures to areas with lower hydrostatic pressures (upgradient to downgradient). The size and shape of a groundwater contaminant plume can vary due to unique and site-specific characteristics of the hydrogeologic setting and aquifer and the physical characteristics of the contaminants. The following discusses the physical hydrogeologic properties that figure prominently in the fate and transport of a chemical. The most influential of these properties are the hydrodynamic processes of advective transport, hydrodynamic dispersion transport, and molecular diffusion transport, total organic carbon, soil sorptive capacity, CEC, redox conditions, pH, soil type, and retardation rate.

In general, the horizontal and vertical shape and extent, of a plume within the saturated zone and the concentration gradient from a source area are indicative of the combined effects of all of these hydrodynamic factors. In most porous media aquifers, the effects of advection, dispersion, and diffusion are the most important to the development of a groundwater contaminant plume. At SWMU 5, advection is the primary hydrodynamic contaminant transport mechanism.

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Advective Transport

Advective transport is the process by which dissolved solids or liquids are carried along with the movement of groundwater from areas of high hydraulic head to areas with lower head. The amount of solute that is transported is a function of its concentration in the groundwater and the volume and rate of groundwater flow. Hydraulic conductivity, effective porosity, average linear velocity, and hydraulic gradient are factors that determine the chemical's rate of movement by the advective transport process. The rate at which a chemical will move in an aquifer is also a function of the aquifer's chemical, biological, and physical properties, as well as the properties of the individual chemical.

Diffusive Transport

Diffusion is a molecular mass-transport process in which solutes move from areas of higher concentration to areas of lower concentration. In fine sediments with very low hydraulic conductivities, diffusive transport may be the dominant mode of migration.

Dispersive Transport

Dispersion is a mixing process caused by heterogeneities within the porous materials and microscopic variations in groundwater velocities within pore spaces and between them. Dispersion causes sharp fronts of contaminants to spread out, diluting the solute at the advancing edge of the contaminant front.

Infiltration

The infiltration of precipitation through the surface and subsurface soils can form leachate and provide a mechanism for contaminants to migrate vertically within the unsaturated zone and into groundwater.

Total Organic Carbon

The total organic carbon (TOC) indicates the soil's adsorptive capabilities; the higher the TOC, the higher the potential for a chemical to adsorb to soil particles.

Soil Sorptive Capacity

See distribution coefficient in Section 9.3.1 for a discussion on K_d.

Cation Exchange Capacity

CEC reflects the soil's capacity to adsorb ions to neutralize an ionic deficiency on its surface. Generally, trivalent ions are preferentially adsorbed to soil over divalent ions, and divalent ions are preferentially adsorbed over monovalent ions. Although this is generally the case, the process also depends on soil pH. High CECs have the potential to adsorb chemicals. Inorganic ions are typically adsorbed to soil particles, although organic compounds with dipole moments are also affected by CEC.

Redox Conditions

Oxidation, the loss of electrons, couples with reduction, the gain of electrons. The resultant changes in oxidation states generate products that are dramatically different from the reactants in their solubilities, toxicities, reactivities, and mobilities. Primarily, redox reactions influence the mobility of inorganic chemicals. Extreme redox conditions tend to mobilize chemicals, especially inorganics.

pH

pH is a logarithmic measure of hydrogen ions in the soil or groundwater. The pH indicates the acidity or basicity of the medium. Chemicals react significantly different under changing pHs. Extreme pH conditions tend to mobilize chemicals, especially inorganics.

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Soil Type

The mineralogical composition, particle size distribution, and organic content of soil influence the fate and transport of chemicals.

Retardation Rate

See retardation rate in Section 9.3.1 for a discussion of retardation rate.

9.4.1.1 Soil

As previously mentioned, soil contamination at SWMU 5 is limited to VOCs, SVOCs, metals and pesticides. Migration of these compounds within soil is essentially negligible after gravity drainage of liquids and leachable fractions of contaminants have been removed.

As discussed in Section 9.3, SVOCs and pesticides adsorb more readily to soil partciles and are less likely to leach to underlying groundwater than VOCs. This is evident by comparing the number of VOC to SVOC detections in groundwater.

9.4.1.2 Surface Water and Sediment

No surface water bodies are present at SWMU 5. Therefore, contaminant migration in surface water will not be discussed.

9.4.1.3 Groundwater

Section 5 describes the geology and hydrogeology associated with SWMU 5 and Section 6 describes the nature and extent of contaminants identified in groundwater during the investigation. As detailed in Sections 9.3.2, 9.3.3, and 9.3.4, groundwater COCs include metals and VOCs. The primary metal COCs in the loess are antimony, arsenic, cadmium, and lead. The only metal COCs in the fluvial deposits are cadmium and lead (however, cadmium and lead were both non-detect during February 1999 sampling of upper fluvial groundwater). Two VOC COCs were

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detected in the loess: methylene chloride and benzene. Three VOC COCs were identified in the fluvial deposits: carbon tetrachloride, chloromethane, and trichloroethene.

Migration pathways for groundwater contaminants include advective flow from upgradient locations in both the loess and fluvial deposits. Advection transport is identified as the primary transport mechanism based on the hydrogeologic characteristics of the water-bearing units. As previously mentioned, the relative effects of other transport mechanisms, such as diffusion, increase as the water velocity decreases. Infiltration (with regards to barium migration from site soil and dispersion) may also be contributing to COC transport and plume migration at SWMU 5.

Infiltration

Precipitation at SWMU 5 can move vertically through subsurface materials, form leachate, and transport contaminants into the unsaturated zone and groundwater. Arsenic, barium, cadmium, lead, and zinc detected at concentrations exceeding SSLs were also identified in both groundwater zones. These inorganics are not very mobile and significant migration is not expected within this environmental setting.

Dispersion

Due to the heterogeneous nature and stratification of the two water-bearing units, mechanical dispersion is anticipated. Often mechanical dispersion or contaminant mixing within the saturated zone may be of even greater magnitude than longitudinal movement (advection).

Advective Flow

Migration of dissolved COCs is the most significant pathway for contaminant movement in both the loess and fluvial deposits groundwater. VOC and SVOC COCs are discussed below in terms of geographic source areas. Inorganics are not discussed due to their lack of solubility. Areas of interest at SWMU 5 are VOCs, SVOCs, and metals.

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VOCs in Groundwater

The VOCs methylene chloride, carbon tetrachloride, chloromethane, trichloroethene, and benzene are the only volatile COCs identified in groundwater at SWMU 5. Benzene is the most significant VOC COC detected in groundwater in the loess. However, it should be noted that benzene was non-detect after sampling of replacement well FFMW08 (the original well FFMW08 had a concentration of 3,900 μg/L prior to the VCA). Benzene will migrate as a free-phase liquid on top of the groundwater and as a dissolved-phase liquid within the upper portion (mixing zone) of the upper water-bearing zone. Steep vertically downward hydraulic gradients can cause benzene to be detected within the saturated zone. The fluvial deposits groundwater is considered confined at SWMU 5; therefore, the potential for dissolved- or free-phase benzene impacting lower zones is minimal. Benzene is highly biodegradable, and the areal extent of benzene plumes is typically controlled by the subsurface benzene-consuming microbiota. Accordingly, benzene plumes tend to be relatively small when compared to more persistent compounds.

Methylene chloride, carbon tetrachloride, and trichloroethene are all chlorinated solvents. None biodegrade readily, and all exhibit the characteristics discussed in Section 9.3.1. Chlorinated solvent plumes can be relatively large and can impact water quality at great depths within the saturated zone. The site-specific controlling factors of chlorinated solvent plumes are: (1) the volume of solvent released to the environment; (2) the nature of the release; and (3) the hydrogeologic setting.

Inorganics in Groundwater

Metals in groundwater at SWMU 5 are the majority of contaminants designated as COCs. Despite the prevalence of inorganics in groundwater at SWMU 5, it is expected that these contaminants are not capable of significant mobility in the water-bearing zone. Cation exchange or sorption on the surface of mineral grain, and precipitation under varying Eh-pH conditions in the loess or fluvial deposits generally keep most inorganics from migrating significant distances. Conditions

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that could promote increased solubility of inorganics are acidic, permeable soil with low organic and clay content. These conditions are not prevalent in the subsurface at SWMU 5.

9.4.2 Potential Receptors

The primary receptor impacted at SWMU 5 is the loess and fluvial deposits groundwater. The general groundwater quality in the loess does not appear to make it suitable as a drinking water source, and the fluvial deposits groundwater is not used as a drinking water supply within a mile of NSA Mid-South. The relatively low concentrations of the contaminants and the amount of dilution (specifically the organic compounds) they are likely to undergo minimize the impact to any potential receptors. The nearest potential receptor is Production Well 4, approximately 500 feet south of Mat 392. The well is not in the direction of groundwater flow in the loess or fluvial deposits and is screened deeper than 1,200 feet below the fluvial deposits with several confining units in between.

If the metals detected in SWMU 5 groundwater are associated with the site, they are also likely to undergo dilution and possibly natural filtration before reaching a potential receptor.

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10.0 CONCLUSIONS AND RECOMMENDATIONS

Based on the information gathered during this investigation, the following conclusions and recommendations have been reached.

10.1 Conclusions

Surface Soil

- VOCs, SVOCs, pesticides, and dioxins were detected in SWMU 5 surface soil at concentrations exceeding RBCs. Sample locations where many of these contaminants were identified were removed during the SWMU 5 tank closures or VCA. Contaminants remaining in SWMU 5 surface soil are dieldrin and benzo(a)pyrene, which were detected in one surface soil sample at concentrations exceeding their residential RBCs. Neither contaminant exceeded its industrial RBC.

Subsurface Soil

- Based on a comparison with the USEPA's default SSL values, VOCs, SVOCs, and metals detected in surface and subsurface soil have the potential to leach into groundwater. SSL values correspond with a dilution attenuation factor of 1, which assumes that soil leachate concentrations do not dilute before reaching groundwater. The absence of many of these contaminants in groundwater indicates that they are sorbed onto soil and not leaching. Most of the organics identified in subsurface soil at concentrations exceeding the SSLs are petroleum-based (benzene, ethylbenzene, toluene, xylenes, naphthalene, and 2-methylnaphthalene). Many were removed during the tank closures and VCA described in Section 3. Metals in surface and subsurface soil exceeding the SSLs and RCs established for surface and subsurface soil are barium, cadmium, chromium, nickel, and selenium. The human health risk assessment (Section 7) concluded that no COPCs were present in subsurface soil.

Groundwater Contaminants in Loess Groundwater

- Groundwater samples collected from loess wells during the RFI and 1992 UST investigation indicated that VOCs and metals were present at concentrations exceeding their screening levels. The most notable groundwater contaminant was benzene, which met or exceeded its MCL (5 μg/L) in three wells; concentrations ranged from 5 to 3,900 μg/L. Methylene chloride was also identified in one of these wells at a concentration of 31 μg/L, exceeding its MCL (5 μg/L). Preliminary indications are that the soil removal activities associated with the VCA and tank removals have effectively removed the source of petroleum constituents in groundwater. Groundwater collected from replacement well FFMW-8 in the area where the benzene and methylene chloride highs were detected before the VCA, did not contain either of these compounds. The effect of the soil removal activities will be confirmed through additional monitoring during the CMS. Trichloroethylene (TCE) was also identified in loess groundwater in one well and one DPT location, at concentrations between its MCL (5 μg/L) and tap water RBC (1.6 μg/L). Arsenic, antimony, and cadmium were identified in loess groundwater at concentrations exceeding their RCs and MCLs or tap water RBCs. Lead was also identified in loess groundwater at concentrations exceeding its RC and TTAL. However, analytical data from the second RFI sampling event (Event 1 of long-term monitoring) indicated the elevated metals detected in the earlier sampling events were likely the result of turbidity in the samples due to the absence of these metals in wells sampled during long-term monitoring Event 1.

Groundwater Contaminants in Fluvial Deposits Groundwater

- VOCs were the only organics exceeding their MCLs in the fluvial deposits groundwater at SWMU 5. Carbon tetrachloride was consistently identified in two co-located upper fluvial deposits wells at the southeast corner of the SWMU at a concentration above its MCL (5 μg/L). The maximum concentrations in the two wells were 6 and 10 μg/L.

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Several attempts to pinpoint the source of contamination during the RFI identified similar or lower concentrations, indicating that the contaminants were localized to the upper fluvial deposits. TCE was also identified in the sample area in one DPT sample at a concentration of 5.3 μg/L, above its MCL (5 μg/L). Other VOCs detected in the fluvial deposits groundwater have no established MCLs, but exceeded their tap water RBCs. During one of six sampling events, chloromethane at a concentration of 5 μg/L exceeded its tap water RBC (1.4 μg/L). In one of five sampling events, chloroform at a concentration of 1 μg/L exceeded its tap water RBC (0.15 μg/L). In two fluvial deposits wells, metals exceeded their RCs and MCL or treatment technique action level (TTAL): cadmium at a concentration of 5.4 μg/L exceeded its RC (3.9 μg/L) and MCL (5 μg/L) and lead at a concentration of 32.8 μg/L exceeded its RC (6.6 μg/L) and TTAL (15 μg/L). However, resampling of these wells in February 1999 did not identify either of these metals.

Risk to Human Health and the Environment

- No chemicals of concern (COCs) were identified in surface soil. The following were identified as COCs in loess groundwater based on their contribution to risk/hazard: antimony, arsenic, barium, cadmium, vanadium, benzene, methylene chloride, carbon tetrachloride, 2-methylnaphthalene, and naphthalene. On the same basis, cadmium, nitrobenzene, chloroform, and carbon tetrachloride were identified as COCs in fluvial deposits groundwater. In summary, the exposure scenarios of concern are the hypothetical future site resident, site worker, and future construction worker with groundwater exposure as the primary pathway of concern. If the zoning were changed in the future and residences were developed, municipal water would likely be used rather than installing domestic wells (as assumed in the risk assessment).

- According to the ecological risk assessment, no quality habitat is available at SWMU 5. This lack of suitable habitat at SWMU 5 limits the presence of a significant population of

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potentially exposed ecological receptors. Without sufficient receptors, exposure pathways associated with SWMU 5 constituents are considered incomplete.

10.2 Recommendations

The following recommendations are based on the information collected to date at SWMU 5:

Soil

No further action is recommended for soil, based on soil removal activities and the limited extent of remaining contaminants (single detections of dieldrin and benzo(a)pyrene only at concentrations between residential and industrial RBCs).

Loess Groundwater

A discrete groundwater sample should be collected using a Geoprobe or similar sampling device from the former tank pit area (near former monitoring well FFMW-11) to evaluate whether this area still poses a concern to loess groundwater. The existing contaminant levels in loess groundwater downgradient from this area and the former fire extinguisher pits area will be further evaluated during the CMS through two additional sampling events of monitoring wells FFMW-6, FFMW-9 and replacement well FFMW-8 for VOCs only.

Fluvial Deposits Groundwater

SWMU 5 fluvial deposits groundwater will be included in the CMS slated for AOC A with the focus being the carbon tetrachloride and TCE identified at the southeast corner of the SWMU. Cadmium and lead identified in the upper fluvial deposits groundwater above their RCs and MCL (or TTAL for lead) during the initial sampling event (March 1995) and below their regulatory thresholds during the second sampling, will also be further evaluated during the CMS. Monitoring wells 05MW02UF and 05MW01UF should undergo two additional monitoring events for cadmium and lead, respectively, to verify the absence or presence of these metals in the fluvial deposits groundwater.

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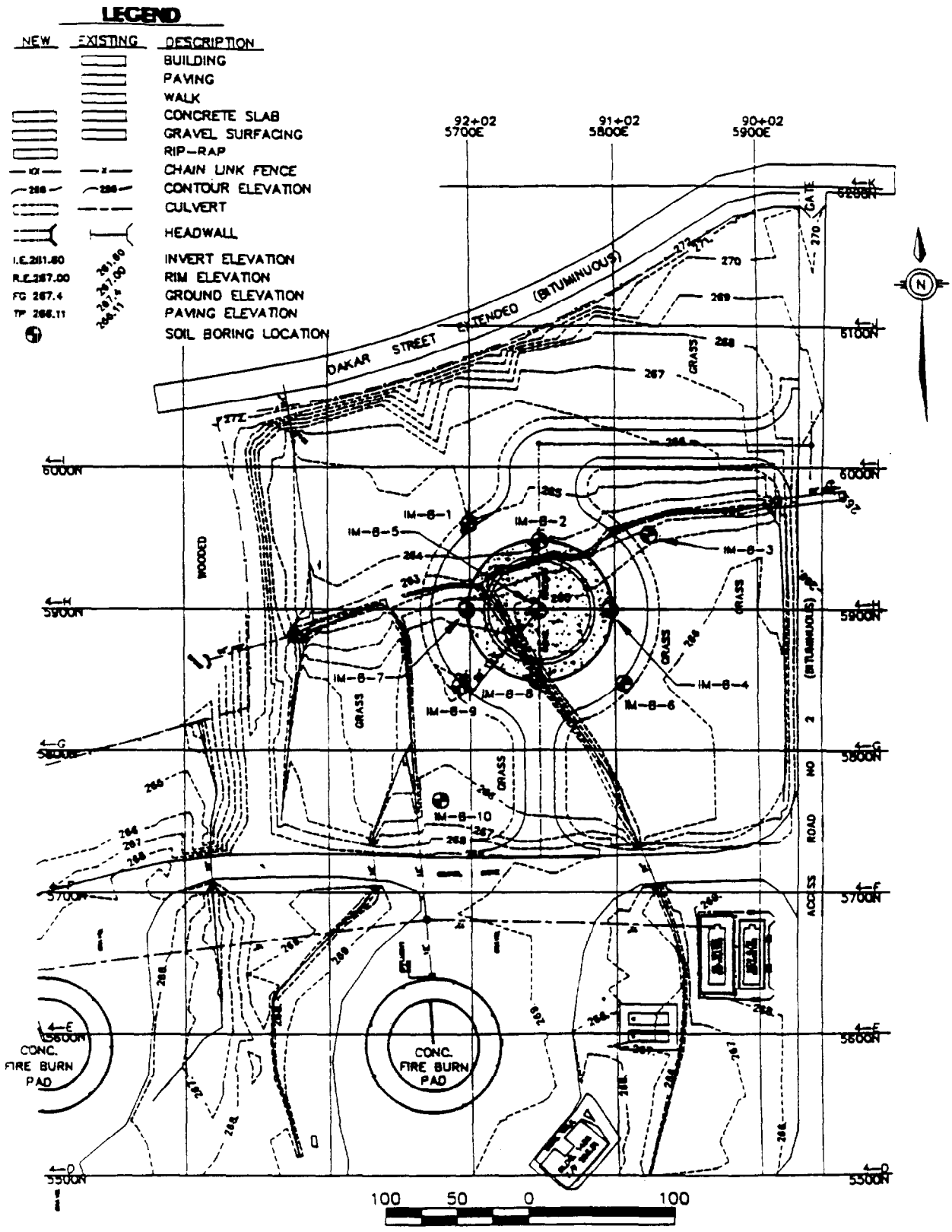
Appendix A

Interim Measures Tech Memo/1992 UST Investigation Data

Technical Memorandum — 1992 USGS Interim Measures Investigation

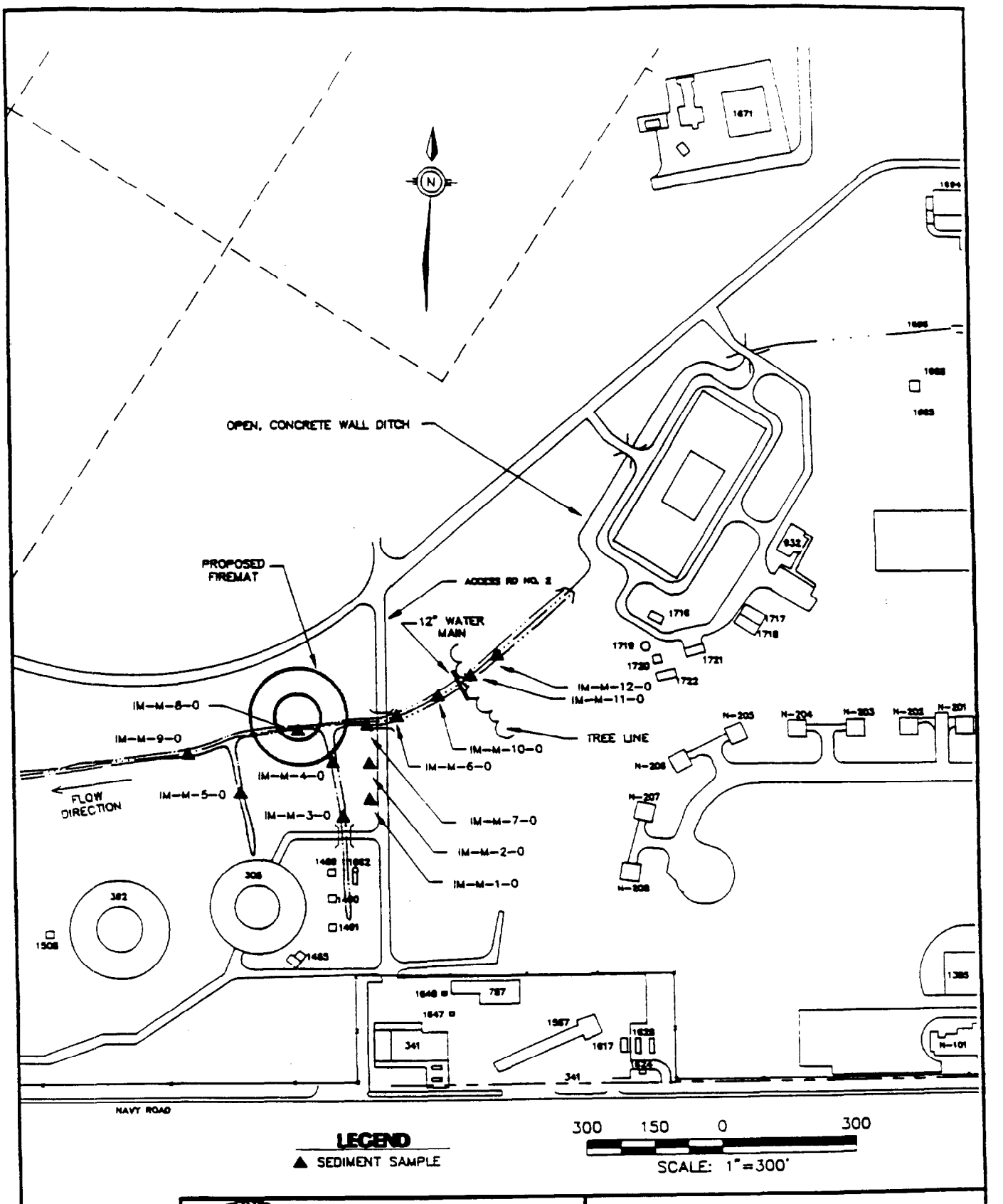
SAMPLING LOCATIONS



INTERIM MEASURE
TECHNICAL MEMO
NAS MEMPHIS
MILLINGTON, TENNESSEE

FIGURE TM-1
INTERIM MEASURE
SOIL BORING
LOCATION MAP

DATE: 02/01/93 | DWG NAME: 016-TM1



LEGEND

▲ SEDIMENT SAMPLE

INTERIM MEASURE
TECHNICAL MEMO
NAS MEMPHIS
MILLINGTON, TENNESSEE

FIGURE TM-2
SEDIMENT SAMPLE
LOCATION MAP

DATE: 02/01/93 | DWG NAME: 016-TM

ANALYTICAL RESULTS

Table TM-5 (3 of 3)
Summary of Validated Positive Results
Inorganic Analytical Data
(mg/kg)

	Sample IM-B-10-0 (0-2 ft)	Sample IM-B-10-5 (5-7 ft)	Sample IM-B-10-11 (11-13 ft) Duplicates	Sample IM-M-1-0 (Sediment)	Sample IM-M-2-0 (Sediment)	Sample IM-M-3-0 (Sediment)	Sample IM-M-4-0 (Sediment)	Sample IM-M-5-0 (Sediment)	Sample IM-B-6-0 (Sediment)	Sample IM-B-7-0 (Sediment)
Cyanide									3.6	
Mercury									0.62	0.20
Tin		249					94.6	450		
Lead	14.9	5.9	6.2/5.8	44.0	25.2	31.2	39.0	18.8	63.7	66.6
Nickel	7.2	33.1	11.2/10.5	10.2	11.2	11.5	22.0	47.0	32.8	14.9
Silver										
Arsenic	4.6	8.3	1.4/2.1	5.7	6.9	3.6	3.5	1.9	12.2	5.3
Barium	80.3	201	35.5/33.2	105	111	162	235	200	196	106
Beryllium	0.50	0.45	0.25/0.23	0.44	0.47	0.56	0.59	0.61	0.61	0.43
Cadmium						0.82	1.0	2.3	5.7	4.8
Chromium	5.9	44.8	6.7/6.9	8.0	8.0	10.3	25.5	83.5	25.6	18.7
Cobalt	4.4	4.7	3.7/3.1	3.9	4.8	4.0	4.1	2.9	19.9	4.8
Copper	8.7	11.4	9.1/9.8	11.1	11.2	16.7	28.6	29.0	21.4	21.4
Vanadium	13.7	17.6	11.1/12.7	14.9	16.1	15.3	14.5	10.1	22.8	12.6
Zinc	25.9	34.3	29.5/33.2	63.0	49.9	82.2	85.1	96.2	170	80.5

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NAS Memphis RFI
Interim Measure - SWMUs 4 & 5

Table TM-5 (2 of 3)
Summary of Validated Positive Results
Inorganic Analytical Data
(mg/kg)

	Sample IM-B-5-0 (0-2 ft)	Sample IM-B-5-5 (5-7 ft)	Sample IM-B-5-10 (10-12 ft)	Sample IM-B-6-0 (0-2 ft)	Sample IM-B-6-5 (5-7 ft)	Sample IM-B-6-10 (10-12 ft)	Sample IM-B-7-0 (0-2 ft)	Sample IM-B-7-5 (5-7 ft) (MS)	Sample IM-B-7-5 (5-7 ft)
Mercury								0.57	
Lead	14.4	10.6	7.8	12.3	14.8	3.9	22.6	9.5	7.4
Nickel	13.8	11.4	16.5	22.5	13.5	11.6	11.1	57.3	13.8
Silver	1.0								
Arsenic	5.7	1.5	6.8	3.7	4.1	1.5	5.9	3.1	
Barium	194	153	178	273	175	92.5	148	298	125
Beryllium	0.72	0.54	0.38	0.75	0.59	0.38	0.60	5.0	0.47
Cadmium				0.76			0.97	5.1	
Chromium	9.6	11.4	9.2	12.3	12.2	10.4	10.7	29.4	11.2
Cobalt	6.8	4.0	8.8	7.4	5.4	3.2	4.5		2.5
Copper	11.1	10.7	11.8	12.7	13.1	8.6	10.7	30.9	8.8
Vanadium	19.7	12.0	16.4	19.6	14.7	10.8	18.1	57.1	12.0
Zinc	44.5	53.2	44.2	58.4	58.8	47.3	50.9	90.7	47.8

NAS Memphis RFI
Interim Measure - SWMUs 4 & 5

Table TM-5 (1 of 3)
Summary of Validated Positive Results
Inorganic Analytical Data
(mg/kg)

	Sample IM-B-1-0 (0-2 ft)	Sample IM-B-1-4 (4-6 ft)	Sample IM-B-1-16 (16-18 ft)	Sample IM-B-2-0 (0-2 ft)	Sample IM-B-2-5 (5-7 ft)	Sample IM-B-2-10 (10-12 ft)	Sample IM-B-3-0 (0-2 ft)	Sample IM-B-3-5 (5-7 ft)	Sample IM-B-3-10 (10-12 ft)
Lead	6.2	7.3	6.2	19.0	6.2	6.2	19.3	6.3	5.2
Nickel	14.0	12.6	8.9	17.2	12.9	17.3	12.8	22.9	11.7
Silver	1.1			1.2				1.2	
Arsenic		0.57	0.57		1.8	9.7		4.6	6.0
Barium	154	173	58.4	273	158	152	146	276	76.1
Beryllium	0.51	0.66	0.27	0.95	0.57	0.36	0.51	0.49	0.27
Cadmium	0.61						0.87	0.78	
Chromium	12.0	12.0	6.4	10.3	11.8	9.4	14.5	9.8	8.8
Cobalt	6.6	2.5	4.9	7.3	2.3	5.0	5.5	7.8	3.8
Copper	17.8	11.2	7.7	11.3	10.4	11.3	12.8	12.9	9.7
Vanadium	18.4	8.6	10.6	21.5	12.0	14.5	15.9	17.9	11.5
Zinc	46.5	61.3	31.4	47.9	53.3	47.9	53.4	53.2	33.8

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NAS Memphis RFI
Interim Measure - SWMUs 4 & 5

Table TM-4
Summary of Validated Positive Results
Pesticides
(mg/kg)

Sample I.D. Number	Sample Depth	Dieldrin Concentration	Data Qualifier
IM-B-1-0	0-2 ft	0.31	V
IM-B-2-0	0-2 ft	0.78	V
IM-B-2-5	5-7 ft	0.07	V
IM-B-3-0	0-2 ft	1.0	V
IM-B-5-0	0-2 ft	0.14	
IM-B-5-5	5-7 ft	0.04	
IM-B-6-0	0-2 ft	0.24	
IM-B-6-5	5-7 ft	0.07	
IM-B-7-0	0-2 ft	0.46	
IM-B-7-5 (MS/MSD)	5-7 ft	0.11/0.10	
IM-B-7-5	5-7 ft	0.10	
IM-B-10-0	0-2 ft	0.48	
IM-M-1-0	Sediment	3.0	
IM-M-2-0	Sediment	1.4	

V = Second column value

Dieldrin was only pesticide detected.

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NAS Memphis RFI
Interim Measure - SWMUs 4 & 5

Table TM-3
Summary of Validated Positive Results
Total Petroleum Hydrocarbons
(mg/kg)

Sample I.D. Number	Sample Depth	TPH Concentration
IM-B-10-5	5-7 ft	1,010
IM-B-10-11 (duplicates)	11-13 ft	33.1/ND
IM-M-1-0	Sediment	23.0
IM-M-2-0	Sediment	28.6
IM-M-3-0	Sediment	29.7
IM-M-4-0	Sediment	45.4
IM-M-5-0	Sediment	292
IM-M-6-0	Sediment	660
IM-M-6R-0 (duplicates)	Sediment	279/332
IM-M-7-0	Sediment	50.9
IM-M-10-0	Sediment	261
IM-M-11-0	Sediment	43.9
IM-M-12-0	Sediment	32.1

Table TM-1
Summary of Validated Positive Results
Volatile Organic Compounds
(mg/kg)

	Sample IM-B-1-0 (0-2 ft)	Sample IM-B-1-4 (4-6 ft)	Sample IM-B-1-16 (16-18 ft)	Sample IM-B-6-0 (0-2 ft)	Sample IM-B-6-5 (5-7 ft)	Sample IM-B-7-5 (5-7 ft)	Sample IM-B-10-5 (5-7 ft)	Sample IM-B-10-11 (11-13 ft) (duplicates)	Sample IM-M-8-0 (Sediment)
Acetone	4.60		0.35	0.34	0.22	0.96	6.70	0.43/0.15	
Benzene							5.20	0.17/0.10	
1,1 Dichloroethene						0.27/0.29 MS/MSD			
1,2-Dichloroethene									0.10
Xylenes (total)		0.52					14.00		

Table TM-2
Summary of Validated Positive Results
Semivolatile Organic Compounds
(mg/kg)

	Sample IM-B-10-5 (5-7 ft)	Sample IM-B-10-11 (11-13 ft) (duplicates)	Sample IM-M-2-0 (Sediment)
Naphthalene	10.00		
2-Methylnaphthalene	44.00	1.20/ND	
Benzo(b)fluoranthene			1.80
Fluoranthene			2.30

1992 UST Investigation Tables & Figures

Table C-5
Groundwater Analytical Results
UST Parameters
Results in ug/L (ppb)

Sample ID (Date)	Benzene	Toluene	Total Xylenes	GRO
MW-01 - (07/09/92)	(1) U	(1) U	(1) U	(100) U
MW-02 - (07/09/92)	350	51	460	1,200
MW-03 - (07/09/92)	(1) U	1	(1) U	(100) U
MW-04 - (07/09/92)	(1) U	(1) U	(1) U	(100) U
MW-05 - (07/09/92)	(1) U	(1) U	(1)	(100) U
MW-06 - (07/09/92)	2	(1)U	9	(100) U
MW-07 - (07/10/92)	5	(1) U	8	(100) U
MW-08 - (07/10/92)	1,100 D	9	150 D	2,600 D
MW-09 - (07/10/92)	(1) U	(1) U	(1) U	(100) U
MW-10 - (07/10/92)	(1) U	(1) U	(1) U	(100) U
MW-11 - (07/10/92)	130 D	(2.5) U*	45	420

NOTES:

U Compound was analyzed for but not detected. The number in parentheses is the detection limit.

D Quantitated from 1:5 dilution.

* Detection limit higher than normal due to sample matrix interferences.

Table C-6
Groundwater Analytical Results
Volatile Organic Compounds
Results in ug/L (ppb)

Sample ID/Date	Compound Detected	Concentration (ppb)
MW-05 (07/09/92)	1,2 - Dichloroethene (total)	5 J
MW-06 (07/09/92)	Benzene Ethylbenzene	2 J 9 J
MW-08 (07/10/92)	Benzene Ethylbenzene Xylenes (total)	1300 E 14 100
MW-11 (07/10/92)	Benzene Toluene Ethylbenzene Xylenes (total)	280 E 1 J 13 83

NOTES:

J Compound detected, but below quantitation limit; value estimated
E Compound exceeded calibration range

000271

Table C-7 Groundwater Analytical Results Base/Neutral Acid Extractables Results in ug/L (ppb)		
Sample ID/Date	**Compound Detected**	**Concentration (ppb)**
MW-05 (07/09/92)	1,2 - Dichlorobenzene	1 J
MW-06 (07/09/92)	Naphthalene	7 J
MW-08 (Re) (08/06/92)	Phenol Naphthalene 2-Methylnaphthalene	26 17 9 J
MW-11 (Re) (08/06/92)	Phenol Naphthalene 2-Methylnaphthalene Acenaphthene	12 28 21 1 J

NOTES:

J Compound detected but below quantitation limit; value estimated
Re Well resampled after laboratory exceeded holding times

Table C-8
Groundwater Analytical Results
Appendix IX Metals
Results in ug/L (ppb)

Sample ID / Date / Parameter	MW-05 (07/09/92)		MW-06 (07/09/92)		MW-08 (07/10/92)		MW-11 (07/10/92)	
Antimony	(4.0)	U	(4.0)	U	(4.0)	U	(4.0)	U
Arsenic[1]	20.9		12.9		82.5[1]		26.2	
Barium	617		183	B	583		355	
Beryllium	4.0	B	1.7	B	3.8	B	2.3	B
Cadmium[2]	11.3[2]		9.1		14.4[2]		11.3[2]	
Chromium[3]	92.4[3]		42.2		70.0[3]		57.6[3]	
Cobalt	36.6	B	22.9	B	46.8	B	29.3	
Copper	60.1		17.8	B	68.2		44.1	
Lead	37.7		(2.0)	U	26.7		9.9	
Mercury	(0.20)	U	(0.20)	U	(0.20)	U	(0.20)	U
Nickel	88.4		37.9	B	98.8		56.0	
Selenium	(6.0)	U	(2.0)	U	(4.0)	U	(4.0)	U
Silver	9.7	B	10.6		14.7		12.6	
Thallium	(2.0)	U	(2.0)	U	(2.0)	U	(2.0)	U
Tin	381		317		514		344	
Vanadium	73.6		33.3	B	81.4		53.1	
Zinc	217		46.0		134		92.8	

NOTES:

U Compound was analysed for but not detected. The number in parentheses is the detection limit.

B Compound found in method blank

1 Federal MCL for Arsenic is 50 ug/L

2 Federal MCL for Cadmium is 10 ug/L

3 Federal MCL for Chromium is 50 ug/L

000276

Table C-9
Groundwater Analytical Results
Cyanide
Results are in ug/L (ppb)

Sample ID/Date	CN^- Concentration (ppb)
MW-05 07/09/92	40
MW-06 07/09/92	90
MW-08 07/10/92	70
MW-11 07/10/92	20

000277

Table C-10
Groundwater Analytical Results
Primary and Secondary Drinking Water Standards
MW-05 (07/27/92)

Parameter	Result	Standard	Units
Primary Standards			
Arsenic	0.007	0.05	PPM
Barium	0.75	1.0	PPM
Cadmium	<0.001	0.01	PPM
Chromium, Total	0.050	0.05	PPM
Fluoride, Electrode	0.33	4.0	PPM
Lead	0.028	0.05	PPM
Mercury	<0.001	0.002	PPM
Nitrogen, Nitrate	<0.10	10.0	PPM
Selenium	<0.005	0.01	PPM
Silver	<0.005	0.05	PPM
Secondary Standards			
Total Hardness	318	—	MG/L CACO3
Chloride	5.3	250	PPM
Color	5	15	PT-CO Units
Copper	0.12	1.0	PPM
Detergents (MBAS)	0.22*	0.05	PPM
Iron	70.8*	0.03	PPM
Manganese	2.09*	0.05	PPM
Odor	0	3	T.O.N. UNIT
pH	6.8	6.5 - 8.5	PPM
Sodium	15.0	—	PPM
Sulfate	18	250	PPM
Solids, Dissolved	403	500	PPM
Zinc	0.31	5.0	PPM
Turbidity	6.6*	1.0	N.T. UNITS

NOTE:
* Exceeds Drinking Water Standards

000278

Table D-1
Soil Analytical Results
UST Parameters
Results in mg/kg (ppm)

Sample ID/Date	Benzene		Toluene		Total Xylenes		Total BTX		GRO	
MW-01-9 (06/22/92)	(0.1)	U	(0.1)	U	(0.1)	U	(0.1)	U	(10)	U
MW-02-06 (06/22/92)	4.2		1.6		54		59.8		640	D
MW-02-10 (06/22/92)	(0.1)	U	(0.1)	U	(0.1)	U	(0.1)	U	16	
MW-03/10 (06/23/92)	(0.1)	U	(0.1)	U	(0.1)	U	(0.1)	U	(10)	U
MW-04-8 (06/23/92)	(0.1)	U	(0.1)	U	(0.1)	U	(0.1)	U	(10)	U
MW-05-8 (06/24/92)	(0.1)	U	(0.1)	U	(0.1)	U	(0.1)	U	(10)	U
MW-06-6 (06/24/92)	(0.1)	U	0.2		5.4		5.6		170	
MW-06-8 (06/24/92)	(0.1)	U	(0.1)	U	0.4		0.4		21	
MW-06-10 (06/24/92)	(0.1)	U	(0.1)	U	(0.1)	U	(0.1)	U	(10)	U
MW-07-4 (06/25/92)	0.5		0.8		17		18.3		230	
MW-07-6 (06/25/92)	(0.1)	U	(0.1)	U	0.2		0.2		(10)	U
MW-07-8 (06/25/92)	(0.1)	U	(0.1)	U	(0.1)	U	(0.1)	U	(10)	U
MW-08-2 (06/25/92)	1	D	40	D	83		134	D	3,300	D
MW-08-8 (06/25/92)	0.1		(0.1)	U	(0.1)	U	0.1		(10)	U
MW-09-8 (06/25/92)	(0.1)	U	(0.1)	U	(0.1)	U	(0.1)	U	(10)	U
MW-10-2 (06/26/92)	(0.2)	U*	(0.2)	U*	11	D	11	D	210	D
MW-10-6 (06/26/92)	(0.1)	U	(0.1)	U	(0.1)	U	(0.1)	U	10	U
MW-10-10 (06/26/92)	(0.1)	U	(0.1)	U	(0.1)	U	(0.1)	U	(10)	U
MW-11-4 (06/26/92)	1.5	D	4.5	D	35	D	41.0	D	500	
MW-11-11 (06/26/92)	(0.1)	U	(0.1)	U	(0.1)	U	(0.1)	U	(10)	U
B-03-8 (06/22/92)	(0.1)	U	(0.1)	U	(0.1)	U	(0.1)	U	(10)	U
B-04-8 (06/22/92)	(1.3)	U*	(1.3)	U*	6.7		6.7		210	D
B-04-10 (06/22/92)	(0.1)	U	(0.1)	U	(0.1)	U	(0.1)	U	(10)	U
B-04-12 (06/22/92)	(0.1)	U	(0.1)	U	(0.1)	U	(0.1)	U	(10)	U
B-07-2 (06/23/92)	2.5		4.5		61		68		230	D
B-07-8 (06/23/92)	2.8		2.4		7.7		12.9		320	
B-08-4 (06/23/92)	(0.1)	U	0.5		2.2		2.7		300	
B-08-10 (06/23/92)	(1.3)	U*	1.3		2.4		3.7		140	

000279

Table D-1
Soil Analytical Results
UST Parameters
Results in mg/kg (ppm)

Sample ID/Date	Benzene		Toluene		Total Xylenes		Total BTX		GRO	
B-09-4 (06/24/92)	(0.1)	U	0.5	*	9.1		9.6		130	D
B-09-9 (06/24/92)	(0.1)	U	(0.1)	U	(0.1)	U	(0.1)	U	(10)	U
B-12-4 (06-24-92)	(0.5)	U*	0.7		3.4		4.1		230	D
B-12-10 (06/24/92)	(0.5)	U	5.2		33		38.2		960	D
B-15-2 (06/25/92)	0.6		0.4	D	33		33.4	D	950	D_1
B-15-8 (06/25/92)	(0.1)	U	(0.1)	U	(0.1)	U	(0.1)	U	(10)	U
B-15-10 (06/26/92)	(0.1)	U	(0.1)	U	(0.1)	U	(0.1)	U	(10)	U
B-16-10 (06/25/92)	(0.1)	U	(0.1) U	U	(0.1)	U	(0.1)	U	(10)	

NOTES:
Sample depths are indicated in the last number of each sample ID. The number represents the top of the 2-foot collection interval. An exception is MW-11-11, which was collected between 11 and 1.5 ft.

U - Compound was analyzed for but not detected. The number in parentheses is the detection limit for the sample.
D - Quantitation taken from a dilution.
* - Detection limit is higher than normal due to sample matrix interferences.

000230

Table D-2
Soil Analytical Results
Volatile Organic Compounds
Results in ug/kg (ppb)

Sample ID/Date	Compound Concentrations			
	Benzene	Toluene	Ethylbenzene	Total Xylenes
MW-02-6 (06/22/92)	3,000 E	1,700 E	8,200 E	26,000 E
MW-02-6 DL (06/22/92)	4,800 J	3,300 J	19,000	97,000
MW-05-8 (06/24/92)	—	—	—	—
MW-06-6 (06/24/92)	3 J	—	62	380 E
MW-06-6 DL (06/24/92)	—	—	920 J	5,600
MW-08-4 (06/25/92)	2,500	—	4,600	21,000
MW-08-14 (06/25/92)	—	—	—	—
MW--11-4 (06/26/92)	6,500	—	20,000	120,000 E
MW-11-4 DL (06/26/92)	6,800 J	—	17,000	75,000
B-08-4 (06/23/92)	—	—	2,400	1,700
B-08-4 RE (06/23/92)	—	—	730 J	1,300 J
B-08-10 (06/23/92)	140	—	440 E	630 E
B-08-10 DL (06/23/92)	250 J	—	2,600	5,000
B-09-4 (06/24/92)	—	—	—	1,500
B-15-2 (06/25/92)	110	—	110	—

NOTES:

E - Compound exceeded calibration range.
DL - Diluted
J - Compound detected but below quantitation limit; value estimated.
RE - Reanalyzed

Table D-3
Soil Analytical Results
Base/Neutral and Acid Extractables
Results in ug/kg (ppb)

Sample/ID/Date	Compound Concentrations					
	Naphthalene	2-Methyl-naphthalene	Ace-naphthene	Phen-anthrene	Fluoranthene	Pyrene
MW-02-6 (06/22/92)	3,000 J	3,900 J	8,200 E	1,800	1,400 J	1,100 J
MW-05-6 (06/24/92) (6-10 ft.)	—	—	—	—	—	—
MW-06-4 (06/24/92) (4-8 ft.)	280 J	100 J	—	—	—	—
MW-11-3 (06/26/92) (3-7 ft.)	4,100	18,000	440 J	—	—	—
B-07-2 (06/24/92)	3,200 J	2,000 J	—	—	—	—
B-08-4 (06/23/92)	320 J	2,500	41 J	—	—	—
B-09-4 (06/24/92)	530 J	3,000	—	—	—	—
B-15-2 (06/25/92)	6,300 J	24,000	—	—	—	—

NOTES:
Unless otherwise noted, sample depths are in 2-foot intervals; the top is noted (in ft.) by the last number in the sample ID.

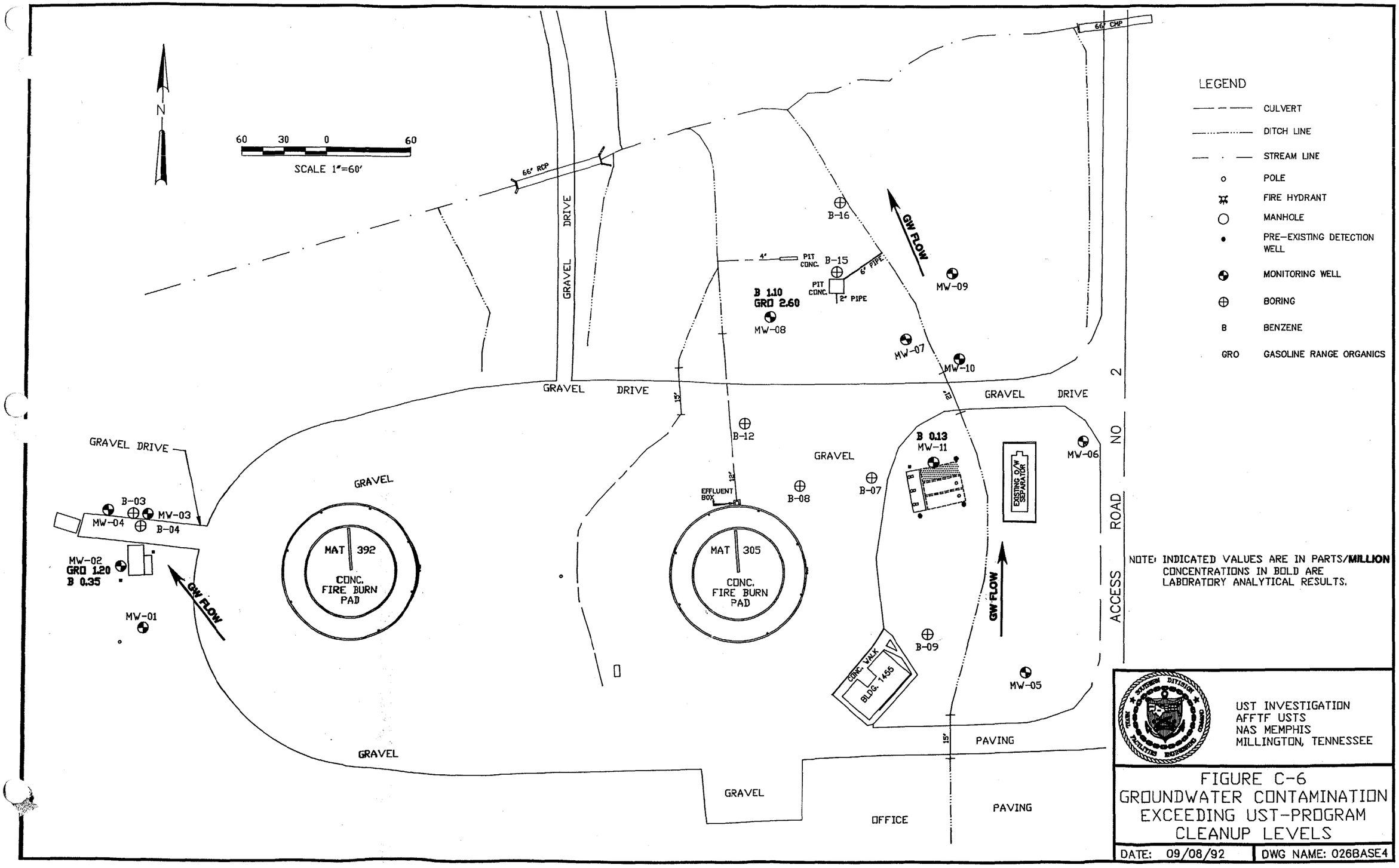
J - Compound detected but below quantitation limit; value estimated.
E - Compound exceeded calibration range.

000232

Table D-4
Soil Analytical Results
Appendix IX Metals
Results in mg/kg (ppm)

Sample ID / Parameter	MW-02-6 (06/22/92)	MW-05-06 (6-10 ft) (06/24/92)	MW-06-4 (4-8 ft) (06/24/92)	MW-11-3 (3-7 ft) (06/26/92)	B-07-2 (06/25/92)	B-08-4 (06/23/92)	B-09-4 (06/24/92)	B-15-2 (2-6 ft) (06/25/92)
Antimony	(0.48) U	(0.50) U	(0.51) U	(0.51) U	(0.50) U	(0.50) U	(0.50) U	(0.50) U
Arsenic	10.5	12.9	2.5	11.3	12.0	12.9	7.2	1.5
Barium	53	173	272	201	151	173	151	183
Beryllium	0.73	1.2	0.77	0.75	0.72	1.2	0.77	0.80
Cadmium	(0.60) U	0.96	0.96	(0.64) U	(0.63) U	0.96	(0.63) U	(0.63) U
Chromium	14.6	16.3	15.3	16.4	17.3	16.3	13.4	12.1
Cobalt	7.0	14.0	10.7	8.2	10.6	14.0	9.2	(2.5) U
Copper	15.1	21.1	10.2	17.9	17.4	21.1	10.8	7.2
Lead	9.1	12.5	10.2	10.4	14.1	12.5	14.2	10.4
Mercury	0.03	0.03	0.04	0.04	0.03	0.03	0.03	0.04
Nickel	17.4	19.5	14.4	21.4	14.4	19.5	13.0	11.9
Selenium	(0.24) U	(0.25) U	0.26 B	(0.25) U	(0.25) U	(0.25) U	(0.25) U	0.31 B
Silver	(0.60) U	(0.62) U	(0.63) U	(0.64) U	(0.63) U	(0.62) U	(0.63) U	(0.63) U
Thallium	0.27 B	0.26 B	(0.25) U	0.29 B	0.28	0.26 B	(0.25) U	(0.25) U
Vanadium	27.5	34.7	25.9	33.0	36.4	34.7	36.5	16.1
Zinc	55.2	72.0	58.2	67.5	63.5	72.0	41.9	49.6
Tin	3.9 B	6.0 B	6.9 B	—	7.7 B	6.0 B	8.0 B	5.5 B

NOTES:
Unless otherwise noted, sample depths are 2-foot intervals, the top of which is denoted by the last number of the sample ID.
B - Compound found in method blank.
U - Compound analyzed for but not detected; value given in parentheses is quantitation limit.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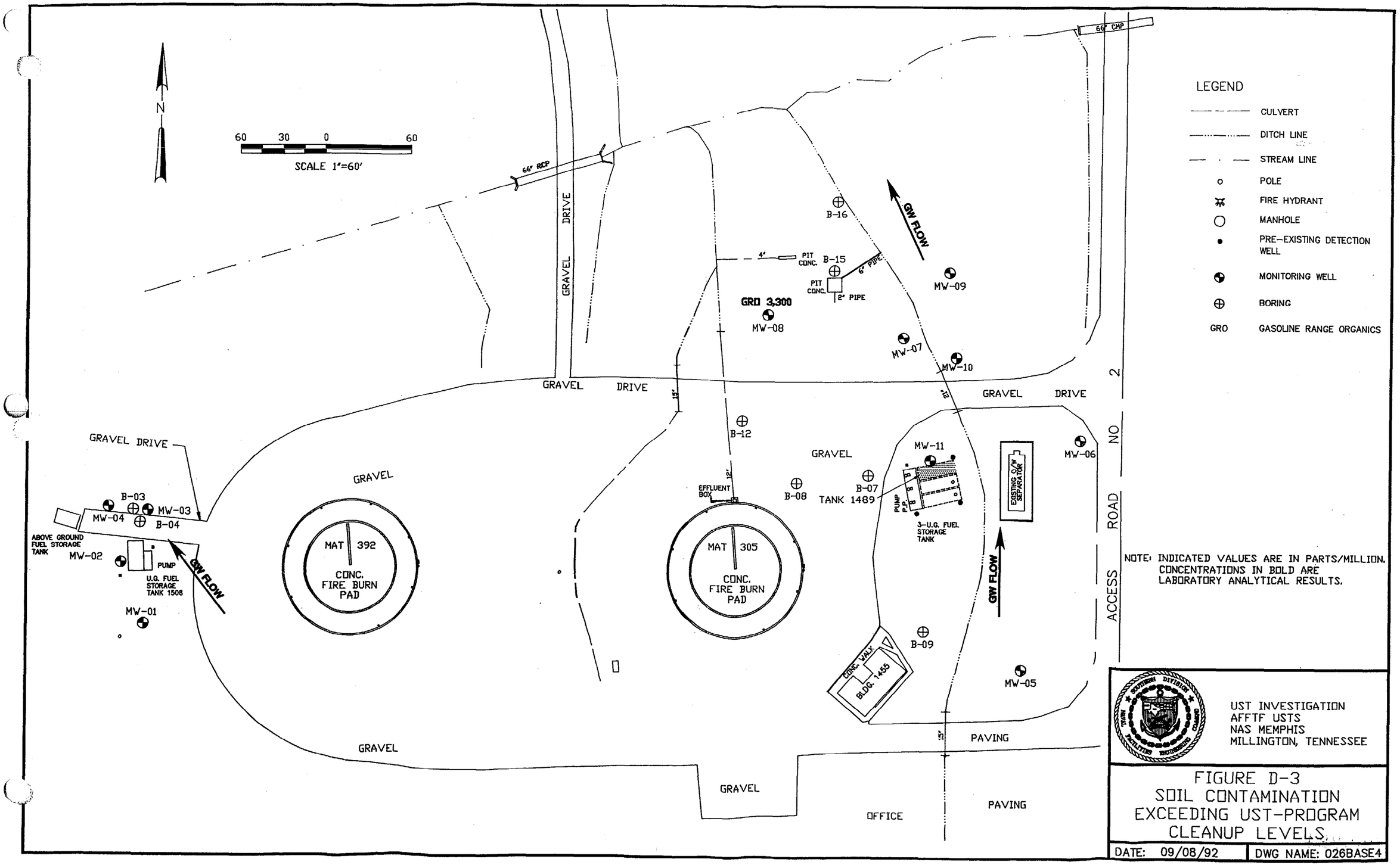
66" CMP
GRAVEL DRIVE
GRAVEL DRIVE
GRAVEL DRIVE
GRAVEL DRIVE
GRAVEL
GRAVEL
GRAVEL
GRAVEL
PAVING
PAVING
OFFICE
ACCESS ROAD NO 2
GW FLOW
GW FLOW
GW FLOW
B-16
B-15
4"
PIT CONC.
PIT CONC.
6" PIPE
2" PIPE
B 1.10
GRO 2.60
MW-08
MW-09
MW-07
MW-10
B-12
EFFLUENT BOX
B-08
B-07
B 0.13
MW-11
MW-06
EXISTING O/W SEPARATOR
B-09
CONC. WALK
BLDG. 1455
MW-05
B-03
MW-03
MW-04
B-04
MW-02
GRO 1.20
B 0.35
MW-01
MAT 392
CONC. FIRE BURN PAD
MAT 305
CONC. FIRE BURN PAD
15'
12'
LEGEND
CULVERT
DITCH LINE
STREAM LINE
POLE
FIRE HYDRANT
MANHOLE
PRE-EXISTING DETECTION WELL
MONITORING WELL
BORING
B BENZENE
GRO GASOLINE RANGE ORGANICS
NOTE: INDICATED VALUES ARE IN PARTS/MILLION
CONCENTRATIONS IN BOLD ARE
LABORATORY ANALYTICAL RESULTS.
UST INVESTIGATION
AFFTF USTS
NAS MEMPHIS
MILLINGTON, TENNESSEE
FIGURE C-6
GROUNDWATER CONTAMINATION
EXCEEDING UST-PROGRAM
CLEANUP LEVELS
DATE: 09/08/92
DWG NAME: 026BASE4

00617FB52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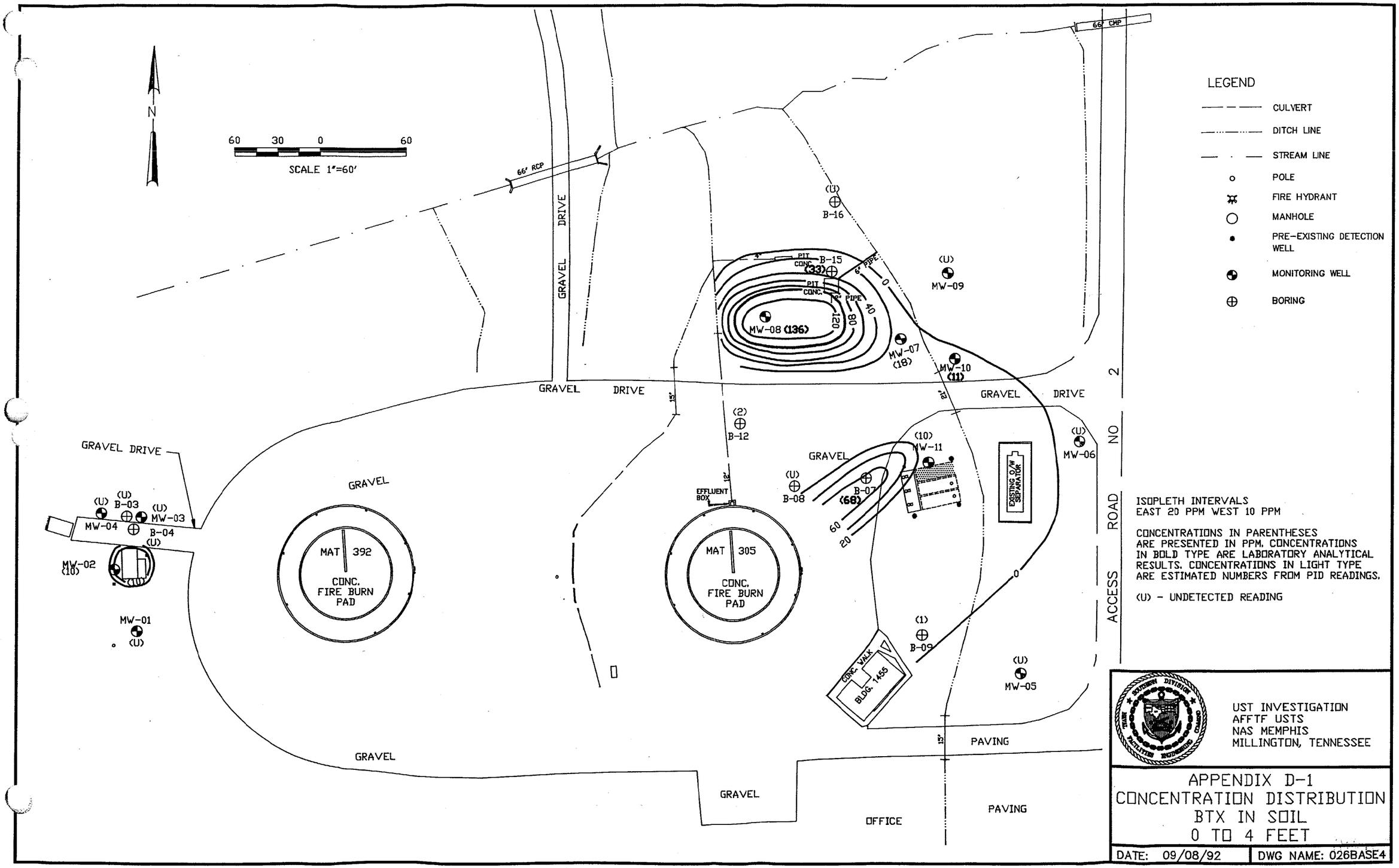
SCALE 1"=60'
66" RCP
66" CMP
GRAVEL DRIVE
GRAVEL DRIVE
GRAVEL DRIVE
GRAVEL DRIVE
GRAVEL
GRAVEL
GRAVEL
GRAVEL
GRAVEL
PAVING
PAVING
OFFICE
ACCESS ROAD NO 2
GW FLOW
GW FLOW
GW FLOW
B-16
B-15
PIT CONC.
4'
6" PIPE
2" PIPE
GRO 3,300
MW-08
MW-09
MW-07
MW-10
B-12
EFFLUENT BOX
B-08
B-07
TANK 1489
MW-11
PUMP
P.P.
3-U.G. FUEL STORAGE TANK
EXISTING O/W SEPARATOR
MW-06
B-09
CONC. WALK
BLDG. 1455
MW-05
MAT 392
CONC. FIRE BURN PAD
MAT 305
CONC. FIRE BURN PAD
B-03
MW-03
MW-04
B-04
ABOVE GROUND FUEL STORAGE TANK
MW-02
PUMP
U.G. FUEL STORAGE TANK 1508
MW-01
LEGEND
CULVERT
DITCH LINE
STREAM LINE
POLE
FIRE HYDRANT
MANHOLE
PRE-EXISTING DETECTION WELL
MONITORING WELL
BORING
GRO GASOLINE RANGE ORGANICS
NOTE: INDICATED VALUES ARE IN PARTS/MILLION. CONCENTRATIONS IN BOLD ARE LABORATORY ANALYTICAL RESULTS.
UST INVESTIGATION
AFFTF USTS
NAS MEMPHIS
MILLINGTON, TENNESSEE
FIGURE D-3
SOIL CONTAMINATION EXCEEDING UST-PROGRAM CLEANUP LEVELS.
DATE: 09/08/92
DWG NAME: 026BASE4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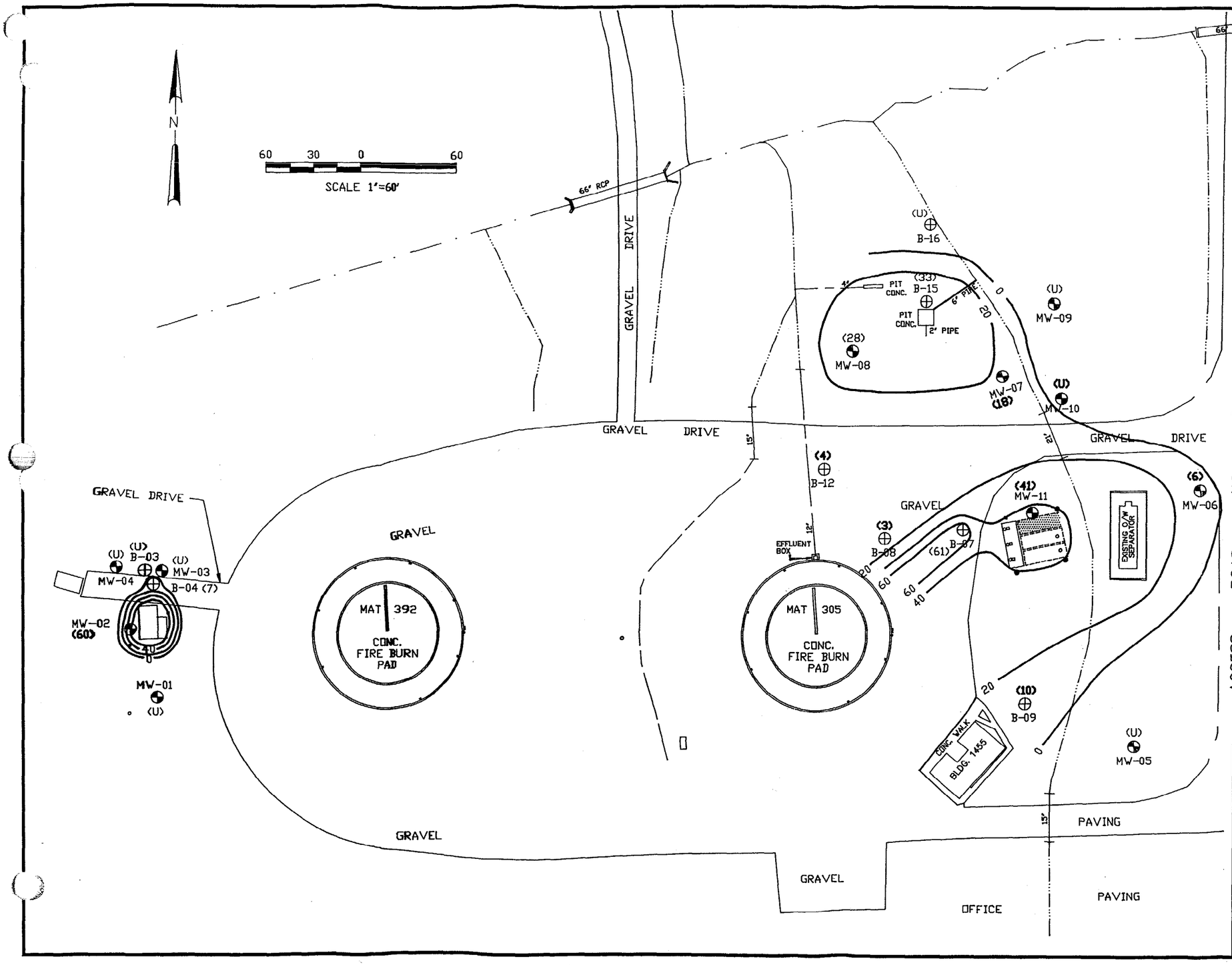
60 30 0 60
SCALE 1"=60'
66" RCP
66" CMP
GRAVEL DRIVE
GRAVEL DRIVE
GRAVEL DRIVE
GRAVEL DRIVE
GRAVEL
GRAVEL
GRAVEL
GRAVEL
PAVING
PAVING
OFFICE
ACCESS ROAD NO 2
B-16
B-15
PIT CONC.
(33)
6" PIPE
MW-09
MW-08 (136)
120
80
40
0
MW-07 (18)
MW-10 (11)
B-12
(10) MW-11
B-07 (68)
60
20
B-08
EFFLUENT BOX
EXISTING O/W SEPARATOR
MW-06
B-09
CONC. WALK
BLDG. 1455
MW-05
MAT 392
CONC. FIRE BURN PAD
MAT 305
CONC. FIRE BURN PAD
B-03
MW-03
MW-04
B-04
MW-02 (10)
MW-01
LEGEND
CULVERT
DITCH LINE
STREAM LINE
POLE
FIRE HYDRANT
MANHOLE
PRE-EXISTING DETECTION WELL
MONITORING WELL
BORING
ISOPLETH INTERVALS
EAST 20 PPM WEST 10 PPM
CONCENTRATIONS IN PARENTHESES ARE PRESENTED IN PPM. CONCENTRATIONS IN BOLD TYPE ARE LABORATORY ANALYTICAL RESULTS. CONCENTRATIONS IN LIGHT TYPE ARE ESTIMATED NUMBERS FROM PID READINGS.
(U) - UNDETECTED READING
UST INVESTIGATION
AFFTF USTS
NAS MEMPHIS
MILLINGTON, TENNESSEE
APPENDIX D-1
CONCENTRATION DISTRIBUTION
BTX IN SOIL
0 TO 4 FEET
DATE: 09/08/92
DWG NAME: 026BASE4



LEGEND

- CULVERT
- DITCH LINE
- STREAM LINE
- POLE
- FIRE HYDRANT
- MANHOLE
- PRE-EXISTING DETECTION WELL
- MONITORING WELL
- BORING

ISOPLETH INTERVALS
EAST 20 PPM WEST 20 PPM

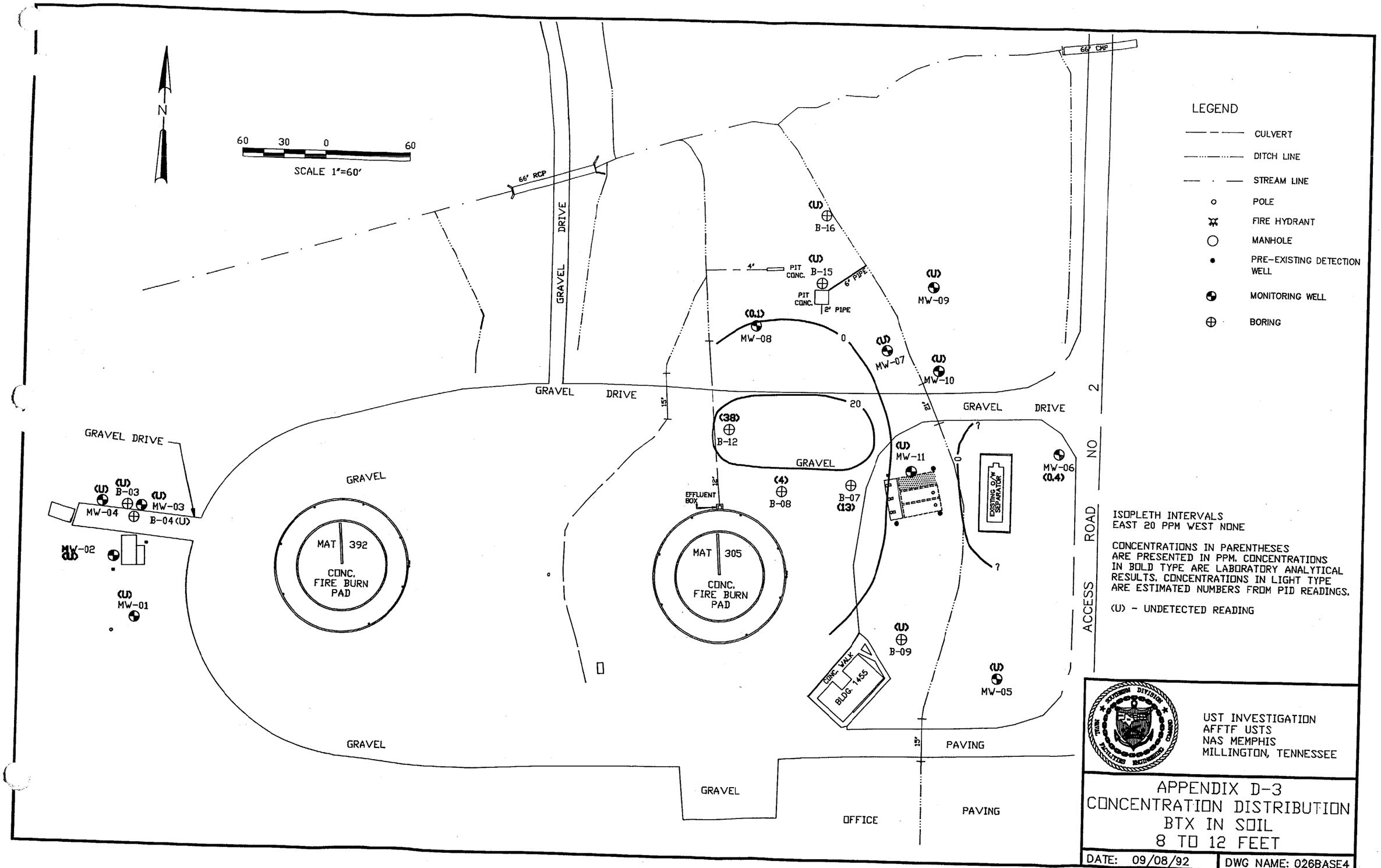
CONCENTRATIONS IN PARENTHESES ARE PRESENTED IN PPM. CONCENTRATIONS IN BOLD TYPE ARE LABORATORY ANALYTICAL RESULTS. CONCENTRATIONS IN LIGHT TYPE ARE ESTIMATED NUMBERS FROM PID READINGS.

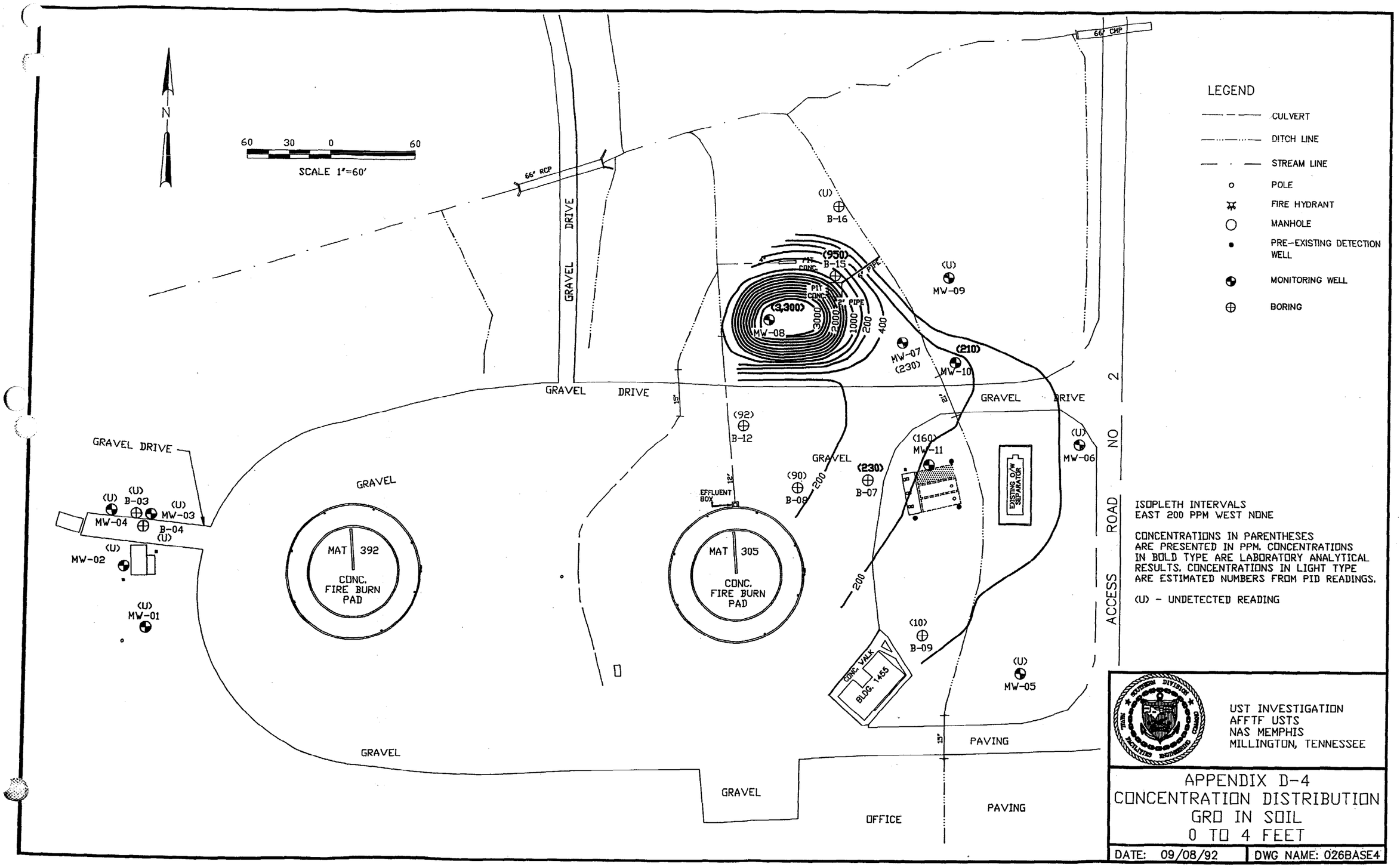
(U) - UNDETECTED READING

UST INVESTIGATION
AFFTF USTS
NAS MEMPHIS
MILLINGTON, TENNESSEE

APPENDIX D-2
CONCENTRATION DISTRIBUTION
BTX IN SOIL
4 TO 8 FEET

DATE: 09/08/92 | DWG NAME: 026BASE4


N
60 30 0 60
SCALE 1"=60'
66" RCP
66" CMP
GRAVEL DRIVE
GRAVEL DRIVE
GRAVEL DRIVE
GRAVEL DRIVE
GRAVEL
GRAVEL
GRAVEL
GRAVEL
PAVING
PAVING
OFFICE
ACCESS ROAD NO
(U) B-16
(U) B-15
PIT CONC.
PIT CONC.
4"
6" PIPE
2" PIPE
(U) MW-09
(0.1) MW-08
0
(U) MW-07
(U) MW-10
20
(38) B-12
(U) MW-11
EXISTING O/W SEPARATOR
MW-06 (0.4)
EFFLUENT BOX
(4) B-08
B-07 (13)
(U) B-03
(U) MW-03
MW-04
B-04 (U)
MW-02 (U)
(U) MW-01
MAT 392
CONC. FIRE BURN PAD
MAT 305
CONC. FIRE BURN PAD
(U) B-09
CONC. WALK
BLDG. 1455
(U) MW-05
15'
12'
LEGEND
CULVERT
DITCH LINE
STREAM LINE
POLE
FIRE HYDRANT
MANHOLE
PRE-EXISTING DETECTION WELL
MONITORING WELL
BORING
ISOPLETH INTERVALS
EAST 20 PPM WEST NONE
CONCENTRATIONS IN PARENTHESES ARE PRESENTED IN PPM. CONCENTRATIONS IN BOLD TYPE ARE LABORATORY ANALYTICAL RESULTS. CONCENTRATIONS IN LIGHT TYPE ARE ESTIMATED NUMBERS FROM PID READINGS.
(U) - UNDETECTED READING
UST INVESTIGATION
AFFTF USTS
NAS MEMPHIS
MILLINGTON, TENNESSEE
APPENDIX D-3
CONCENTRATION DISTRIBUTION
BTX IN SOIL
8 TO 12 FEET
DATE: 09/08/92
DWG NAME: 026BASE4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66" RCP
66" CMP
GRAVEL DRIVE
GRAVEL DRIVE
GRAVEL DRIVE
GRAVEL DRIVE
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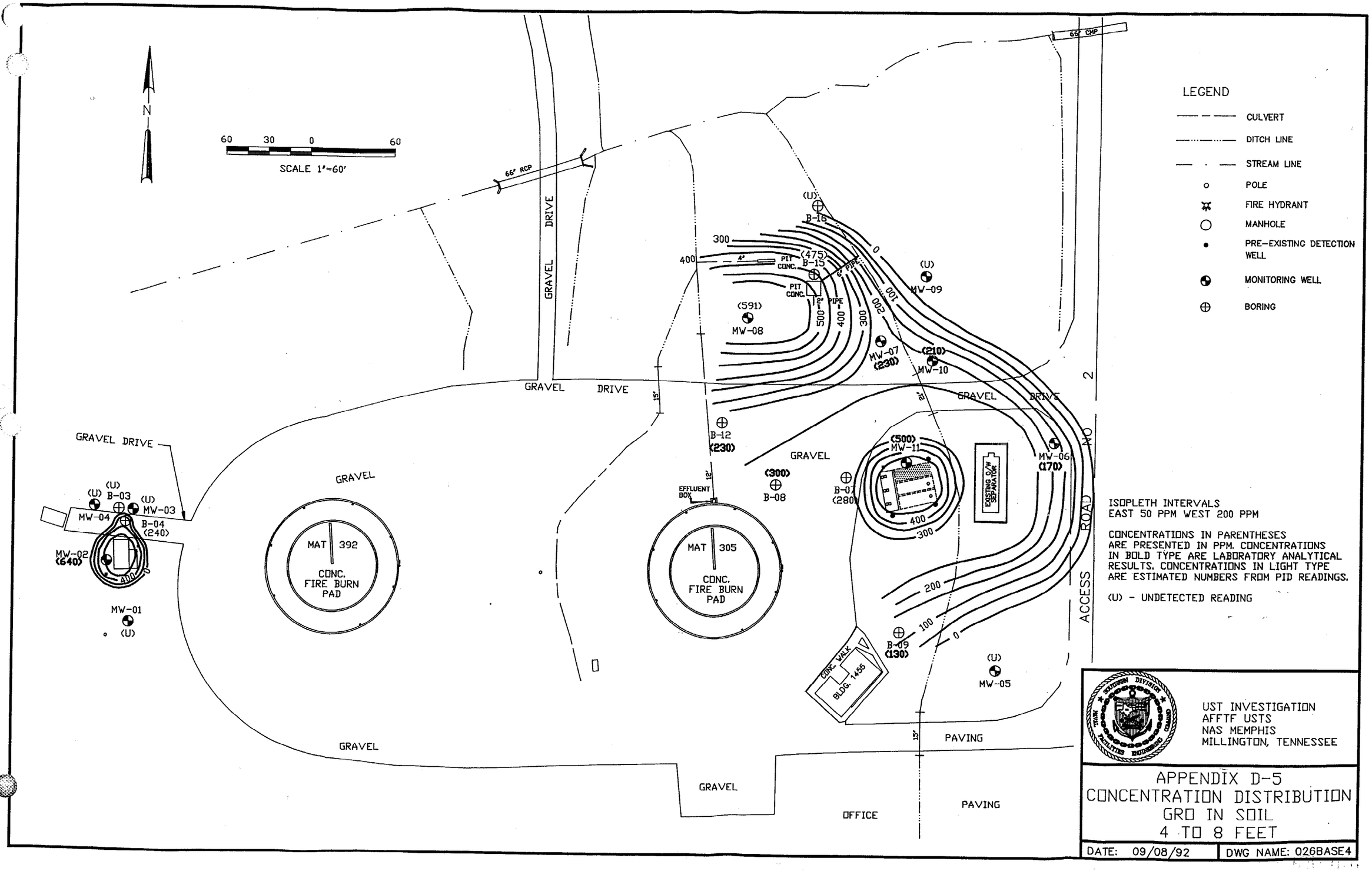
GRAVEL
GRAVEL
GRAVEL
PAVING
PAVING
OFFICE
ACCESS ROAD NO 2
(U) B-16
(950) B-15
PIT CONC.
2" PIPE
(3,300)
MW-08
3000
2000
1000
200
400
(U) MW-09
MW-07 (230)
(210) MW-10
(92) B-12
EFFLUENT BOX
(90) B-08
200
(230) B-07
(160) MW-11
EXISTING O/W SEPARATOR
(U) MW-06
(10) B-09
CONC. WALK
BLDG. 1455
(U) MW-05
MAT 392
CONC. FIRE BURN PAD
MAT 305
CONC. FIRE BURN PAD
(U) B-03
(U) MW-03
MW-04
B-04
(U)
(U) MW-02
(U) MW-01
LEGEND
CULVERT
DITCH LINE
STREAM LINE
POLE
FIRE HYDRANT
MANHOLE
PRE-EXISTING DETECTION WELL
MONITORING WELL
BORING
ISOPLETH INTERVALS
EAST 200 PPM WEST NONE
CONCENTRATIONS IN PARENTHESES ARE PRESENTED IN PPM. CONCENTRATIONS IN BOLD TYPE ARE LABORATORY ANALYTICAL RESULTS. CONCENTRATIONS IN LIGHT TYPE ARE ESTIMATED NUMBERS FROM PID READINGS.
(U) - UNDETECTED READING
UST INVESTIGATION
AFFTF USTS
NAS MEMPHIS
MILLINGTON, TENNESSEE
APPENDIX D-4
CONCENTRATION DISTRIBUTION
GRO IN SOIL
0 TO 4 FEET
DATE: 09/08/92
DWG NAME: 026BASE4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60 30 0 60
SCALE 1"=60'
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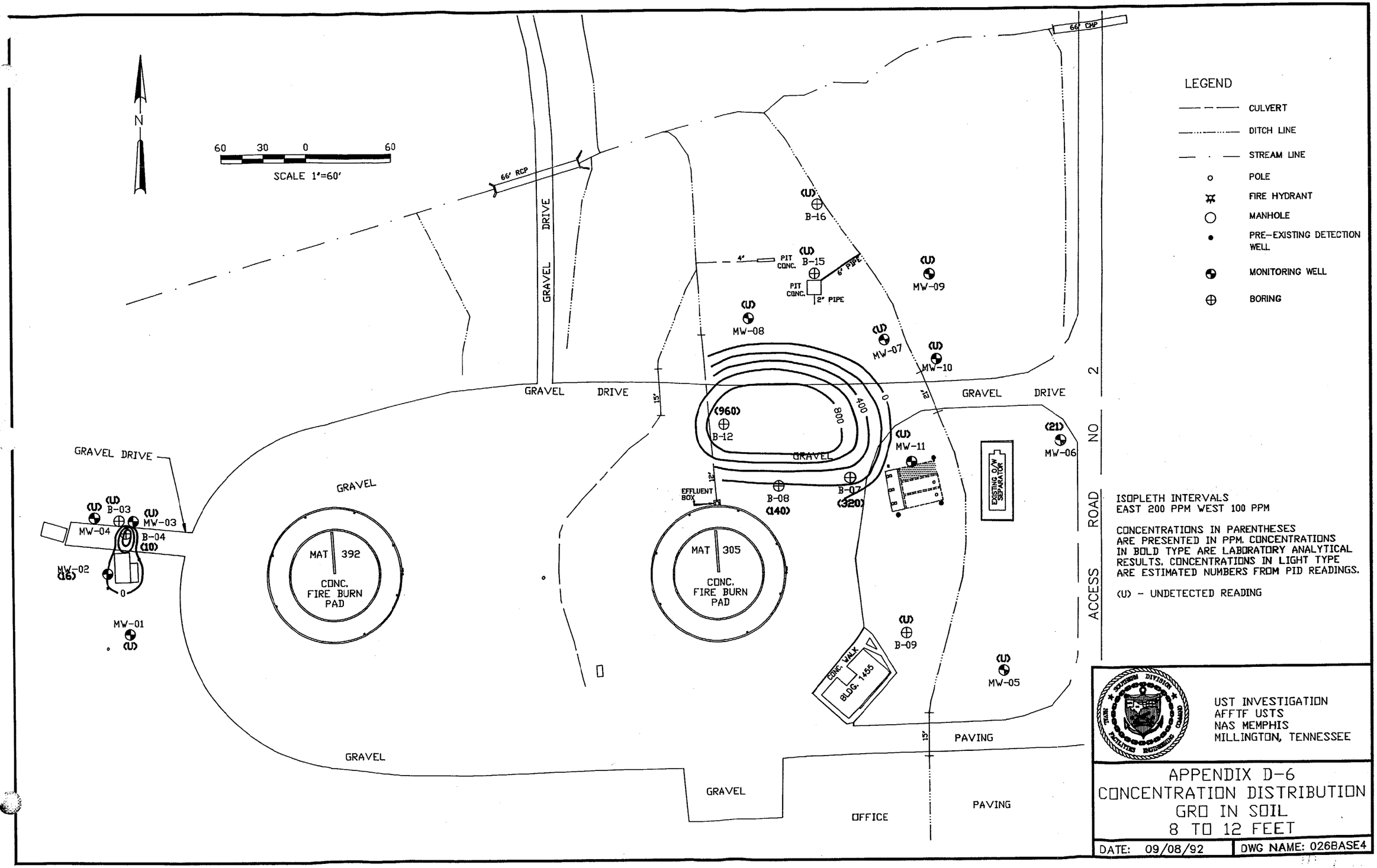
66" CMP
GRAVEL DRIVE
GRAVEL DRIVE
GRAVEL DRIVE
GRAVEL
GRAVEL
GRAVEL
GRAVEL
GRAVEL
PAVING
PAVING
OFFICE
ACCESS ROAD
MAT 392
CONC. FIRE BURN PAD
MAT 305
CONC. FIRE BURN PAD
EFFLUENT BOX
CONC. WALK
BLDG. 1456
EXISTING O/W SEPARATOR
PIT CONC.
PIT CONC.
6" PIPE
12" PIPE
4"
MW-01 (U)
MW-02 (640)
MW-03 (U)
MW-04 (U)
MW-05 (U)
MW-06 (170)
MW-07 (230)
MW-08 (591)
MW-09 (U)
MW-10 (210)
MW-11 (500)
B-03 (U)
B-04 (240)
B-07 (280)
B-08 (300)
B-09 (130)
B-12 (230)
B-15 (475)
B-16 (U)
400
300
200
100
0
15'
12'
LEGEND
CULVERT
DITCH LINE
STREAM LINE
POLE
FIRE HYDRANT
MANHOLE
PRE-EXISTING DETECTION WELL
MONITORING WELL
BORING
ISOPLETH INTERVALS
EAST 50 PPM WEST 200 PPM
CONCENTRATIONS IN PARENTHESES ARE PRESENTED IN PPM. CONCENTRATIONS IN BOLD TYPE ARE LABORATORY ANALYTICAL RESULTS. CONCENTRATIONS IN LIGHT TYPE ARE ESTIMATED NUMBERS FROM PID READINGS.
(U) - UNDETECTED READING
UST INVESTIGATION
AFFTF USTS
NAS MEMPHIS
MILLINGTON, TENNESSEE
APPENDIX D-5
CONCENTRATION DISTRIBUTION
GRO IN SOIL
4 TO 8 FEET
DATE: 09/08/92
DWG NAME: 026BASE4


N
60 30 0 60
SCALE 1"=60'
66' RCP
66' CMP
GRAVEL DRIVE
GRAVEL DRIVE
GRAVEL DRIVE
GRAVEL DRIVE
GRAVEL
GRAVEL
GRAVEL
GRAVEL
PAVING
PAVING
OFFICE
B-16
B-15
PIT CONC.
4"
6" PIPE
2" PIPE
MW-09
MW-08
MW-07
MW-10
(960)
B-12
800
400
0
MW-11
(21)
MW-06
EXISTING O/W SEPARATOR
EFFLUENT BOX
B-08
(140)
B-07
(320)
MAT 392
CONC. FIRE BURN PAD
MAT 305
CONC. FIRE BURN PAD
B-09
CONC. WALK
BLDG. 1455
MW-05
B-03
MW-03
MW-04
B-04
(10)
MW-02
(16)
MW-01
NO ACCESS ROAD
15'
12'
LEGEND
CULVERT
DITCH LINE
STREAM LINE
POLE
FIRE HYDRANT
MANHOLE
PRE-EXISTING DETECTION WELL
MONITORING WELL
BORING
ISOPLETH INTERVALS
EAST 200 PPM WEST 100 PPM
CONCENTRATIONS IN PARENTHESES ARE PRESENTED IN PPM. CONCENTRATIONS IN BOLD TYPE ARE LABORATORY ANALYTICAL RESULTS. CONCENTRATIONS IN LIGHT TYPE ARE ESTIMATED NUMBERS FROM PID READINGS.
(U) - UNDETECTED READING
UST INVESTIGATION
AFFTF USTS
NAS MEMPHIS
MILLINGTON, TENNESSEE
APPENDIX D-6
CONCENTRATION DISTRIBUTION
GRO IN SOIL
8 TO 12 FEET
DATE: 09/08/92
DWG NAME: 026BASE4

Appendix B

Technical Memorandum — Surface Soil (0 to 1 foot) Background Dieldrin Concentrations at NSA Memphis

EnSafe / Allen & Hoshall

a joint venture for professional services

TECHNICAL MEMORANDUM

TO: Mark Taylor/David Porter, SOUTHDIV
Tonya Barker/Rob Williamson, NSA Memphis
Jack Carmichael, USGS
Brian Donaldson, EPA
Jim Morrison, TDEC
Brenda Duggar, MSCHD
E/A&H Project Team

FROM: Brian Mulhearn, EnSafe/Allen & Hoshall

DATE: January 9, 1997

RE: Surface Soil (0 to 1 foot) Background Dieldrin Concentrations at NSA Memphis

During the July 24, 1996 BRAC Cleanup Team (BCT) meeting, the BCT decided that the June 2, 1995 *Soil Dieldrin Technical Memorandum* should be re-submitted and finalized to clarify the anthropogenic background reference concentration (RC) to be used for dieldrin screening comparisons. Two-times the arithmetic mean soil dieldrin concentrations, resulting in an RC of 0.262 mg/kg for dieldrin, will be used in baseline risk assessments to determine if dieldrin is a chemical of potential concern. The maximum dieldrin concentration reported at a site will be compared to the RC, and exceedances will be discussed. Dieldrin will not be identified as a chemical of potential concern unless the average reported concentration exceeds the RC. However, site-specific exceedances will be noted and discussed as is appropriate. Sample locations the BCT determines to be hot spots will be addressed on a site-specific basis. The dieldrin RC was determined as discussed in the June 2 memo, which is the source of the text below.

Chlorinated pesticides (specifically dieldrin) were used extensively in the 1950s and 1960s during a U.S. Department of Agriculture white fringed beetle quarantine. NSA Memphis has record that the agents were applied aerially for their intended purpose over the majority of the facility. During the RCRA

Facility Investigation, dieldrin and other chlorinated pesticides were detected in most surface soil and some subsurface soil samples collected at both SWMUs and background locations. Due to the ubiquitous presence of dieldrin in site soil, the following assessment was performed to support risk management decisions to be made by the BCT. Figure 1 shows reported surface soil dieldrin concentrations at background locations.

Table 1 shows concentrations ranged from below quantitation limits to 0.311 mg/kg with a mean of 0.131 mg/kg at background locations. Standard risk assessment methods were used to evaluate the significance of the reported concentrations. Default assumptions for residential and occupational exposure scenarios were used to project dieldrin-related carcinogenic risk through incidental ingestion and dermal contact soil pathways, which were detailed in the November 15, 1996 Technical Memorandum, *General Human Health Risk Assessment (HHRA) Approach for NSA Memphis*. For each exposure scenario, risk was estimated using the maximum and mean SWMU-specific dieldrin concentrations. The results of this process are provided in Table 2, including concentrations at SWMUs ranging from below quantitation limits to 0.609 mg/kg (e.g., average of the duplicate results at SWMU 5, boring 4).

As shown in Table 2, SWMU 5 had the highest projected soil pathway risk associated with dieldrin at maximum concentrations (2.2E-5). The SWMU 5 risk estimate was approximately twice that of the corresponding background. When mean concentrations were used as the exposure point concentration, SWMU 8 dieldrin risk was found to be the highest although it did not differ appreciably from background. In no instance (onsite or background) did dieldrin risk projections exceed 1E-4. This finding indicates that dieldrin concentrations reported at each SWMU do not necessitate remedial action in the absence of other significant carcinogenic risk contributors. USEPA's generally acceptable range for carcinogenic risk is 1E-6 to 1E-4.

Soil dieldrin is not expected to pose a substantial threat to shallow groundwater at any SWMU or background location. This conclusion is based on the strong soil binding properties of the compound as well as empirical data for subsurface soil that show significant vertical migration has not occurred.

000294

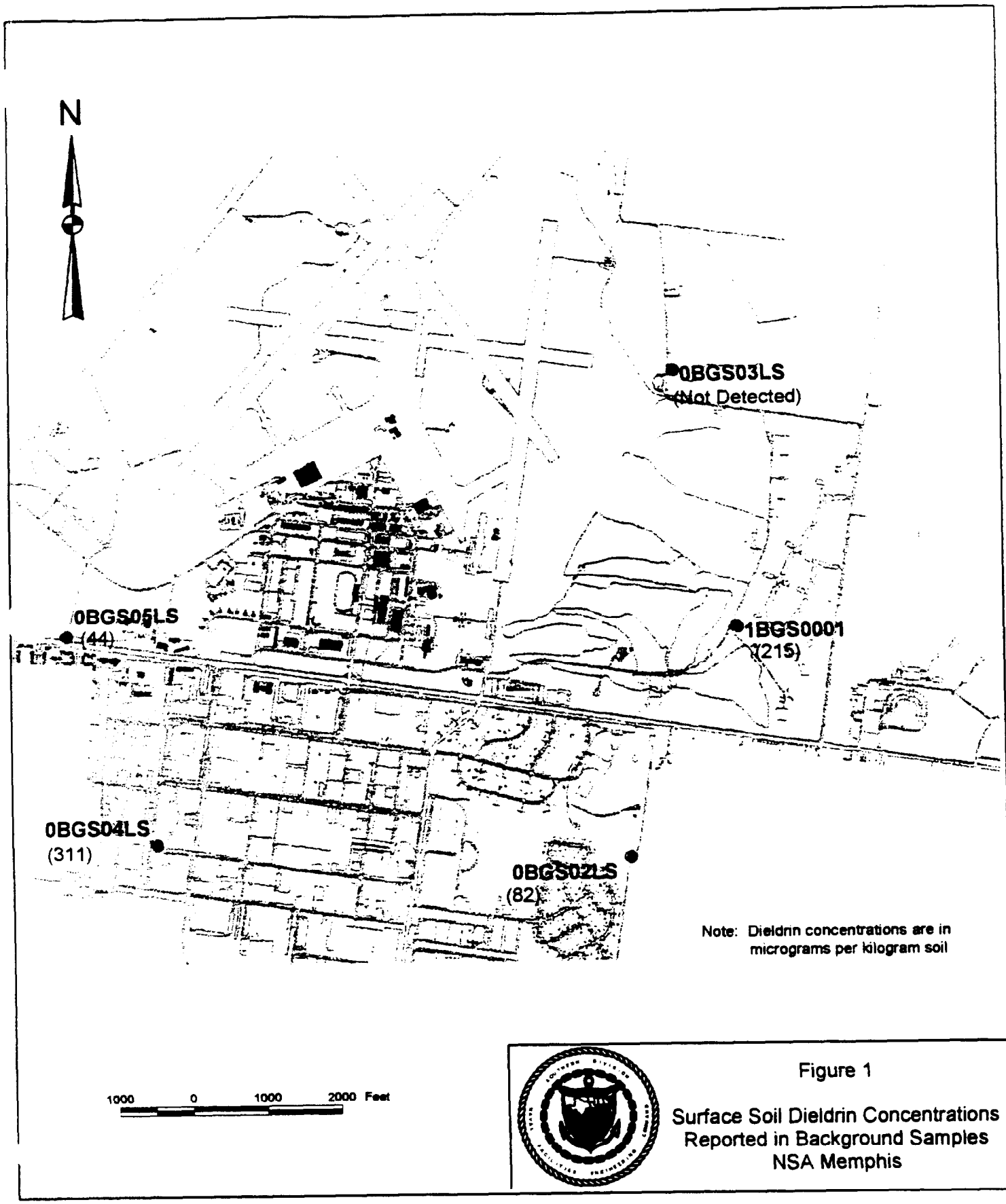


Figure 1

Surface Soil Dieldrin Concentrations Reported in Background Samples NSA Memphis

Table 1
Summary of Dieldrin Concentrations Reported at NSA Memphis Background Locations

Location	Concentration (mg/kg)	Qualifier
1BGS000101	0.215	D
OBGS02LS01	0.082	D
OBGS03LS01	0.004	U
OBGS04LS01	0.311	D
OBGS05LS01	0.044	

Note:
D = sample diluted by Laboratory
U = analyte not detected
The arithmetic mean dieldrin concentration (i.e., 0.131 mg/kg) was calculated assuming one-half of the detection limit was present in sample 0BGS03LS01.

Table 2
NSA Memphis Dieldrin Risk Estimates

Location	Maximum Dieldrin (mg/kg)	Mean Dieldrin (mg/kg)	Residential Risk-Based Max.	Residential Risk-Based Mean	Occupational Risk-Based Max.	Occupational Risk-Based Mean
SWMU 1	0.192	NA	7.04E-6	NA	1.12E-6	NA
SWMU 3	0.023	0.0072	8.43E-7	2.64E-7	1.34E-7	4.19E-8
SWMU 5	0.609	0.126	2.23E-5	4.62E-6	3.54E-6	7.33E-7
SWMU 7	0.055	0.0095	2.02E-6	3.48E-7	3.20E-7	5.52E-8
SWMU 8	0.471	0.144	1.73E-5	5.28E-6	2.74E-6	8.37E-7
SWMU 60	0.069	0.0155	2.53E-6	5.68E-7	4.01E-7	9.01E-8
Background	0.311	0.131	1.14E-5	4.80E-6	1.81E-6	7.62E-7

Note: the calculations above are based on a slope factor of 16 kg-day/mg.

000276

A historical use discussion is also helpful to provide a frame of reference for evaluating reported soil dieldrin (and other chlorinated pesticide) concentrations. Information provided by NSA Memphis states that chlorinated pesticides (primarily chlordane) were previously used until the late 1980's for termite control around buildings. Although chlordane was used as a single active ingredient application, mixtures including dieldrin, aldrin, and heptachlor were also common in the pest control trade. Standard application rates resulted in soil concentrations of 500 to 1,000 mg/kg total chlorinated pesticides. For comparison, a 10:1 chlordane:dieldrin mixture used for general subterranean termite control would have resulted in residual soil dieldrin concentrations of 50 to 100 mg/kg. These residual application concentrations are 50 to 100 times higher than the maximum soil dieldrin concentration reported in NSA Memphis surface soil.

This memo is intended to provide an RC for dieldrin and a risk-based framework for decision making regarding how the dieldrin issue is resolved. Although standard risk assessment techniques are applied, final resolution of this issue will require a consensus risk management decision. Of paramount importance is the determination of what level of risk is acceptable in light of the extent of dieldrin. EnSafe/Allen & Hoshall as the contractor can only provide the facts and suggestions for a viable risk management strategy. The following paragraph outlines suggestions based on currently available information and the preceding risk evaluation.

Dieldrin was used at NSA Memphis as intended, which has been documented and has resulted in dieldrin's widespread extent. Consequently, institutional controls are considered to be the most appropriate means of dealing with the dieldrin issue from a human health perspective. These controls may include (but are not limited to) public/worker awareness, access restrictions and maintenance of adequate vegetative cover to minimize contact. The focus of future investigative efforts should center around prevention of further migration (i.e., surface runoff), and evaluation of sensitive ecological receptor points (i.e., terrestrial habitats, drainage systems, streams, and lakes.) These areas should be emphasized as little control can be exercised over the animals who use them.

000297

Appendix C
DPT Screening Results

DIRECT PUSH TECHNOLOGY SUBSURFACE EXPLORATORY AND SAMPLING INVESTIGATIONS AT BRAC ASSEMBLY A RFI SWMUs, NSA MEMPHIS, MILLINGTON, TENNESSEE

The first phase of the RCRA Facility Investigation (RFI) at Naval Support Activity (NSA) Memphis consisted of use of Direct Push Technology (DPT) methods of subsurface exploration. Between November 14 and December 21, 1994, DPT methods were used to investigate the shallow hydrogeologic conditions at six Solid Waste Management Units (SWMUs) which comprise BRAC Assembly A. The SWMUs in this group have the highest priority for environmental investigations at NSA Memphis because they are located on or near property within the North Complex which is scheduled for transfer to the City of Millington.

DPT methods were used to obtain detailed lithologic information for the shallow geologic formations (loess, alluvium, and the uppermost part of the fluvial deposits) and to determine whether contaminants are present in these formations at NSA Memphis. Information from DPT was used to plan Rotosonic drilling and sampling investigations and the installation of monitoring wells for soil and groundwater quality data. The DPT work was conducted by SubSurface Technology, a subsidiary of Hydrologic, Inc., under contract to EnSafe/Allen & Hoshall (E/A&H). Hydrologic, Inc., provided a laboratory for onsite analysis of soil and water samples to facilitate planning of the DPT work while it was in progress. Technical oversight for the DPT work was shared jointly by the U.S. Geological Survey (USGS) and E/A&H. USGS personnel directed the field investigations and collected soil and groundwater samples for analysis.

DPT work conducted at selected locations at the six SWMUs essentially consisted of three main components. During the first component, a DPT rig was used to push a piezocone PC-1 tool into the ground while making measurements of point stress, sleeve friction, and pore pressure with sensors in the tool. The data for these soil and groundwater characteristics were recorded with an uphole computer. The PC-1 tool was pushed to refusal — the depth at which sediment densities prevented further downward advancement of the tool. At NSA Memphis, refusal was in a sandy silt or silty sand in the uppermost part of the fluvial deposits. At most locations, refusal ranged from 30 to 45 feet below land surface. The data collected with the PC-1 tool was

processed with the computer to produce tabular and graphic logs displaying lithology and groundwater related parameters associated with the horizons penetrated.

For the second component of the DPT work, the lithologic information from each location at a SWMU where PC-1 data were collected was evaluated in the field to select depth intervals for collection of soil and groundwater samples. A minimum of one soil sample and one groundwater sample were collected at each PC-1 location and at additional locations at a SWMU where PC-1 data were not collected. Additional soil samples were collected when attempts to collect groundwater samples were unsuccessful. Soil sampling was accomplished by pushing a SS-1 soil sampler, a modified split-spoon sampler, to the prescribed depth with the DPT rig, then opening the tool, pushing it approximately 24 inches further, and retrieving the sampler and contents.

Groundwater samples were collected using a GS-1 groundwater sampler. The GS-1 sampler is a gas-operated/electronically monitored tool which also is pushed to sampling intervals selected from the PC-1 log. Once the interval for groundwater sampling was reached, the opening, filling rate, and closure of the sampler all were accomplished by a system delivering argon, a chemically inactive gas, under variable pressure to the tool from the rig. The GS-1 sampler is designed to monitor the infilling rate of groundwater as it enters the sampler under natural hydrostatic pressure present in the sampling interval. Information on the time rate of filling of the sampler is selected and input to software on the computer to calculate an estimate of the horizontal hydraulic conductivity of material in the sample interval.

The third component of the DPT work consisted of field laboratory analysis of the soil and groundwater samples. A mobile laboratory was present onsite for performing Level II volatile organic compound (VOC) determinations using gas chromatography. A substantial benefit derived from onsite laboratory analysis was that the water-quality data could be evaluated in a relatively short time after the samples were collected. Rapid turnaround time for sample analysis facilitated adjustments in the number of samples or sampling depths while the field work was being conducted. Additionally, a subset of the samples were selected and prepared for Level III confirmatory analysis for VOCs at an contracted offsite laboratory (NET, Bedford, Massachusetts) to fulfill regulatory QA/QC requirements.

Background Information For Assembly A SWMUs

and Summary of DPT Analytical Results

Soil and groundwater samples collected at each SWMU were analyzed according to EPA Method 8021 (halogenated and aromatic volatile organic compounds) using a gas chromatograph with an electrolytic conductivity detector and a photoionization detector (GC/ELCD/PID). The ELCD, also known as a Hall detector, was selected to improve detection of halogenated VOCs (e.g., chlorinated solvents such as trichloroethene), while the PID was selected because of its ability to identify volatile petroleum constituents (e.g., the aromatic compounds benzene, toluene, ethylbenzene, and xylenes).

At least 25 percent of the samples collected were split and sent to the offsite laboratory for confirmatory VOC analysis using EPA Method 8240. This method requires the use of a gas chromatograph with mass spectrometer (GC/MS). GC/MS methods are generally more accurate for compound identification, but less accurate for determining the concentrations of the identified compounds, than GC methods utilizing an ELCD or PID.

Reasons for selecting VOC analysis as the field screening analytical method include:

- It is a good "indicator" method. Many wastes that require other methods for detection (e.g., metals or PCBs) are often components of petroleum products that contain volatile constituents. Thus, detection of VOCs indicates that a waste release has possibly occurred, and further investigation may be necessary.

- Though the required laboratory equipment is sophisticated, the amount of equipment needed and sample preparation are fairly minimal.

- Test results can be obtained within hours which facilitates quick decision making and sampling strategy development.

- Chlorinated solvents can be detected. These are primary contaminants of concern because they are often "sinkers" that can threaten groundwater supplies and many of them are carcinogens.

The sampling strategy was essentially the same for all SWMUs, but was often modified based on site-specific conditions. An attempt was made at each SWMU to collect the following samples:

- Shallow soil from the unsaturated zone in the loess (usually less than 13 feet bls).

- Shallow ground water from the loess (typically at 13 feet bls or a little deeper). If the formation was too tight to yield water, a soil sample was usually collected in place of a groundwater sample.

- Intermediate ground water from the loess (typically about 25 feet bls). If ground water could not be obtained, soil samples were usually collected.

- Deeper ground water from the top of the fluvial deposits (typically around 40 feet bls). The fluvial deposits are more permeable than the loess. Therefore, it generally yield more water than the loess and also may provide less resistance to lateral migration of contaminants. At most places, the top of the fluvial deposits also was the maximum depth of penetration for the DPT tools because of the silty sand or sandy silt composition.

General Summary of Analytical Results

At SWMU 5 (Aircraft Fire Fighting Training Facility), no solvents were detected. As expected, petroleum constituents were detected in shallow soil and ground water in areas of known contamination (from previous investigations). Shallow soil near the old fire extinguisher pits was highly contaminated.

More-detailed summaries of the analytical results, as well as historical information for SWMU 5 is, is given in the following sections.

SWMU 5 — Aircraft Fire Fighting Training Facility

Background

SWMU 5 (Figure 3) is the Aircraft Fire Fighting Training Facility (AFFTF) used to train Navy and Marine firemen in rescue techniques. Training at the AFFTF began in 1949 and continues to the present. The AFFTF consists of three 2-foot x 8-foot x 1-foot rectangular, concrete lined pits (inactive) and two circular concrete lined pits which are 75 feet in diameter (active).

The three rectangular pits are numbered, and prior to 1977, overflow discharges of JP-4 fuel occurred. This overflow drained into the adjacent storm drainage ditch (SWMU 4). The normal training procedure consisted of placing approximately 40 gallons of fuel into one of the rectangular pits and igniting the fuel. The fire then was extinguished by a student with a hand-held extinguisher and re-lit for the next student. The process continued until all of the students had participated. Any remaining fuel was left in the pit. Occasionally, the leftover fuel is reported to have overflowed into the drainage ditch. Since 1977, the fuel has been allowed to burn itself out following the last burn of the day, thus preventing overflow discharge.

The two circular pits have a double-lip curb to contain fuel during the burning operation. In 1977, an oil-water separator was installed, and the facility was connected to the sanitary sewer system. After the installation of the separator, several explosions occurred in the drain line between the firemat and the separator as a result of ignition of fumes from the unburned fuel. Cleaning of the separator and modification of operating procedures have eliminated the occurrence of explosions in the drain line. Prior to 1977, spent fuel and waste discharges from the training facility flowed directly to the drainage ditch (SWMU 4) on the north side of the site.

The AFFTF and the portion of SWMU 4 that flows through the site were investigated in 1992 during an underground storage tank assessment and an interim measure investigation conducted to facilitate a military construction project. These investigations documented shallow soil and groundwater contamination related to petroleum releases.

Summary

Soil and groundwater samples were collected at the 14 locations shown in Figure 3. The attached table provides the sample depths and types (i.e., soil or water). In general, soil samples were collected at 0-2 feet, 8-10 feet, and 25 feet; water samples were collected at 12-13 feet and 40+ feet. No solvents were detected. Petroleum constituents were detected in shallow soil and ground water in areas of known contamination. Soil in the 8-10 ft. interval at the old fire extinguisher pits was highly contaminated.

Petroleum constituents (benzene, xylene, and naphthalene) were detected in ground water at a depth of 44 feet at Location 7. This is unusual because these would normally be expected to "float" and be found in shallow, rather than deep, ground water. It is possible that the sampling tool was contaminated by passing through a water/fuel mixture standing in a hole previously opened for collection of a shallow soil sample. A similar circumstance was encountered at Location 9, which was resampled by pushing a separate hole immediately adjacent to the hole that yielded petroleum-constituent hits at 43 feet bls. Test results for the second groundwater sample were BDL. Locations 7 and 9 are both in the vicinity of the highly contaminated soil near the fire extinguisher pits.

Table 1
NAS Memphis RFI
DPT Survey Results
SWMU 5

Sample Location	Sample ID	Soil or Water	Depth (ft. bls)	Compound Detected/Concentration
1	5SG0102	S	2	NONE
1	5GH0110	W	10	NONE
1	5SG0110	S	10	NONE
1	5GH0113	W	13	NONE
1	5SG0127	S	27	NONE
1	5GH0145	W	45	NONE
2	5SG0202	S	2	NONE
2	5SG0210	S	10	NONE
2	5GH0213	W	13	NONE
2	5SG0232	S	32	NONE
2	5GH0243	W	43	NONE
3	5SG0302	S	2	NONE
3	5SG0310	S	10	NONE
3	5GH0313	W	13	NONE
3	5SG0327	S	27	NONE
3	5GH0344	W	44	NONE
4	5SG0403	S	3	NONE
4	5SG0410	S	10	NONE
4	5GH0414	W	14	NONE
4	5SG0426	S	26	NONE
4	5GH0446	W	46	NONE
5	5SG0502	S	2	Naphthalene 0.026 mg/kg
5	5SG0510	S	10	NONE
5	5GH0513	W	13	NONE

Table 1
NAS Memphis RFI
DPT Survey Results
SWMU 5

Sample Location	Sample ID	Soil or Water	Depth (ft. bls)	Compound Detected/Concentration
5	5SG0528	S	28	NONE
5	5GH0550	W	50	NONE
6	5SG0602	S	2	NONE
6	5SG0610	S	10	NONE
6	5GH0613	W	13	NONE
6	5SG0626	S	26	Naphthalene 0.019 mg/kg
6	5GH0647	W	47	NONE
7	5SG0702	S	2	n-Butylbenzene 30.0 mg/kg sec-Butylbenzene 70.0 mg/kg tert-Butylbenzene 30.0 mg/kg Ethylbenzene 13.0 mg/kg p-Isopropyltoluene 16.0 mg/kg Naphthalene 55.0 mg/kg n-Propylbenzene 86.0 mg/kg Toluene 5.8 mg/kg 1,2,4-Trimethylbenzene 30.0 mg/kg 1,3,5-Trimethylbenzene 27.0 mg/kg Xylene 60.0 mg/kg
7	5SG0710	S	10	n-Butylbenzene 0.016 mg/kg sec-Butylbenzene 0.027 mg/kg tert-Butylbenzene 0.012 mg/kg Ethylbenzene 0.011 mg/kg Naphthalene 0.046 mg/kg n-Propylbenzene 0.056 mg/kg 1,2,4-Trimethylbenzene 0.052 mg/kg 1,3,5-Trimethylbenzene 0.018 mg/kg Xylene (Total) 0.019 mg/kg
7	5GH0713	W	13	Naphthalene 34.2 μg/l Xylene 19.5 μg/l

Table 1
NAS Memphis RFI
DPT Survey Results
SWMU 5

Sample Location	Sample ID	Soil or Water	Depth (ft. bls)	Compound Detected/Concentration
7	5SG0728	S	28	NONE
7	5GH0744	W	44	Benzene 5.7 μg/l Naphthalene 51.0 μg/l Xylene 16.0 μg/l
8	5SG0803	S	3	Benzene 0.024 mg/kg Ethylbenzene 0.022 mg/kg Naphthalene 0.040 mg/kg n-Propylbenzene 0.018 mg/kg 1,2,4-Trimethylbenzene 0.038 mg/kg 1,3,5-Trimethylbenzene 0.018 mg/kg Xylene (Total) 0.037 mg/kg
8	5SG0810	S	10	NONE
8	5GH0813	W	13	NONE
8	5SG0826	S	26	NONE
8	5GH0854	W	54	NONE
9	5SG0902	S	2	NONE
9	5SG0910	S	10	sec-Butylbenzene 12.6 mg/kg Naphthalene 21.0 mg/kg 1,2,4-Trimethylbenzene 16.4 mg/kg
9	5SG0928	S	28	NONE
9	5GH0943	W	43	NONE
10	5SG1003	S	3	NONE
10	5SG1010	S	10	NONE
10	5SG1015	S	15	NONE
10	5SG1026	S	26	NONE
10	5GH1040	W	40	NONE

Table 1
NAS Memphis RFI
DPT Survey Results
SWMU 5

Sample Location	Sample ID	Soil or Water	Depth (ft. bls)	Compound Detected/Concentration
10	5GH1047	W	47	NONE
11	5SG1102	S	2	NONE
11	5SG1110	S	10	NONE
11	5GH1113	W	13	NONE
11	5SG1126	S	26	NONE
11	5GH1149	W	49	NONE
12	5SG1203	S	3	NONE
12	5SG1210	S	10	NONE
12	5SG1215	S	15	NONE
12	5SG1226	S	26	NONE
12	5GH1240	W	40	NONE
13	5SG1304	S	4	NONE
13	5SG1310	S	10	NONE
13	5GH1313	W	13	NONE
13	5GH1326	W	26	NONE
14	5SG1402	S	2	NONE
14	5SG1410	S	10	NONE
14	5GH1413	W	13	NONE
14	5SG1426	S	26	NONE
14	5GH1443	W	43	NONE

Appendix D

Geophysical Log

000309

Century GEOPHYSICAL CORP.

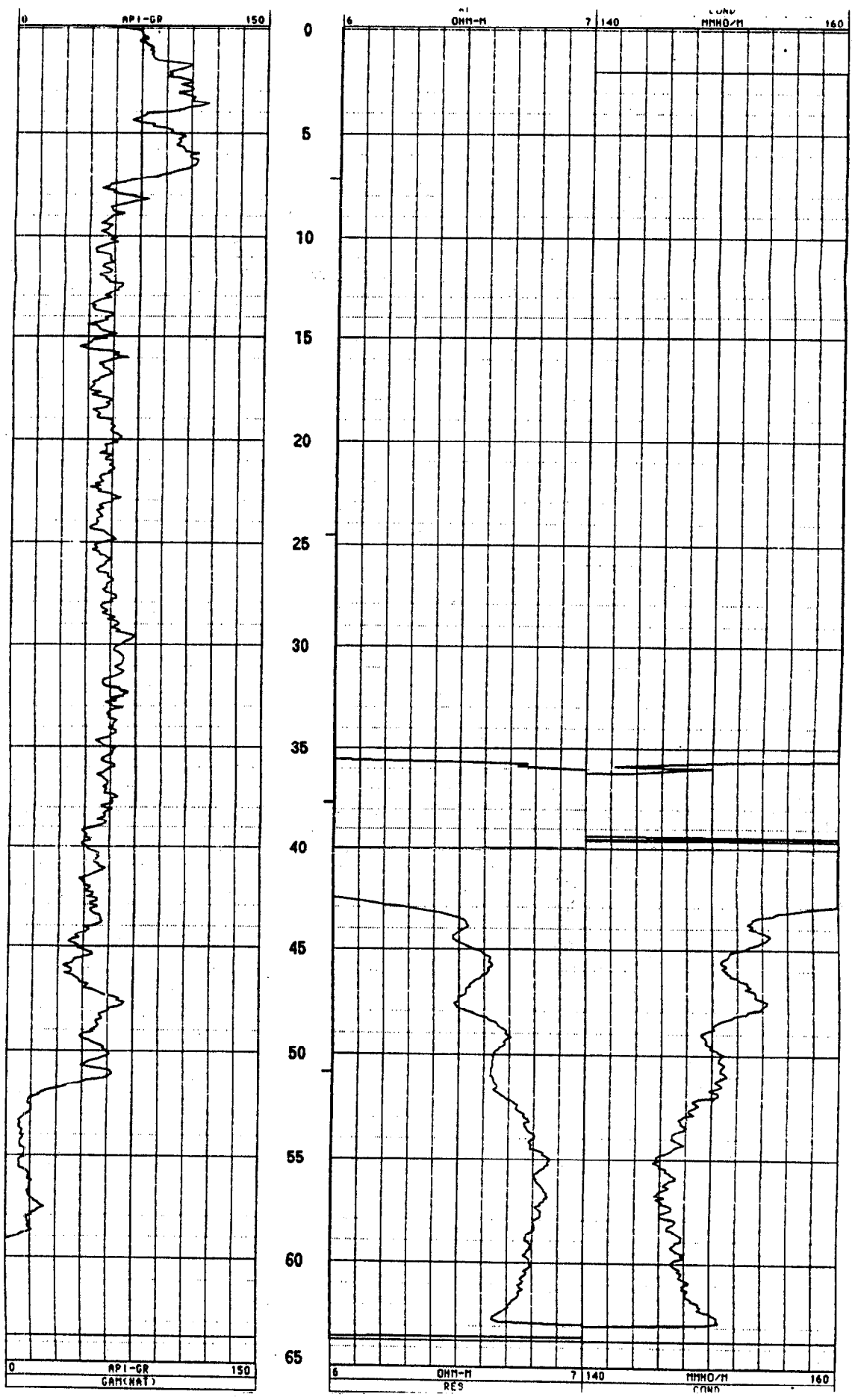
05MW05-LF

COMPANY	: ENSAFE			OTHER SERVICES:	
WELL	: 05MW05-LF			-	
LOCATION/FIELD	: NAS MEMPHIS			-	
COUNTY	: SHELBY			-	
STATE	: TN				
SECTION	: -	TOWNSHIP	: -	RANGE	: -
DATE	: 04/25/95	PERMANENT DATUM	: -	ELEVATIONS	
DEPTH DRILLER	: 68.1	ELEV PERM. DATUM	: -	KB	: -
LOG BOTTOM	: 63.70	LOG MEASURED FROM	: G.L.	DF	: -
LOG TOP	: -2.30	DRL MEASURED FROM	: G.L.	GL	: -
CASING DRILLER	: 68.1	LOGGING UNIT	: 9401		
CASING TYPE	: PVC	FIELD OFFICE	: LAS VEGAS		
CASING THICKNESS	: -	RECORDED BY	: D.STEWART		
BIT SIZE	: -	BOREHOLE FLUID	: H20	FILE	: ORIGINAL
MAGNETIC DECL.	: -	RM	: -	TYPE	: 9510A
MATRIX DENSITY	: -	RM TEMPERATURE	: -	LOG	: 5
FLUID DENSITY	: -	MATRIX DELTA T	: -	PLOT	: ALAMOS 8
NEUTRON MATRIX	: SANDSTONE	FLUID DELTA T	: 1	THRESH	: 500000

REMARKS :

LOGGER TD 66.8 FT, DEPTH OF OUTER STEEL CASING 44 FT.

ALL SERVICES PROVIDED SUBJECT TO STANDARD TERMS AND CONDITIONS



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Appendix E

Boring Logs

EnSafe/Allen & Hoshall

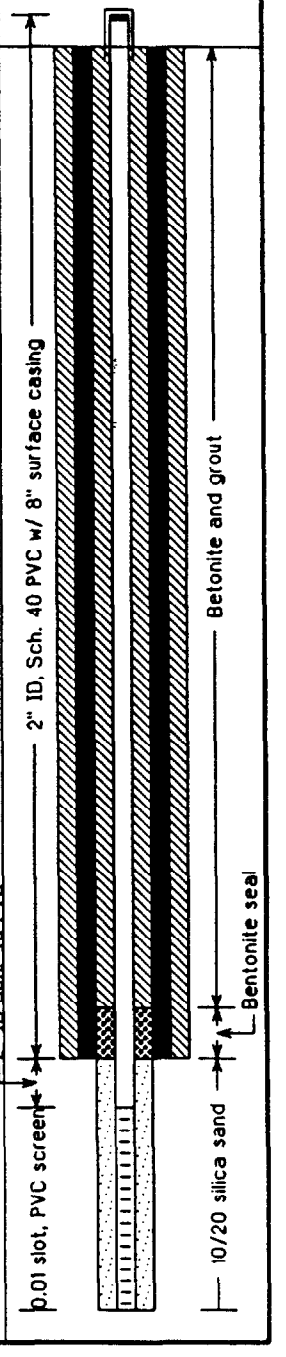
Log of Monitoring Well 05MW01UF

Project: *NAS Memphis*	Location: *Millington, TN SWMU#5 - F.F.T.A.*
Project No.: *0094*	Surface Elevation: *268.64 feet msl*
Started at *0850 on 1/28/95*	TOC Elevation: *271.03 feet msl*
Completed at *0945 on 1/29/95*	Depth to Groundwater: *14.52 feet* Measured: *3/31/95*
Drilling Method: *Rotasonic*	Groundwater Elevation: *256.51 feet msl*
Drilling Company: *North Star Drilling*	Total Depth: *52 feet*
Geologist: *David Ladd*	Well Screen: *42 to 52 feet*

DEPTH IN FEET	SAMPLE NO.	% RECOVERY	PID (ppm)	SOIL CLASS	GEOLOGIC DESCRIPTION
					0' to 12' Clayey silt, moderate to dark yellowish-brown. Stiff, moist. Slightly wet around 11'.
5	1	70	BG		
10	2	107	BG		
					12' to 25' Clayey fine silt. Medium gray to medium dark gray. Sample getting darker about 16.5'. By 18' color has become medium dark gray to brownish gray. Moist. Sample becomes firm at about 21'.
15	3	110	BG		
20				ML	
					25' to 40' Fine silt, clayey, grayish-orange very firm starting at 36'. 36' to 40' contains light gray silt seams. 25' to 31.5' transitional zone (gray silt mottled with yellowish- gray clayey silt).
25					
30					
35					
40	4	89	BG		Sand, yellowish gray to pinkish gray, wet. Some gravels, increasing around 45'. Clay, fine with gravel, light gray (46'-47'), turning dark yellowish orange to moderate yellowish brown, abundant.
45				SP	
50				GP	

ELEV. (ft-msl): 228.6; 221.6

WELL DIAGRAM



000312

EnSafe/Allen & Hoshall

Log of Monitoring Well 05MW01UF

Project: *NAS Memphis*	Location: *Millington, TN SWMU#5 - F.F.T.A.*
Project No.: *0094*	Surface Elevation: *268.64 feet msl*
Started at *0850 on 1/28/95*	TOC Elevation: *271.03 feet msl*
Completed at *0945 on 1/29/95*	Depth to Groundwater: *14.52 feet* Measured: *3/31/95*
Drilling Method: *Rotasonic*	Groundwater Elevation: *256.51 feet msl*
Drilling Company: *North Star Drilling*	Total Depth: *52 feet*
Geologist: *David Ladd*	Well Screen: *42 to 52 feet*

DEPTH IN FEET	LITHOLOGIC SAMPLE	ANALYTICAL SAMPLE	SAMPLE NO.	% RECOVERY	PID (ppm)	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	ELEV. (ft-msl)	WELL DIAGRAM
							GP		216.6	
								End of soil boring at 52'. BG = Background (1.0 ppm) Set well through 8" casing and 6" boring to 52'.		
55										
60										
65										
70										
75										
80										
85										
90										
95										
100										

000313

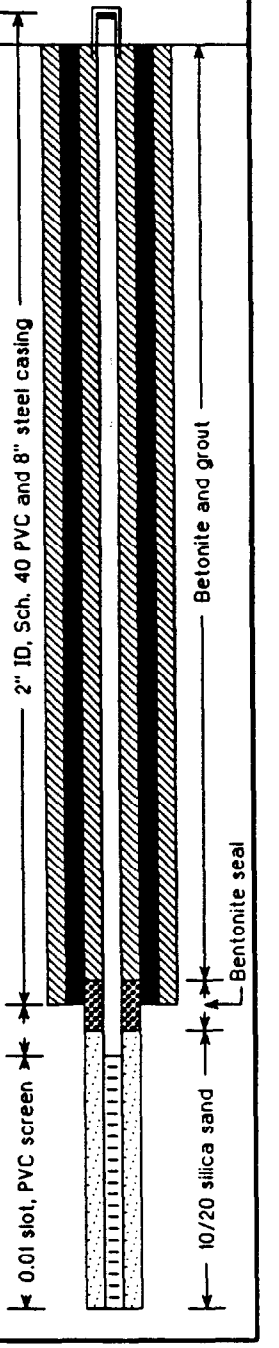
EnSafe/Allen & Hoshall

Log of Monitoring Well 05MW02UF

Project: *NAS Memphis*	Location: *Millington, TN. SWMU#5 - F.F.T.A.*
Project No.: *0094*	Surface Elevation: *267.74 feet msl*
Started at *1030 on 1/28/95*	TOC Elevation: *270.06 feet msl*
Completed at *1505 on 2/11/95*	Depth to Groundwater: *14.11 feet* Measured: *3/31/95*
Drilling Method: *Rotasonic*	Groundwater Elevation: *255.95 feet msl*
Drilling Company: *North Star Drilling*	Total Depth: *50 feet*
Geologist: *David Ladd/Jack Carmichael*	Well Screen: *40 to 50 feet*

DEPTH IN FEET	LITHOLOGIC SAMPLE	ANALYTICAL SAMPLE	SAMPLE NO.	% RECOVERY	PID (ppm)	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	ELEV. (ft-msl)
5			1	70	BG		ML	Clayey silt, moderate yellowish brown to grayish-orange, firm. (0'-10')	
10			2	100	BG		ML	(10'-30') Silt, clayey, most turns medium gray to medium dark gray. Sample loses brown at 13'. Gets increasingly darker (dark gray to brownish gray).	
15			3	110	BG		ML		
20							ML		
25							ML		
30							ML	(30'-38) Clayey silt; grayish-orange to moderate yellowish-brown. Stiff. Still contains some gray silt. Silt mottled with yellowish- gray silt (30'-35').	
35			4	94	BG		ML		
40							SP	Boring stopped at 1150 on 1/28/95. Boring completed and drilling resumed at 1430 on 2/11/95. No recovery from 38'-40'. 40'to 45' Same as above.	229.7
45			5	71	BG		SP	45' to 47.5' Sand, fine, occasional gravel to 1", silty, dense, yellowish-gray stained yellowish-orange. Wet.	220.2
50			6	110	BG		GP	47.5' to 50' Gravel, sandy, some silt; grayish-orange to dark yellowish-orange, wet.	217.7

WELL DIAGRAM



000314

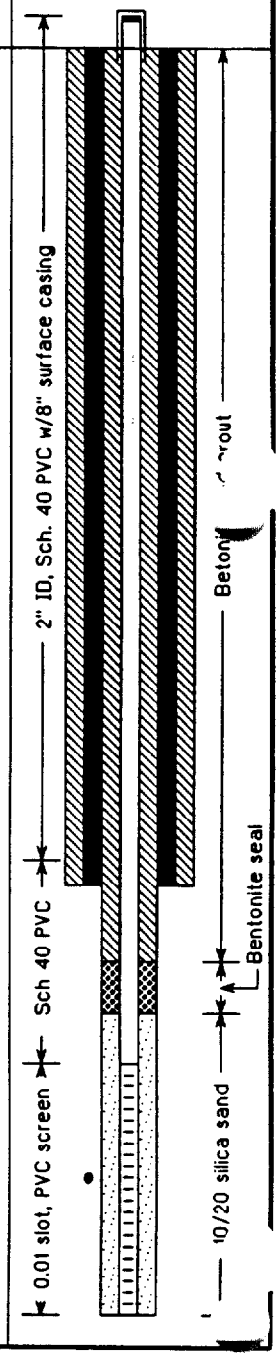
EnSafe/Allen & Hoshall

Log of Monitoring Well 05MW03UF

Project: *NAS Memphis*	Location: *Millington, TN. SWMU#5 - F.F.T.A.*
Project No.: *0094*	Surface Elevation: *265.45 feet msl*
Started at *1410 on 1/28/95*	TOC Elevation: *267.46 feet msl*
Completed at *0850 on 2/12/95*	Depth to Groundwater: *11.08 feet* Measured: *3/31/95*
Drilling Method: *Rotasonic*	Groundwater Elevation: *256.38 feet msl*
Drilling Company: *North Star Drilling*	Total Depth: *50 feet*
Geologist: *David Ladd/Jack Carmichael*	Well Screen: *40 to 50 feet*

DEPTH IN FEET	LITHOLOGIC SAMPLE	ANALYTICAL SAMPLE	SAMPLE NO.	% RECOVERY	PID (ppm)	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	ELEV. (ft-msl)
5			1	70	BG		ML	Silt, clayey, moderate yellowish-brown, 0' to 3.5'. 3.5' to 12'Clay, silty, dark gray to brownish gray. Very hard, stiff material, getting softer near bottom of sample and lighter in color. Lost most of the sample from 8'-12'.	
10			2	43	BG				
15			3	130	BG			12' to 19.5' silt, clayey, dark to moderate yellowish-brown. Picks up some dark gray silt clay about 16.5' to 18. 18' to 19.5' silty, dark to moderate yellowish-brown mixed with dark yellowish-brown silt, dry.	
20								19.5' to 26' silt, clayey, medium gray.	
25								26' to 36.5' Gray silt mottled with silt, dark yellowish-orange becoming much more orange at 34' to 36.5' and more clay rich.	
30									
35			4	91	BG		SP		229.4
40								(36.5'-50') Sand, fine to coarse, with gravel and some silt. Very gravelly zone from about 43'-45', about 1 foot clayey zone with gravel (trace) from about 45'-46'; Color ranges from very pale orange to mderate reddish brown; wet.	
45									
50			5	88	BG				215.4

WELL DIAGRAM



000315

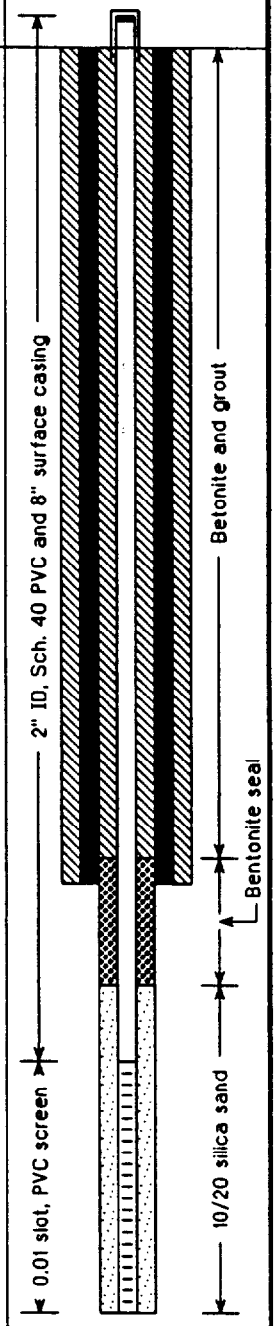
EnSafe/Allen & Hoshall

Log of Monitoring Well 05MW04UF

Project: *NAS Memphis*	Location: *Millington, TN. SWMU#5 - F.F.T.A.*
Project No.: *0094*	Surface Elevation: *268.72 feet msl*
Started at *1605 on 1/28/95*	TOC Elevation: *269.03 feet msl*
Completed at *1100 on 2/11/95*	Depth to Groundwater: *12.10 feet* Measured: *3/31/95*
Drilling Method: *Rotasonic*	Groundwater Elevation: *256.93 feet msl*
Drilling Company: *North Star Drilling*	Total Depth: *50 feet*
Geologist: *David Ladd/Jack Carmichael*	Well Screen: *40 to 50 feet*

DEPTH IN FEET	LITHOLOGIC SAMPLE	ANALYTICAL SAMPLE	SAMPLE NO.	% RECOVERY	PID (ppm)	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	ELEV. (ft-msl)
								0' to 3' Hand dug to 3'.	
								3' to 6' Silt, clayey, dark gray, firm, moist.	
5			1	100	100			(6'-12') Color change at 6', grayish-orange to moderate yellowish- brown.	
10			2	100	BG			Saturated 10' to 12'.	
15							ML	12' to 22' Gray clayey silt mottled with brown at 20', and becomes more clay rich and wet at 22'.	
20			3	105	BG			(22' to 27.5') Color turns medium gray.	
25									
30								27.5' to 35' Transitional. 27.5' to 31' gray clayey silt mottled with dark yellowish-orange silt. 31' to 35' Reworked material. Dark yellowish-orange silt, iron- stained. Becoming sandy near 35', very wet.	
35			4	?	BG				231.7
40							SW	35' to 45' Sand, fine to coarse silty with gravel; yellowish-gray to dark yellowish-orange; some 3" to 6" layers of sandy clay, light gray to yellowish-gray; wet.	
							CL		223.2
45			5	85	BG		SW	45' to 50' Sand, fine to coarse with some gravel, trace silt; pale yellowish- to dark yellowish-orange, wet.	221.7
50			6	110	BG				218.7

WELL DIAGRAM



000316

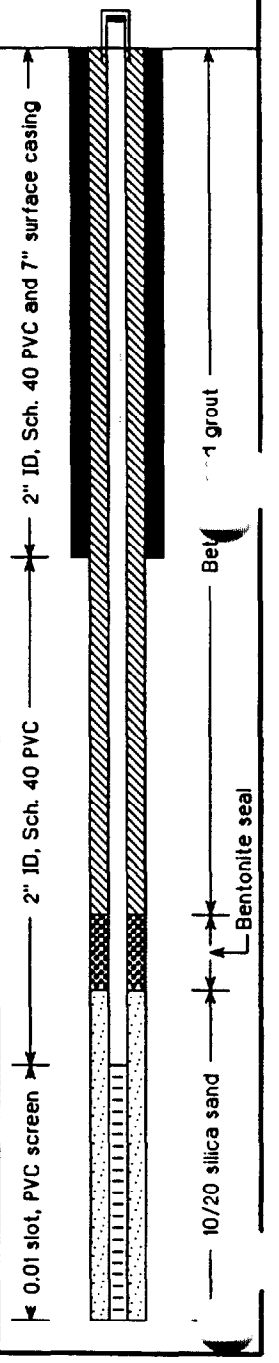
EnSafe/Allen & Hoshall

Log of Monitoring Well 05MW04AUF

Project: *NAS Memphis*	Location: *Millington, TN. SWMU#5 - F.F.T.A.*
Project No.: *0094*	Surface Elevation: *266.93 feet msl*
Started at *0840 on 2/26/95*	TOC Elevation: *269.13 feet msl*
Completed at *Unknown on 2/26/95*	Depth to Groundwater: *13.81 feet* Measured: *3/31/95*
Drilling Method: *Rotasonic*	Groundwater Elevation: *256.85 feet msl*
Drilling Company: *North Star Drilling*	Total Depth: *50 feet*
Geologist: *Ben Brantley*	Well Screen: *40 to 50 feet*

DEPTH IN FEET	LITHOLOGIC SAMPLE	ANALYTICAL SAMPLE	PID (ppm)	SAMPLE NO.		GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	ELEV. (ft-msl)
5			1	100	5.8			0' to 3.5' Brownish black stiff silty clay. 3.5' to 8' Greenish gray silt clay. Fuel odor.	
10								8' to 13.5' Yellowish-brown to light olive gray with organics. Clayey silt. Medium stiff to soft; moist.	
15			7	93	BKG		ML	13.5' to 15' Dusky yellow with light olive gray and light gray clayey silt. 15' to 21' Light olive gray with iron (orange streaks) clayey silt. Medium stiff to soft. Moist.	
20								21' to 25' Light olive gray silt with dusky yellow streaks. Dry and friable.	
25			11	120	BKG			25' to 33' Light olive gray to pale yellowish-brown clayey silt. Yellowish orange silt nodules at 25' to 25.5'. Medium stiff to stiff.	
30									
35			12	80	BKG		SP	(33'-34') Fine sandy silt. (Same Color). Medium stiff to soft. Moist. 34' to 35' Yellowish-orange fine to medium silty clayey sand. 35' to 39.5' Yellowish-orange to light brown medium sand.	233.9
40							CL	39.5' to 40' Very light gray sandy stiff clay.	227.9 / 226.9
							SW	40' to 45' Yellowish-orange coarse to very coarse gravelly sand. Chert gravel up to 1".	
45							CL	45' to 45.5' Yellowish-gray sandy clay. Medium stiff to soft.	221.9 / 221.4
							SW	45'.5 to 50' Grayish-orange and yellowish-gray and yellowish- orange medium sand.	
50			13	93	BKG				216.9

WELL DIAGRAM



000317

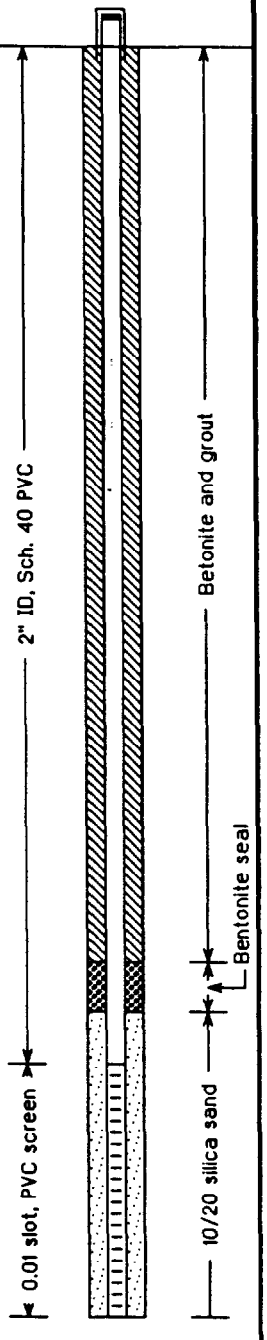
EnSafe/Allen & Hoshall

Log of Monitoring Well 05MW04BUF

Project: *NAS Memphis*	Location: *Millington, TN. SWMU#5 - F.F.T.A.*
Project No.: *0094*	Surface Elevation: *268.74 feet msl*
Started at *1515 on 2/26/95*	TOC Elevation: *268.78 feet msl*
Completed at *Unknown on 2/26/95*	Depth to Groundwater: *11.80 feet* Measured: *3/31/95*
Drilling Method: *Rotasonic*	Groundwater Elevation: *256.96 feet msl*
Drilling Company: *North Star Drilling*	Total Depth: *50 feet*
Geologist: *Ben Brantley*	Well Screen: *40 to 50 feet*

DEPTH IN FEET	LITHOLOGIC SAMPLE	ANALYTICAL SAMPLE	PID (ppm)	SAMPLE NO.		GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	ELEV. (ft-msl)
								0' to 6.5' Browninsh-black stiff silty clay with organics.	
5	X		1	100	NR				
								6.5' to 9' Greenish-gray moist silty clay.	
10	X		2	100	NR			9' to 15' Yellowish-brown to dusky yellow and light olive gray clayey silt; with organics. Faint traces of greenish-gray extending to 13.5'.	
15	X		3	80	NR		ML	Silt, medium dark gray, clayey silt from 15' to 17'.	
								Light olive gray with iron-staining and organics 17' to 25'. Clayey silt.	
20								Light olive gray silt with dusky yellow streaks to 25'.	
25			4	80	NR			Light olive gray to pale yellowish-brown clayey silt 25' to 31'.	
30								Pale yellowish-brown sandy silt 31' to 33'.	235.7
								Yellowish-orange to grayish-orange fine to medium sand 33' to 40'.	
35							SP		
40							CL	6" clay lenses at 40' and 45'. Yellowish-orange to grayish-orange coarse to very coarse gravelly sand.	228.7 / 228.2
							SW		
45			5	80	NR		CL	Clay at 45' (6" thick); maroon mixed with gray.	221.7 / 221.2
							SW	Grayish-orange to yellowish-orange medium sand.	
50			6	80	NR				218.7

WELL DIAGRAM



000318

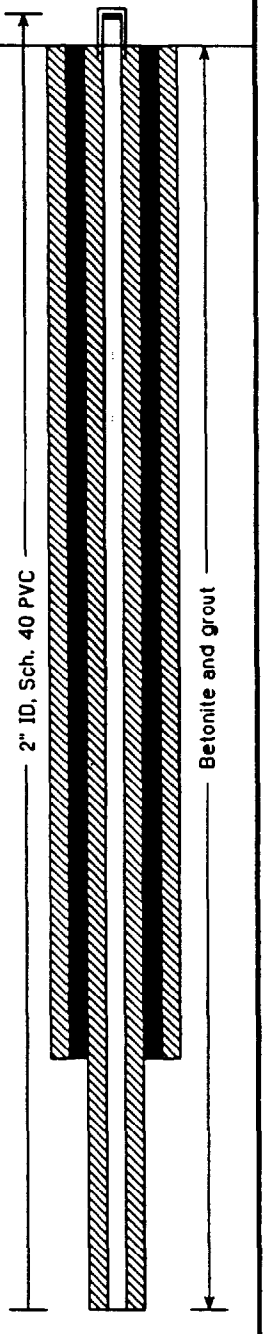
EnSafe/Allen & Hoshall

Log of Monitoring Well 05MW05LF

Project: *NAS Memphis*	Location: *Millington, TN. SWMU#5 - F.F.T.A.*
Project No.: *0094*	Surface Elevation: *268.69 feet msl*
Started at *0855 on 1/29/95*	TOC Elevation: *271.21 feet msl*
Completed at *1000 on 1/29/95*	Depth to Groundwater: *14.73 feet* Measured: *3/31/95*
Drilling Method: *Rotasonic*	Groundwater Elevation: *256.48 feet msl*
Drilling Company: *North Star Drilling*	Total Depth: *65.5 feet*
Geologist: *David Ladd*	Well Screen: *55.5 to 65.5 feet*

DEPTH IN FEET	LITHOLOGIC SAMPLE	ANALYTICAL SAMPLE	SAMPLE NO.	% RECOVERY	PID (ppm)	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	ELEV. (ft-msl)
								The first 40 feet of 5MW-5LF was logged from 05-SB-01 (05-MW-01UF).	
5			1	70	BG			0' to 12' Clayey silt, moderate to dark yellowish-brown. Stiff, moist. Slightly wet around 11'.	
10			2	107	BG				
15								12' to 25' Clayey fine silt. Medium gray to medium dark gray. Sample getting darker about 16.5'. By 18' color has become medium dark gray to brownish gray. Moist. Sample becomes firm at about 21'.	
20			3	110	BG		ML		
25								25' to 40' Fine silt, clayey, grayish-orange very firm starting at 36'. 36' to 40' contains light gray silt seams. 25' to 31.5' (gray silt mottled with yellowish- gray clayey silt).	
30									
35									
40			4	89	BG				228.7
								40' to 65' Sand, yellowish gray to pinkinsh gray, wet. Some gravel, increasing at 45'.	
45			5	42	BG		SW		
								(46' to 47') Clay, fine, with gravel, light gray.	
								(47' to 52') Turning dark yellowish-orange to moderate yellowish-brown with abundant gravel.	
50									

WELL DIAGRAM



000319

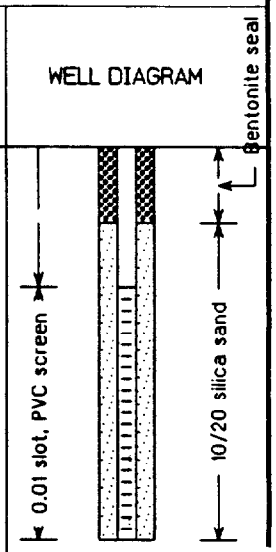
EnSafe/Allen & Hoshall

Log of Monitoring Well 05MW05LF

Project: *NAS Memphis*	Location: *Millington, TN. SWMU#5 - F.F.T.A.*
Project No.: *0094*	Surface Elevation: *268.69 feet msl*
Started at *0855 on 1/29/95*	TOC Elevation: *271.21 feet msl*
Completed at *1000 on 1/29/95*	Depth to Groundwater: *14.73 feet* Measured: *3/31/95*
Drilling Method: *Rotasonic*	Groundwater Elevation: *256.48 feet msl*
Drilling Company: *North Star Drilling*	Total Depth: *65.5 feet*
Geologist: *David Ladd*	Well Screen: *55.5 to 65.5 feet*

DEPTH IN FEET	LITHOLOGIC SAMPLE	ANALYTICAL SAMPLE	SAMPLE NO.	% RECOVERY	PID (ppm)	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	ELEV. (ft-msl)
55	X		6	90	BG		SW	(52' to 53') Sand, dark yellowish-orange, amount of gravel diminishes. (53' to 56') Coarse sand, grayish-orange, little gravel. (56' to 61.5') Coarse sand, dark yellowish-orange, wet, abundant gravel.	
60	X							(61.5 to 63.5') Sand becoming lighter color.	
65	X		7	100	BG			(63.5' to 64.75') Coarse sand, yellowish-gray, no gravel. (64.75' to 65') Sand, moderate brown, iron-stained, large gravel.	203.7
70								Top of Cockfield Formation Total depth of boring at 66'. First forty feet of log from MW-01-UF. Analytical samples collected from paired well MW-01-UF.	
75									
80									
85									
90									
95									
100									

WELL DIAGRAM



000320

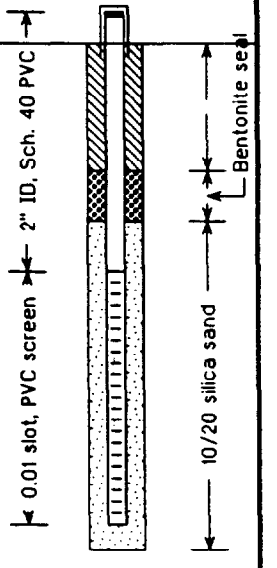
EnSafe/Allen & Hoshall

Log of Monitoring Well 05MW03S

Project: *NAS Memphis*	Location: *Millington, TN. SWMU#5 - F.F.T.A.*
Project No.: *0094*	Surface Elevation: *265.45 feet msl*
Started at *Unknown on 2/12/95*	TOC Elevation: *267.90 feet msl*
Completed at *Unknown on 2/12/95*	Depth to Groundwater: *6.88 feet* Measured: *3/31/95*
Drilling Method: *Rotasonic*	Groundwater Elevation: *261.02 feet msl*
Drilling Company: *North Star Drilling*	Total Depth: *19 feet*
Geologist: *David Ladd/Jack Carmichael*	Well Screen: *9 to 19 feet*

DEPTH IN FEET	LITHOLOGIC SAMPLE	ANALYTICAL SAMPLE	SAMPLE NO.	% RECOVERY	PID (ppm)	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	ELEV. (ft-msl)
5			1	70	BG			**Boring information taken from 05-SB-03.** Silt, clayey, moderate yellowish-brown 0' to 3.5'. 3.5' to 12' Clay, silty, dark gray to brownish gray. Very hard, stiff material, getting softer near bottom of sample and lighter in color. Lost most of sample from 8'-12'.	
10			2	43	BG		ML		
15			3	130	BG			12' to 19.5' silt, clayey, dark to moderate yellowish-brown. Some dark gray silty clay about 16.5' to 18. 18' to 19.5' silt, dark to moderate yellowish-brown mixed with dark yellowish-brown silt, dry.	
20								19.5' to 28' silt, clayey, medium gray.	245.4
25								End of boring at 20. Boring information taken from 05-SB-03.	
30									
35									
40									
45									
50									

WELL DIAGRAM



EnSafe/Allen & Hoshall

Log of Monitoring Well 05MW06S

Project: *NAS Memphis*	Location: *Millington, TN. SWMU#5 - F.F.T.A.*
Project No.: *0094*	Surface Elevation: *264.53 feet msl*
Started at *0830 on 1/29/95*	TOC Elevation: *266.75 feet msl*
Completed at *Unknown on 1/29/95*	Depth to Groundwater: *6.73 feet* Measured: *3/31/95*
Drilling Method: *Rotasonic*	Groundwater Elevation: *260.02 feet msl*
Drilling Company: *North Star Drilling*	Total Depth: *18 feet*
Geologist: *Ben Brantley*	Well Screen: *8 to 18 feet*

DEPTH IN FEET	LITHOLOGIC SAMPLE	ANALYTICAL SAMPLE	SAMPLE NO.	% RECOVERY	PID (ppm)	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	ELEV. (ft-msl)
								Dark yellowish-brown silt with organics (root zone 0' to 0.5').	
								0.5' to 4' Yellowish-brown clayey silt, medium stiff, moist to wet.	
5			1	100	BG			4' to 5' Olive black to brownish-black silty clay. Very hard and dry. Grading into olive gray to 6'.	
10							ML	6' to 8' Light olive gray stiff silty clay; hard.	
								8' to 15' Dusky yellow to yellowish-gray soft clayey silt (moist to wet).	
15			2	69	BG			15' to 20' Grayish-green medium stiff silt (moist); slightly clayey.	
20			3	80	BG			19' to 20' Darker gray in color.	244.5
								Total depth of boring is 20'.	
								BG = Background	
25									
30									
35									
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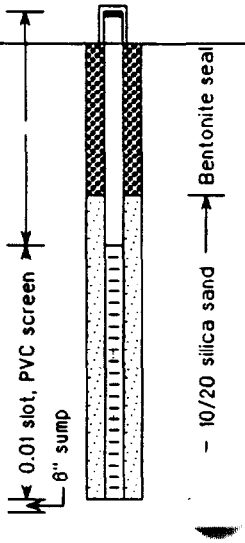
45									
50									

WELL DIAGRAM



000322

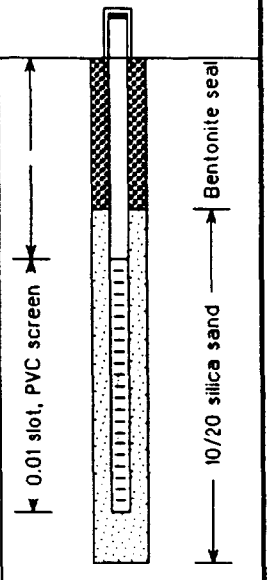
EnSafe/Allen & Hoshall

Log of Monitoring Well 05MW07S

Project: *NAS Memphis*	Location: *Millington, TN*
Project No.: *0094*	Surface Elevation: *264.48 feet msl*
Started at *1050 on 1/29/95*	TOC Elevation: *268.87 feet msl*
Completed at *Unknown on 1/29/95*	Depth to Groundwater: *6.38 feet* Measured: *3/31/95*
Drilling Method: *Rotasonic*	Groundwater Elevation: *260.49 feet msl*
Drilling Company: *North Star Drilling*	Total Depth: *18 feet*
Geologist: *Ben Brantley*	Well Screen: *8 to 18 feet*

DEPTH IN FEET	LITHOLOGIC SAMPLE	ANALYTICAL SAMPLE	SAMPLE NO.	% RECOVERY	PID (ppm)	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	ELEV. (ft-msl)
								0' to 4.5' Moderate to pale brown clayey silt, moist, medium stiff to soft with organics.	
5			1	58				4.5' to 7' Dusky yellowish-brown silty clay. Very stiff and dry.	
								7' to 10.5' Light to dark olive gray silty clay with iron staining and organics. Very stiff and hard.	
10			2	100			ML	10.5' to 13.5' Light olive gray to brown silt. Very moist to wet. Soft.	
								13.5' to 15' Grayish-green medium stiff silt. Moist to wet.	
15			3	98				15' to 20' Grayish green medium stiff silt. Moist to wet. Small snail shells present.	
20			4	100				End of boring.	244.5
25									
30									
35									
40									
45									
50									

WELL DIAGRAM



000323

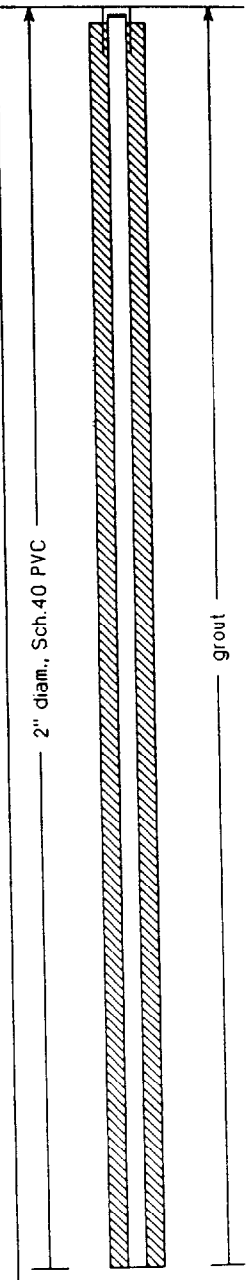
Environmental & Safety Designs, Inc.

Log of Monitoring Well 005G08LF

Project: *NAS Memphis Millington, TN*	Location: *SMWU 5*
Project No.: *0094*	Surface Elevation: *feet msl*
Started at *1015 on 8-5-98*	TOC Elevation: *feet msl*
Completed at *1530 on 8-5-98*	Depth to Groundwater: Measured:
Drilling Method: *Rotasonic; 4" core barrel through 6" casing*	Groundwater Elevation:
Drilling Company: *Alliance*	Total Depth: *75 feet*
Geologist: *Ben Brantley*	Well Screen: *55 to 65 feet*

DEPTH IN FEET	LITHOLOGIC SAMPLE	ANALYTICAL SAMPLE	SAMPLE NO.	% RECOVERY	PID (ppm)	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	ELEV. (ft-msl)
								Surface soil: Roots and organic debris.	
								(0-3') Moderate yellowish brown silt mixed with light olive gray silt, dry and medium stiff.	
								NO RECOVERY from 3-11.5'	
5			s-1	60	0.2				
10									
								(11.5-13.5') Grayish green silt, wet and medium stiff; petroleum odor.	
								(13.5-18.5') Moderate yellowish brown with light olive gray silt, moist to wet, and medium stiff; manganese inclusions present.	
15			s-2	35	78.0		ML		
								(18.5-25') Olive gray clayey silt, stiff and moist.	
20									
								(23.5-26.5') Olive gray clayey silt mixed with light olive brown, stiff and moist.	
25			s-3	80	BG				
								(26.5-30') Moderate yellowish brown streaked with dark yellowish brown and light olive gray silt.	
30									
								(30.5-35') Light gray to light olive gray sandy clay, stiff to medium stiff, moist to wet.	
35			s-4	90	0.6		CL	(35-38') Light olive gray clay (very stiff and hard) with dark yellowish orange sandy clay.	
							SM	(38-42.5') Dark yellowish orange and grayish orange fine micaceous sand.	
40									

WELL DIAGRAM



EnSafe (SM)

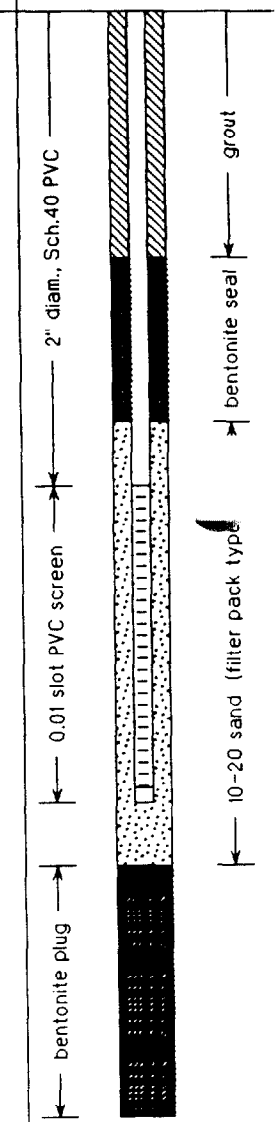
Environmental & Safety Designs, Inc.

Log of Monitoring Well 005G08LF

Project: *NAS Memphis Millington, TN*	Location: *SMMU 5*
Project No.: *0094*	Surface Elevation: *feet msl*
Started at *1015 on 8-5-98*	TOC Elevation: *feet msl*
Completed at *1530 on 8-5-98*	Depth to Groundwater: Measured:
Drilling Method: *Rotasonic; 4" core barrel through 6" casing*	Groundwater Elevation:
Drilling Company: *Alliance*	Total Depth: *75 feet*
Geologist: *Ben Brantley*	Well Screen: *55 to 65 feet*

DEPTH IN FEET	LITHOLOGIC SAMPLE	ANALYTICAL SAMPLE	SAMPLE NO.	% RECOVERY	PID (ppm)	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	ELEV. (ft-msl)
							SM	(40.5-51') 6" thick section of gravels present.	
45			s-5	100	0.2		SW	Grayish orange coarse sand with scattered gravels up to 1" long dimension. Same as above at 42.5'.	
50							SP	(47-51') Dark yellowish orange and grayish orange fine sand.	
55			s-6	85	0.8		SW	(51-55') Same lithologic colors; fine to medium gravelly sand; gravels up to .75" long dimension. (55-65') Grayish orange, medium to coarse gravelly sand; gravels up to 1" long dimension.	
65			s-7	90	0.4		GM	(65-65.5') Dark yellowish orange silty sandy gravel, wet.	
70							CL	Dusky yellowish brown clay, stiff to hard.	
75			s-8	100	0.4			Light olive gray fine sand lenses within clay matrix from 74.5-75'.	
80								**Boring completed at 75'bgs**	

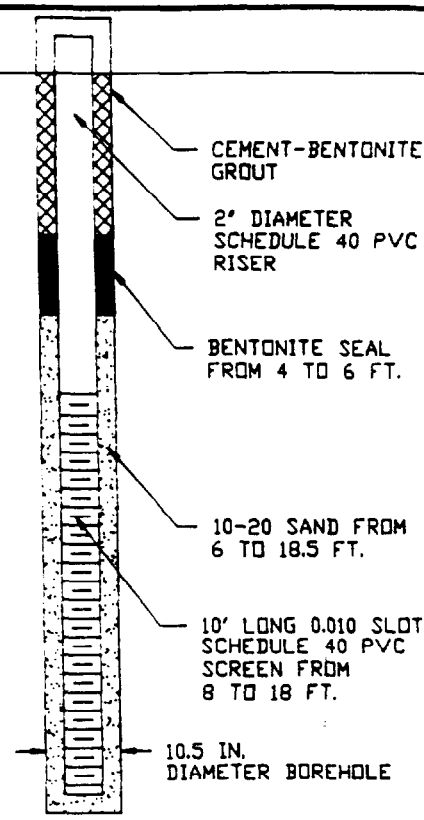
WELL DIAGRAM



000325

DEPTH (FEET)	SAMPLE INTERVAL	SAMPLE NUMBER	PID (PPM) (INITIAL/15 MIN.)	LABORATORY ANALYSIS	DESCRIPTION OF SUBSURFACE MATERIALS
		MW01 0	1/2		0-0.5 LIGHT BROWN SAND AND SILT WITH ORGANICS AND ROOTS.
		MW01 2	1/2		0.5-2 DARK BROWN SILT AND CLAY WITH LAYERED TEXTURE. TIGHT,DRY.
		MW01 4	1/2		2-4 MOTTLED BROWN,LIGHT-BROWN,ORANGE-BROWN SILT AND CLAY WITH DARK ORGANIC SPECKS. TIGHT,DRY.
5		MW01 6	1/2		4-12 MOTTLED CLAY,SOME SILT BECOMING LIGHT GRAY/BROWN. TIGHT,MOIST.
		MW01 8	1/3	GRO, BTX	
10		MW01 10	1/3		● WATER AT 10-12 FT.
		MW01 12	1/3		12-18 HOMOGENOUS GRAY SILT. FIRM TO SOFT,WET
		MW01 14	1/5		
15		MW01 16	1/3		
					18-18.5 NO SAMPLE END OF BORING AT 18.5 FT.
20					
25					
30					

WELL CONSTRUCTION DETAILS



DRILLER: PROFESSIONAL SERVICE INDUSTRIES, INC.
4161 RIDGEMOOR AVENUE
MEMPHIS, TN. 38118

DRILLING AND SAMPLING METHOD:
6.25-INCH ID HOLLOW STEM AUGERS
2 FT. LONG, 2 IN. OD SPLIT BARREL SAMPLER

DATE OF COMPLETION: 06/22/92

ENVIRONMENTAL ASSESSMENT
UNDERGROUND STORAGE TANKS
AIRCRAFT FIRFIGHTING TRAINING FACILITY
NAS MEMPHIS, TN.

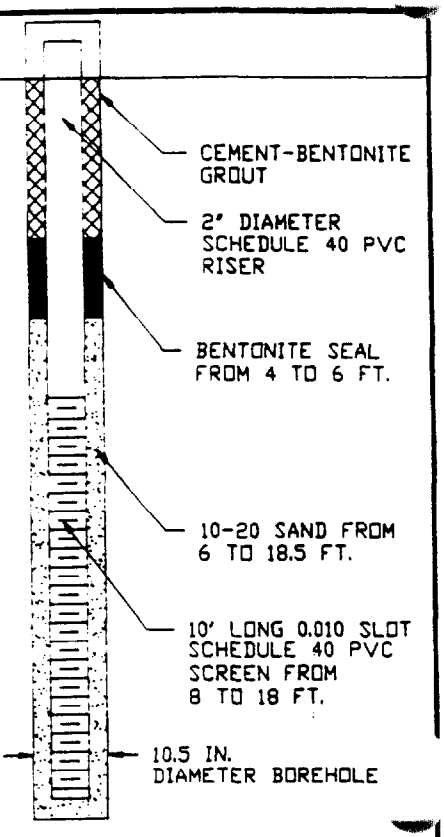
BORING B-01
MW-01

DATE: 08/08/92 | DWG NAME: 026MW-01

DEPTH (FEET)	SAMPLE INTERVAL	SAMPLE NUMBER	PID (PPM) (INITIAL/15 MIN.)	LABORATORY ANALYSIS	DESCRIPTION OF SUBSURFACE MATERIALS
		MW02 0	1/11		0-0.5 LIGHT BROWN SAND AND SILT WITH ORGANICS AND ROOTS.
		MW02 2	28/25		0.5-2 MOTTLED BROWN, ORANGE-BROWN SILT AND CLAY. TIGHT,DRY.
		MW02 4	100/200		2-5 MOTTLED BROWN, ORANGE-BROWN, GREEN-GRAY SILT AND CLAY WITH FEW BLACK ORGANIC SPECKS. TIGHT,MOIST,WITH HYDROCARBON ODOR.
5		MW02 6	100/NH*	K, GRO, BTX RFI-SCAN	
		MW02 8	100/NH*		
10		MW02 10	200/NH*	K, GRO, BTX	5-11.5 DARK GRAY HYDROCARBON-STAINED. SILT AND CLAY. TIGHT,SOFT,WET TO MOIST. STRONG HYDROCARBON ODOR.
					● WATER AT 11.5 FT.
		MW02 12	200/200		11.5-12 BROWN SAND,SOME GRAVEL AND SILT. WET,LOOSE,NO APPARENT ODOR.
		MW02 14	10/14		12-12.5 GRAY, BROWN, ORANGE-BROWN SILT AND CLAY TIGHT,MOIST TO WET.
15		MW02 16	20/11		12.5-18 HOMOGENOUS GRAY SILT. FIRM, WET. -WITH A GRAVEL ISOLATE AT 15 FT.
					18-18.5 NO SAMPLE END OF BORING AT 18.5 FT.
20					
25					
30					

* NH-NO 15 MINUTE HEADSPACE ANALYSIS.

WELL CONSTRUCTION DETAILS



DRILLER:

DRILLING AND SAMPLING METHOD:
6.25-INCH ID HOLLOW-STEM AUGERS.
2 FT. LONG, 2 IN. OD SPLIT BARREL SAMPLER.
SHELBY TUBE FOR PERMEABILITY SAMPLES.

DATE OF COMPLETION: 06/22/92 MONITORING WELL
06/27/92 SHELBY TUBE

ENVIRONMENTAL ASSESSMENT
UNDERGROUND STORAGE TANKS
AIRCRAFT FIRFIGHTING TRAINING FACILITY
NAS MEMPHIS, TN.

BORING B-02
MW-02

DATE: 08/08/92 | DWG NAME: 026MW-02

000327

DEPTH (FEET)	SAMPLE INTERVAL	SAMPLE NUMBER	PID (PPM) (INITIAL/15 MIN.)	LABORATORY ANALYSIS	DESCRIPTION OF SUBSURFACE MATERIALS
		B03 0	5/5		0-17 BROWN SAND,SILT AND ORGANICS,SOME GRAVEL 17-4 BROWN TO DARK BROWN SILT,LITTLE CLAY. TIGHT,DRY.
		B03 2	10/4		
		B03 4	5/4		4-6 MOTTLED LIGHT-BROWN,GRAY,ORANGE-BROWN SILT AND CLAY,WITH SOME BLACK ORGANIC SPECKS. LOOSE,WET.
5					
		B03 6	2/5		6-6.5 ORANGE-BROWN SILT AND GRAVEL. LOOSE,WET. 6.5-8 MOTTLED LIGHT-BROWN,GRAY,ORANGE-BROWN SILT AND CLAY,WITH SOME BLACK ORGANIC SPECKS.
		B03 8	2/4	GRO, BTX	8-12 GRADING TO MOTTLED GRAY,ORANGE-BROWN SILT WITH SOME BLACK ORGANIC SPECKS.
10		B03 10	2/4		● WATER AT 10 FT.
					END OF BORING AT 12 FT.
15					
20					
25					
30					

DRILLER: PROFESSIONAL SERVICE INDUSTRIES, INC.
4161 RIDGEMOOR AVENUE
MEMPHIS, TN. 38118

DRILLING AND SAMPLING METHOD:
3.25-INCH ID HOLLOW-STEM AUGERS.
2 FT. LONG, 2 IN. OD SPLIT BARREL SAMPLER.

DATE OF COMPLETION: 06/22/92

ENVIRONMENTAL ASSESSMENT
UNDERGROUND STORAGE TANKS
AIRCRAFT FIRFIGHTING TRAINING FACILITY
NAS MEMPHIS, TN.

BORING B-03

DATE: 07/28/92

DWG NAME: 026B-03

DESCRIPTION OF SUBSURFACE MATERIALS

DEPTH (FEET)	SAMPLE INTERVAL	SAMPLE NUMBER	PID (PPM) (INITIAL/15 MIN.)	LABORATORY ANALYSIS	
					GRAVEL ROAD BEDDING.
		B04 2	0/1		2-4 BROWN SILT,WITH MINOR BLACK ORGANIC SPECKS. TIGHT,DRY.
		B04 4	0/1		4-6 BROWN SILT AND CLAY,WITH MINOR BLACK ORGANIC SPECKS. TIGHT,DRY.
5		B04 6	0/4		6-7 LIGHT GRAY SILT AND CLAY,MOTTLED WITH ORANGE -BROWN PATCHES. TIGHT,DRY.
		B04 8	6/40	GRO, BTX	7-10 DARK GRAY CLAY, MOTTLED WITH ORANGE-BROWN PATCHES. TIGHT,DRY TO MOIST. -WITH HYDROCARBON ODOR AT 8-10 FT.
10		B04 10	5/5	GRO, BTX	10-11 DARK GRAY SILT AND CLAY,MOTTLED WITH ORANGE -BROWN PATCHES. TIGHT,MOIST,WITH HYDROCARON ODOR.
		B04 12	2/4	GRO, BTX	11-16 LIGHT GRAY SILT AND CLAY, MOTTLED WITH ORANGE-BROWN PATCHES. TIGHT,MOIST TO WET NO APPARENT ODOR.
		B04 14	2/3		● WATER AT 14 FT.
15		B04 16	1/2		16-19.5 MOTTLED GRAY,BROWN,ORANGE-BROWN SILT,SOME CLAY. TIGHT,WET.
		B04 18	3/2		19.5-20 GRAY UNIFORM SILT. FIRM,WET.
20					END OF BORING AT 20 FT.
25					
30					

DRILLER: PROFESSIONAL SERVICE INDUSTRIES, INC.
4161 RIDGEMOOR AVENUE
MEMPHIS, TN. 38118

DRILLING AND SAMPLING METHOD:
3.25-INCH ID HOLLOW-STEM AUGERS.
2 FT. LONG, 2 IN. OD SPLIT BARREL SAMPLER.

DATE OF COMPLETION: 06/22/92

ENVIRONMENTAL ASSESSMENT
UNDERGROUND STORAGE TANKS
AIRCRAFT FIRFIGHTING TRAINING FACILITY
NAS MEMPHIS, TN.

BORING B-04

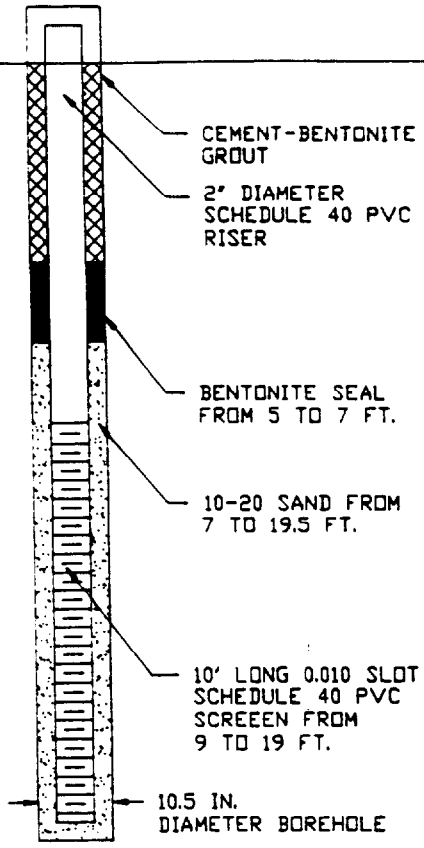
DATE: 07/28/92

DWG NAME: 026B-04

000329

DEPTH (FEET)	SAMPLE INTERVAL	SAMPLE NUMBER	PID (PPM) (INITIAL/15 MIN.)	LABORATORY ANALYSIS	DESCRIPTION OF SUBSURFACE MATERIALS
		MW03 0	3/2		0-1 BROWN SAND,SILT AND ORGANICS,SOME GRAVEL. LOOSE,DRY.
		MW03 2	2/2		1-4 BROWN, ORANGE-BROWN SILT,SOME GRAVEL AND CLAY,BECOMING (AT 4 FT.) MOTTLED BROWN, ORANGE-BROWN SILT,LITTLE CLAY.
		MW03 4	1/2		4-7 GRAY-BROWN SILT,LITTLE CLAY,BECOMING (AT 4.5 FT.) GRAY SILT AND CLAY WITH ORANGE-BROWN MOTTLING AND BLACK ORGANIC SPECKS.
5		MW03 6	1/2		7-10 GRADING TO DARK-GRAY CLAY, LITTLE SILT, WITH ORANGE-BROWN MOTTLES AND BLACK ORGANIC SPECKS. VERY TIGHT,MOIST.
		MW03 8	1/2		
10		MW03 10	1/2	GRO, BTX	10-12 LIGHT GRAY SILT AND CLAY WITH ORANGE-BROWN MOTTLES AND BLACK ORGANIC SPECKS. TIGHT,MOIST TO WET.
		MW03 12	1/2		● WATER AT 12 FT. 12-17 MOTTLED GRAY,BROWN,ORANGE-BROWN SILT AND CLAY,WITH BLACK ORGANIC SPECKS. SOFT,WET.
		MW03 14	1/3		
15		MW03 16	1/4		17- 19 BECOMING MOTTLED LIGHT-GRAY, ORANGE-BROWN SILT,WITH SCATTERED BLACK ORGANIC SPECKS.
					19-19.5 NO SAMPLE END OF BORING AT 19.5 FT.
20					
25					
30					

WELL CONSTRUCTION DETAILS



DRILLER: PROFESSIONAL SERVICE INDUSTRIES, INC.
4161 RIDGEMOOR AVENUE
MEMPHIS, TN. 38118

DRILLING AND SAMPLING METHOD:
6.25-INCH ID HOLLOW-STEM AUGERS.
2 FT. LONG, 2 IN. OD SPLIT BARREL SAMPLER.

DATE OF COMPLETION: 06/23/92

ENVIRONMENTAL ASSESSMENT
UNDERGROUND STORAGE TANKS
AIRCRAFT FIRFIGHTING TRAINING FACILITY
NAS MEMPHIS, TN.

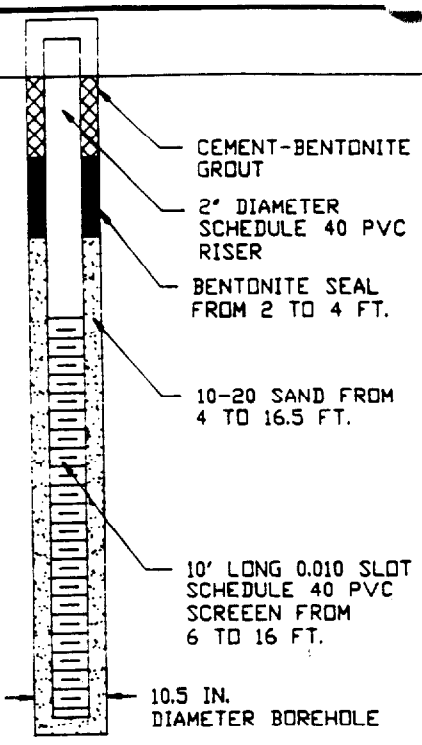
BORING B-05
MW-03

DATE: 08/08/92 | DWG NAME: 026MW-03

000330

DEPTH (FEET)	SAMPLE INTERVAL	SAMPLE NUMBER	PID (PPM) (INITIAL/15 MIN.)	LABORATORY ANALYSIS	DESCRIPTION OF SUBSURFACE MATERIALS
		MW04 0	3/3		0-2 BROWN SAND, SILT AND ORGANICS; BECOMING (AT 1 FT.) BROWN, ORANGE SAND AND SILT,SOME GRAVEL. LOOSE TO TIGHT,DRY TO MOIST.
		MW04 2	2/4		2-4 LAYERED BROWN, LIGHT-BROWN SILT, SOME CLAY, WITH MINOR ORANGE-BROWN MOTTLES AND BLACK ORGANIC SPECKS; BECOMING (AT 3 FT.) LIGHT-BROWN,ORANGE-BROWN SILT AND CLAY. TIGHT, MOIST.
		MW04 4	2/4		
5		MW04 6	2/3		4-6 BECOMING LIGHT-BROWN TO GRAY CLAY, WITH ORANGE-BROWN MOTTLED ZONES AND BLACK TO BROWN-DARK RED ORGANIC SPECKS.
		MW04 8	1/3	GRO, BTX	6-10 BECOMING LIGHT BROWN TO GRAY SILT AND CLAY, WITH ORANGE-BROWN MOTTLING AND DARK BROWN TO DARK RED ORGANIC NODULES.
10		MW04 10	1/2		● WATER AT 10 FT.
		MW04 12	1/3		10-15.5 BECOMING GRAY SILT,SOME CLAY,WITH ORANGE-BROWN MOTTLING AND DARK BROWN TO DARK RED ORGANIC NODULES. TIGHT,WET.
		MW04 14	1/3		
15					15.5-16.5 BECOMING MOTTLED GRAY AND ORANGE-BROWN SILT AND CLAY. TIGHT,WET.
					16-16.5 NO SAMPLE END OF BORING AT 16.5 FT.
20					
25					
30					

WELL CONSTRUCTION DETAILS



DRILLER: PROFESSIONAL SERVICE INDUSTRIES, INC.
4161 RIDGEMOOR AVENUE
MEMPHIS, TN. 38118

DRILLING AND SAMPLING METHOD:
6.25-INCH ID HOLLOW-STEM AUGERS.
2 FT. LONG, 2 IN. OD SPLIT BARREL SAMPLER.

DATE OF COMPLETION: 06/23/92

ENVIRONMENTAL ASSESSMENT
UNDERGROUND STORAGE TANKS
AIRCRAFT FIRFIGHTING TRAINING FACILITY
NAS MEMPHIS, TN.

BORING B-06
MW-04

DATE: 08/08/92

DWG NAME: 026MW-04

000331

DEPTH (FEET)	SAMPLE INTERVAL	SAMPLE NUMBER	PID (PPM) (INITIAL/15 MIN.)	LABORATORY ANALYSIS	DESCRIPTION OF SUBSURFACE MATERIALS
		B07 0	1000/700		0-0.5 BROWN AND GRAY-BLACK SILT AND ASH,LITTLE SAND. LOOSE,DRY,HYDROCARBON ODOR.
		B07 2	1000/1000	RFI-SCAN, GRO, BTX	0.5-3.5 BROWN TO GRAY-BROWN SILT,SOME CLAY,ORGANICS AND ROOTS;BECOMING (AT 2 FT.) MOTTLED GRAY-BROWN,ORANGE-BROWN SILT,SOME CLAY WITH BLACK TO DARK-RED ORGANIC SPECKS AND SOME ROOTS. TIGHT,DRY,HYDROCARBON ODOR.
		B07 4	900/900		
5					3.5-11 DARK GRAY-BROWN TO GRAY-GREEN-BROWN, HYDROCARBON STAINED SILT AND CLAY,WITH GRAY MOTTLED PATCHES. TIGHT,MOIST TO WET, HYDROCARBON ODOR.
		B07 6	700/900		
		B07 8	300/NH*	GRO, BTX	
		B07 10	5/10		● WATER AT 10 FT.
10					11-16 GRAY,DARK-GRAY SILT. FIRM,WET.
		B07 12	3/7		
		B07 14	2/5		
15					END OF BORING AT 16 FT.
		B07 16			
		B07 18			
20					
25					
30					* NH-NO 15 MINUTE HEADSPACE ANALYSIS.

DRILLER: PROFESSIONAL SERVICE INDUSTRIES, INC.
4161 RIDGEMOOR AVENUE
MEMPHIS, TN. 38118

DRILLING AND SAMPLING METHOD:
3.25-INCH ID HOLLOW-STEM AUGERS.
2 FT. LONG, 2 IN. OD SPLIT BARREL SAMPLER.

DATE OF COMPLETION: 06/23/92

ENVIRONMENTAL ASSESSMENT
UNDERGROUND STORAGE TANKS
AIRCRAFT FIRFIGHTING TRAINING FACILITY
NAS MEMPHIS, TN.

BORING B-07

DATE: 07/28/92

DWG NAME: 026B-07

DESCRIPTION OF SUBSURFACE MATERIALS

DEPTH (FEET)	SAMPLE INTERVAL	SAMPLE NUMBER	PID (PPM) (INITIAL/15 MIN.)	LABORATORY ANALYSIS	DESCRIPTION
		B08 0	20/30		0-0.5 COMPACTED SAND AND GRAVEL OVERLYING 1/2" THICK LAYER OF ASH.
					0.5-2 BROWN SILT AND CLAY. COMPACT,DRY TO MOIST.
		B08 2	4/25		2-5 MOTTLED BROWN,ORANGE-BROWN SILT,SOME CLAY, WITH DARK-BROWN,DARK-RED ORGANIC NODULES.
		B08 4	1000/1000	RFI-SCAN, GRO, BTX	
5					5-11 DARK GREEN-GRAY,HYDROCARBON STAINED SILT AND CLAY, WITH FAINT LIGHT-GRAY AND ORANGE-BROWN MOTTLING. TIGHT,MOIST,CHEMICAL ODOR.
		B08 6	200/200		
		B08 8	600/800		
10		B08 10	600/NH*	GRO, BTX, VOC	● WATER AT 11 FT.
					11-12 GRAY,DARK-GRAY SILT. WET.
					END OF BORING AT 12 FT.
15					
20					
25					
30					* NH-NO 15 MINUTE HEADSPACE ANALYSIS.

DRILLER: PROFESSIONAL SERVICE INDUSTRIES, INC.
4161 RIDGEMOOR AVENUE
MEMPHIS, TN. 38118

DRILLING AND SAMPLING METHOD:
3.25-INCH ID HOLLOW-STEM AUGERS.
2 FT. LONG, 2 IN. OD SPLIT BARREL SAMPLER.

DATE OF COMPLETION: 06/23/92

ENVIRONMENTAL ASSESSMENT
UNDERGROUND STORAGE TANKS
AIRCRAFT FIRFIGHTING TRAINING FACILITY
NAS MEMPHIS, TN.

BORING B-08

DATE: 07/28/92 | DWG NAME: 026B-08

DEPTH (FEET)	SAMPLE INTERVAL	SAMPLE NUMBER	PID (PPM) (INITIAL/15 MIN.)	LABORATORY ANALYSIS	DESCRIPTION OF SUBSURFACE MATERIALS
		B09 0	40/30		0-1 BROWN SILT AND ORGANICS,SOME GRAVEL,LITTLE SAND;BECOMING (AT 1 FT.) MOTTLED BROWN, ORANGE-BROWN SILT,SOME ORGANICS.
		B09 2	20/55		2-4 DARK GRAY CLAY WITH SUBDUED ORANGE-BROWN, LIGHT-GRAY MOTTLING. TIGHT,MOIST.
		B09 4	600/1100	RFI-SCAN, GRO, BTX	4-7 DARK GRAY CLAY,SOME SILT. TIGHT,MOIST, CHEMICAL ODOR.
5					
		B09 6	500/600		7-12 BECOMING MOTTLED LIGHT-GRAY AND ORANGE-BROWN SILT,SOME CLAY,WITH SCATTERED BLACK ORGANIC SPECKS. TIGHT,MOIST TO WET.
		B09 8	20/20		
10		B09 10	6/2	GRO, BTX	
					● WATER AT 11 FT.
					END OF BORING AT 12 FT.
15					
20					
25					
30					

DRILLER: PROFESSIONAL SERVICE INDUSTRIES, INC.
4161 RIDGEMOOR AVENUE
MEMPHIS, TN. 38118

DRILLING AND SAMPLING METHOD:
3.25-INCH ID HOLLOW-STEM AUGERS.
2 FT. LONG, 2 IN. OD SPLIT BARREL SAMPLER.

DATE OF COMPLETION: 06/24/92

ENVIRONMENTAL ASSESSMENT
UNDERGROUND STORAGE TANKS
AIRCRAFT FIRFIGHTING TRAINING FACILITY
NAS MEMPHIS, TN.

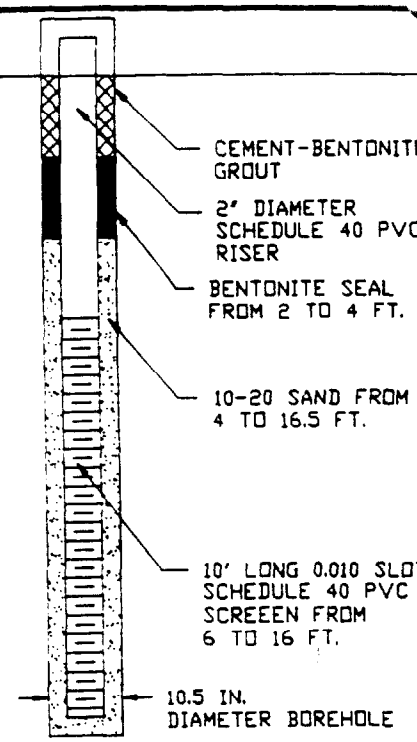
BORING B-09

DATE: 07/28/92

DWG NAME: 026B-09

DEPTH (FEET)	SAMPLE INTERVAL	SAMPLE NUMBER	PID (PPM) (INITIAL/15 MIN.)	LABORATORY ANALYSIS	DESCRIPTION OF SUBSURFACE MATERIALS
		MW05 0	1/4		0-2 DARK BROWN SILT AND ORGANICS. 2-6 DARK BROWN CLAY,WITH INTERSPERSED ORANGE-BROWN NODULES. VERY TIGHT TO MOIST.
		MW05 2	2/2		
		MW05 4	1/3		
5		MW05 6	1/2		6-13 BECOMING MOTTLED BROWN-GRAY,ORANGE-BROWN SILT AND CLAY. TIGHT,MOIST TO WET.
		MW05 8	1/2	RFI-SCAN, BTX GRO, BTX	
10		MW05 10	1/NH*		● WATER AT 10 FT.
		MW05 12	0/2		13-14.5 BECOMING DARK BROWN CLAY,LITTLE SILT, BECOMING DARK BROWN TO BLACK CLAY WITH ROOTS AND ORGANICS. VERY TIGHT.
		MW05 14	1/1		14.5-16.5 NO SAMPLE END OF BORING AT 16.5 FT.
15					
20					
25					
30					* NH-NO 15 MINUTE HEADSPACE ANALYSIS.

WELL CONSTRUCTION DETAILS



DRILLER: PROFESSIONAL SERVICE INDUSTRIES, INC.
4161 RIDGEMOOR AVENUE
MEMPHIS, TN. 38118

DRILLING AND SAMPLING METHOD:
6.25-INCH ID HOLLOW-STEM AUGERS.
2 FT. LONG, 2 IN. OD SPLIT BARREL SAMPLER.

DATE OF COMPLETION: 06/24/92

ENVIRONMENTAL ASSESSMENT
UNDERGROUND STORAGE TANKS
AIRCRAFT FIRFIGHTING TRAINING FACILITY
NAS MEMPHIS, TN.

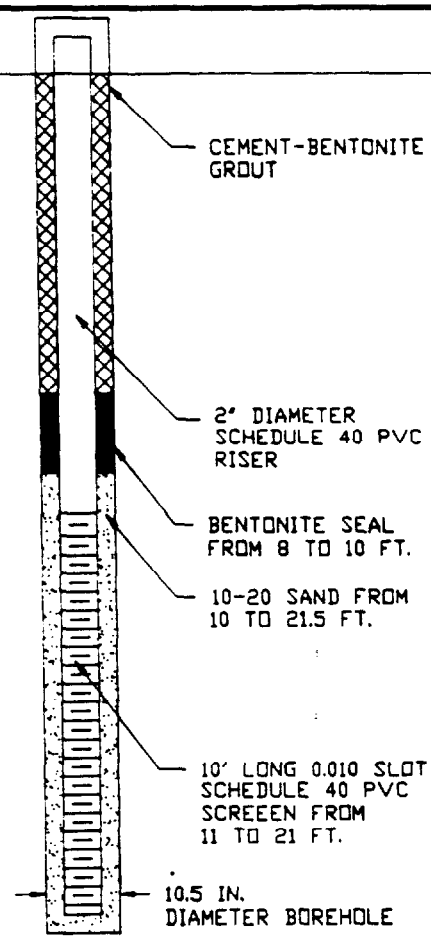
BORING B-10
MW-05

DATE: 08/08/92

DWG NAME: 026MW-05

DEPTH (FEET)	SAMPLE INTERVAL	SAMPLE NUMBER	PID (PPM) (INITIAL/15 MIN.)	LABORATORY ANALYSIS	DESCRIPTION OF SUBSURFACE MATERIALS
		MW06 0	1/3		0-2 BROWN SILT AND SAND, SOME GRAVEL AND ORGANICS. LOOSE, DRY.
		MW06 2	1/5		2-3.5 BROWN-GRAY SILT AND CLAY, SOME ORGANICS AND ROOTS. TIGHT, MOIST.
		MW06 4	200/400		3.5-7.5 BECOMING DARK GRAY, BLACK CLAY. PLIABLE TO HARD, MOIST TO WET TO MOIST. HYDROCARBON ODOR.
5		MW06 6	1500 NH*	RFI-SCAN, GRO, BTX	7.5-10.5 BECOMING DULL GREEN-GRAY, HYDROCARBON STAINED SILT AND CLAY WITH ORANGE-BROWN MOTTLING AND MINOR DARK BROWN-RED NODULES.
		MW06 8	400/500		10.5-11 DARK BROWN-GRAY CLAY, LITTLE SILT. PLIABLE, MOIST.
10		MW06 10	3/7	GRO, BTX	11-20 MOTTLED LIGHT-BROWN-GRAY AND ORANGE-BROWN SILT, SOME CLAY, WITH BLACK ORGANIC PATCHES. WET.
		MW06 12	3/1		● WATER AT 12 FT.
		MW06 14	1/1		
15		MW06 16	0/2		
		MW06 18	1/1		
20					20-21.5 NO SAMPLE. END OF BORING AT 21.5 FT.
25					
30					* NH-NO 15 MINUTE HEADSPACE ANALYSIS.

WELL CONSTRUCTION DETAILS



DRILLER: PROFESSIONAL SERVICE INDUSTRIES, INC.
4161 RIDGEMOOR AVENUE
MEMPHIS, TN. 38118

DRILLING AND SAMPLING METHOD:
6.25-INCH ID HOLLOW-STEM AUGERS.
2 FT. LONG, 2 IN. OD SPLIT BARREL SAMPLER.

DATE OF COMPLETION: 06/24/92

ENVIRONMENTAL ASSESSMENT
UNDERGROUND STORAGE TANKS
AIRCRAFT FIRFIGHTING TRAINING FACILITY
NAS MEMPHIS, TN.

BORING B-11
MW-06

DATE: 07/29/92 | DWG NAME: 026MW-06

DESCRIPTION OF SUBSURFACE MATERIALS

DEPTH (FEET)	SAMPLE INTERVAL	SAMPLE NUMBER	PID (PPM) (INITIAL/15 MIN.)	LABORATORY ANALYSIS	DESCRIPTION
		B12 0	50/NH*		0-1 TAN-BROWN SAND AND GRAVEL. LOOSE,DRY.
		B12 2	200/NH*		1-2 DARK GREEN-GRAY SILT AND ASH,WITH A PIECE OF BLACK RUBBER-TAR-LIKE MATERIAL. TIGHT,DRY.
		B12 4	500/650	GRO, BTX	2-11 DARK GRAY-GREEN SILT AND CLAY,WITH SUBDUED LIGHT-GRAY AND ORANGE-BROWN MOTTLING. HYDROCARBON STAINED. TIGHT,MOIST.
5					
		B12 6	300/700		
		B12 8	500/850		
10		B12 10	500/750	GRO, BTX	● WATER AT 11 FT.
					11-12 DARK GRAY-GREEN SILT
					END OF BORING AT 12 FT.
15					
20					
25					
30					* NH-NO 15 MINUTE HEADSPACE ANALYSIS.

DRILLER: PROFESSIONAL SERVICE INDUSTRIES, INC.
4161 RIDGEMOOR AVENUE
MEMPHIS, TN. 38118

DRILLING AND SAMPLING METHOD:
3.25-INCH ID HOLLOW-STEM AUGERS.
2 FT. LONG, 2 IN. OD SPLIT BARREL SAMPLER.

DATE OF COMPLETION: 06/24/92

ENVIRONMENTAL ASSESSMENT
UNDERGROUND STORAGE TANKS
AIRCRAFT FIRFIGHTING TRAINING FACILITY
NAS MEMPHIS, TN.

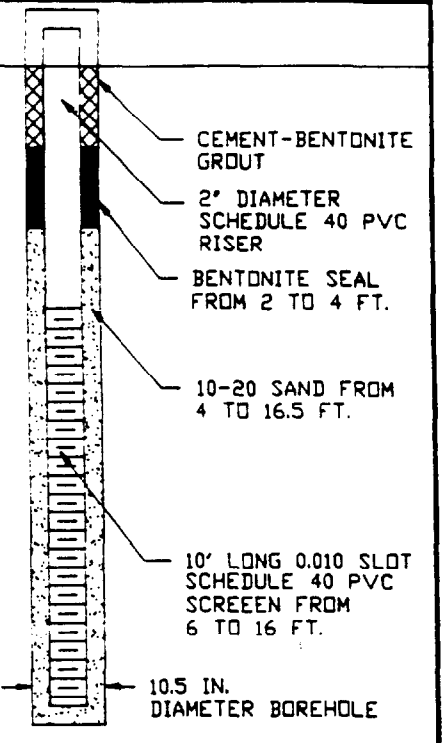
BORING B-12

DATE: 07/28/92

DWG NAME: 026B-12

DEPTH (FEET)	SAMPLE INTERVAL	SAMPLE NUMBER	PID (PPM) (INITIAL/15 MIN.)	LABORATORY ANALYSIS	DESCRIPTION OF SUBSURFACE MATERIALS
		MW07 0	2/2		0-1 BROWN SILT AND ORGANICS, SOME CLAY AND ROOTS.
		MW07 2	200/700		1-3 DARK BROWN SILT AND CLAY WITH FAINT GRAY AND ORANGE-BROWN MOTTLING, AND BLACK ORGANIC SPECKS TO RUST-BROWN NODULES. TIGHT, MOIST.
		MW07 4	250/850	GRO, BTX	3-6 BECOMING GRAY-GREEN HYDROCARBON STAINED CLAY, WITH SUBDUED ORANGE-BROWN MOTTLING AND RUST-BROWN NODULES. VERY TIGHT, MOIST, HYDROCARBON ODOR.
5		MW07 6	50/400	GRO, BTX	6-9.5 BECOMING DARK GREEN-GRAY SILT AND CLAY. TIGHT, MOIST.
		MW07 8	1/5	GRO, BTX	9.5 BECOMING DARK BROWN CLAY. WET, VERY PLIABLE. ● WATER AT 9.5 FT.
10		MW07 10	2/5		
		MW07 12	2/2		10-16 MOTTLED LIGHT-BROWN, GRAY, ORANGE-BROWN SILT, WITH DARK-BROWN, RED-BLACK NODULES. FIRM, WET.
		MW07 14	1/2		
15					16-16.5 NO SAMPLE. END OF BORING AT 16.5 FT.
20					
25					
30					

WELL CONSTRUCTION DETAILS



DRILLER: PROFESSIONAL SERVICE INDUSTRIES, INC.
4161 RIDGEMOOR AVENUE
MEMPHIS, TN. 38118

DRILLING AND SAMPLING METHOD:
6.25-INCH ID HOLLOW-STEM AUGERS.
2 FT. LONG, 2 IN. OD SPLIT BARREL SAMPLER.

DATE OF COMPLETION: 06/25/92

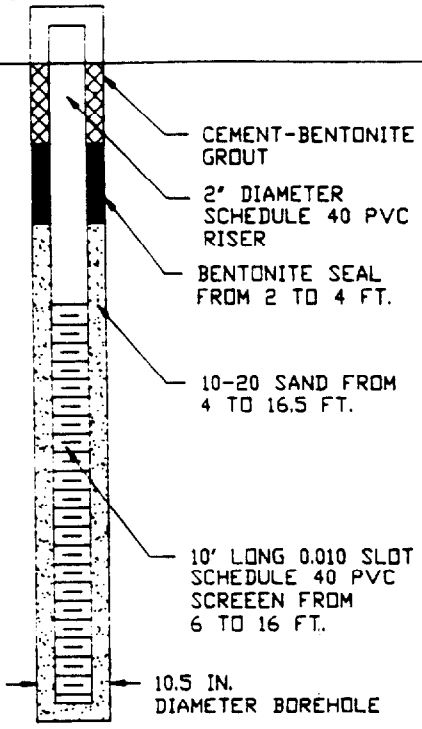
ENVIRONMENTAL ASSESSMENT
UNDERGROUND STORAGE TANKS
AIRCRAFT FIRFIGHTING TRAINING FACILITY
NAS MEMPHIS, TN.

BORING B-13
MW-07

DATE: 08/08/92 | DWG NAME: 026MW-07

DEPTH (FEET)	SAMPLE INTERVAL	SAMPLE NUMBER	PID (PPM) (INITIAL/15 MIN.)	LABORATORY ANALYSIS	DESCRIPTION OF SUBSURFACE MATERIALS
		MW08 0	1/0		0-0.5 BROWN SILT, ORGANICS AND ROOTS 0.5-2 MOTTLED LIGHT-BROWN-GRAY, ORANGE-BROWN SILT, SOME CLAY AND ROOTS. DRY.
		MW08 2	1000/1100	GRO, BTX	2-10 DARK GREEN-GRAY SILT AND CLAY. HYDROCARBON-STAINED. TIGHT, MOIST TO WET. UNIDENTIFIED ODOR.
		MW08 4	1000/1100	VOC	
5		MW08 6	500/700		
		MW08 8	10/8	GRO, BTX	● WATER AT 9-10 FT.
10		MW08 10	7/0		10-13 BECOMING MOTTLED GRAY, ORANGE-BROWN SILT. FIRM, WET. 13 THIN HORIZON (3") OF BLACK SILT.PASTE-LIKE,WET.
		MW08 12	200/20	VOC	13-15 MOTTLED GRAY, ORANGE-BROWN SILT;BECOMING RED -BROWN SILT WITH MINOR ORANGE-BROWN STREAKS.
		MW08 14	3/16		
15					15-16 UNIFORM GRAY SILT. 16-16.5 NO SAMPLE. END OF BORING AT 16.5 FT.
20					
25					
30					

WELL CONSTRUCTION DETAILS



DRILLER: PROFESSIONAL SERVICE INDUSTRIES, INC.
4161 RIDGEMOOR AVENUE
MEMPHIS, TN. 38118

DRILLING AND SAMPLING METHOD:
6.25-INCH ID HOLLOW-STEM AUGERS.
2 FT. LONG, 2 IN. OD SPLIT BARREL SAMPLER.

DATE OF COMPLETION: 06/25/92

ENVIRONMENTAL ASSESSMENT
UNDERGROUND STORAGE TANKS
AIRCRAFT FIRFIGHTING TRAINING FACILITY
NAS MEMPHIS, TN.

BORING B-14
MW-08

DATE: 08/08/92 | DWG NAME: 026MW-08

000337

DEPTH (FEET)	SAMPLE INTERVAL	SAMPLE NUMBER	PID (PPM) (INITIAL/15 MIN.)	LABORATORY ANALYSIS	DESCRIPTION OF SUBSURFACE MATERIALS
		B15 0	14/200		0-1? BROWN SILT AND ORGANICS. 1-7 DARK BROWN-BLACK SILT AND CLAY,HYDROCARBON STAINED. TIGHT,HARD.
		B15 2	1000/1100	RFI-SCAN, GRO, BTX	
		B15 4	800/1100		
5		B15 6	700/100		7-8 BECOMING GREEN-GRAY SILT,POSSIBLY HYDROCARBON STAINED. FIRM,MOIST.
		B15 8	10/10	GRO, BTX	8-11 BECOMING MOTTLED GRAY,ORANGE-BROWN SILT AND CLAY. FIRM,MOIST.
10		B15 10	3/4	GRO, BTX	● WATER AT 11 FT. 11-11.5 DARK BROWN CLAY,SOME SILT. 11.5-12 GREEN-GRAY SILT AND CLAY. END OF BORING AT 12 FT.
15					
20					
25					
30					

DRILLER: PROFESSIONAL SERVICE INDUSTRIES, INC.
4161 RIDGEMOOR AVENUE
MEMPHIS, TN. 38118

DRILLING AND SAMPLING METHOD:
3.25-INCH ID HOLLOW-STEM AUGERS.
2 FT. LONG, 2 IN. OD SPLIT BARREL SAMPLER.

DATE OF COMPLETION: 06/25/92

ENVIRONMENTAL ASSESSMENT
UNDERGROUND STORAGE TANKS
AIRCRAFT FIRFIGHTING TRAINING FACILITY
NAS MEMPHIS, TN.

BORING B-15

DATE: 07/28/92 | DWG NAME: 026B-15

000340

DESCRIPTION OF SUBSURFACE MATERIALS

DEPTH (FEET)	SAMPLE INTERVAL	SAMPLE NUMBER	PID (PPM) (INITIAL/15 MIN.)	LABORATORY ANALYSIS	
		B16 0	1/1		0-1 BROWN,ORANGE-BROWN SILT,ORGANICS AND ROOTS.
		B16 2	1/0		1-4 DARK BROWN ORGANIC-RICH SILT AND CLAY; BECOMING (AT 2 FT.) DARK BROWN-BLACK ORGANIC-RICH CLAY. TIGHT TO VERY TIGHT,DRY.
		B16 4	1/1		4-6 BECOMING MOTTLED GRAY-GREEN,GRAY-BROWN, DARK-BROWN SILT AND CLAY.
5					
		B16 6	1/2		6-7.5 BECOMING GREEN-GRAY SILT,LITTLE CLAY. FIRM,WET.
		B16 8	1/1		7.5-10 BECOMING LIGHT-BROWN,GRAY-BROWN SILT AND CLAY. TIGHT,MOIST.
10		B16 10	1/1	GRO, BTX	10-12 BECOMING MOTTLED GRAY,ORANGE-BROWN SILT, SOME CLAY. TIGHT,MOIST.
					● WATER AT 11 FT.
					END OF BORING AT 12 FT.
15					
20					
25					
30					

DRILLER: PROFESSIONAL SERVICE INDUSTRIES, INC.
4161 RIDGEMOOR AVENUE
MEMPHIS, TN. 38118

DRILLING AND SAMPLING METHOD:
3.25-INCH ID HOLLOW-STEM AUGERS.
2 FT. LONG, 2 IN. OD SPLIT BARREL SAMPLER.

DATE OF COMPLETION: 06/25/92

ENVIRONMENTAL ASSESSMENT
UNDERGROUND STORAGE TANKS
AIRCRAFT FIRFIGHTING TRAINING FACILITY
NAS MEMPHIS, TN.

BORING B-16

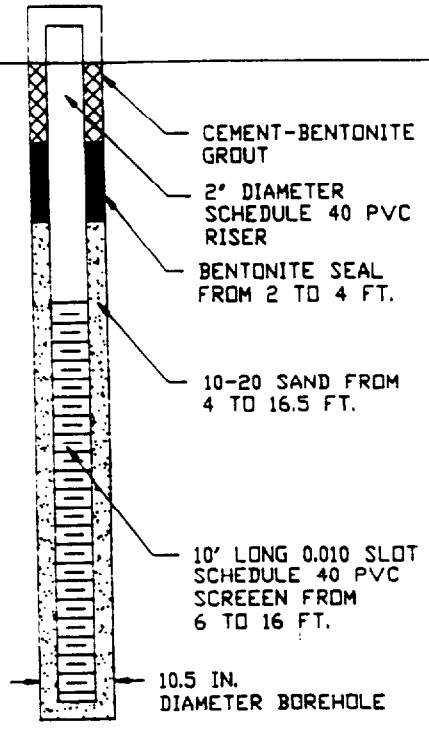
DATE: 07/28/92

DWG NAME: 026B-16

000341

DEPTH (FEET)	SAMPLE INTERVAL	SAMPLE NUMBER	PID (PPM) (INITIAL/15 MIN.)	LABORATORY ANALYSIS	DESCRIPTION OF SUBSURFACE MATERIALS
		MW09 0	0/0		0-1.5 BROWN SILT,CLAY,ORGANICS AND ROOTS; BECOMING MOTTLED BROWN,ORANGE-BROWN SILT, CLAY AND ROOTS.
		MW09 2	0/0		1.5-4 BECOMING DARK BROWN CLAY,TURNING DARK BROWN-BLACK ORGANIC-RICH CLAY WITH SOME ROOTS,TIGHT,MOIST.
		MW09 4	0/0		4-6 BECOMING GRAY SILT AND CLAY WITH FAINT ORANGE-BROWN INTERBEDS. TIGHT,MOIST.
5		MW09 6	0/0		6-10 MOTTLED GRAY-BROWN,BLUE-GRAY SILT AND CLAY. BECOMING (AT 8 FT.) MOTTLED LIGHT-BROWN AND BLUE-GRAY. TIGHT,MOIST.
		MW09 8	0/0	GRO, BTX	
10		MW09 10	0/0		● WATER AT 9.5 FT. 10-12 GRAY-BROWN SILT.
		MW09 12	0/0		12-16 MOTTLED GRAY,ORANGE-BROWN SILT,WITH MINOR BLACK TO DARK-RED NODULES OR PATCHES. FIRM,WET.
		MW09 14	0/0		
15					16-16.5 NO SAMPLE END OF BORING AT 16.5 FT.
20					
25					
30					

WELL CONSTRUCTION DETAILS



DRILLER: PROFESSIONAL SERVICE INDUSTRIES, INC.
4161 RIDGEMOOR AVENUE
MEMPHIS, TN. 38118

DRILLING AND SAMPLING METHOD:
6.25-INCH ID HOLLOW-STEM AUGERS.
2 FT. LONG, 2 IN. OD SPLIT BARREL SAMPLER.

DATE OF COMPLETION: 06/26/92

ENVIRONMENTAL ASSESSMENT
UNDERGROUND STORAGE TANKS
AIRCRAFT FIRFIGHTING TRAINING FACILITY
NAS MEMPHIS, TN.

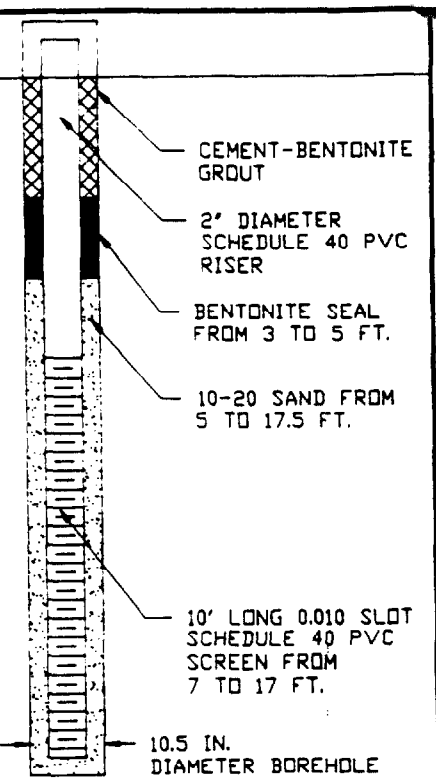
BORING B-17
MW-09

DATE: 08/08/92

DWG NAME: 026MW-09

DEPTH (FEET)	SAMPLE INTERVAL	SAMPLE NUMBER	PID (PPM) (INITIAL/15 MIN.)	LABORATORY ANALYSIS	DESCRIPTION OF SUBSURFACE MATERIALS
		MW10 0	0/0		0-0.5 BROWN SILT,CLAY AND ORGANICS
					0.5-2 MOTTLED BROWN,GRAY-BROWN,ORANGE-BROWN SILT AND CLAY WITH MINOR BLACK ORGANIC NODULES. FIRM,MOIST.
		MW10 2	12/600	GRO, BTX	
					2-4 BECOMING DARK GRAY CLAY. TIGHT,MOIST, HYDORCARBON ODOR.
		MW10 4	14/600		4-6 BECOMING DARK-GREEN-GRAY,HYDROCARBON STAINED SILT AND CLAY. TIGHT,MOIST,HYDROCARBON ODOR.
5		MW10 6	1/5	GRO, BTX	6-8 GREEN-GRAY SILT AND CLAY.
		MW10 8	1/0		8-10 MOTTLED GREEN-GRAY ORANGE-BROWN SILT AND CLAY.
10		MW10 10	1/0	GRO, BTX	10-12 BECOMING GREEN-GRAY SILT. FIRM,MOIST.
					● WATER AT 12 FT.
		MW10 12	1/1		12-16 MOTTLED GRAY-BROWN,ORANGE-BROWN SILT WITH BLACK TO RED NODULES OR PATCHES FIRM,WET.
		MW10 14	1/1		
15					16-17.5 NO SAMPLE. END OF BORING AT 17.5 FT.
20					
25					
30					

WELL CONSTRUCTION DETAILS



DRILLER: PROFESSIONAL SERVICE INDUSTRIES, INC.
4161 RIDGEMOOR AVENUE
MEMPHIS, TN. 38118

DRILLING AND SAMPLING METHOD:
6.25-INCH ID HOLLOW-STEM AUGERS.
2 FT. LONG, 2 IN. OD SPLIT BARREL SAMPLER.

DATE OF COMPLETION: 06/26/92

ENVIRONMENTAL ASSESSMENT
UNDERGROUND STORAGE TANKS
AIRCRAFT FIRFIGHTING TRAINING FACILITY
NAS MEMPHIS, TN.

BORING B-18
MW-10

DATE: 07/29/92 | DWG NAME: 026MW-10

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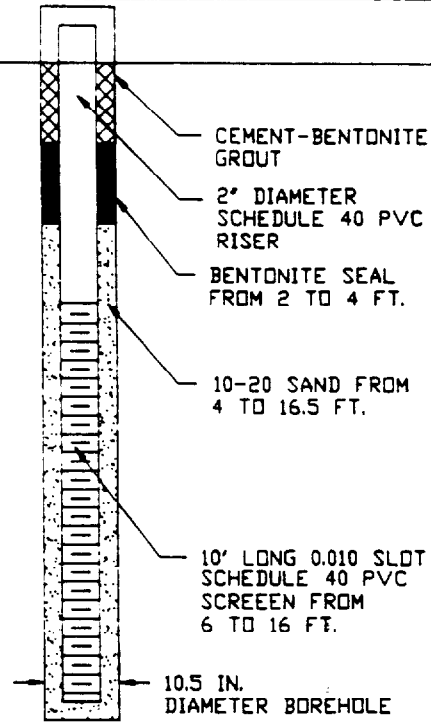
DEPTH (FEET)	SAMPLE INTERVAL	SAMPLE NUMBER	PID (PPM) (INITIAL/15 MIN.)	LABORATORY ANALYSIS	DESCRIPTION OF SUBSURFACE MATERIALS
		MW11 0	13/10		0-1 SILT AND ORGANICS,SOME CLAY.
					1-2 INTERLAYERED BROWN,GRAY-BROWN,ORANGE-BROWN SILT AND CLAY,MINOR GRAVEL. TIGHT,MOIST.
		MW11 2	300/500		2-9 BECOMING DARK GREEN-GRAY,HYDROCARBON-STAINED SILT AND CLAY. TIGHT,MOIST,HYDROCARBON ODOR.
		MW11 4	1300/NH*	K GRO, BTX, RFI-SCAN	
5		MW11 6	500/1100		● PERCHED WATER AT 7 FT.
					-WITH FAINT GRAY,ORANGE-BROWN MOTTLING FROM 7 TO 10 FT.
		MW11 8	150/300		9-11 MOTTLED GRAY,ORANGE-BROWN SILT. FIRM,MOIST.
10		MW11 10	20/80	K, GRO, BTX	11 THIN (3" THICK) HORIZON OF ORANGE-BROWN SILT AND CLAY. EXTREMELY TIGHT AND COMPACT, DRY.
					● WATER AT ~ 11.5 FT.
		MW11 12	1/1		11-16 GRAY UNIFORM SILT. FIRM,WET.
		MW11 14	0/0		
15					16-16.5 NO SAMPLE. END OF BORING AT 16.5 FT.
20					
25					
30					* NH-NO 15 MINUTE HEADSPACE ANALYSIS.

WELL CONSTRUCTION DETAILS



DRILLER: PROFESSIONAL SERVICE INDUSTRIES, INC.
4161 RIDGEMOOR AVENUE
MEMPHIS, TN. 38118

DRILLING AND SAMPLING METHOD:
6.25-INCH ID HOLLOW-STEM AUGERS.
2 FT. LONG, 2 IN. OD SPLIT BARREL SAMPLER.

DATE OF COMPLETION: 06/26/92-MONITORING WELL
06/27/92-SHELBY TUBE

ENVIRONMENTAL ASSESSMENT
UNDERGROUND STORAGE TANKS
AIRCRAFT FIRFIGHTING TRAINING FACILITY
NAS MEMPHIS, TN.

BORING B-19
MW-11

DATE: 08/08/92 | DWG NAME: 026MW-11

Appendix F
Analytical Data

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1.0 INTRODUCTION

This report presents the analytical data collected during the RCRA Facility Investigation (RFI) at Naval Support Activity (NSA) Mid-South (formerly NSA Memphis) solid waste manage unit (SWMU) 5 and the quality assurance/quality control (QA/QC) evaluation of those data. The data were evaluated to verify that the QC requirements of the data set have been met and to characterize the uncertainties of the data.

The SWMU 5 RFI soil and groundwater samples were collected between August 1996 and June 1998. This sampling event consisted of collecting soil and groundwater during an investigation of the Aircraft Fire Fighting Training Facility. Investigative samples were submitted to National Environmental Testing Inc. (NET) Laboratory in Bedford, Massachusetts, and Savannah Laboratory and Environmental Services Inc. in Savannah, Georgia, and reported using U.S. Environmental Protection Agency (USEPA) data deliverable levels III and IV.

Level III data consist of the following:

- Case narratives
- Sample results
- Surrogate results
- Analytical sequences
- Preparation logs
- GC/MS tuning data
- Calibration information
  - Percent relative standard deviation
  - Percent difference from calibration
- Method blanks
- Organic MS/MSDs
- GC/MS internal standard areas and retention times
- Inorganic matrix spikes/laboratory duplicates
- Laboratory control samples
- ICP check standards
- ICP interference check samples
- ICP serial dilutions

Notes:

GC/MS	=	gas chromatography/mass spectrometry
MS/MSD	=	matrix spike/matrix spike duplicate
ICP	=	inductively coupled plasma

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Level IV data consist of all level III QC information, plus all raw data, bench sheets, and instrument printouts. The analytical methods and laboratory deliverables for this phase of the RFI are summarized in Table 1-1.

Table 1-1
NSA Mid-South Analytical Program

Analytical Method	USEPA Method Reference
RFI Parameters	
Volatile Organic Compounds	SW-846 8240
Volatile Organic Compounds	SW-846 8260
Remedial Design Parameters	
Alkalinity	USEPA 310.1
5-Day Biochemical Oxygen Demand (BOD_5)	USEPA 405.1
Chemical Oxygen Demand (COD)	USEPA 410.1
Chloride	USEPA 300.0
Hardness	SW-846 6010 & USEPA 130.2
Heterotrophic Plate Count (HPC)	Standard Methods 9215
Iron and Manganese (Fe & Mn)	SW-846 6010
Methane	SW-846 Modified 8015
Nitrate (NO_3)	USEPA 300.0 & 353.2
Sulfate (SO_4)	USEPA 300.0
Total Dissolved Solids (TDS)	USEPA 160.1
Total Kjeldahl Nitrogen (TKN)	USEPA 351.2
Total Organic Carbon (TOC)	SW-846 Modified 9060
Total Phosphorus	USEPA 365.3
Total Suspended Solids (TSS)	USEPA 160.2
Turbidity	USEPA 180.1
Cation Exchange Capacity (CEC)	SW-846 9080/9081

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The references for the methods listed in Table 1-1 were from:

- *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods* (SW-846), USEPA Office of Solid Waste and Emergency Response (OSWER), Third Edition, revised December 1996.

- *Methods for Chemical Analysis of Water and Wastes* (MCAWW), USEPA Environmental Monitoring and Support Laboratory, EPA-600/4-79-020, revised March 1983.

- *Standard Methods for the Examination of Water and Wastewater*, American Public Health Association, 17th Edition, revised 1989.

- *USEPA Data Quality Objectives for Remedial Response Activities,* EPA-540/G-87/003, March 1987.

Data were validated using the following documents (as appropriate):

- *USEPA Contract Laboratory Program National Functional Guidelines for Organic Data Review*, OSWER, February 1994 (EPA-540/R-94/012). (Organic Functional Guidelines).

- *USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review*, OSWER, February 1994 (EPA-540/R-94/013). (Inorganic Functional Guidelines).

- *Requirements For Quality Control of Analytical Data*, Martin Marietta Energy Systems, Inc., Hazardous Waste Remedial Actions Program (HAZWRAP) Support Contract Office, DOE/HWP-65/R1, July 1990.

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The NSA Mid-South data were validated by EnSafe personnel or EnSafe's subcontractor, Heartland Environmental Services Inc. (Heartland) of St. Charles, Missouri. Of the samples submitted to NET and Savannah, 95% of the data was validated at level III while 5% was validated at level IV. The data validation findings were summarized separately for each individual sample delivery group (SDG). Each SDG usually contained 20 investigative samples of one matrix type, i.e., either solid (soil and/or sediment) or water (groundwater and/or surface water) samples, except for QC samples, which were not counted as investigative samples. All validation summary reports are included in Attachment A to this appendix. All data summary tables are included in Attachment B of this document.

Samples collected at NSA Mid-South were evaluated for volatile organic compounds (VOCs) and various remedial design parameters; including, alkalinity, biological oxygen demand — 5 day (BOD_5), chloride, chemical oxygen demand (COD), iron (Fe), manganese (Mn), hardness, heterotrophic plate count (HPC), total kjeldahl nitrogen (TKN), methane, nitrate (NO_3), sulfate (SO_4), total dissolved solids (TDS), total organic carbon (TOC), total phosphorus, total suspended solids (TSS), and turbidity.

1.1 Organic Evaluation Criteria

The USEPA methods listed in Table 1-1 define QC criteria that the laboratory must meet, although they do not address data evaluation from a user's perspective. Evaluation criteria available in the Organic Functional Guidelines (February 1994) were used throughout the data evaluation process when the analytical methods did not address data usability.

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Data evaluation for samples collected at NSA Mid-South included the following parameters:

- Holding times
- GC/MS instrument performance checks
- Surrogate spike recoveries
- Instrument calibration
- MS/MSD results
- Laboratory control and duplicate samples
- Blank analysis
- Internal standard performance
- Field duplicate precision
- Compound quantitation

When QC parameters do not fall within the specified method guidelines, the data evaluator annotates or "flags" corresponding deficient compounds, as outlined in Organic Functional Guidelines. The data from SWMU 5 were evaluated using this approach. The following flags were used to annotate data with laboratory and/or field deficiencies or problems:

Validation Qualifiers

U **Undetected** — The analyte was present in a sample, but at a concentration less than 10 times the blank concentration for common organic constituents (methylene chloride, acetone, 2-butanone and phthalate esters), or five times the blank concentration for other constituents; the associated value shown is the quantitation limit after evaluation of the blank.

J **Estimated Value** — At least one QC parameter was outside control limits.

UJ **Undetected and Estimated** — The target analyte was analyzed for, but not detected above the listed estimated quantitation limit; the quantitation limit is estimated because one or more QC parameters were outside control limits.

D **Diluted Result** — The result was obtained from a diluted sample.

R/UR **Unusable Data** — At least one QC parameter grossly exceeded control limits.

NJ **Presumptive Evidence** — The sample analysis indicates the presence of an analyte for which there is presumptive evidence to make a tentative identification and the associated numerical value represents its approximate concentration.

These flags were applied to data where deficiencies were noted during validation. Because the laboratory uses some of the same qualifiers during analyses, laboratory qualifiers "U" and "J" remained on the data, unless superseded by a validation qualifier (e.g., "UJ" or "UR"). Laboratory qualifiers that remained on the data after validation are described below:

Laboratory Qualifiers

U **Undetected** — The target analyte was not detected above the Practical Quantitation Limit (PQL).

J **Estimated Value Below PQL** — The analyte was detected below the PQL and is estimated.

Attachment B includes tables of all data.

1.1.1 Holding Times

Acceptable technical holding times are specified in the analytical methods. The sample holding time depends on the type of analysis and whether the sample was preserved. The holding time for methane and preserved VOC analysis is 14 days from the collection date.

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1.1.2 GC/MS Mass Calibration (Instrument Performance Checks)

Tuning and performance criteria are established to ensure that the data produced by the instrument can be correctly interpreted according to method requirements. These criteria are not sample-specific; conformance is determined using standard materials, and therefore must be met in all circumstances. The performance standard for VOC (bromofluorobenzene) is analyzed to determine if the data produced by each instrument can be correctly interpreted according to the method requirements. The performance standard must be analyzed within 12 hours of sample analysis, and the results must be within the established criteria.

1.1.3 Surrogate Spike Recoveries

Surrogate compounds are added to samples and laboratory blanks prior to extraction and sample preparation to evaluate the effect of the sample matrix on extraction and measurement procedures. Surrogates are organic compounds chemically similar to analytes of interest, but those not normally found in environmental samples. Toluene-d8, bromofluorobenzene, and 1,2-dichloroethane-d4 are added to samples for VOC analysis. Percent recovery (%R) of the surrogates is calculated by comparing the amount of the compound recovered by the analysis to the amount added to the sample.

1.1.4 Instrument Calibration

Instruments are initially and continually calibrated with standard solutions to verify that they can produce acceptable quantitative data for the compounds.

Initial calibration (GC/MS): The instrument is initially calibrated at the beginning of the analytical run to check its performance and to establish a linear five-point calibration curve. The initial calibration is verified by calculating the relative response factor (RRF) and the percent relative standard deviation (%RSD) for each compound. Two methods for calibration may be

used: response factor or linear regression methods. For the response factor method, the initial calibration may be verified by calculating the RRF and the %RSD for each compound. An RRF less than 0.05 or an average %RSD greater than 20% is outside the QC limits for the initial calibration. If linear regression is used, the correlation coefficient must meet or exceed 0.990 before the samples can be analyzed.

Continuing calibration (GC/MS): Standard solutions are analyzed periodically to check the instrument's daily performance and to establish the 12-hour RRF on which the sample quantitations are based. The continuing calibration is verified by calculating the RRF and the percent difference (%D) for each compound. An RRF less than 0.05, or an average %D or %drift greater than 15% is outside the QC limits for the continuing calibration.

Initial calibration (GC): A five-point initial calibration is analyzed by response factor or linear regression methods for methane. For the response factor method, the initial calibration may be verified by calculating the RRF and the %RSD for each compound. An RRF less than 0.05 or a %RSD greater than 20% is outside the QC limits for the initial calibration. If linear regression is used, the correlation coefficient must meet or exceed 0.995 before the samples can be analyzed.

Continuing calibration (GC): Methane continuing calibration is verified by calculating the RRF and the %D for each compound. An RRF less than 0.05 or a %D greater than 15% is outside the QC limits for the continuing calibration.

1.1.5 Matrix Spikes/Matrix Spike Duplicates

The MS, which is used to determine the accuracy of the analysis for a given matrix, consists of adding a known quantity of stock solution to the sample before its preparation and analysis. Evaluating the MS data involves two calculations. First, the %R is calculated by comparing the

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amount of the compound recovered by the analysis to the amount added to the sample. In addition, the relative percent difference (RPD) between the MS and the MSD samples is calculated and assessed. No specific requirements have been established for qualifying MS/MSD data. However, criteria for applying professional judgment are discussed in Organic Functional Guidelines.

1.1.6 Laboratory Control and Duplicate Samples

Some GC methods may require that a laboratory control sample (LCS) and laboratory duplicate be analyzed with each SDG. The LCS monitors the overall performance of each step during analysis, including sample preparation. All aqueous LCS %R results must fall within the control limits established by the laboratory. Laboratory duplicate samples are used to demonstrate acceptable method precision at the time of analysis. The RPD between the sample and the duplicate sample is calculated. Although no guidelines are established for organic laboratory duplicates, sample qualification is left to professional judgment.

1.1.7 Blank Analysis

Laboratory method blanks: Method blanks are used to assess the presence and magnitude of potential contamination introduced during analysis. Additionally, *field blanks* may be collected to assess any contamination introduced during sample collection, as well as ambient field conditions. When chemicals are present in both samples and laboratory blanks analyzed within the same 12-hour period, **and/or** field-derived blanks, the usability of the data depends on the reviewer's judgment and the blank's origin. According to Organic Functional Guidelines, a sample result should not be considered positive unless the concentration of the compound in the sample exceeds 10 times the amount in **any** blank for common laboratory constituents (i.e., methylene chloride, acetone, and 2-butanone), or five times the amount for other constituents. These amounts are referred to as *action levels* (ALs). Sample weight, volume, and

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dilution should be considered when calculating ALs because blank samples may not be prepared using the same weight, dilution, or volume of sample. The specific actions to be taken are as follows:

- If a chemical is found in the blank but not the sample, no action is taken.

- If the sample concentration is greater than the AL, the concentration may be used unqualified.

- If the sample concentration is less than the quantitation limit and less than the AL, then the sample is reported as nondetect at the quantitation limit.

  Example (using 10X rule):

Water Sample		**Diluted Water Sample**	
Blank result	1	Blank result	1
Blank AL	10	Dilution Factor	5
PQL	5	Blank AL	50
Sample result	4J	Diluted PQL	25
Final result	5U	Sample result	4J
		Final result	25U

  In this example, data are not reported as 4U because they are less than the PQL. The dilution factor is used to calculate an AL of 50 (1 x 5 x 10).

- If the sample concentration is greater than the quantitation limit, but less than the AL, the concentration is reported as nondetect "U."

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Example (using 10X rule):

Water Sample		**Soil Sample**		**Diluted Soil Sample**	
Blank result	6	Blank result	6	Blank result	6
Blank AL	60	% Solids	80	% Solids	80
PQL	5	Blank AL	75	Dilution Factor	5
Sample result	50	PQL	5	Blank AL	375
Final result	50U	Sample result	50	PQL	25
		Final result	50U	Sample result	250
				Final result	250U

In this example, water sample results less than 60 (or 10 x 6) would be qualified as nondetect. Soil results of less than 75 would be qualified as nondetect because percent solids are used to calculate the AL: [(6 ÷ 0.8) x 10]. In the diluted soil sample, results less than 375 would be qualified as nondetect because dilution factors and percent solids are used to calculate the AL: [(6 ÷ 0.8) x 10 x 5].

Field-derived blanks: For this project, three types of field-derived blanks were collected: the *field blank*, the *equipment rinsate blank* (also called a *rinsate blank*), and the *trip blank*. The field blank is a sample of the source water used onsite, primarily to decontaminate equipment. The equipment rinsate blank is a sample of runoff water from one or more pieces of the decontaminated equipment used to collect samples. The trip blank is a 40-milliliter volatile organic analysis vial filled at the laboratory with certifiable water to assess cross-contamination during VOC sample container shipment and handling, both before and after the sample collection.

The frequencies for collecting these QC samples were defined in Section 4 of the NSA Memphis *Comprehensive RFI Work Plan* (EnSafe/Allen & Hoshall, October 1994) as follows:

- *Field blanks* — one per source of water per sampling event
- *Rinsate blank* — one per week
- *Trip blank* — one per shipment containing VOC samples

For data validation, each trip blank is associated only with the samples from the same shipment/cooler. The field blanks and rinsate blanks apply to a larger number of samples because only one is collected per source of water per sampling event. Because field-derived blanks are used with method blanks to assess potential cross-contamination of field investigative samples, no action is taken if contamination is detected in the method blanks associated with the field-derived blanks.

1.1.8 Internal Standard Performance

GC/MS internal standards are added to samples to ensure the stability of the instrument's sensitivity and response during each analytical VOC run. Internal standard area counts for samples and blanks must not vary by more than a factor of two (-50% to +100%) from the associated calibration standard. If an internal standard area count is outside this window, action should be taken. 1,4-Dichlorobenzene-d4, 1,2-dichloroethane-d4, 1,4-difluorobenzene, and chlorobenzene-d5 are the IS compounds recommended by the methods.

1.1.9 Field Duplicate Precision

One field duplicate was collected at NSA Mid-South for each 10 water and/or soil samples collected. Field duplicate samples are analyzed to evaluate data precision. Field duplicates measure both field and lab precision; therefore, the results may have more variability than laboratory duplicates that measure only laboratory performance.

For the NSA Mid-South RFI, RPDs between the samples and duplicates were calculated during the validation processes for sample results exceeding the PQL. If the results for any compounds did not meet RPD criteria of less than 30% for water and less than 50% for soil, the positive results for that compound were flagged as estimated for the sample and duplicate only. If one

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value was nondetected and the other value exceeded the PQL, the positive result was flagged as estimated "J," and the nondetected result as estimated "UJ."

1.2 Inorganic Evaluation Criteria

SW-846 and the methods outlined in Table 1-1 define QC criteria that the laboratory must meet; however, the methods do not address data evaluation from a user's perspective. When the analytical methods did not address data usability, Inorganic Functional Guidelines (February 1994) was used throughout the data evaluation process.

Data evaluation for samples collected at NSA Mid-South included the following parameters:

- Holding times
- Instrument calibration
- Blank analysis
- ICP interference check samples
- LCS results
- Matrix spike results
- Laboratory duplicates
- ICP serial dilutions
- Field duplicate precision

According to Inorganic Functional Guidelines, when the QC parameters do not fall within the specific method guidelines, the data evaluator annotates or "flags" the corresponding deficient analytes. The data from SWMU 5 were evaluated using this approach. The following flags were used to annotate data with laboratory and/or field deficiencies or problems:

Validation Qualifiers

U **Undetected** — The analyte was present in a sample, but at a concentration less than five times the blank concentration; the associated value shown is the quantitation limit after evaluation of the blank.

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J **Estimated Value** — At least one QC parameter was outside control limits.

UJ **Undetected and Estimated** — The target analyte was analyzed for, but not detected above the listed quantitation limit; the quantitation limit is estimated because at least one QC parameter was outside control limits.

R/UR **Unusable Data** — At least one QC parameter grossly exceeded control limits.

These validation flags were applied to data where data deficiencies were noted during validation. The laboratory flags metal values between the instrument detection limit (IDL) and the PQL with a "B" qualifier to indicate that the analyte was detected below the PQL and is estimated. During validation, all results between the IDL and PQL flagged "B" by the laboratory were changed to "J" to remain consistent with the organic data.

Because the laboratory uses some of the same qualifiers during analyses, the laboratory "U" qualifier remained on the data unless superseded by a validation qualifier (e.g., "UJ" or "UR"). The laboratory "U" qualifier which remained on the data after validation is defined as:

Laboratory Qualifiers

U **Undetected** — The target analyte was not detected above the PQL.

Attachment B includes tables of all qualified data. Results for alkalinity, BOD_5, chloride, COD, hardness, HPC, TKN, NO_3, SO_4, TDS, TOC, total phosphorus, TSS, and turbidity were not validated, but are presented in Attachment B with the remaining data.

1.2.1 Holding Times

Acceptable technical holding times are specified in the analytical methods. The holding time for metals analysis is six months. Table 1-2 depicts the holding times for the various remedial design parameters analyzed throughout the investigation.

Table 1-2
Remedial Design Holding Times

Analytical Method	Holding Time	Analytical Method	Holding Time
Alkalinity	14 days	Turbidity	48 hours
5-Day Biochemical Oxygen Demand	48 hours	Nitrate	48 hours
Cation Exchange Capacity	28 days	Sulfate	28 days
Chemical Oxygen Demand	28 days	Total Dissolved Solids	7 days
Chloride	28 days	Total Kjeldahl Nitrogen	28 days
Hardness	180 days	Total Organic Carbon	28 days
Heterotrophic Plate Count	24 hours	Total Phosphorus	28 days
Iron and Manganese	10 days	Total Suspended Solids	7 days

1.2.2 Instrument Calibration

Initial and continuing calibrations with standard solutions are used to check that the instrument is capable of producing acceptable qualitative and quantitative data for any target analytes.

Initial calibration is executed to check the instrument's performance at the beginning of the analytical run and to establish a linear calibration curve. Calibration standard solutions are analyzed periodically to check the instrument's performance and confirm that the initial calibration curve is still valid. Calibrations are verified by calculating the %R and comparing the amount of the analyte recovered by analysis to the known amount of standard. The %R for metals and the remedial design parameters should fall between 90% and 110%.

1.2.3 Blank Analysis

Laboratory method blanks are used to assess the existence and magnitude of potential contamination introduced during analysis. Additionally, *field blanks* may be collected to assess the potential contamination introduced during sample collection as well as ambient field conditions. When chemicals are present in samples and laboratory blanks, the data's usability depends on the reviewer's judgment and the blank's origin. According to Inorganic Functional Guidelines, a sample result should not be considered positive unless the analyte's concentration in the sample exceeds five times the amount in **any** blank, referred to as ALs. Weight, dilutions, and sample volumes should be considered when using the blank criteria because blank samples may not be prepared using the same weight, dilution, or volume of sample. The specific actions to be taken are as follows:

- If a chemical is found in the blank but not the sample, no action is taken.
- If the sample concentration is between the IDL, and less than the AL, the concentration is reported as "U."
- If the sample concentration is greater than the AL, the concentration may be used unqualified.

When the blank concentration was less than the IDL (negative value), but had an absolute value greater than the IDL, the AL was 10 times the absolute value of the blank concentration. The specific actions are as follows:

- If the sample concentration is greater than the AL, the concentration may be used unqualified.

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- If the concentration of any detected analyte is less than the AL, the concentration is qualified as estimated "J."

- If the result is nondetect, the concentration is qualified as estimated "UJ."

1.2.4 ICP Interference Check Samples

The ICP interference check sample (ICS) is used to confirm the laboratory instrument's inter-element and background correction factors. Interference samples should be run at the beginning and end of each sample analysis or at least twice per eight-hour working shift. The ICS consists of two solutions: A and AB. Solution A contains the interferants (aluminum, calcium, iron, and magnesium); Solution AB contains the target analytes mixed with the interferants. An ICS analysis consists of analyzing both solutions consecutively, starting with Solution A, for all wavelengths used for each analyte reported by ICP.

No analytes should be detected in ICS Solution A other than aluminum, calcium, iron, and magnesium. The presence of other analytes' could lead to the possibility of false positives or false negatives of that analyte in the investigative samples. The %Rs for the ICS Solution AB should fall between 80% and 120%.

1.2.5 Laboratory Control Samples

LCSs are used to monitor the overall performance of analysis steps, including the sample preparation. All aqueous LCS %R results must fall within the control limits of 80% to 120%. Soil LCS standards are generally provided by the USEPA (or state agency or private laboratory). Control limits are established for each soil LCS standard prepared.

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1.2.6 Matrix Spike Analysis

Samples are spiked with known quantities of analytes to evaluate the effect of the sample matrix on digestion and measurement procedures. The %R should be within the range of 75% to 125%. However, when the sample concentration exceeds the spike concentration by a factor of at least four, spike recovery criteria are not applicable. When an element was outside matrix spike QC limits, positive and undetected results for that analyte were qualified for all samples in the SDG as specified in Inorganic Functional Guidelines.

1.2.7 Laboratory Duplicates

Laboratory duplicate samples are analyzed to evaluate data precision, a measure of the analysis' reproducibility. The RPD between the sample and the duplicate sample is calculated. A control limit of 20 RPD for aqueous samples and 35 RPD for soil samples for concentrations greater than five times the PQL should not be exceeded. For concentrations less than five times the PQL, a control window equal to the PQL for aqueous samples and two times the PQL for soil samples should not be exceeded.

1.2.8 ICP Serial Dilutions

ICP serial dilutions assess the absence or presence of matrix interference. One sample from each set of similar matrix type is chosen for the serial dilution (a five-fold dilution). For an analyte concentration that exceeds the IDL by at least 10 times, the measured concentrations of the undiluted and diluted samples should agree within 10%. When an element was outside QC criteria, that analyte was flagged as estimated "J" for all positive sample values in the SDG as specified in Inorganic Functional Guidelines.

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1.2.9 Field Duplicate Precision

One field duplicate was collected for each 10 water and/or soil samples collected. Field duplicate samples are analyzed to evaluate overall precision. Field duplicates measure both field and lab precision; therefore, the results may have more variability than laboratory duplicates that measure only laboratory performance.

For the NSA Mid-South RFI, RPDs between the samples and duplicates were calculated during the validation processes when at least one sample result exceeded the IDL. If the results for any analytes did not meet RPD criteria of less than 30% for water and less than 50% for soil, the positive results for that analyte were flagged as estimated for the sample and duplicate only. If one value was nondetected and the other value was above the IDL, the positive result was flagged as estimated "J," and the nondetected result was flagged as estimated "UJ."

2.0 DATA VALIDATION RESULTS — SWMU 5 RFI INVESTIGATION

All samples were received by the laboratory intact and with the proper documentation. Table 2-1 summarizes the samples that were included in SWMU 5.

Table 2-1
SWMU 5 Sample IDs

Sample ID	SDG	8240 VOCs	8260 VOCs	Remedial Design Parameters
005G01UF03	1969		X	
005G02UF03	1969		X	
005G03UF03	1969		X	
005H03UF03	1969		X	
005G04UF03	1969		X	
005G05FF03	1975		X	
005G05LF03	1969		X	
005G08FF03	1969		X	
005G09FF03	1969		X	
005G4AUF	1969		X	

000365

Table 2-1
SWMU 5 Sample IDs

Sample ID	SDG	8240 VOCs	8260 VOCs	Remedial Design Parameters
005G4BUF	1969		X	
005G01UF04	MEM07		X	
005G02UF04	MEM07		X	
005G03LS04	MEM18		X	X
005G03UF04	MEM07			
005H03UF04	MEM07			
005G04UF04	MEM07			
005G05FF04	MEM07			
005H05FF04	MEM18		X	X
005H05FF04	MEM18		X	X
005G05LF04	MEM18		X	X
005G06LS04	MEM18		X	X
005G07LS04	MEM18		X	X
005G08FF04	MEM18		X	X
005G09FF04	MEM18		X	X
005G01UF05	MEM32		X	
005G02UF05	MEM32		X	
005H02UF05	MEM32		X	
005G03LS05	MEM32		X	X
005G03UF05	MEM32		X	
005G04UF05	MEM32		X	
005G05FF05	MEM32		X	X
005H05FF05	MEM32		X	X
005G05LF05	MEM32		X	X
005G06LS05	MEM32		X	X
005G07LS05	MEM32		X	X
005G09FF05	MEM32		X	X

Notes:
Remedial Design Parameters = Alkalinity, BOD_5, chloride, COD, Fe, Mn, hardness, HPC, TKN, methane, NO_3, SO_4, TDS, TOC, total phosphorus, TSS, and turbidity.

000366

Thirty-seven investigative samples were analyzed in five SDGs for SWMU 5. Full validation reports of this SDG are in Attachment A; data tables are in Attachment B. The 67 RFI samples that were collected prior to May 1996 are detailed in *NAS Memphis RCRA Facility Investigation, Data Validation Report, Assembly A*, dated September 8, 1995 and *NSA Memphis RCRA Facility Investigation, Data Validation Report, Assembly A*, dated July 31, 1996

2.1 Data Quality

The overall data quality of the analytical work performed for SWMU 5 was considered satisfactory and usable for site remediation and risk assessment. Results outside QA/QC requirements were flagged as estimated "J." This qualification indicates that the data could be biased either high or low. Although the data are qualified as estimated, they remain acceptable for use in risk assessment and site remediation.

2.2 Blanks

Iron, manganese, and tetrachloroethene were detected in several method, trip, and calibration blanks. The sample results for these analytes that were attributed to blank contamination were nullified during validation.

3.0 DATA VALIDATION RESULTS — SWMU 5 DPT INVESTIGATION

All samples were received by the laboratory intact and with the proper documentation. Table 3-1 summarizes the samples that were included in SWMU 5.

Table 3-1
SWMU 5 DPT Sample IDs

Sample ID	SDG	8260 VOCs	Sample ID	SDG	8260 VOCs
005G08LF5A	MEM59	X	005GGB0312	MEM54	X
005H08LF50	MEM59	X	005GGB0347	MEM54	X
005SGB0110	MEM53	X	005GGB0412	MEM54	X
005GGB0112	MEM54	X	005GGB0447	MEM54	X
005GGB0147	MEM54	X	005HGB0447	MEM54	X
005GGB0212	MEM54	X	005GGB0512	MEM54	X
005GGB0248	MEM54	X	005GGB0547	MEM54	X

Fourteen investigative samples were analyzed in four SDGs for SWMU 5. Full validation reports of this SDG are in Attachment A; data tables are in Attachment B.

3.1 Data Quality

The overall data quality of the analytical work performed for SWMU 5 was considered satisfactory and usable for site remediation and risk assessment. Results outside QA/QC requirements were flagged as estimated "J." This qualification indicates that the data could be biased either high or low. Although the data are qualified as estimated, they remain acceptable for use in risk assessment and site remediation.

3.2 Unusable Data

A few sample results were rendered unusable because the samples grossly exceeded QC parameters. Table 3-2 summarizes the unusable data and explains the qualification.

Table 3-2
Unusable Data

SDG	Sample ID	Fraction	Analyte(s)	Explanation
MEM53	005SGB0110	Volatiles	Chloroethane	correlation coefficient < 0.990
MEM54	005GGB0112, 005GGB0147, 005GGB0212, 005GGB0412, 005GGB0447, 005HGB0447, 005GGB0512, 005GGB0547	Volatiles	Bromomethane	correlation coefficient < 0.990

000368

Attachment A

Data Validation Summary Narratives

DATA ASSESSMENT AND NARRATIVE

VOLATILE ORGANICS

General

The organic findings offered in this screening report assumes that all analytical results are correct as reported and is based upon the examination of the reported holding times, blank analysis results, surrogate and matrix spike recoveries, GC/MS performance, tuning results, calibration results and internal standard areas. This report was prepared in compliance relative to the analytical and deliverable requirements specified in the U.S. EPA SW846, Method 8240; the National Functional Guidelines for Organic Data Review, June 1991, and DQO Level IV. All comments made within this report should be considered when examining the analytical results. Please refer the specific findings found in each category to the Summary of Data Qualifications table.

SDG # 1969

A validation was performed on the Volatile Data from SDG 1969. The data was evaluated based on the following parameters.

	•	Data Completeness
*	•	Holding Times
*	•	GC/MS Tuning
	•	Calibrations
*	•	Internal Standard Performance
*	•	Blanks
*	•	Surrogate Recoveries
*	•	Matrix Spike/Matrix Spike Duplicates
*	•	Field Duplicates
*	•	Compound Identification /Quantitation

* - All criteria were met for this parameter

Contractual Non compliance

The BFB tune analyzed on 08/22/96, did not meet the tuning criteria establish by the SW846 Method 8240. The BFB tune was evaluated using the 3/90 CLP criteria. It is the data reviewer opinion that additional qualifcations are not required, because of the differences in criteria.

Continuing calibrations

The continuing calibrations that were analyzed with this data package exhibited %Ds and RRFs that were not within continuing calibration criteria.

Continuing calibrations (continued)

Specific Finding:

The continuing calibration, H1497, contained compounds with %RSDs greater than 25% but less than 50%. For the samples and non-compliant compounds listed below, qualify all positive results as estimated (J).

005G4AUF03	carbon tetrachloride (32.4)
005G4BUF03	

The continuing calibration, H1545, contained compounds with %RSDs greater than 25% but less than 50%. For the samples and non-compliant compounds listed below, qualify all positive results as estimated (J).

007G01UF03	1,2-dichloroethene (total) (30.5)

System Performance and Overall Assessment

The overall system performance was acceptable. The laboratory did not encounter any large problems. The data package is missing the Form V for tune and continuing calibration analyzed on 08/21/96, page 12 of the data package. The tune and calibration were evaluated using the raw data and no additional qualifications are required. The Form V should be submitted for data completeness. The data reviewer estimates that less than 5% of the data is qualified.

GLOSSARY OF DATA QUALIFIERS

QUALIFICATION CODES

U = Not detected

J = Estimated value

UJ = Reported quantitation limit is qualified as estimated

R = Result is rejected and unusable

D= result value is based on dilution analysis

METHOD BLANK QUALIFICATION CODES

CRQL =	The sample result for the blank contaminant is less than the sample CRQL and is less than 10X the method blank value. The sample result for the blank contaminant is rejected and the CRQL for that analyte is reported.
U =	The sample result for the blank contaminant is greater than the sample CRQL and is less than 10X the method blank value. The sample result for the blank contaminant is qualified as non detected at the analyte value reported.
No Action =	The sample result for the blank contaminant is greater than the sample CRQL and is greater than 10X the method blank value. The sample result for the blank contaminant is not qualified with any blank qualifiers.

The specific findings will be noted in numerical form on the Form Is in this data validation report. These specific finding footnotes will reflect the conclusions found in the data validation process that resulted in the qualification of the data.

SUMMARY OF DATA QUALIFICATIONS

SAMPLE ID	ANALYTE ID	DL	QL
005G4AUF03 005G4BUF03	carbon tetrachloride (32.4)	+	J
007G01UF03	1,2-dichloroethene (total) (30.5)	+	J

* DL denotes the Form I qualifier supplied by the laboratory
QL denotes the qualifier used by the data validation firm
+ in the DL column denotes a positive result
- in the DL column denotes a non detect result

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ENVIRONMENTAL SERVICES, INC.

Data Validation Report

SDG#:	1975
Date:	October 3, 1996
Client Name:	Ensafe/ Allen & Hoshall
Project/Site Name:	NSA Memphis
Date Sampled:	August 22-23, 1996
Number of Samples:	21 Aqueous Sample(s) with 0 MS/MSD(s)
Laboratory:	National Environmental Testing, Inc.
Validation Guidance:	National Functional Guidelines for Organic and Inorganic Data, June 1991 and February, 1994, respectively
QA/QC Level:	EPA DQO Level III
Method(s) Utilized:	SW846 Third Edition
Analytical Fractions:	Volatiles, Iron, Manganese

Analytical data in this report were screened to determine usability of results and also to determine contractual compliance relative to these requirements and deliverables. This screening assumes analytical results are correct as reported and merely provides an interpretation of the reported quality control results. A minimum of 10% of all laboratory calculations have been verified as part of this validation. All instrument output, i.e. spectra, chromatograms, etc., for each sample have been carefully reviewed. The end-user in urged to review the Specific Findings and associated Data Qualifications presented in this report. Annotated Form 1s or spreadsheets for all samples reviewed are included after the Data Assessment Narratives. Form 1s for MS/MSD samples or spreadsheets are not annotated.

The release of this Data Validation Report is authorized by the following signature:

for Kimberly S. Thopp
Paul B. Humburg, President

8 October 1996
Date

4127 Plaza 94 South · St. Charles, MO 63304
(314) 936-1332 · Fax (314) 936-1335

SDG# 1975

Samples and Fractions Reviewed

Sample Identifications — Analytical Fractions

ENSAFE ID	MATRIX	VOA		FE		MN	
000T082296	WATER	X					
000T082396	WATER	X					
005G05FF03	WATER	X					
007G01LF03	WATER	X		X		X	
007G04UC03	WATER	X					
007G05UC03	WATER	X					
007G07UC03	WATER	X					
007G10LF03	WATER	X					
007G11LF03	WATER	X		X		X	
007G13LF03	WATER	X		X		X	
007G14LF03	WATER	X		X		X	
007G15LF03	WATER	X		X		X	
007G15UF03	WATER	X		X		X	
007G16LF03	WATER	X		X		X	
007G17LF03	WATER	X		X		X	
007H17LF03	WATER			X		X	
007G18LF03	WATER	X		X		X	
007GL6LF03	WATER	X		X		X	
007HL6LF03	WATER	X		X		X	
007GP6LF03	WATER	X		X		X	
007HP6LF03	WATER	X		X		X	
Total Billable Samples	(Water/Soil)	20	0	14	0	14	0

VOA= SW846 Volatiles
FE= SW846 Iron
MN= SW846 Manganese

DATA ASSESSMENT NARRATIVE

VOLATILE ORGANICS

General

The organic findings offered in this screening report assumes that all analytical results are correct as reported and is based upon the examination of the reported holding times, blank analysis results, surrogate and matrix spike recoveries, GC/MS performance, tuning results, calibration results and internal standard areas. This report was prepared in compliance relative to the analytical and deliverable requirements specified in the U.S.EPA SW846 Method 8240 with CLP deliverables; the National Functional Guidelines for Organic Data Validation, June 1991, and DQO Level III requirements. All comments made within this report should be considered when examining the analytical results. Please refer the specific findings found in each category to the Summary of Data Qualification table.

SDG # 1975

A validation was performed on the Volatile Data from SDG 1975. The data was evaluated based on the following parameters:

* • Data Completeness
* • Holding Times
* • GC/MS Tuning
* • Calibration
* • Blanks
* • Surrogate Recoveries
* • Matrix Spike/Matrix Spike Duplicates
* • Field Duplicates
* • Internal Standard Performance
* • Compound Identification
* • Compound Quantitation

* - All criteria were met for this parameter.

System Performance and Overall Assessment

The overall performance was acceptable. The laboratory reported all parameters using CLP 3/90 criteria, not SW846 8240. The data as presented did not require qualifications.

GLOSSARY OF DATA QUALIFIERS

QUALIFICATION CODES

U = Not detected

J = Estimated value

UJ = Reported Quantitation limit is qualified as estimated

UR = Result is rejected and unusable

D = Result value is based on dilution analysis

METHOD BLANK QUALIFICATION CODES

CRQL = The sample result for the blank contaminant is less than the sample CRQL and is less than 10X the method blank value. The sample result for the blank contaminant is rejected and the CRQL for that compound is reported.

U = The sample result for the blank contaminant is greater than the sample CRQL and is less than 10X the method blank value. The sample result for the blank contaminant is qualified as non detected at the compound value reported.

No Action = The sample result for the blank contaminant is greater than the sample CRQL and is greater than 10X the method blank value. The sample result for the blank contaminant is not qualified with any blank qualifiers.

SUMMARY OF DATA QUALIFICATIONS

SAMPLE ID	ANALYTE ID	DL	QL

NO QUALIFICATIONS WERE REQUIRED

* DL denotes the Form I qualifier supplied by the laboratory
QL denotes the qualifier used by the data validation firm
+ in the DL column denotes a positive result
- in the DL column denotes a non detect result

DATA ASSESSMENT NARRATIVE

VOLATILE ORGANICS

General

The organic findings offered in this screening report assumes that all analytical results are correct as reported and is based upon the examination of the reported holding times, blank analysis results, surrogate and matrix spike recoveries, GC/MS performance, tuning results, calibration results and internal standard areas. This report was prepared in compliance relative to the analytical and deliverable requirements specified in the SW-846 Method 8240; the National Functional Guidelines for Organic Data Validation, June 1991, and DQO Level III requirements. All comments made within this report should be considered when examining the analytical results. Please refer the specific findings found in each category to the Summary of Data Qualification table.

SDG # MEM07

A validation was performed on the Volatile Data from SDG MEM07. The data was evaluated based on the following parameters:

*	•	Data Completeness
*	•	Holding Times
*	•	GC/MS Tuning
	•	Calibration
*	•	Blanks
*	•	Surrogate Recoveries
*	•	Matrix Spike/Matrix Spike Duplicates
*	•	Field Duplicates
*	•	Internal Standard Performance
*	•	Compound Identification
	•	Compound Quantitation

* - All criteria were met for this parameter.

Continuing Calibrations

The continuing calibrations were not acceptable for all compound %Ds. Qualifications were required.

Continuing Calibrations, continued

Specific Findings

The continuing calibration AB372 contained one (1) compound with a %D greater than 50% but less than 90%. For the samples and non-compliant compound listed below, the positive results are qualified as estimated, J, and the non-detect results are qualified as estimated, UJ.

007G01LF04	acetone (75.0%)
007G03LF04	
007G04LF04	
007G04UF04	
007G06LF04	
007G06UF04	
007G13LF04	
007G14LF04	
007G17LF04	
007H04LF04	
007H06LF04	

The continuing calibration AQ557 contained one (1) compound with a %D greater than 25% but less than 50%. For the samples and non-compliant compound listed below, the positive results are qualified as estimated, J.

007G06UF04	2-hexanone (33.3%)

Compound Quantitation

Specific Finding

For the following samples, the E flagged results are replaced with the corresponding results from the dilution analyses. All other results from the dilutions are not used in favor of the results reported from the original analysis.

007G04LF04
007H04LF04

System Performance and Overall Assessment

The data reviewer estimates that less than 5% of the data required qualifications.

GLOSSARY OF DATA QUALIFIERS

QUALIFICATION CODES

U = Not detected

J = Estimated value

UJ = Reported Quantitation limit is qualified as estimated

UR = Result is rejected and unusable

D = Result value is based on dilution analysis

METHOD BLANK QUALIFICATION CODES

CRQL = The sample result for the blank contaminant is less than the sample CRQL and is less than 5X (10X for common laboratory contaminants) the method blank value. The sample result for the blank contaminant is rejected and the CRQL for that compound is reported.

U = The sample result for the blank contaminant is greater than the sample CRQL and is less than 5X (10X for common laboratory contaminants) the method blank value. The sample result for the blank contaminant is qualified as non detected at the compound value reported.

No Action = The sample result for the blank contaminant is greater than the sample CRQL and is greater than 5X (10X for common laboratory contaminants) the method blank value. The sample result for the blank contaminant is not qualified with any blank qualifiers.

SUMMARY OF DATA QUALIFICATIONS

SAMPLE ID	COMPOUND ID	DL	QL
007G01LF04	acetone	+/-	J/UJ
007G03LF04			
007G04LF04			
007G04UF04			
007G06LF04			
007G06UF04			
007G13LF04			
007G14LF04			
007G17LF04			
007H04LF04			
007H06LF04			
007G06UF04	2-hexanone	+	J
007G04LF04	All E Flagged	+E	D
007H04LF04			
007G04LF04DL	All except corresponding	+/-	Not Used
007H04LF04DL	D flagged results		

* DL denotes the Form I qualifier supplied by the laboratory
QL denotes the qualifier used by the data validation firm
\+ in the DL column denotes a positive result
\- in the DL column denotes a non detect result

HEARTLAND
ENVIRONMENTAL SERVICES, INC.

RECEIVED JUL 1 1997

Data Validation Report

SDG#:	MEM18
Date:	June 27, 1997
Client Name:	Ensafe/ Allen & Hoshall
Project/Site Name:	NSA Memphis
Date Sampled:	May 2-8, 1997
Number of Samples:	19 Aqueous Sample(s) with 0 MS/MSD(s)
Laboratory:	Savannah Laboratories
Validation Guidance:	National Functional Guidelines for Organic and Inorganic Data, June 1991 and February, 1994, respectively
QA/QC Level:	EPA DQO Level III
Method(s) Utilized:	SW846 Third Edition
Analytical Fractions:	Volatiles, Methane, Iron, Manganese

Analytical data in this report were screened to determine usability of results and also to determine contractual compliance relative to these requirements and deliverables. This screening assumes analytical results are correct as reported and merely provides an interpretation of the reported quality control results. A minimum of 10% of all laboratory calculations have been verified as part of this validation. All instrument output, i.e. spectra, chromatograms, etc., for each sample have been carefully reviewed. The end-user in urged to review the Specific Findings and associated Data Qualifications presented in this report. Annotated Form 1s or spreadsheets for all samples reviewed are included after the Data Assessment Narratives. Form 1s for MS/MSD samples or spreadsheets are not annotated.

The release of this Data Validation Report is authorized by the following signature:

Craig G. Searfoss
Paul B. Humburg, President

6/30/97
Date

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SDG# MEM18

Samples and Fractions Reviewed

Sample Identifications — Analytical Fractions

ENSAFE ID	MATRIX	VOA		METH		FE		MN	
000T050697	WATER	X							
000T050897	WATER	X							
005G03LS04	WATER	X		X		X		X	
005G05FF04	WATER	X		X		X		X	
005H05FF04	WATER	X		X		X		X	
005G05LF04	WATER	X		X		X		X	
005G06LS04	WATER	X		X		X		X	
005G07LS04	WATER	X		X		X		X	
005G08FF04	WATER	X		X		X		X	
005G09FF04	WATER	X		X		X		X	
007G01UC04	WATER	X							
007G03UF04	WATER	X							
007G04UC04	WATER	X							
007G05UC04	WATER	X							
007G07LF04	WATER	X							
007G07UF04	WATER	X							
007G08LF04	WATER	X							
007G08UF04	WATER	X							
007G10LF04	WATER	X							
Total Billable Samples	(Water/Soil	19	0	8	0	8	0	8	0

VOA = SW846 Volatiles
METH = SW846 Methane
FE = SW846 Iron
MN = SW846 Manganese

DATA ASSESSMENT NARRATIVE

VOLATILE ORGANICS

General

The organic findings offered in this screening report assumes that all analytical results are correct as reported and is based upon the examination of the reported holding times, blank analysis results, surrogate and matrix spike recoveries, GC/MS performance, tuning results, calibration results and internal standard areas. This report was prepared in compliance relative to the analytical and deliverable requirements specified in the SW-846 Method 8240; the National Functional Guidelines for Organic Data Validation, February 1994, and DQO Level III requirements. All comments made within this report should be considered when examining the analytical results. Please refer the specific findings found in each category to the Summary of Data Qualification table.

SDG # MEM18

A validation was performed on the Volatile Data from SDG MEM18. The data was evaluated based on the following parameters:

*	•	Data Completeness
*	•	Holding Times
*	•	GC/MS Tuning
*	•	Calibration
	•	Blanks
*	•	Surrogate Recoveries
*	•	Matrix Spike/Matrix Spike Duplicates
*	•	Field Duplicates
*	•	Internal Standard Performance
*	•	Compound Identification
*	•	Compound Quantitation

* - All criteria were met for this parameter.

Method Blanks

Qualifications were required due to contamination in one (1) of the method blanks associated with the samples in this SDG. The end-user should note that the action levels indicated for the blank analysis may not involve the same weights, volumes, dilution factors, or percent moisture as associated samples. These factors must be taken into consideration when applying the 5X or 10X criteria to field samples.

Method Blanks, continued

Associated Blank	Compound	Conc.	Action Level
IM0514MB	tetrachloroethene	0.89 μg/L	4.45 μg/L

Samples	Compound	Qualification
007G05UC04	tetrachloroethene	CRQL
007G08LF04		

System Performance and Overall Assessment

The data required qualifications.

GLOSSARY OF DATA QUALIFIERS

QUALIFICATION CODES

U = Not detected

J = Estimated value

UJ = Reported Quantitation limit is qualified as estimated

UR = Result is rejected and unusable

D = Result value is based on dilution analysis

METHOD BLANK QUALIFICATION CODES

CRQL = The sample result for the blank contaminant is less than the sample CRQL and is less than 5X (10X for common laboratory contaminants) the method blank value. The sample result for the blank contaminant is rejected and the CRQL for that compound is reported.

U = The sample result for the blank contaminant is greater than the sample CRQL and is less than 5X (10X for common laboratory contaminants) the method blank value. The sample result for the blank contaminant is qualified as non detected at the compound value reported.

No Action = The sample result for the blank contaminant is greater than the sample CRQL and is greater than 5X (10X for common laboratory contaminants) the method blank value. The sample result for the blank contaminant is not qualified with any blank qualifiers.

SUMMARY OF DATA QUALIFICATIONS

SAMPLE ID	COMPOUND ID	DL	QL
007G05UC04	tetrachloroethene	+	CRQL
007G08LF04			

* DL denotes the Form I qualifier supplied by the laboratory
QL denotes the qualifier used by the data validation firm
+ in the DL column denotes a positive result
- in the DL column denotes a non detect result

DATA ASSESSMENT NARRATIVE

METHANE

General

The organic findings offered in this screening report assumes that all analytical results are correct as reported and is based upon the examination of the reported holding times, blank analysis results, surrogate and matrix spike recoveries, GC performance, and calibration results. This report was prepared in compliance relative to the analytical and deliverable requirements specified in the Savannah Laboratories' SOP (AR30:08.11.94); the National Functional Guidelines for Organic Data Validation, February 1994; and DQO Level III requirements. All comments made within this report should be considered when examining the analytical results. Please refer the specific findings found in each category to the Summary of Data Qualification table.

SDG # MEM18

A validation was performed on the Methane Data from SDG MEM18. The data was evaluated based on the following parameters:

*	•	Data Completeness
*	•	Holding Times
*	•	GC Performance
	•	Calibration
*	•	Blanks
*	•	Surrogate Recoveries
*	•	Matrix Spike/Matrix Spike Duplicates
*	•	Field Duplicates
*	•	Compound Identification
	•	Compound Quantitation

* - All criteria were met for this parameter.

Initial Calibration

The initial calibration of 05/19/97 contained a compound with a R^2 less than 0.995 but greater than 0.990. For the sample and the non-compliant compound listed below, the positive results are qualified as estimated, J.

005G08FF04DL Methane (0.992)

Compound Identification/Quantitation

One (1) sample required dilution to accurately quantitate target compounds. For the following sample, the original analysis is not used in favor of the results reported from the dilution analysis.

005G08FF04

System Performance and Overall Assessment

The data required qualifications.

GLOSSARY OF DATA QUALIFIERS

QUALIFICATION CODES

U = Not detected

J = Estimated value

UJ = Reported quantitation limit is qualified as estimated

NJ = Result is considered presumptively present at an estimated concentration

UR = Result is rejected and unusable

D = Result value is based on dilution analysis

METHOD BLANK QUALIFICATION CODES

CRQL = The sample result for the blank contaminant is less than the sample CRQL and is less than 5X the method blank value. The sample result for the blank contaminant is rejected and the CRQL for that compound is reported.

U = The sample result for the blank contaminant is greater than the sample CRQL and is less than 5X the method blank value. The sample result for the blank contaminant is qualified as non detected at the compound value reported.

No Action = The sample result for the blank contaminant is greater than the sample CRQL and is greater than 5X the method blank value. The sample result for the blank contaminant is not qualified with any blank qualifiers.

SUMMARY OF DATA QUALIFICATIONS

SAMPLE ID	COMPOUND ID	DL	QL
005G08FF04DL	Methane	+	J
005G08FF04	ALL	+/-	Not Used

* DL denotes the Form I qualifier supplied by the laboratory
QL denotes the qualifier used by the data validation firm
\+ in the DL column denotes a positive result
\- in the DL column denotes a non-detect result

DATA ASSESSMENT NARRATIVE
Iron and Manganese

General

The inorganic findings offered in this screening report assumes that all analytical results are correct as reported and is based upon the examination of the reported holding times, blank analysis results, matrix spike and LCS recoveries, matrix duplicates and calibration results. This report was prepared in compliance relative to the analytical and deliverable requirements specified in the SW 846 Methods; the Functional Guidelines for Inorganic Data Validation, February 1994, and DQO Level III requirements. All comments made within this report should be considered when examining the analytical results. Please refer the specific findings found in each category to the Summary of Data Qualification table.

SDG # MEM18

A validation was performed on the Iron and Manganese Data from SDG MEM18. The data was evaluated based on the following parameters.

*	•	Data Completeness
*	•	Holding Times
*	•	Calibrations
	•	Blanks
*	•	Interferences
*	•	Matrix Spike Recovery
*	•	Matrix Duplicates
*	•	Field Duplicates
*	•	Laboratory Control Samples
*	•	Serial Dilutions

* - All criteria were met for this parameter.

Preparation and Field Blanks

The calibration blanks exhibited contamination for the following elements.

Elements	Conc.	Samples affected
Iron	37.5 ug/l	all water samples below 187.5 ug/l
Manganese	4.2 ug/l	all water samples below 21.0 ug/l

The preparation blank exhibited contamination for the following elements.

Elements	Conc.	Samples affected
Iron	6.3 ug/l	no impact

The USEPA requires that all sample values below five times the preparation, field, DI or calibration blank contamination be qualified as non-detect, "U".

"B" qualifier

All sample results left with a "B" qualifier after all other qualifications, will be qualified with a "J" qualifier in place of the "B" per Ensafe's request.

SUMMARY OF DATA QUALIFICATIONS

Sample ID	Analyte	DL	QL
All water samples below 187.5 ug/l	Fe.	+	U
All water samples below 21.0 ug/l	Mn.		
All "B" results	all analytes	B	J

HEARTLAND
ENVIRONMENTAL SERVICES, INC.

Data Validation Report

SDG#:	MEM32
Date:	February 10, 1998
Client Name:	EnSafe
Project/Site Name:	NSA Memphis
Date Sampled:	November 4-5, 1997
Number of Samples:	22 Aqueous Sample(s) with 0 MS/MSD(s)
Laboratory:	Savannah Laboratories
Validation Guidance:	National Functional Guidelines for Organic and Inorganic Data, February, 1994
QA/QC Level:	EPA DQO Level III
Method(s) Utilized:	SW846 Third Edition
Analytical Fractions:	Volatiles, Methane, Iron, Manganese

Analytical data in this report were screened to determine usability of results and also to determine contractual compliance relative to these requirements and deliverables. This screening assumes analytical results are correct as reported and merely provides an interpretation of the reported quality control results. A minimum of 10% of all laboratory calculations have been verified as part of this validation. All instrument output, i.e. spectra, chromatograms, etc., for each sample have been carefully reviewed. The end-user is urged to review the Specific Findings and associated Data Qualifications presented in this report. Annotated Form 1s or spreadsheets for all samples reviewed are included after the Data Assessment Narratives. Form 1s for MS/MSD samples or spreadsheets are not annotated.

The release of this Data Validation Report is authorized by the following signature:

Craig G. Seaman
Paul B. Humburg, President

2/13/98
Date

4127 Plaza 94 South · St. Charles, MO 63304
(314) 936-1332 · Fax (314) 936-1335

SDG# MEM32

Samples and Fractions Reviewed

Sample Identifications — Analytical Fractions

ENSAFE ID	MATRIX	VOA		MET		FE		MN	
000T110497	WATER	X							
000T110597	WATER	X							
005G01UF05	WATER	X							
005G02UF05	WATER	X							
005H02UF05	WATER	X							
005G03LS05	WATER	X		X		X		X	
005G03UF05	WATER	X							
005G04UF05	WATER	X							
005G05FF05	WATER	X		X		X		X	
005H05FF05	WATER	X		X		X		X	
005G05LF05	WATER	X		X		X		X	
005G06LS05	WATER	X		X		X		X	
005G07LS05	WATER	X		X		X		X	
005G09FF05	WATER	X		X		X		X	
005F110497	WATER	X		X		X		X	
007G03UC05	WATER	X							
007G03UF05	WATER	X							
060G04LF05	WATER	X							
060H04LF05	WATER	X							
105E110597	WATER	X							
205E110597	WATER	X							
305E110597	WATER	X							
Total Billable Samples	(Water/Soil)	22	0	8	0	8	0	8	0

VOA = SW846 Volatiles
MET = Methane
FE = Iron
MN = Manganese

DATA ASSESSMENT AND NARRATIVE

VOLATILE ORGANICS

General

The organic findings offered in this screening report assumes that all analytical results are correct as reported and is based upon the examination of the reported holding times, blank analysis results, surrogate and matrix spike recoveries, GC/MS performance, tuning results, calibration results and internal standard areas. This report was prepared in compliance relative to the analytical and deliverable requirements specified in the U.S. EPA SW846, Method 8260 with CLP deliverables; the National Functional Guidelines for Organic Data Review, February 1994, and DQO Level III. All comments made within this report should be considered when examining the analytical results. Please refer the specific findings found in each category to the Summary of Data Qualifications table.

SDG # MEM32

A validation was performed on the Volatile Data from SDG MEM32. The data was evaluated based on the following parameters.

* • Data Completeness
* • Holding Times
* • GC/MS Tuning
* • Calibrations
* • Internal Standard Performance
* • Blanks
* • Surrogate Recoveries
* • Matrix Spike/Matrix Spike Duplicates
* • Field Duplicates
* • Compound Identification /Quantitation

* - All criteria were met for this parameter

System Performance and Overall Assessment

The laboratory did not encounter any large problems. The data as reported did not require qualifications.

GLOSSARY OF DATA QUALIFIERS

QUALIFICATION CODES

U = Not detected

J = Estimated value

UJ = Reported quantitation limit is qualified as estimated

R = Result is rejected and unusable

D= result value is based on dilution analysis

METHOD BLANK QUALIFICATION CODES

CRQL = The sample result for the blank contaminant is less than the sample CRQL and is less than 10X the method blank value. The sample result for the blank contaminant is rejected and the CRQL for that analyte is reported.

U = The sample result for the blank contaminant is greater than the sample CRQL and is less than 10X the method blank value. The sample result for the blank contaminant is qualified as non detected at the analyte value reported.

No Action = The sample result for the blank contaminant is greater than the sample CRQL and is greater than 10X the method blank value. The sample result for the blank contaminant is not qualified with any blank qualifiers.

The specific findings will be noted in numerical form on the Form Is in this data validation report. These specific finding footnotes will reflect the conclusions found in the data validation process that resulted in the qualification of the data.

SUMMARY OF DATA QUALIFICATIONS

SAMPLE ID	ANALYTE ID	DL	QL

No qualifications are required.

* DL denotes the Form I qualifier supplied by the laboratory
QL denotes the qualifier used by the data validation firm
+ in the DL column denotes a positive result
- in the DL column denotes a non detect result

DATA ASSESSMENT NARRATIVE

METHANE

General

The organic findings offered in this screening report assumes that all analytical results are correct as reported and is based upon the examination of the reported holding times, blank analysis results, calibration results, surrogate and matrix spike recoveries, and GC performance. This report was prepared in compliance relative to the analytical and deliverable requirements specified in the Savannah Laboratories' SOP; the National Functional Guidelines for Organic Data Review, where applicable; and EPA DQO Level III requirements. Please refer the specific findings found in each category to the Summary of Data Qualifications table.

SDG# MEM32

A validation was performed on the METHANE data from SDG MEM32. The data was evaluated based on the following parameters.

*	•	Data Completeness
*	•	Holding Times
*	•	GC/MS Tuning
*	•	Calibrations
*	•	Internal Standard Performance
*	•	Blanks
*	•	Surrogate Recoveries
*	•	Matrix Spike/Matrix Spike Duplicate
*	•	Field Duplicates
*	•	Identification/Quantitation

* - All criteria were met for this parameter.

Method Deviations

The laboratory did not spike the samples, standards and blanks with a surrogate compound. No qualifications were required.

Overall Performance

The data did not require qualification.

GLOSSARY OF DATA QUALIFIERS

QUALIFICATION CODES

U = Not detected

J = Estimated value

UJ = Reported Quantitation limit is qualified as estimated

UR = Result is rejected and unusable

D = Result value is based on dilution analysis

METHOD BLANK QUALIFICATION CODES

CRQL = The sample result for the blank contaminant is less than the sample CRQL and is less than 10X the method blank value. The sample result for the blank contaminant is rejected and the CRQL for that compound is reported.

U = The sample result for the blank contaminant is greater than the sample CRQL and is less than 10X the method blank value. The sample result for the blank contaminant is qualified as non detected at the compound value reported.

No Action = The sample result for the blank contaminant is greater than the sample CRQL and is greater than 10X the method blank value. The sample result for the blank contaminant is not qualified with any blank qualifiers.

SUMMARY OF DATA QUALIFICATIONS

SAMPLE ID	COMPOUND ID	DL	QL

NO QUALIFICATIONS WERE REQUIRED

* DL denotes the Form I qualifier supplied by the laboratory
QL denotes the qualifier used by the data validation firm
+ in the DL column denotes a positive result
- in the DL column denotes a non detect result

DATA ASSESSMENT NARRATIVE
IRON AND MANGANESE

General

The inorganic findings offered in this screening report assumes that all analytical results are correct as reported and is based upon the examination of the reported holding times, blank analysis results, matrix spike and LCS recoveries, matrix duplicates and calibration results. This report was prepared in compliance relative to the analytical and deliverable requirements specified in the SW 846 Methods; the Functional Guidelines for Inorganic Data Validation, February 1994, and DQO Level III requirements. All comments made within this report should be considered when examining the analytical results. Please refer the specific findings found in each category to the Summary of Data Qualification table.

SDG # MEM32

A validation was performed on the Iron and Manganese Data from SDG MEM32. The data was evaluated based on the following parameters.

*	•	Data Completeness
*	•	Holding Times
*	•	Calibrations
*	•	Blanks
*	•	Interferences
*	•	Matrix Spike Recovery
*	•	Matrix Duplicates
*	•	Field Duplicates
*	•	Laboratory Control Samples
*	•	Serial Dilutions

* - All criteria were met for this parameter.

"B" Qualifier

All sample results left with a "B" qualifier after all other qualifications, will be qualified with a "J" qualifier in place of the "B" per Ensafe's request.

SUMMARY OF DATA QUALIFICATIONS

Sample ID	Analyte	DL	QL
All "B" results	all analytes	B	J

ENSAFE VALIDATION SUMMARY REPORT

Site Name:	NSA Mid-South, Millington, Tennessee
CTO and Subtask No.:	0094-001-04-730-00
Laboratory:	Savannah Laboratory and Environmental Services, Savannah, Georgia
Sample Delivery Group:	MEM53
Matrix:	Soil
DQO Level:	III

Table 1
SDG MEM53 Sample IDs and Analyses

Sample ID	8260-Volatile Organic Compounds
005SGB0110	X
039S002311	X
039S002313	X

VALIDATION RESULTS

All samples were received by the laboratory intact and with the proper documentation on June 4 and 9, 1998. The following section summarizes the data validation results. Tentatively identified compounds (TICs) have not been discussed in great detail because most compounds are quantitatively uncertain (many TICs are unidentifiable and are reported as unknowns).

Volatile Organic Compound Fraction

1. All holding times, GC/MS instrument performance check standard, surrogate, continuing calibration, internal standard, blank spike/blank spike duplicate, method and trip blank results were acceptable. A field duplicate was not collected with this SDG. No problems were encountered during review of sample result verification.

2. Chloroethane was calibrated by linear regression for this SDG. The correlation coefficient for chloroethane (0.986) was below the control limit of 0.990. The results for chloroethane in sample 005SGB0110 was qualified as unusable "UR" for the nondetect result.

3. Methylene chloride was detected in the LCS and LCSD at concentrations of 1.2 micrograms per kilogram (μg/kg) and 180 μg/kg, respectively. Methylene chloride was qualified as nondetect in samples 005SGB0110 and 039S002313 due to the detection of a compound that was not spiked into the standards.

ENSAFE VALIDATION SUMMARY REPORT

Site Name:	NSA Mid-South, Millington, Tennessee
CTO and Subtask No.:	0094-001-04-730-00
Laboratory:	Savannah Laboratory and Environmental Services, Savannah, Georgia
Sample Delivery Group:	MEM54
Matrix:	Water
DQO Level:	III

Table 1
SDG MEM54 Sample IDs and Analyses

Sample ID	8260-Volatile Organic Compounds
005GGB0112	X
005GGB0147	X
005GGB0212	X
005GGB0248	X
005GGB0312	X
005GGB0347	X
005GGB0412	X
005GGB0447	X
005GGB0512	X
005GGB0547	X
005HGB0447	X
775G000144	X
775G000116	X

VALIDATION RESULTS

All samples were received by the laboratory intact and with the proper documentation on June 4, 6, and 9, 1998. The following section summarizes the data validation results. Tentatively identified compounds (TICs) have not been discussed in great detail because most compounds are quantitatively uncertain (many TICs are unidentifiable and are reported as unknowns).

Volatile Organic Compound Fraction

1. All holding times, GC/MS instrument performance check standard, surrogate, continuing calibration, internal standard, blank spike/blank spike duplicate, method blank, and field duplicate results were acceptable. No problems were encountered during review of sample result verification.

2. Bromomethane was calibrated by linear regression for this SDG. The correlation coefficient for bromomethane (0.986) was below the control limit of 0.990. The results for bromomethane in samples 005GGB0112, 005GGB0147, 005GGB0212, 005GGB0412, 005GGB0447, 005HGB0447, 005GGB0512, 005GGB0547, 775G000116, and 775G000144 were qualified as unusable "UR" for their nondetect results.

3. Methylene chloride was detected in the LCS at a concentration of 3.1 micrograms per liter. Methylene chloride was qualified as nondetect in samples 005GGB0248, 005GGB0312, and 005GGB0347 due to the detection of a compound that was not spiked into the standard.

ENSAFE VALIDATION SUMMARY REPORT

Site Name:	NSA Mid-South, Millington, Tennessee
CTO and Subtask No.:	0094-001-04-730-00
Laboratory:	Savannah Laboratory and Environmental Services, Savannah, Georgia
Sample Delivery Group:	MEM59
Matrix:	Water
DQO Level:	III

Table 1
SDG MEM59 Sample IDs and Analyses

Sample ID	8260-Volatile Organic Compounds
007G04LF5A	X
007G04UF5A	X
007G10LF5A	X
007G11LF5A	X
007G15LF5A	X
007G15UF5A	X
007G27LF5A	X
007G28LF5A	X
007G29LF5A	X
007G30LF5A	X
007H15UF5A	X
005G08LF5A	X
005H08LF50	X
007G20LF5A	X
007G24MF5A	X
007G25MF5A	X
007G26MF5A	X
N12G02LF5A	X

VALIDATION RESULTS

All samples were received by the laboratory intact and with the proper documentation on August 20 and 22, 1998. The following section summarizes the data validation results. Tentatively

identified compounds (TICs) have not been discussed in great detail because most compounds are quantitatively uncertain (many TICs are unidentifiable and are reported as unknowns).

Volatile Organic Compound Fraction

1. All holding times, GC/MS instrument performance check standard, surrogate, initial calibration, internal standard, blank spike/blank spike duplicate, method and trip blank results were acceptable. No problems were encountered during review of sample result verification.

2. Table 2 illustrates compounds whose continuing calibration %D exceeded the control limits of $\leq$ 15%.

Table 2
Continuing Calibration Outliers

Analyte	%D	Qualifiers
Chloromethane	40.0	J (+)/UJ (ND)
Chloroethane	40.0	J (+)/UJ (ND)
1,1,1-Trichloroethane	36.0	J (+)/UJ (ND)
Carbon Tetrachloride	40.0	J (+)/UJ (ND)
1,2-Dichloroethane	28.0	J (+)/UJ (ND)
Bromodichloromethane	28.0	J (+)/UJ (ND)
Tetrachloroethene	28.0	J (+)/UJ (ND)
Dibromochloromethane	28.0	J (+)/UJ (ND)
Bromoform	28.0	J (+)/UJ (ND)
trans-1,1-Dichloropropene	28.0	J (+)/UJ (ND)

Note: J (+)/UJ (ND) = Positive results were qualified as estimated "J" and nondetect results were also qualified as estimated "UJ."

The compounds listed in Table 2 were qualified as indicated in samples 007G04LF5ADL, 007G15UF5ADL, 007G28LF5A, and 007H15UF5A.

3. Samples 005G08LF5A and 005H08LF50 and 007G15UF5A and 007H15UF5A were analyzed as field duplicates. The RPD of 2-butanone (200%) in samples 005G08LF5A and 005H08LF50 exceeded the control limits of $\leq$ 30%. 2-Butanone was qualified as estimated "J" for a detected result and "UJ" for a nondetect result due to poor precision.

Attachment B

Analytical Data Tables

Loess Groundwater Data

Initial Sampling Event Errata

During the initial sampling event (March 22 and March 29, 1995), groundwater samples were collected from the RFI monitoring wells and one existing UST well FFMW-5 and analyzed for FSA, as described previously in Section 4. Five of the 1992 UST investigation shallow monitoring wells (FFMW-4, FFMW-5, FFMW-6, FFMW-8, and FFMW-9) were then sampled on April 17, 1995, for metals, SVOCs, VOCs, and TPH to provide additional loess groundwater data. Monitoring wells and the analyses performed during the initial March and April sampling event are provided in Table F.1.

As shown in the table original sample IDs have been corrected due to sample identification errors made during the initial groundwater sampling event in March and April 1995. Well FFMW-5, adjacent to 05MW04UF, was sampled in March 1995 (mislabeled 05GMW05LS) and again in April 1995 (mislabeled 05MW05LS). To distinguish between wells sampled in March and April of 1995, "0A" and "0B" have been respectively added to the last two digits of the corrected sample IDs to the attached analytical data. Sample identification numbers for the 1992 UST investigation monitoring wells have been corrected to distinguish from similarly numbered RFI wells by inserting an FF in place of the MW. During the April 1995 sampling round, a groundwater sample collected from UST well FFMW-4 was mislabeled as 05GMW04LS — it has been corrected to 05GFF040B. The groundwater sample collected March 1995 from RFI well 05MW06S was identified as 05GMW06LS while the groundwater sample collected from the UST investigation well FFMW-6 in April 1995 was given the same name. The former groundwater sample ID has been corrected to 05GFF060A and the latter to 05GFF060B. These samples can be distinguished by the sample date on the original field notes and sampling forms. Table F.1 summarizes the original and corrected sample identifications and the analytical suite run for each sampling event.

Table F.1
Loess and Fluvial Deposits Groundwater Sample Identifications
Initial Sampling Event (March and April, 1995)

Original RFI Sample ID	1992 UST Investigation ID	Corrected Sample ID	Groundwater	H	M	O	P	SV	V	TPH
05GMW03LS	NA	05GMW030A	S [a]	X	X	X	X	X	X	X
05GMW04LS	FFMW-04	05GFF040B	S [b]		X				X	X
05GMW05LS	FFMW-05	05GFF050A	S [a]	X	X	X	X	X	X	X
05GMW05LS	FFMW-05	05GFF050B	S [b]		X			X	X	X
05GMW06LS	NA	05GMW060A	S [a]	X	X	X	X	X	X	X
05GMW06LS	FFMW-06	05GFF060B	S [b]		X			X	X	X
05GMW07LS	NA	05GMW070A	S [a]	X	X	X	X	X	X	X
05GMW08LS	FFMW-08	05GFF080B	S [b]		X			X	X	X
05GMW09LS	FFMW-09	05GFF090B	S [b]		X			X	X	X
05GMW01UF	NA	05GMW01UF	UF [a]	X	X	X	X	X	X	
05GMW02UF	NA	05GMW02UF	UF [a]	X	X	X	X	X	X	
05GMW03UF	NA	05GMW03UF	UF [a]	X	X	X	X	X	X	
05GMW04UF	NA	05GMW04UF	UF [a]	X	X	X	X	X	X	
05GMW04AUF	NA	05GMW04AUF	UF [a]	X	X	X	X	X	X	
05GMW04BUF	NA	05GMW04BUF	UF [a]	X	X	X	X	X	X	
05GMW05LF	NA	05GMW05LF	LF [a]	X	X	X	X	X	X	

Notes:

NA — Not applicable
UF — Upper fluvial deposits groundwater
LF — Lower fluvial deposits groundwater
S — Loess groundwater
[a] — Sample collected 3/95 (last two digits of corrected sample ID designated with "0A")
[b] — Sample collected 4/95 (last two digits of corrected sample ID designated with "0B")
H — Chlorinated herbicides
M — Metals
O — Organophosphorus pesticides
P — Chlorinated pesticides/PCBs
SV — SVOCs
V — VOCs
TPH — Total Petroleum Hydrocarbons
X — Samples were analyzed using the method indicated in Table 4.1 in Section 4.

DATALCP3
11/05/98

NSA Mid-South, Assembly A - SWMU 5
Initial Sampling Event
Loess Groundwater

APX9-METAL	SAMPLE ID ------->	005-G-FF04-0B		005-G-FF05-0A		005-G-FF05-0B		005-G-FF06-0B		005-G-FF08-0B		005-G-FF09-0B	
	ORIGINAL ID ----->	005GMW04LS		005GMW05LS		005GMW05LS		005GMW06LS		005GMW08LS		005GMW09LS	
	LAB SAMPLE ID --->	1-122125S		2-120949S		1-122126S		1-122127S		1-122128S		1-122129S	
	ID FROM REPORT -->	005GMW04LS		005GMW05LS		005GMW05LS		005GMW06LS		005GMW08LS		005GMW09LS	
	SAMPLE DATE ----->	04/17/95		03/29/95		04/17/95		04/17/95		04/17/95		04/17/95	
	MATRIX ---------->	Water		Water		Water		Water		Water		Water	
	UNITS ---------->	UG/L		UG/L		UG/L		UG/L		UG/L		UG/L	
CAS #	Parameter	1376	VAL	1354	VAL	1376	VAL	1376	VAL	1376	VAL	1376	VAL
7440-36-0	Antimony					64.8							
7440-38-2	Arsenic	11.2		8.5	J	14.2		8.6	J	159.		2.7	J
7440-39-3	Barium	441.		417.		1400.		138.	J	564.		407.	
7440-41-7	Beryllium	2.1	J	1.5	J	3.7	J					1.4	J
7440-43-9	Cadmium	7.9	J	7.7	J	8.3	J			8.5	J		
7440-47-3	Chromium	31.		26.5		45.4							
7440-48-4	Cobalt	11.7	J	8.3	J	21.3	J	3.9	J	7.8	J	4.2	J
7440-50-8	Copper	46.7		37.4		71.5							
7439-92-1	Lead	17.3				22.6		2.	J	4.5		4.6	
7439-97-6	Mercury					0.63						0.23	
7440-02-0	Nickel	39.8	J	26.6	J	69.5				56.4		27.8	J
7782-49-2	Selenium												
7440-22-4	Silver												
7440-28-0	Thallium												
7440-62-2	Vanadium	43.2	J	37.2	J	74.4						4.8	J
7440-66-6	Zinc	132.		157.		233.				26.7		61.5	
7440-31-5	Tin												

000415

*** Validation Complete ***

NSA Mid-South, Assembly A - SWMU 5
Initial Sampling Event
Loess Groundwater

APX9-METAL

		SAMPLE ID ------->	005-G-MW03-0A		005-G-MW06-0A		005-G-MW07-0A				
		ORIGINAL ID ----->	005GMW03LS		005GMW06LS		005GMW07LS				
		LAB SAMPLE ID --->	4-120616S		4-120617S		2-120951S				
		ID FROM REPORT -->	005GMW03LS		005GMW06LS		005GMW07LS				
		SAMPLE DATE ----->	03/24/95		03/24/95		03/29/95				
		MATRIX ---------->	Water		Water		Water				
		UNITS ---------->	UG/L		UG/L		UG/L				
CAS #	Parameter		1353	VAL	1353	VAL	1354	VAL			
7440-36-0	Antimony										
7440-38-2	Arsenic		8.8	J	8.3	J	2.6	J			
7440-39-3	Barium		394.		714.		256.				
7440-41-7	Beryllium				2.8	J					
7440-43-9	Cadmium		6.1		18.1						
7440-47-3	Chromium		19.4		59.9						
7440-48-4	Cobalt		7.4	J	37.2	J					
7440-50-8	Copper		26.9		89.6						
7439-92-1	Lead		13.4	J	56.4	J					
7439-97-6	Mercury										
7440-02-0	Nickel		37.5	J	94.2						
7782-49-2	Selenium										
7440-22-4	Silver										
7440-28-0	Thallium										
7440-62-2	Vanadium		29.3	J	102.		4.5	J			
7440-66-6	Zinc		130.		551.		53.7				
7440-31-5	Tin										

*** Validation Complete ***

NSA Mid-South, Assembly A - SWMU 5
Initial Sampling Event
Loess Groundwater

METAL-CN													
	SAMPLE ID ------->	005-G-FF04-0B		005-G-FF05-0A		005-G-FF05-0B		005-G-FF06-0B		005-G-FF08-0B		005-G-FF09-0B	
	ORIGINAL ID ----->	005GMW04LS		005GMW05LS		005GMW05LS		005GMW06LS		005GMW08LS		005GMW09LS	
	LAB SAMPLE ID --->	122118		120942		122119		122120		122121		122122	
	ID FROM REPORT -->	005GMW04LS		005GMW05LS		005GMW05LS		005GMW06LS		005GMW08LS		005GMW09LS	
	SAMPLE DATE ----->	04/17/95		03/29/95		04/17/95		04/17/95		04/17/95		04/17/95	
	DATE EXTRACTED -->	04/20/95		04/06/95		04/20/95		04/20/95		04/20/95		04/20/95	
	DATE ANALYZED --->	04/23/95		04/10/95		04/23/95		04/23/95		04/23/95		04/23/95	
	MATRIX ---------->	Water		Water		Water		Water		Water		Water	
	UNITS ---------->	mg/L		mg/L		mg/L		mg/L		mg/L		mg/L	
CAS #	Parameter	1376	VAL	1354	VAL	1376	VAL	1376	VAL	1376	VAL	1376	VAL
57-12-5	Cyanide (CN)												

*** Validation Complete ***

NSA Mid-South, Assembly A - SWMU 5
Initial Sampling Event
Loess Groundwater

METAL-CN

SAMPLE ID ------->		005-G-MW06-0A		005-G-MW07-0A			
ORIGINAL ID ----->		005GMW06LS		005GMW07LS			
LAB SAMPLE ID --->		120609		120940			
ID FROM REPORT -->		005GMW06LS		005GMW07LS			
SAMPLE DATE ----->		03/24/95		03/29/95			
DATE EXTRACTED -->		03/31/95		04/06/95			
DATE ANALYZED --->		04/03/95		04/10/95			
MATRIX ---------->		Water		Water			
UNITS ---------->		mg/L		mg/L			
CAS #	Parameter	1353	VAL	1354	VAL		
57-12-5	Cyanide (CN)						

*** Validation complete ***

NSA Mid-South, Assembly A - SWMU 5
Initial Sampling Event
Loess Groundwater

SW846-HERB							
	SAMPLE ID ------->	005-G-FF05-0A	005-G-MW03-0A	005-G-MW06-0A	005-G-MW07-0A		
	ORIGINAL ID ----->	005GMW05LS	005GMW03LS	005GMW06LS	005GMW07LS		
	LAB SAMPLE ID --->	120942	120608	120609	120940		
	ID FROM REPORT -->	005GMW05LS	005GMW03LS	005GMW06LS	005GMW07LS		
	SAMPLE DATE ----->	03/29/95	03/24/95	03/24/95	03/29/95		
	DATE EXTRACTED -->	04/21/95	04/13/95	04/13/95	04/21/95		
	DATE ANALYZED --->	04/22/95	04/13/95	04/13/95	04/22/95		
	MATRIX ---------->	Water	Water	Water	Water		
	UNITS ---------->	ug/L	ug/L	ug/L	ug/L		
CAS #	Parameter	1354 VAL	1353 VAL	1353 VAL	1354 VAL		
94-82-6	2,4-DB						
88-85-7	Dinoseb						
93-76-5	2,4,5-T						
93-72-1	2,4,5-TP (Silvex)						
75-99-0	Dalapon						
1918-00-9	Dicamba						
120-36-5	Dichlorprop						
94-74-6	MCPA						
93-65-2	MCPP						
94-75-7	2,4-D						

*** Validation Complete ***

NSA Mid-South, Assembly A - SWMU 5
Initial Sampling Event
Loess Groundwater

SW846-OP P

SAMPLE ID ------->	005-G-FF05-0A	005-G-MW03-0A	005-G-MW06-0A	005-G-MW07-0A		
ORIGINAL ID ----->	005GMW05LS	005GMW03LS	005GMW06LS	005GMW07LS		
LAB SAMPLE ID --->	120942	120608	120609	120940		
ID FROM REPORT -->	005GMW05LS	005GMW03LS	005GMW06LS	005GMW07LS		
SAMPLE DATE ----->	03/29/95	03/24/95	03/24/95	03/29/95		
DATE EXTRACTED -->	04/11/95	04/10/95	04/10/95	04/11/95		
DATE ANALYZED --->	04/13/95	04/12/95	04/12/95	04/13/95		
MATRIX ---------->	Water	Water	Water	Water		
UNITS ---------->	ug/L	ug/L	ug/L	ug/L		

CAS #	Parameter	1354	VAL	1353	VAL	1353	VAL	1354	VAL				
86-50-0	Azinphos methyl												
35400-43-2	Sulprofos (Bolstar)												
2921-88-2	Chloropyrifos												
56-72-4	Coumaphos												
8065-48-3	Demeton,O												
333-41-5	Diazinon												
62-73-7	Dichlorvos												
298-04-4	Disulfoton												
13194-48-4	Ethoprop												
115-90-2	Fensulfothion												
55-38-9	Fenthion												
150-50-5	Merphos												
7786-34-7	Mevinphos, Alpha												
300-76-5	Naled	4.3		2.8	J	3.	J						
298-00-0	Methyl parathion												
298-02-2	Phorate												
299-84-3	Ronnel												
22248-79-9	Stirophos (Tetrachlorovinphos)												
34643-46-4	Tokuthion												
327-98-0	Trichloronate												
126-75-0	Demeton,S												

*** Validation complete ***

NSA Mid-South, Assembly A - SWMU 5
Initial Sampling Event
Loess Groundwater

SW846-PEST											
	SAMPLE ID ------->	005-G-FF05-0A		005-G-MW03-0A		005-G-MW06-0A		005-G-MW07-0A			
	ORIGINAL ID ----->	005GMW05LS		005GMW03LS		005GMW06LS		005GMW07LS			
	LAB SAMPLE ID --->	120949		120616		120617		120951			
	ID FROM REPORT -->	005GMW05LS		005GMW03LS		005GMW06LS		005GMW07LS			
	SAMPLE DATE ----->	03/29/95		03/24/95		03/24/95		03/29/95			
	DATE EXTRACTED -->	04/03/95		03/30/95		03/30/95		04/03/95			
	DATE ANALYZED --->	04/19/95		04/09/95		04/09/95		04/19/95			
	MATRIX ---------->	Water		Water		Water		Water			
	UNITS ---------->	UG/L		UG/L		UG/L		UG/L			
CAS #	Parameter	1354	VAL	1353	VAL	1353	VAL	1354	VAL		
319-84-6	alpha-BHC										
319-85-7	beta-BHC										
319-86-8	delta-BHC										
58-89-9	gamma-BHC (Lindane)										
76-44-8	Heptachlor										
309-00-2	Aldrin										
1024-57-3	Heptachlor epoxide										
959-98-8	Endosulfan I										
60-57-1	Dieldrin										
72-55-9	4,4'-DDE										
72-20-8	Endrin										
33213-65-9	Endosulfan II										
72-54-8	4,4'-DDD										
1031-07-8	Endosulfan sulfate										
50-29-3	4,4'-DDT										
72-43-5	Methoxychlor										
53494-70-5	Endrin ketone										
7421-93-4	Endrin aldehyde										
5103-71-9	alpha-Chlordane										
5103-74-2	gamma-Chlordane										
8001-35-2	Toxaphene										
12674-11-2	Aroclor-1016										
11104-28-2	Aroclor-1221										
53469-21-9	Aroclor-1242										
12672-29-6	Aroclor-1248										
11097-69-1	Aroclor-1254										
11096-82-5	Aroclor-1260										
11141-16-5	Aroclor-1232										
12789-03-6	Technical Chlordane	NR		NR		NR		NR			

*** Validation Complete ***

NSA Mid-South, Assembly A - SWMU 5
Initial Sampling Event
Loess Groundwater

SW846-SVOA

SAMPLE ID ------->	005-G-FF05-0A	005-G-FF05-0B	005-G-FF06-0B	005-G-FF08-0B	005-G-FF09-0B	005-G-MW03-0A
ORIGINAL ID ----->	005GMW05LS	005GMW05LS	005GMW06LS	005GMW08LS	005GMW09LS	005GMW03LS
LAB SAMPLE ID --->	120949	122126	122127	122128	122129	120616
ID FROM REPORT -->	005GMW05LS	005GMW05LS	005GMW06LS	005GMW08LS	005GMW09LS	005GMW03LS
SAMPLE DATE ----->	03/29/95	04/17/95	04/17/95	04/17/95	04/17/95	03/24/95
DATE EXTRACTED -->	04/05/95	04/24/95	04/24/95	04/24/95	04/24/95	03/31/95
DATE ANALYZED --->	04/27/95	05/05/95	05/05/95	05/05/95	05/05/95	04/13/95
MATRIX ---------->	Water	Water	Water	Water	Water	Water
UNITS ---------->	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L

CAS #	Parameter	1354	VAL	1376	VAL	1376	VAL	1376	VAL	1376	VAL	1353	VAL
108-95-2	Phenol							98.	J				
111-44-4	bis(2-Chloroethyl)ether												
95-57-8	2-Chlorophenol												
541-73-1	1,3-Dichlorobenzene												
106-46-7	1,4-Dichlorobenzene												
95-50-1	1,2-Dichlorobenzene	7.	J	6.	J								
95-48-7	2-Methylphenol (o-Cresol)												
108-60-1	2,2'-oxybis(1-Chloropropane)												
106-44-5	4-Methylphenol (p-Cresol)												
621-64-7	N-Nitroso-di-n-propylamine												
67-72-1	Hexachloroethane												
98-95-3	Nitrobenzene												
78-59-1	Isophorone												
88-75-5	2-Nitrophenol												
105-67-9	2,4-Dimethylphenol												
120-83-2	2,4-Dichlorophenol												
120-82-1	1,2,4-Trichlorobenzene												
91-20-3	Naphthalene							120.	J				
106-47-8	4-Chloroaniline												
87-68-3	Hexachlorobutadiene												
111-91-1	bis(2-Chloroethoxy)methane												
59-50-7	4-Chloro-3-methylphenol												
91-57-6	2-Methylnaphthalene							100.	J				
77-47-4	Hexachlorocyclopentadiene												
88-06-2	2,4,6-Trichlorophenol												
95-95-4	2,4,5-Trichlorophenol												
91-58-7	2-Chloronaphthalene												
88-74-4	2-Nitroaniline												
131-11-3	Dimethylphthalate												
208-96-8	Acenaphthylene												
606-20-2	2,6-Dinitrotoluene												
99-09-2	3-Nitroaniline												
83-32-9	Acenaphthene							3.	J				
51-28-5	2,4-Dinitrophenol												
100-02-7	4-Nitrophenol												
132-64-9	Dibenzofuran												

*** Validation Complete ***

NSA Mid-South, Assembly A - SWMU 5
Initial Sampling Event
Loess Groundwater

SW846-SVOA							
	SAMPLE ID ------->	005-G-FF05-0A	005-G-FF05-0B	005-G-FF06-0B	005-G-FF08-0B	005-G-FF09-0B	005-G-MW03-0A
	ORIGINAL ID ----->	005GMW05LS	005GMW05LS	005GMW06LS	005GMW08LS	005GMW09LS	005GMW03LS
	LAB SAMPLE ID --->	120949	122126	122127	122128	122129	120616
	ID FROM REPORT -->	005GMW05LS	005GMW05LS	005GMW06LS	005GMW08LS	005GMW09LS	005GMW03LS
	SAMPLE DATE ----->	03/29/95	04/17/95	04/17/95	04/17/95	04/17/95	03/24/95
	DATE EXTRACTED -->	04/05/95	04/24/95	04/24/95	04/24/95	04/24/95	03/31/95
	DATE ANALYZED --->	04/27/95	05/05/95	05/05/95	05/05/95	05/05/95	04/13/95
	MATRIX ---------->	Water	Water	Water	Water	Water	Water
	UNITS ---------->	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L
CAS #	Parameter	1354 VAL	1376 VAL	1376 VAL	1376 VAL	1376 VAL	1353 VAL
121-14-2	2,4-Dinitrotoluene						
84-66-2	Diethylphthalate						
7005-72-3	4-Chlorophenylphenyl ether						
86-73-7	Fluorene						
100-01-6	4-Nitroaniline						
534-52-1	2-Methyl-4,6-Dinitrophenol						
86-30-6	N-Nitrosodiphenylamine						
101-55-3	4-Bromophenyl-phenylether						
118-74-1	Hexachlorobenzene						
87-86-5	Pentachlorophenol						
85-01-8	Phenanthrene						
120-12-7	Anthracene						
86-74-8	Carbazole						
84-74-2	Di-n-butylphthalate						
206-44-0	Fluoranthene						
129-00-0	Pyrene						
85-68-7	Butylbenzylphthalate						
91-94-1	3,3'-Dichlorobenzidine						
56-55-3	Benzo(a)anthracene						
218-01-9	Chrysene						
117-81-7	bis(2-Ethylhexyl)phthalate (BEHP)						
117-84-0	Di-n-octylphthalate						
205-99-2	Benzo(b)fluoranthene						
207-08-9	Benzo(k)fluoranthene						
50-32-8	Benzo(a)pyrene						
193-39-5	Indeno(1,2,3-cd)pyrene						
53-70-3	Dibenz(a,h)anthracene						
191-24-2	Benzo(g,h,i)perylene						
9999900-32-2	3-Methylphenol/4-Methylphenol	NR	NR	NR	NR	NR	NR
122-39-4	Diphenylamine	NR	NR	NR	NR	NR	NR

000423

*** Validation Complete ***

NSA Mid-South, Assembly A - SWMU 5
Initial Sampling Event
Loess Groundwater

SW846-SVOA

SAMPLE ID ------->	005-G-MW06-0A		005-G-MW07-0A				
ORIGINAL ID ----->	005GMW06LS		005GMW07LS				
LAB SAMPLE ID --->	120617		120951				
ID FROM REPORT -->	005GMW06LS		005GMW07LS				
SAMPLE DATE ----->	03/24/95		03/29/95				
DATE EXTRACTED -->	03/31/95		04/05/95				
DATE ANALYZED --->	04/13/95		04/28/95				
MATRIX ---------->	Water		Water				
UNITS ---------->	UG/L		UG/L				
CAS # Parameter	1353	VAL	1354	VAL			
108-95-2 Phenol							
111-44-4 bis(2-Chloroethyl)ether							
95-57-8 2-Chlorophenol							
541-73-1 1,3-Dichlorobenzene							
106-46-7 1,4-Dichlorobenzene							
95-50-1 1,2-Dichlorobenzene							
95-48-7 2-Methylphenol (o-Cresol)							
108-60-1 2,2'-oxybis(1-Chloropropane)							
106-44-5 4-Methylphenol (p-Cresol)							
621-64-7 N-Nitroso-di-n-propylamine							
67-72-1 Hexachloroethane							
98-95-3 Nitrobenzene							
78-59-1 Isophorone							
88-75-5 2-Nitrophenol							
105-67-9 2,4-Dimethylphenol							
120-83-2 2,4-Dichlorophenol							
120-82-1 1,2,4-Trichlorobenzene							
91-20-3 Naphthalene							
106-47-8 4-Chloroaniline							
87-68-3 Hexachlorobutadiene							
111-91-1 bis(2-Chloroethoxy)methane							
59-50-7 4-Chloro-3-methylphenol							
91-57-6 2-Methylnaphthalene							
77-47-4 Hexachlorocyclopentadiene							
88-06-2 2,4,6-Trichlorophenol							
95-95-4 2,4,5-Trichlorophenol							
91-58-7 2-Chloronaphthalene							
88-74-4 2-Nitroaniline							
131-11-3 Dimethylphthalate							
208-96-8 Acenaphthylene							
606-20-2 2,6-Dinitrotoluene							
99-09-2 3-Nitroaniline							
83-32-9 Acenaphthene							
51-28-5 2,4-Dinitrophenol							
100-02-7 4-Nitrophenol							
132-64-9 Dibenzofuran							

*** Validation Complete ***

000124

NSA Mid-South, Assembly A - SWMU 5
Initial Sampling Event
Loess Groundwater

SW846-SVOA							
	SAMPLE ID ------->	005-G-MW06-0A	005-G-MW07-0A				
	ORIGINAL ID ----->	005GMW06LS	005GMW07LS				
	LAB SAMPLE ID --->	120617	120951				
	ID FROM REPORT -->	005GMW06LS	005GMW07LS				
	SAMPLE DATE ----->	03/24/95	03/29/95				
	DATE EXTRACTED -->	03/31/95	04/05/95				
	DATE ANALYZED --->	04/13/95	04/28/95				
	MATRIX ---------->	Water	Water				
	UNITS ---------->	UG/L	UG/L				
CAS #	Parameter	1353 VAL	1354 VAL				
121-14-2	2,4-Dinitrotoluene						
84-66-2	Diethylphthalate						
7005-72-3	4-Chlorophenylphenyl ether						
86-73-7	Fluorene						
100-01-6	4-Nitroaniline						
534-52-1	2-Methyl-4,6-Dinitrophenol						
86-30-6	N-Nitrosodiphenylamine						
101-55-3	4-Bromophenyl-phenylether						
118-74-1	Hexachlorobenzene						
87-86-5	Pentachlorophenol						
85-01-8	Phenanthrene						
120-12-7	Anthracene						
86-74-8	Carbazole						
84-74-2	Di-n-butylphthalate						
206-44-0	Fluoranthene						
129-00-0	Pyrene						
85-68-7	Butylbenzylphthalate						
91-94-1	3,3'-Dichlorobenzidine						
56-55-3	Benzo(a)anthracene						
218-01-9	Chrysene						
117-81-7	bis(2-Ethylhexyl)phthalate (BEHP)						
117-84-0	Di-n-octylphthalate						
205-99-2	Benzo(b)fluoranthene						
207-08-9	Benzo(k)fluoranthene						
50-32-8	Benzo(a)pyrene						
193-39-5	Indeno(1,2,3-cd)pyrene						
53-70-3	Dibenz(a,h)anthracene						
191-24-2	Benzo(g,h,i)perylene						
9999900-32-2	3-Methylphenol/4-Methylphenol	NR	NR				
122-39-4	Diphenylamine	NR	NR				

000425

*** Validation Complete ***

NSA Mid-South, Assembly A - SWMU 5
Initial Sampling Event
Loess Groundwater

SW846-VOA													
	SAMPLE ID ------->	005-G-FF04-0B		005-G-FF05-0A		005-G-FF05-0B		005-G-FF06-0B		005-G-FF08-0B		005-G-FF09-0B	
	ORIGINAL ID ----->	005GMW04LS		005GMW05LS		005GMW05LS		005GMW06LS		005GMW08LS		005GMW09LS	
	LAB SAMPLE ID --->	122125		120949		122126		122127		122128		122129	
	ID FROM REPORT -->	005GMW04LS		005GMW05LS		005GMW05LS		005GMW06LS		005GMW08LS		005GMW09LS	
	SAMPLE DATE ----->	04/17/95		03/29/95		04/17/95		04/17/95		04/17/95		04/17/95	
	DATE ANALYZED --->	04/28/95		04/07/95		05/01/95		04/28/95		05/01/95		04/28/95	
	MATRIX ---------->	Water		Water		Water		Water		Water		Water	
	UNITS ---------->	UG/L		UG/L		UG/L		UG/L		UG/L		UG/L	
CAS #	Parameter	1376	VAL	1354	VAL	1376	VAL	1376	VAL	1376	VAL	1376	VAL
74-87-3	Chloromethane												
74-83-9	Bromomethane												
75-01-4	Vinyl chloride												
75-00-3	Chloroethane												
75-09-2	Methylene chloride									31.	J		
67-64-1	Acetone			38.	J								
75-15-0	Carbon disulfide												
75-35-4	1,1-Dichloroethene												
75-34-3	1,1-Dichloroethane												
540-59-0	1,2-Dichloroethene (total)			8.	J	8.	J						
67-66-3	Chloroform												
107-06-2	1,2-Dichloroethane												
78-93-3	2-Butanone (MEK)												
71-55-6	1,1,1-Trichloroethane												
56-23-5	Carbon tetrachloride												
75-27-4	Bromodichloromethane												
78-87-5	1,2-Dichloropropane												
10061-01-5	cis-1,3-Dichloropropene												
79-01-6	Trichloroethene			1.	J	2.	J						
124-48-1	Dibromochloromethane												
79-00-5	1,1,2-Trichloroethane												
71-43-2	Benzene									3900.		5.	J
10061-02-6	trans-1,3-Dichloropropene												
75-25-2	Bromoform												
108-10-1	4-Methyl-2-Pentanone (MIBK)												
591-78-6	2-Hexanone												
127-18-4	Tetrachloroethene												
79-34-5	1,1,2,2-Tetrachloroethane												
108-88-3	Toluene												
108-90-7	Chlorobenzene					2.	J						
100-41-4	Ethylbenzene									30.	J		
100-42-5	Styrene												
1330-20-7	Xylene (Total)												
110-75-8	2-Chloroethylvinylether	NR		NR		NR		NR		NR		NR	
95-50-1	1,2-Dichlorobenzene	NR		NR		NR		NR		NR		NR	
541-73-1	1,3-Dichlorobenzene	NR		NR		NR		NR		NR		NR	
106-46-7	1,4-Dichlorobenzene	NR		NR		NR		NR		NR		NR	

*** Validation Complete ***

000426

NSA Mid-South, Assembly A - SWMU 5
Initial Sampling Event
Loess Groundwater

SW846-VOA													
	SAMPLE ID ------->	005-G-FF04-OB		005-G-FF05-OA		005-G-FF05-OB		005-G-FF06-OB		005-G-FF08-OB		005-G-FF09-OB	
	ORIGINAL ID ----->	005GMW04LS		005GMW05LS		005GMW05LS		005GMW06LS		005GMW08LS		005GMW09LS	
	LAB SAMPLE ID --->	122125		120949		122126		122127		122128		122129	
	ID FROM REPORT -->	005GMW04LS		005GMW05LS		005GMW05LS		005GMW06LS		005GMW08LS		005GMW09LS	
	SAMPLE DATE ----->	04/17/95		03/29/95		04/17/95		04/17/95		04/17/95		04/17/95	
	DATE ANALYZED --->	04/28/95		04/07/95		05/01/95		04/28/95		05/01/95		04/28/95	
	MATRIX ---------->	Water		Water		Water		Water		Water		Water	
	UNITS ---------->	UG/L		UG/L		UG/L		UG/L		UG/L		UG/L	
CAS #	Parameter	1376	VAL	1354	VAL	1376	VAL	1376	VAL	1376	VAL	1376	VAL
75-69-4	Trichlorofluoromethane	NR		NR		NR		NR		NR		NR	
108-05-4	Vinyl acetate	NR		NR		NR		NR		NR		NR	
108-38-3	m-Xylene	NR		NR		NR		NR		NR		NR	
95-47-6	o-Xylene	NR		NR		NR		NR		NR		NR	
106-42-3	p-Xylene	NR		NR		NR		NR		NR		NR	

*** Validation Complete ***

NSA Mid-South, Assembly A - SWMU 5
Initial Sampling Event
Loess Groundwater

SW846-VOA							
	SAMPLE ID ------->	005-G-MW03-0A	005-G-MW06-0A	005-G-MW07-0A			
	ORIGINAL ID ----->	005GMW03LS	005GMW06LS	005GMW07LS			
	LAB SAMPLE ID --->	120616	120617	120951			
	ID FROM REPORT -->	005GMW03LS	005GMW06LS	005GMW07LS			
	SAMPLE DATE ----->	03/24/95	03/24/95	03/29/95			
	DATE ANALYZED --->	04/03/95	04/03/95	04/06/95			
	MATRIX ---------->	Water	Water	Water			
	UNITS ---------->	UG/L	UG/L	UG/L			
CAS #	Parameter	1353 VAL	1353 VAL	1354 VAL			
74-87-3	Chloromethane						
74-83-9	Bromomethane						
75-01-4	Vinyl chloride						
75-00-3	Chloroethane						
75-09-2	Methylene chloride						
67-64-1	Acetone		27.				
75-15-0	Carbon disulfide						
75-35-4	1,1-Dichloroethene						
75-34-3	1,1-Dichloroethane						
540-59-0	1,2-Dichloroethene (total)						
67-66-3	Chloroform						
107-06-2	1,2-Dichloroethane						
78-93-3	2-Butanone (MEK)						
71-55-6	1,1,1-Trichloroethane						
56-23-5	Carbon tetrachloride						
75-27-4	Bromodichloromethane						
78-87-5	1,2-Dichloropropane						
10061-01-5	cis-1,3-Dichloropropene						
79-01-6	Trichloroethene						
124-48-1	Dibromochloromethane						
79-00-5	1,1,2-Trichloroethane						
71-43-2	Benzene						
10061-02-6	trans-1,3-Dichloropropene						
75-25-2	Bromoform						
108-10-1	4-Methyl-2-Pentanone (MIBK)						
591-78-6	2-Hexanone						
127-18-4	Tetrachloroethene						
79-34-5	1,1,2,2-Tetrachloroethane						
108-88-3	Toluene						
108-90-7	Chlorobenzene						
100-41-4	Ethylbenzene						
100-42-5	Styrene						
1330-20-7	Xylene (Total)						
110-75-8	2-Chloroethylvinylether	NR	NR	NR			
95-50-1	1,2-Dichlorobenzene	NR	NR	NR			
541-73-1	1,3-Dichlorobenzene	NR	NR	NR			
106-46-7	1,4-Dichlorobenzene	NR	NR	NR			

*** Validation complete ***

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NSA Mid-South, Assembly A - SWMU 5
Initial Sampling Event
Loess Groundwater

SW846-VOA							
	SAMPLE ID ------->	005-G-MW03-0A	005-G-MW06-0A	005-G-MW07-0A			
	ORIGINAL ID ----->	005GMW03LS	005GMW06LS	005GMW07LS			
	LAB SAMPLE ID --->	120616	120617	120951			
	ID FROM REPORT -->	005GMW03LS	005GMW06LS	005GMW07LS			
	SAMPLE DATE ----->	03/24/95	03/24/95	03/29/95			
	DATE ANALYZED --->	04/03/95	04/03/95	04/06/95			
	MATRIX ---------->	Water	Water	Water			
	UNITS ---------->	UG/L	UG/L	UG/L			
CAS #	Parameter	1353 VAL	1353 VAL	1354 VAL			
75-69-4	Trichlorofluoromethane	NR	NR	NR			
108-05-4	Vinyl acetate	NR	NR	NR			
108-38-3	m-Xylene	NR	NR	NR			
95-47-6	o-Xylene	NR	NR	NR			
106-42-3	p-Xylene	NR	NR	NR			

*** Validation Complete ***

NSA Mid-South, Assembly A - SWMU 5
Initial Sampling Event
Loess Groundwater

TPH

	SAMPLE ID ------->	005-G-FF04-0B		005-G-FF05-0A		005-G-FF05-0B		005-G-FF06-0B		005-G-FF08-0B		005-G-FF09-0B	
	ORIGINAL ID ----->	005GMW04LS		005GMW05LS		005GMW05LS		005GMW06LS		005GMW08LS		005GMW09LS	
	LAB SAMPLE ID --->	122118		120942		122119		122120		122121		122122	
	ID FROM REPORT -->	005GMW04LS		005GMW05LS		005GMW05LS		005GMW06LS		005GMW08LS		005GMW09LS	
	SAMPLE DATE ----->	04/17/95		03/29/95		04/17/95		04/17/95		04/17/95		04/17/95	
	DATE EXTRACTED -->	04/26/95		04/24/95		04/26/95		04/26/95		04/26/95		04/26/95	
	DATE ANALYZED --->	04/26/95		04/24/95		04/26/95		04/26/95		04/26/95		04/26/95	
	MATRIX ---------->	Water		Water		Water		Water		Water		Water	
	UNITS ---------->	mg/L		mg/L		mg/L		mg/L		mg/L		mg/L	
CAS #	Parameter	1376	VAL	1354	VAL	1376	VAL	1376	VAL	1376	VAL	1376	VAL
9999900-02-4	Petroleum Hydrocarbons, TPH												

*** Validation complete ***

NSA Mid-South, Assembly A - SWMU 5
Initial Sampling Event
Loess Groundwater

TPH							
	SAMPLE ID ------->	005-G-MW03-0A	005-G-MW06-0A	005-G-MW07-0A			
	ORIGINAL ID ----->	005GMW03LS	005GMW06LS	005GMW07LS			
	LAB SAMPLE ID --->	120608	120609	120940			
	ID FROM REPORT -->	005GMW03LS	005GMW06LS	005GMW07LS			
	SAMPLE DATE ----->	03/24/95	03/24/95	03/29/95			
	DATE EXTRACTED -->	04/17/95	04/17/95	04/24/95			
	DATE ANALYZED --->	04/18/95	04/18/95	04/24/95			
	MATRIX ---------->	Water	Water	Water			
	UNITS ---------->	mg/L	mg/L	mg/L			
CAS #	Parameter	1353 VAL	1353 VAL	1354 VAL			
9999900-02-4	Petroleum Hydrocarbons, TPH						

*** Validation Complete ***

DATALCP3
11/05/98

NSA MEMPHIS, Assembly A - SWMU 5
Event 1 of Long Term Monitoring
Loess Groundwater

APX9-METAL

		SAMPLE ID -------->	005-G-03LS-01		005-G-05LS-01		005-G-06LS-01		005-G-07LS-01		
		ORIGINAL ID ----->	005G1003LS		005G1005UF		005G1006LS		005G1007LS		
		LAB SAMPLE ID --->	139704S		139705S		139706S L		139707S		
		ID FROM REPORT -->	005G1003LS		005G1005UF		005G1006LS		005G1007LS		
		SAMPLE DATE ----->	12/04/95		12/04/95		12/04/95		12/04/95		
		MATRIX ---------->	Water		Water		Water		Water		
		UNITS ---------->	UG/L		UG/L		UG/L		UG/L		
CAS #	Parameter		1638	VAL	1638	VAL	1638	VAL	1638	VAL	
7440-36-0	Antimony										
7440-38-2	Arsenic										
7440-39-3	Barium		152.	J	142.	J	123.	J	267.		
7440-41-7	Beryllium										
7440-43-9	Cadmium								3.2	J	
7440-47-3	Chromium		16.4						40.2		
7440-48-4	Cobalt								6.3	J	
7440-50-8	Copper		11.8	J	7.1	J	5.2	J	20.4	J	
7439-92-1	Lead		2.2	J	2.9	J			5.8		
7439-97-6	Mercury										
7440-02-0	Nickel								37.3	J	
7782-49-2	Selenium										
7440-22-4	Silver										
7440-28-0	Thallium										
7440-62-2	Vanadium		5.2	J					12.5	J	
7440-66-6	Zinc								113.		
7440-31-5	Tin		40.9	J	63.5	J	46.2	J	52.1	J	

*** Validation Complete ***

NSA MEMPHIS, Assembly A - SWMU 5
Event 1 of Long Term Monitoring
Loess Groundwater

METAL-CN							
	SAMPLE ID ------->	005-G-03LS-01	005-G-05LS-01	005-G-06LS-01	005-G-07LS-01		
	ORIGINAL ID ----->	005G1003LS	005G1005UF	005G1006LS	005G1007LS		
	LAB SAMPLE ID --->	139704	139705	139706	139707		
	ID FROM REPORT -->	005G1003LS	005G1005UF	005G1006LS	005G1007LS		
	SAMPLE DATE ----->	12/04/95	12/04/95	12/04/95	12/04/95		
	DATE ANALYZED --->	12/07/95	12/07/95	12/07/95	12/07/95		
	MATRIX ---------->	Water	Water	Water	Water		
	UNITS ---------->	MG/L	MG/L	MG/L	MG/L		
CAS #	Parameter	1638 VAL	1638 VAL	1638 VAL	1638 VAL		
57-12-5	Cyanide (CN)						

*** Validation Complete ***

NSA MEMPHIS, Assembly A - SWMU 5
Event 1 of Long Term Monitoring
Loess Groundwater

SW846-HERB												
		SAMPLE ID ------->	005-G-03LS-01		005-G-05LS-01		005-G-06LS-01		005-G-07LS-01			
		ORIGINAL ID ----->	005G1003LS		005G1005UF		005G1006LS		005G1007LS			
		LAB SAMPLE ID --->	139704		139705		139706		139707			
		ID FROM REPORT -->	005G1003LS		005G1005UF		005G1006LS		005G1007LS			
		SAMPLE DATE ----->	12/04/95		12/04/95		12/04/95		12/04/95			
		DATE EXTRACTED -->	12/16/95		12/16/95		12/16/95		12/16/95			
		DATE ANALYZED --->	12/17/95		12/17/95		12/17/95		12/17/95			
		MATRIX ---------->	Water		Water		Water		Water			
		UNITS ---------->	UG/L		UG/L		UG/L		UG/L			
CAS #	Parameter		1638	VAL	1638	VAL	1638	VAL	1638	VAL		
94-75-7	2,4-D											
94-82-6	2,4-DB											
88-85-7	Dinoseb											
93-76-5	2,4,5-T											
93-72-1	2,4,5-TP (Silvex)											
75-99-0	Dalapon											
1918-00-9	Dicamba											
120-36-5	Dichlorprop											
94-74-6	MCPA											
93-65-2	MCPP											

*** Validation Complete ***

NSA MEMPHIS, Assembly A - SWMU 5
Event 1 of Long Term Monitoring
Loess Groundwater

SW846-OP P							
	SAMPLE ID ------->	005-G-03LS-01 RE	005-G-05LS-01	005-G-06LS-01	005-G-07LS-01		
	ORIGINAL ID ----->	005G1003LSRE	005G1005UF	005G1006LS	005G1007LS		
	LAB SAMPLE ID --->	139704RE	139705	139706	139707		
	ID FROM REPORT -->	005G1003LSRE	005G1005UF	005G1006LS	005G1007LS		
	SAMPLE DATE ----->	12/04/95	12/04/95	12/04/95	12/04/95		
	DATE EXTRACTED -->	12/08/95	12/22/95	12/22/95	12/22/95		
	DATE ANALYZED --->	01/30/96	01/05/96	01/05/96	01/05/96		
	MATRIX ---------->	Water	Water	Water	Water		
	UNITS ---------->	ug/L	UG/L	UG/L	UG/L		
CAS #	Parameter	1638 VAL	1638 VAL	1638 VAL	1638 VAL		
86-50-0	Azinphos methyl						
35400-43-2	Sulprofos (Bolstar)						
2921-88-2	Chloropyrifos						
56-72-4	Coumaphos						
8065-48-3	Demeton,O						
333-41-5	Diazinon						
62-73-7	Dichlorvos						
298-04-4	Disulfoton						
13194-48-4	Ethoprop						
115-90-2	Fensulfothion						
55-38-9	Fenthion						
150-50-5	Merphos						
7786-34-7	Mevinphos, Alpha						
300-76-5	Naled						
298-00-0	Methyl parathion						
298-02-2	Phorate						
299-84-3	Ronnel						
22248-79-9	Stirophos (Tetrachlorovinphos)						
34643-46-4	Tokuthion						
327-98-0	Trichloronate						
126-75-0	Demeton,S						

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*** Validation Complete ***

NSA MEMPHIS, Assembly A - SWMU 5
Event 1 of Long Term Monitoring
Loess Groundwater

SW846-PEST

SAMPLE ID ------->	005-G-03LS-01	005-G-05LS-01	005-G-06LS-01	005-G-07LS-01		
ORIGINAL ID ----->	005G1003LS	005G1005UF	005G1006LS	005G1007LS		
LAB SAMPLE ID --->	139704	139705	139706	139707		
ID FROM REPORT -->	005G1003LS	005G1005UF	005G1006LS	005G1007LS		
SAMPLE DATE ----->	12/04/95	12/04/95	12/04/95	12/04/95		
DATE EXTRACTED -->	12/22/95	12/22/95	12/22/95	12/22/95		
DATE ANALYZED --->	12/29/95	12/29/95	12/30/95	12/30/95		
MATRIX ---------->	Water	Water	Water	Water		
UNITS ---------->	UG/L	UG/L	UG/L	UG/L		

CAS #	Parameter	1638	VAL	1638	VAL	1638	VAL	1638	VAL				
319-84-6	alpha-BHC												
319-85-7	beta-BHC												
319-86-8	delta-BHC							0.027	J				
58-89-9	gamma-BHC (Lindane)												
76-44-8	Heptachlor												
309-00-2	Aldrin												
1024-57-3	Heptachlor epoxide												
959-98-8	Endosulfan I												
60-57-1	Dieldrin												
72-55-9	4,4'-DDE												
72-20-8	Endrin												
33213-65-9	Endosulfan II												
72-54-8	4,4'-DDD												
1031-07-8	Endosulfan sulfate												
50-29-3	4,4'-DDT												
72-43-5	Methoxychlor												
53494-70-5	Endrin ketone												
7421-93-4	Endrin aldehyde												
5103-71-9	alpha-Chlordane												
5103-74-2	gamma-Chlordane												
8001-35-2	Toxaphene												
12674-11-2	Aroclor-1016												
11104-28-2	Aroclor-1221												
53469-21-9	Aroclor-1242												
12672-29-6	Aroclor-1248												
11097-69-1	Aroclor-1254												
11096-82-5	Aroclor-1260												
11141-16-5	Aroclor-1232												
12789-03-6	Technical Chlordane												

*** Validation Complete ***

NSA MEMPHIS, Assembly A - SWMU 5
Event 1 of Long Term Monitoring
Loess Groundwater

SW846-SVOA													
		SAMPLE ID ------->	005-G-03LS-01		005-G-05LS-01		005-G-06LS-01		005-G-07LS-01				
		ORIGINAL ID ----->	005G1003LS		005G1005UF		005G1006LS		005G1007LS				
		LAB SAMPLE ID --->	139704		139705		139706		139707				
		ID FROM REPORT -->	005G1003LS		005G1005UF		005G1006LS		005G1007LS				
		SAMPLE DATE ----->	12/04/95		12/04/95		12/04/95		12/04/95				
		DATE EXTRACTED -->	12/07/95		12/07/95		12/07/95		12/07/95				
		DATE ANALYZED --->	12/26/95		12/26/95		12/26/95		12/26/95				
		MATRIX ---------->	Water		Water		Water		Water				
		UNITS ---------->	ug/L		ug/L		ug/L		ug/L				
CAS #	Parameter		1638	VAL	1638	VAL	1638	VAL	1638	VAL			
108-95-2	Phenol												
111-44-4	bis(2-Chloroethyl)ether												
95-57-8	2-Chlorophenol												
541-73-1	1,3-Dichlorobenzene												
106-46-7	1,4-Dichlorobenzene												
95-50-1	1,2-Dichlorobenzene				6.	J							
95-48-7	2-Methylphenol (o-Cresol)												
108-60-1	2,2'-oxybis(1-Chloropropane)												
106-44-5	4-Methylphenol (p-Cresol)												
621-64-7	N-Nitroso-di-n-propylamine												
67-72-1	Hexachloroethane												
98-95-3	Nitrobenzene												
78-59-1	Isophorone												
88-75-5	2-Nitrophenol												
105-67-9	2,4-Dimethylphenol												
120-83-2	2,4-Dichlorophenol												
120-82-1	1,2,4-Trichlorobenzene												
91-20-3	Naphthalene						3.	J	2.	J			
106-47-8	4-Chloroaniline												
87-68-3	Hexachlorobutadiene												
111-91-1	bis(2-Chloroethoxy)methane												
59-50-7	4-Chloro-3-methylphenol												
91-57-6	2-Methylnaphthalene												
77-47-4	Hexachlorocyclopentadiene												
88-06-2	2,4,6-Trichlorophenol												
95-95-4	2,4,5-Trichlorophenol												
91-58-7	2-Chloronaphthalene												
88-74-4	2-Nitroaniline												
131-11-3	Dimethylphthalate												
208-96-8	Acenaphthylene												
606-20-2	2,6-Dinitrotoluene												
99-09-2	3-Nitroaniline												
83-32-9	Acenaphthene												
51-28-5	2,4-Dinitrophenol												
100-02-7	4-Nitrophenol												
132-64-9	Dibenzofuran												

*** Validation Complete ***

NSA MEMPHIS, Assembly A - SWMU 5
Event 1 of Long Term Monitoring
Loess Groundwater

SW846-SVOA

SAMPLE ID ------->	005-G-03LS-01	005-G-05LS-01	005-G-06LS-01	005-G-07LS-01		
ORIGINAL ID ----->	005G1003LS	005G1005UF	005G1006LS	005G1007LS		
LAB SAMPLE ID --->	139704	139705	139706	139707		
ID FROM REPORT -->	005G1003LS	005G1005UF	005G1006LS	005G1007LS		
SAMPLE DATE ----->	12/04/95	12/04/95	12/04/95	12/04/95		
DATE EXTRACTED -->	12/07/95	12/07/95	12/07/95	12/07/95		
DATE ANALYZED --->	12/26/95	12/26/95	12/26/95	12/26/95		
MATRIX ---------->	Water	Water	Water	Water		
UNITS ---------->	ug/L	ug/L	ug/L	ug/L		

CAS #	Parameter	1638	VAL	1638	VAL	1638	VAL	1638	VAL				
121-14-2	2,4-Dinitrotoluene												
84-66-2	Diethylphthalate												
7005-72-3	4-Chlorophenylphenyl ether												
86-73-7	Fluorene												
100-01-6	4-Nitroaniline												
534-52-1	2-Methyl-4,6-Dinitrophenol												
86-30-6	N-Nitrosodiphenylamine												
101-55-3	4-Bromophenyl-phenylether												
118-74-1	Hexachlorobenzene												
87-86-5	Pentachlorophenol												
85-01-8	Phenanthrene												
120-12-7	Anthracene												
86-74-8	Carbazole												
84-74-2	Di-n-butylphthalate												
206-44-0	Fluoranthene												
129-00-0	Pyrene												
85-68-7	Butylbenzylphthalate												
91-94-1	3,3'-Dichlorobenzidine												
56-55-3	Benzo(a)anthracene												
218-01-9	Chrysene												
117-81-7	bis(2-Ethylhexyl)phthalate (BEHP)												
117-84-0	Di-n-octylphthalate												
205-99-2	Benzo(b)fluoranthene												
207-08-9	Benzo(k)fluoranthene												
50-32-8	Benzo(a)pyrene												
193-39-5	Indeno(1,2,3-cd)pyrene												
53-70-3	Dibenz(a,h)anthracene												
191-24-2	Benzo(g,h,i)perylene												

*** Validation Complete ***

000438

NSA MEMPHIS, Assembly A - SWMU 5
Event 1 of Long Term Monitoring
Loess Groundwater

SW846-VOA											
	SAMPLE ID ------->	005-G-03LS-01		005-G-05LS-01		005-G-06LS-01		005-G-07LS-01			
	ORIGINAL ID ----->	005G1003LS		005G1005UF		005G1006LS		005G1007LS			
	LAB SAMPLE ID --->	139704		139705		139706		139707			
	ID FROM REPORT -->	005G1003LS		005G1005UF		005G1006LS		005G1007LS			
	SAMPLE DATE ----->	12/04/95		12/04/95		12/04/95		12/04/95			
	DATE ANALYZED --->	12/14/95		12/14/95		12/14/95		12/14/95			
	MATRIX ---------->	Water		Water		Water		Water			
	UNITS ---------->	UG/L		UG/L		UG/L		UG/L			
CAS #	Parameter	1638	VAL	1638	VAL	1638	VAL	1638	VAL		
74-87-3	Chloromethane										
74-83-9	Bromomethane										
75-01-4	Vinyl chloride										
75-00-3	Chloroethane										
75-09-2	Methylene chloride										
67-64-1	Acetone										
75-15-0	Carbon disulfide										
75-35-4	1,1-Dichloroethene										
75-34-3	1,1-Dichloroethane										
540-59-0	1,2-Dichloroethene (total)			3.	J						
67-66-3	Chloroform										
107-06-2	1,2-Dichloroethane										
78-93-3	2-Butanone (MEK)										
71-55-6	1,1,1-Trichloroethane										
56-23-5	Carbon tetrachloride										
75-27-4	Bromodichloromethane										
78-87-5	1,2-Dichloropropane										
10061-01-5	cis-1,3-Dichloropropene										
79-01-6	Trichloroethene			1.	J						
124-48-1	Dibromochloromethane										
79-00-5	1,1,2-Trichloroethane										
71-43-2	Benzene										
10061-02-6	trans-1,3-Dichloropropene										
75-25-2	Bromoform										
108-10-1	4-Methyl-2-Pentanone (MIBK)										
591-78-6	2-Hexanone										
127-18-4	Tetrachloroethene										
79-34-5	1,1,2,2-Tetrachloroethane										
108-88-3	Toluene										
108-90-7	Chlorobenzene										
100-41-4	Ethylbenzene										
100-42-5	Styrene										
1330-20-7	Xylene (Total)										

*** Validation Complete ***

NSA MEMPHIS, Assembly A - SWMU 5
Event 1 of Long Term Monitoring
Loess Groundwater

TPH-DRO

SAMPLE ID ------->	005-G-03LS-01	005-G-05LS-01	005-G-06LS-01	005-G-07LS-01		
ORIGINAL ID ----->	005G1003LS	005G1005UF	005G1006LS	005G1007LS		
LAB SAMPLE ID --->	139704	139705	139706	139707		
ID FROM REPORT -->	005G1003LS	005G1005UF	005G1006LS	005G1007LS		
SAMPLE DATE ----->	12/04/95	12/04/95	12/04/95	12/04/95		
DATE EXTRACTED -->	12/20/95	12/20/95	12/20/95	12/20/95		
DATE ANALYZED --->	12/15/95	12/15/95	12/15/95	12/15/95		
MATRIX ---------->	Water	Water	Water	Water		
UNITS ---------->	UG/L	UG/L	UG/L	UG/L		

CAS #	Parameter	1638	VAL	1638	VAL	1638	VAL	1638	VAL				
9999900-02-6	TPH - Diesel Range Organics					170.		300.					

*** Validation complete ***

000410

DATALCP3
11/05/98

NSA Mid-South, Assembly A - SWMU 5
Event 3 of Long Term Monitoring
Loess Groundwater

SW846-VOA								
	SAMPLE ID ------->	005-G-05FF-03		005-G-08FF-03		005-G-09FF-03		
	ORIGINAL ID ----->	005G05FF03		005G08FF03		005G09FF03		
	LAB SAMPLE ID --->	152988		152802		152803		
	ID FROM REPORT -->	005g05ff03		005g08ff03		005g09ff03		
	SAMPLE DATE ----->	08/22/96		08/16/96		08/16/96		
	DATE ANALYZED --->	08/28/96		08/23/96		08/22/96		
	MATRIX ---------->	Water		Water		Water		
	UNITS ---------->	ug/L		ug/L		ug/L		
CAS #	Parameter	1975	VAL	1969	VAL	1969	VAL	
74-87-3	Chloromethane							
74-83-9	Bromomethane							
75-01-4	Vinyl chloride							
75-00-3	Chloroethane							
75-09-2	Methylene chloride							
67-64-1	Acetone							
75-15-0	Carbon disulfide							
75-35-4	1,1-Dichloroethene							
75-34-3	1,1-Dichloroethane							
540-59-0	1,2-Dichloroethene (total)	1.	J					
67-66-3	Chloroform							
107-06-2	1,2-Dichloroethane							
78-93-3	2-Butanone (MEK)							
71-55-6	1,1,1-Trichloroethane							
56-23-5	Carbon tetrachloride							
75-27-4	Bromodichloromethane							
78-87-5	1,2-Dichloropropane							
10061-01-5	cis-1,3-Dichloropropene							
79-01-6	Trichloroethene							
124-48-1	Dibromochloromethane							
79-00-5	1,1,2-Trichloroethane							
71-43-2	Benzene			1900.				
10061-02-6	trans-1,3-Dichloropropene							
75-25-2	Bromoform							
108-10-1	4-Methyl-2-Pentanone (MIBK)							
591-78-6	2-Hexanone							
127-18-4	Tetrachloroethene							
79-34-5	1,1,2,2-Tetrachloroethane							
108-88-3	Toluene							
108-90-7	Chlorobenzene							
100-41-4	Ethylbenzene							
100-42-5	Styrene							
1330-20-7	Xylene (Total)							

*** Validation Complete ***

000441

DATALCP3
11/05/98

NSA Mid-South, Assembly A - SWMU 5
Event 4 of Long Term Monitoring
Loess Groundwater

SW846-VOA													
	SAMPLE ID ------->	005-G-03LS-04		005-G-05FF-04		005-H-05FF-04		005-G-06LS-04		005-G-07LS-04		005-G-08FF-04	
	ORIGINAL ID ----->	005G03LS04		005G05FF04		005H05FF04		005G06LS04		005G07LS04		005G08FF04	
	LAB SAMPLE ID --->	S772489*1		S772562*1		S772562*5		S772489*2		S772562*3		S772562*4	
	ID FROM REPORT -->	005G03LS04		005G05FF04		005H05FF04		005G06LS04		005G07LS04		005G08FF04	
	SAMPLE DATE ----->	05/02/97		05/06/97		05/06/97		05/02/97		05/06/97		05/06/97	
	DATE ANALYZED --->	05/09/97		05/14/97		05/14/97		05/09/97		05/14/97		05/18/97	
	MATRIX ---------->	Water		Water		Water		Water		Water		Water	
	UNITS ---------->	UG/L		UG/L		UG/L		UG/L		UG/L		UG/L	
CAS #	Parameter	MEM18	NV	MEM18	NV	MEM18	NV	MEM18	NV	MEM18	NV	MEM18	NV
74-87-3	Chloromethane												
75-01-4	Vinyl chloride												
74-83-9	Bromomethane												
75-00-3	Chloroethane												
75-35-4	1,1-Dichloroethene												
75-09-2	Methylene chloride												
75-34-3	1,1-Dichloroethane												
67-66-3	Chloroform												
71-55-6	1,1,1-Trichloroethane												
56-23-5	Carbon tetrachloride												
71-43-2	Benzene											3200.	
107-06-2	1,2-Dichloroethane												
79-01-6	Trichloroethene												
78-87-5	1,2-Dichloropropane												
75-27-4	Bromodichloromethane												
108-88-3	Toluene												
79-00-5	1,1,2-Trichloroethane												
127-18-4	Tetrachloroethene												
124-48-1	Dibromochloromethane												
108-90-7	Chlorobenzene												
100-41-4	Ethylbenzene												
100-42-5	Styrene												
75-25-2	Bromoform												
79-34-5	1,1,2,2-Tetrachloroethane												
67-64-1	Acetone												
75-15-0	Carbon disulfide												
78-93-3	2-Butanone (MEK)												
108-10-1	4-Methyl-2-Pentanone (MIBK)												
10061-01-5	cis-1,3-Dichloropropene												
10061-02-6	trans-1,3-Dichloropropene												
591-78-6	2-Hexanone												
1330-20-7	Xylene (Total)												
540-59-0	1,2-Dichloroethene (total)			2.5	J	2.6	J						

*** Unvalidated Data - Do NOT Cite ***

NSA Mid-South, Assembly A - SWMU 5
Event 4 of Long Term Monitoring
Loess Groundwater

SW846-VOA

SAMPLE ID ------->	005-G-09FF-04
ORIGINAL ID ----->	005G09FF04
LAB SAMPLE ID --->	S772527*1
ID FROM REPORT -->	005G09FF04
SAMPLE DATE ----->	05/05/97
DATE ANALYZED --->	05/09/97
MATRIX ---------->	Water
UNITS ----------->	UG/L

CAS #	Parameter	MEM18 NV
74-87-3	Chloromethane	
75-01-4	Vinyl chloride	
74-83-9	Bromomethane	
75-00-3	Chloroethane	
75-35-4	1,1-Dichloroethene	
75-09-2	Methylene chloride	
75-34-3	1,1-Dichloroethane	
67-66-3	Chloroform	
71-55-6	1,1,1-Trichloroethane	
56-23-5	Carbon tetrachloride	
71-43-2	Benzene	
107-06-2	1,2-Dichloroethane	
79-01-6	Trichloroethene	
78-87-5	1,2-Dichloropropane	
75-27-4	Bromodichloromethane	
108-88-3	Toluene	
79-00-5	1,1,2-Trichloroethane	
127-18-4	Tetrachloroethene	
124-48-1	Dibromochloromethane	
108-90-7	Chlorobenzene	
100-41-4	Ethylbenzene	
100-42-5	Styrene	
75-25-2	Bromoform	
79-34-5	1,1,2,2-Tetrachloroethane	
67-64-1	Acetone	
75-15-0	Carbon disulfide	
78-93-3	2-Butanone (MEK)	
108-10-1	4-Methyl-2-Pentanone (MIBK)	
10061-01-5	cis-1,3-Dichloropropene	
10061-02-6	trans-1,3-Dichloropropene	
591-78-6	2-Hexanone	
1330-20-7	Xylene (Total)	
540-59-0	1,2-Dichloroethene (total)	

*** Unvalidated Data - Do NOT Cite ***

DATALCP3
11/05/98

NSA Mid-South, Assembly A - SWMU 5
Event 5 of Long Term Monitoring
Loess Groundwater

SW846-VOA

SAMPLE ID ------->	005-G-03LS-05	005-G-05FF-05	005-H-05FF-05	005-G-06LS-05	005-G-07LS-05	005-G-09FF-05
ORIGINAL ID ----->	005G03LS05	005G05FF05	005H05FF05	005G06LS05	005G07LS05	005G09FF05
LAB SAMPLE ID --->	S776275*2	S776296*1	S776296*4	S776275*4	S776296*2	S776296*3
ID FROM REPORT -->	005G03LS05	005G05FF05	005H05FF05	005G06LS05	005G07LS05	005G09FF05
SAMPLE DATE ----->	11/04/97	11/05/97	11/05/97	11/04/97	11/05/97	11/05/97
DATE ANALYZED --->	11/06/97	11/07/97	11/07/97	11/06/97	11/07/97	11/07/97
MATRIX ---------->	Water	Water	Water	Water	Water	Water
UNITS ---------->	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L

CAS #	Parameter	MEM32	VAL	MEM32	VAL	MEM32	VAL	MEM32	VAL	MEM32	VAL	MEM32	VAL
74-87-3	Chloromethane												
74-83-9	Bromomethane												
75-01-4	Vinyl chloride												
75-00-3	Chloroethane												
75-35-4	1,1-Dichloroethene												
75-09-2	Methylene chloride												
75-34-3	1,1-Dichloroethane												
67-66-3	Chloroform												
71-55-6	1,1,1-Trichloroethane												
56-23-5	Carbon tetrachloride												
71-43-2	Benzene												
107-06-2	1,2-Dichloroethane												
79-01-6	Trichloroethene			0.7	J	0.59	J						
78-87-5	1,2-Dichloropropane												
75-27-4	Bromodichloromethane												
108-88-3	Toluene												
79-00-5	1,1,2-Trichloroethane												
127-18-4	Tetrachloroethene												
124-48-1	Dibromochloromethane												
108-90-7	Chlorobenzene												
100-41-4	Ethylbenzene												
100-42-5	Styrene												
75-25-2	Bromoform												
79-34-5	1,1,2,2-Tetrachloroethane												
67-64-1	Acetone												
75-15-0	Carbon disulfide												
78-93-3	2-Butanone (MEK)												
108-10-1	4-Methyl-2-Pentanone (MIBK)												
10061-01-5	cis-1,3-Dichloropropene												
10061-02-6	trans-1,3-Dichloropropene												
591-78-6	2-Hexanone												
1330-20-7	Xylene (Total)												
540-59-0	1,2-Dichloroethene (total)			1.4	J	1.4	J						

*** Validation Complete ***

Fluvial Deposits Groundwater Data

NSA Mid-South, Assembly A - SWMU 5
Initial Sampling Event
Fluvial Deposits Groundwater

APX9-METAL													
		SAMPLE ID ------->	005-G-01UF-00		005-G-02UF-00		005-G-03UF-00		005-G-04UF-00		005-G-05LF-00		005-G-4AUF-00
		ORIGINAL ID ----->	005GMW01UF		005GMW02UF		005GMW03UF		005GMW04UF		005GMW05LF		005GMW4AUF
		LAB SAMPLE ID --->	7-120671S		5-120765S		5-120766S		2-120950S		9-120533S		2-120952S
		ID FROM REPORT -->	005GMW01UF		005GMW02UF		005GMW03UF		005GMW04UF		005GMW05LF		005GMW4AUF
		SAMPLE DATE ----->	03/27/95		03/28/95		03/28/95		03/29/95		03/24/95		03/29/95
		MATRIX ---------->	Water		Water		Water		Water		Water		Water
		UNITS ---------->	UG/L		UG/L		UG/L		UG/L		UG/L		UG/L
CAS #	Parameter		1353	VAL	1354	VAL	1354	VAL	1354	VAL	1353	VAL	1354	VAL
7440-36-0	Antimony													
7440-38-2	Arsenic													
7440-39-3	Barium		48.6	J	112.	J	61.4	J	50.8	J	214.		76.8	J
7440-41-7	Beryllium													
7440-43-9	Cadmium				5.4	J								
7440-47-3	Chromium													
7440-48-4	Cobalt										6.9	J	8.7	J
7440-50-8	Copper										6.	J		
7439-92-1	Lead		32.8	J							5.4	J		
7439-97-6	Mercury													
7440-02-0	Nickel													
7782-49-2	Selenium													
7440-22-4	Silver													
7440-28-0	Thallium													
7440-62-2	Vanadium													
7440-66-6	Zinc		6.4	J							12.5	J		
7440-31-5	Tin													

*** Validation Complete ***

000446

NSA Mid-South, Assembly A - SWMU 5
Initial Sampling Event
Fluvial Deposits Groundwater

000447

APX9-METAL

SAMPLE ID ------->	005-G-4BUF-00
ORIGINAL ID ----->	005GMW4BUF
LAB SAMPLE ID --->	2-120953S
ID FROM REPORT -->	005GMW4BUF
SAMPLE DATE ----->	03/29/95
MATRIX ---------->	Water
UNITS ---------->	UG/L

CAS #	Parameter	1354	VAL
7440-36-0	Antimony		
7440-38-2	Arsenic		
7440-39-3	Barium	82.1	J
7440-41-7	Beryllium		
7440-43-9	Cadmium		
7440-47-3	Chromium		
7440-48-4	Cobalt	9.4	J
7440-50-8	Copper		
7439-92-1	Lead		
7439-97-6	Mercury		
7440-02-0	Nickel		
7782-49-2	Selenium		
7440-22-4	Silver		
7440-28-0	Thallium		
7440-62-2	Vanadium		
7440-66-6	Zinc		
7440-31-5	Tin		

*** Validated Complete ***

NSA Mid-South, Assembly A - SWMU 5
Initial Sampling Event
Fluvial Deposits Groundwater

METAL-CN													
	SAMPLE ID ------->	005-G-01UF-00		005-G-02UF-00		005-G-03UF-00		005-G-04UF-00		005-G-05LF-00		005-G-4AUF-00	
	ORIGINAL ID ----->	005GMW01UF		005GMW02UF		005GMW03UF		005GMW04UF		005GMW05LF		005GMW4AUF	
	LAB SAMPLE ID --->	120669		120759		120762		120943		120518		120944	
	ID FROM REPORT -->	005GMW01UF		005GMW02UF		005GMW03UF		005GMW04UF		005GMW05LF		005GMW4AUF	
	SAMPLE DATE ----->	03/27/95		03/28/95		03/28/95		03/29/95		03/23/95		03/29/95	
	DATE EXTRACTED -->	04/06/95		04/06/95		04/06/95		04/06/95		03/31/95		04/06/95	
	DATE ANALYZED --->	04/10/95		04/10/95		04/10/95		04/10/95		04/03/95		04/10/95	
	MATRIX ---------->	Water		Water		Water		Water		Water		Water	
	UNITS ---------->	mg/L		mg/L		mg/L		mg/L		mg/L		mg/L	
CAS #	Parameter	1353	VAL	1354	VAL	1354	VAL	1354	VAL	1353	VAL	1354	VAL
57-12-5	Cyanide (CN)												

*** Validation Complete ***

NSA Mid-South, Assembly A - SWMU 5
Initial Sampling Event
Fluvial Deposits Groundwater

METAL-CN

SAMPLE ID -------->	005-G-4BUF-00
ORIGINAL ID ----->	005GMW4BUF
LAB SAMPLE ID --->	120945
ID FROM REPORT -->	005GMW4BUF
SAMPLE DATE ----->	03/29/95
DATE EXTRACTED -->	04/06/95
DATE ANALYZED --->	04/10/95
MATRIX ---------->	Water
UNITS ---------->	mg/L

CAS #	Parameter	1354	VAL
57-12-5	Cyanide (CN)		

*** Validation Complete ***

NSA Mid-South, Assembly A - SWMU 5
Initial Sampling Event
Fluvial Deposits Groundwater

SW846-HERB													
	SAMPLE ID ------->	005-G-01UF-00		005-G-02UF-00		005-G-03UF-00		005-G-04UF-00		005-G-05LF-00		005-G-4AUF-00	
	ORIGINAL ID ----->	005GMW01UF		005GMW02UF		005GMW03UF		005GMW04UF		005GMW05LF		005GMW4AUF	
	LAB SAMPLE ID --->	120669		120759		120762		120943		120518		120944	
	ID FROM REPORT -->	005GMW01UF		005GMW02UF		005GMW03UF		005GMW04UF		005GMW05LF		005GMW4AUF	
	SAMPLE DATE ----->	03/27/95		03/28/95		03/28/95		03/29/95		03/23/95		03/29/95	
	DATE EXTRACTED -->	04/13/95		04/21/95		04/21/95		04/21/95		04/06/95		04/21/95	
	DATE ANALYZED --->	04/14/95		04/22/95		04/22/95		04/22/95		04/06/95		04/22/95	
	MATRIX ---------->	Water		Water		Water		Water		Water		Water	
	UNITS ---------->	ug/L		ug/L		ug/L		ug/L		ug/L		ug/L	
CAS #	Parameter	1353	VAL	1354	VAL	1354	VAL	1354	VAL	1353	VAL	1354	VAL
94-82-6	2,4-DB												
88-85-7	Dinoseb												
93-76-5	2,4,5-T												
93-72-1	2,4,5-TP (Silvex)												
75-99-0	Dalapon												
1918-00-9	Dicamba												
120-36-5	Dichlorprop												
94-74-6	MCPA												
93-65-2	MCPP												
94-75-7	2,4-D												

*** Validation Complete ***

NSA Mid-South, Assembly A - SWMU 5
Initial Sampling Event
Fluvial Deposits Groundwater

SW846-HERB

SAMPLE ID ------->	005-G-4BUF-00
ORIGINAL ID ----->	005GMW4BUF
LAB SAMPLE ID --->	120945
ID FROM REPORT -->	005GMW4BUF
SAMPLE DATE ----->	03/29/95
DATE EXTRACTED -->	04/21/95
DATE ANALYZED --->	04/22/95
MATRIX ---------->	Water
UNITS ---------->	ug/L

CAS #	Parameter	1354	VAL
94-82-6	2,4-DB		
88-85-7	Dinoseb		
93-76-5	2,4,5-T		
93-72-1	2,4,5-TP (Silvex)		
75-99-0	Dalapon		
1918-00-9	Dicamba		
120-36-5	Dichlorprop		
94-74-6	MCPA		
93-65-2	MCPP		
94-75-7	2,4-D		

*** Validation Complete ***

000431

NSA Mid-South, Assembly A - SWMU 5
Initial Sampling Event
Fluvial Deposits Groundwater

SW846-OP P

SAMPLE ID ------->	005-G-01UF-00	005-G-02UF-00	005-G-03UF-00	005-G-04UF-00	005-G-05LF-00	005-G-4AUF-00
ORIGINAL ID ----->	005GMW01UF	005GMW02UF	005GMW03UF	005GMW04UF	005GMW05LF	005GMW4AUF
LAB SAMPLE ID --->	120669	120759	120762	120943	120518	120944
ID FROM REPORT -->	005GMW01UF	005GMW02UF	005GMW03UF	005GMW04UF	005GMW05LF	005GMW4AUF
SAMPLE DATE ----->	03/27/95	03/28/95	03/28/95	03/29/95	03/23/95	03/29/95
DATE EXTRACTED -->	04/11/95	04/11/95	04/11/95	04/11/95	04/08/95	04/11/95
DATE ANALYZED --->	04/12/95	04/13/95	04/13/95	04/13/95	04/11/95	04/13/95
MATRIX ---------->	Water	Water	Water	Water	Water	Water
UNITS ---------->	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L

CAS #	Parameter	1353 VAL	1354 VAL	1354 VAL	1354 VAL	1353 VAL	1354 VAL
86-50-0	Azinphos methyl						
35400-43-2	Sulprofos (Bolstar)						
2921-88-2	Chloropyrifos						
56-72-4	Coumaphos						
8065-48-3	Demeton,O						
333-41-5	Diazinon						
62-73-7	Dichlorvos						
298-04-4	Disulfoton						
13194-48-4	Ethoprop						
115-90-2	Fensulfothion						
55-38-9	Fenthion						
150-50-5	Merphos						
7786-34-7	Mevinphos, Alpha						
300-76-5	Naled						
298-00-0	Methyl parathion						
298-02-2	Phorate						
299-84-3	Ronnel						
22248-79-9	Stirophos (Tetrachlorovinphos)						
34643-46-4	Tokuthion						
327-98-0	Trichloronate						
126-75-0	Demeton,S						

*** Validation Complete ***

NSA Mid-South, Assembly A - SWMU 5
Initial Sampling Event
Fluvial Deposits Groundwater

SW846-OP P

SAMPLE ID ------->	005-G-4BUF-00
ORIGINAL ID ----->	005GMW4BUF
LAB SAMPLE ID --->	120945
ID FROM REPORT -->	005GMW4BUF
SAMPLE DATE ----->	03/29/95
DATE EXTRACTED -->	04/11/95
DATE ANALYZED --->	04/13/95
MATRIX ---------->	Water
UNITS ---------->	ug/L

CAS #	Parameter	1354 VAL
86-50-0	Azinphos methyl	
35400-43-2	Sulprofos (Bolstar)	
2921-88-2	Chloropyrifos	
56-72-4	Coumaphos	
8065-48-3	Demeton,O	
333-41-5	Diazinon	
62-73-7	Dichlorvos	
298-04-4	Disulfoton	
13194-48-4	Ethoprop	
115-90-2	Fensulfothion	
55-38-9	Fenthion	
150-50-5	Merphos	
7786-34-7	Mevinphos, Alpha	
300-76-5	Naled	
298-00-0	Methyl parathion	
298-02-2	Phorate	
299-84-3	Ronnel	
22248-79-9	Stirophos (Tetrachlorovinphos)	
34643-46-4	Tokuthion	
327-98-0	Trichloronate	
126-75-0	Demeton,S	

*** Validation Complete ***

NSA Mid-South, Assembly A - SWMU 5
Initial Sampling Event
Fluvial Deposits Groundwater

SW846-PEST							
	SAMPLE ID ------->	005-G-01UF-00	005-G-02UF-00	005-G-03UF-00	005-G-04UF-00	005-G-05LF-00	005-G-4AUF-00
	ORIGINAL ID ----->	005GMW01UF	005GMW02UF	005GMW03UF	005GMW04UF	005GMW05LF	005GMW4AUF
	LAB SAMPLE ID --->	120671	120765	120766	120950	120533	120952
	ID FROM REPORT -->	005GMW01UF	005GMW02UF	005GMW03UF	005GMW04UF	005GMW05LF	005GMW4AUF
	SAMPLE DATE ----->	03/27/95	03/28/95	03/28/95	03/29/95	03/23/95	03/29/95
	DATE EXTRACTED -->	04/03/95	04/03/95	04/03/95	04/03/95	03/29/95	04/04/95
	DATE ANALYZED --->	04/10/95	04/10/95	04/10/95	04/19/95	04/08/95	04/19/95
	MATRIX ---------->	Water	Water	Water	Water	Water	Water
	UNITS ---------->	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L
CAS #	Parameter	1353 VAL	1354 VAL	1354 VAL	1354 VAL	1353 VAL	1354 VAL
319-84-6	alpha-BHC						
319-85-7	beta-BHC						
319-86-8	delta-BHC						
58-89-9	gamma-BHC (Lindane)						
76-44-8	Heptachlor						
309-00-2	Aldrin						
1024-57-3	Heptachlor epoxide						
959-98-8	Endosulfan I						
60-57-1	Dieldrin						
72-55-9	4,4'-DDE						
72-20-8	Endrin						
33213-65-9	Endosulfan II						
72-54-8	4,4'-DDD						
1031-07-8	Endosulfan sulfate						
50-29-3	4,4'-DDT						
72-43-5	Methoxychlor						
53494-70-5	Endrin ketone						
7421-93-4	Endrin aldehyde						
5103-71-9	alpha-Chlordane						
5103-74-2	gamma-Chlordane						
8001-35-2	Toxaphene						
12674-11-2	Aroclor-1016						
11104-28-2	Aroclor-1221						
53469-21-9	Aroclor-1242						
12672-29-6	Aroclor-1248						
11097-69-1	Aroclor-1254						
11096-82-5	Aroclor-1260						
11141-16-5	Aroclor-1232						
12789-03-6	Technical Chlordane	NR	NR	NR	NR	NR	NR

000451

*** Validation Complete ***

NSA Mid-South, Assembly A - SWMU 5
Initial Sampling Event
Fluvial Deposits Groundwater

SW846-PEST

SAMPLE ID ------->	005-G-4BUF-00
ORIGINAL ID ----->	005GMW4BUF
LAB SAMPLE ID --->	120953
ID FROM REPORT -->	005GMW4BUF
SAMPLE DATE ----->	03/29/95
DATE EXTRACTED -->	04/04/95
DATE ANALYZED --->	04/19/95
MATRIX ---------->	Water
UNITS ---------->	UG/L

CAS #	Parameter	1354 VAL
319-84-6	alpha-BHC	
319-85-7	beta-BHC	
319-86-8	delta-BHC	
58-89-9	gamma-BHC (Lindane)	
76-44-8	Heptachlor	
309-00-2	Aldrin	
1024-57-3	Heptachlor epoxide	
959-98-8	Endosulfan I	
60-57-1	Dieldrin	
72-55-9	4,4'-DDE	
72-20-8	Endrin	
33213-65-9	Endosulfan II	
72-54-8	4,4'-DDD	
1031-07-8	Endosulfan sulfate	
50-29-3	4,4'-DDT	
72-43-5	Methoxychlor	
53494-70-5	Endrin ketone	
7421-93-4	Endrin aldehyde	
5103-71-9	alpha-Chlordane	
5103-74-2	gamma-Chlordane	
8001-35-2	Toxaphene	
12674-11-2	Aroclor-1016	
11104-28-2	Aroclor-1221	
53469-21-9	Aroclor-1242	
12672-29-6	Aroclor-1248	
11097-69-1	Aroclor-1254	
11096-82-5	Aroclor-1260	
11141-16-5	Aroclor-1232	
12789-03-6	Technical Chlordane	NR

*** Validatic Complete ***

NSA Mid-South, Assembly A - SWMU 5
Initial Sampling Event
Fluvial Deposits Groundwater

SW846-SVOA													
	SAMPLE ID ------->	005-G-01UF-00		005-G-02UF-00		005-G-03UF-00		005-G-04UF-00		005-G-05LF-00		005-G-4AUF-00	
	ORIGINAL ID ----->	005GMW01UF		005GMW02UF		005GMW03UF		005GMW04UF		005GMW05LF		005GMW4AUF	
	LAB SAMPLE ID --->	120671		120765		120766		120950		120533		120952	
	ID FROM REPORT -->	005GMW01UF		005GMW02UF		005GMW03UF		005GMW04UF		005GMW05LF		005GMW4AUF	
	SAMPLE DATE ----->	03/27/95		03/28/95		03/28/95		03/29/95		03/23/95		03/29/95	
	DATE EXTRACTED -->	03/31/95		04/03/95		04/03/95		04/05/95		03/30/95		04/10/95	
	DATE ANALYZED --->	04/13/95		04/13/95		04/13/95		04/27/95		04/12/95		04/28/95	
	MATRIX ---------->	Water		Water		Water		Water		Water		Water	
	UNITS ---------->	UG/L		UG/L		UG/L		UG/L		UG/L		UG/L	
CAS #	Parameter	1353	VAL	1354	VAL	1354	VAL	1354	VAL	1353	VAL	1354	VAL
108-95-2	Phenol												
111-44-4	bis(2-Chloroethyl)ether												
95-57-8	2-Chlorophenol												
541-73-1	1,3-Dichlorobenzene												
106-46-7	1,4-Dichlorobenzene												
95-50-1	1,2-Dichlorobenzene												
95-48-7	2-Methylphenol (o-Cresol)												
108-60-1	2,2'-oxybis(1-Chloropropane)												
106-44-5	4-Methylphenol (p-Cresol)												
621-64-7	N-Nitroso-di-n-propylamine												
67-72-1	Hexachloroethane												
98-95-3	Nitrobenzene												
78-59-1	Isophorone												
88-75-5	2-Nitrophenol												
105-67-9	2,4-Dimethylphenol												
120-83-2	2,4-Dichlorophenol												
120-82-1	1,2,4-Trichlorobenzene												
91-20-3	Naphthalene												
106-47-8	4-Chloroaniline												
87-68-3	Hexachlorobutadiene												
111-91-1	bis(2-Chloroethoxy)methane												
59-50-7	4-Chloro-3-methylphenol												
91-57-6	2-Methylnaphthalene												
77-47-4	Hexachlorocyclopentadiene												
88-06-2	2,4,6-Trichlorophenol												
95-95-4	2,4,5-Trichlorophenol												
91-58-7	2-Chloronaphthalene												
88-74-4	2-Nitroaniline												
131-11-3	Dimethylphthalate												
208-96-8	Acenaphthylene												
606-20-2	2,6-Dinitrotoluene												
99-09-2	3-Nitroaniline												
83-32-9	Acenaphthene												
51-28-5	2,4-Dinitrophenol												
100-02-7	4-Nitrophenol												
132-64-9	Dibenzofuran												

*** Validation Complete ***

NSA Mid-South, Assembly A - SWMU 5
Initial Sampling Event
Fluvial Deposits Groundwater

SW846-SVOA													
	SAMPLE ID ------->	005-G-01UF-00		005-G-02UF-00		005-G-03UF-00		005-G-04UF-00		005-G-05LF-00		005-G-4AUF-00	
	ORIGINAL ID ----->	005GMW01UF		005GMW02UF		005GMW03UF		005GMW04UF		005GMW05LF		005GMW4AUF	
	LAB SAMPLE ID --->	120671		120765		120766		120950		120533		120952	
	ID FROM REPORT -->	005GMW01UF		005GMW02UF		005GMW03UF		005GMW04UF		005GMW05LF		005GMW4AUF	
	SAMPLE DATE ----->	03/27/95		03/28/95		03/28/95		03/29/95		03/23/95		03/29/95	
	DATE EXTRACTED -->	03/31/95		04/03/95		04/03/95		04/05/95		03/30/95		04/10/95	
	DATE ANALYZED --->	04/13/95		04/13/95		04/13/95		04/27/95		04/12/95		04/28/95	
	MATRIX ---------->	Water		Water		Water		Water		Water		Water	
	UNITS ---------->	UG/L		UG/L		UG/L		UG/L		UG/L		UG/L	
CAS #	Parameter	1353	VAL	1354	VAL	1354	VAL	1354	VAL	1353	VAL	1354	VAL
121-14-2	2,4-Dinitrotoluene												
84-66-2	Diethylphthalate												
7005-72-3	4-Chlorophenylphenyl ether												
86-73-7	Fluorene												
100-01-6	4-Nitroaniline												
534-52-1	2-Methyl-4,6-Dinitrophenol												
86-30-6	N-Nitrosodiphenylamine												
101-55-3	4-Bromophenyl-phenylether												
118-74-1	Hexachlorobenzene												
87-86-5	Pentachlorophenol												
85-01-8	Phenanthrene												
120-12-7	Anthracene												
86-74-8	Carbazole												
84-74-2	Di-n-butylphthalate												
206-44-0	Fluoranthene												
129-00-0	Pyrene												
85-68-7	Butylbenzylphthalate												
91-94-1	3,3'-Dichlorobenzidine												
56-55-3	Benzo(a)anthracene												
218-01-9	Chrysene												
117-81-7	bis(2-Ethylhexyl)phthalate (BEHP)											3.	J
117-84-0	Di-n-octylphthalate												
205-99-2	Benzo(b)fluoranthene												
207-08-9	Benzo(k)fluoranthene												
50-32-8	Benzo(a)pyrene												
193-39-5	Indeno(1,2,3-cd)pyrene												
53-70-3	Dibenz(a,h)anthracene												
191-24-2	Benzo(g,h,i)perylene												
9999900-32-2	3-Methylphenol/4-Methylphenol	NR		NR		NR		NR		NR		NR	
122-39-4	Diphenylamine	NR		NR		NR		NR		NR		NR	

*** Validation Complete ***

000437

NSA Mid-South, Assembly A - SWMU 5
Initial Sampling Event
Fluvial Deposits Groundwater

SW846-SVOA

SAMPLE ID ------->	005-G-4BUF-00
ORIGINAL ID ----->	005GMW4BUF
LAB SAMPLE ID --->	120953
ID FROM REPORT -->	005GMW4BUF
SAMPLE DATE ----->	03/29/95
DATE EXTRACTED -->	04/05/95
DATE ANALYZED --->	04/28/95
MATRIX ---------->	Water
UNITS ---------->	UG/L

CAS #	Parameter	1354	VAL
108-95-2	Phenol		
111-44-4	bis(2-Chloroethyl)ether		
95-57-8	2-Chlorophenol		
541-73-1	1,3-Dichlorobenzene		
106-46-7	1,4-Dichlorobenzene		
95-50-1	1,2-Dichlorobenzene		
95-48-7	2-Methylphenol (o-Cresol)		
108-60-1	2,2'-oxybis(1-Chloropropane)		
106-44-5	4-Methylphenol (p-Cresol)		
621-64-7	N-Nitroso-di-n-propylamine		
67-72-1	Hexachloroethane		
98-95-3	Nitrobenzene	1.	J
78-59-1	Isophorone		
88-75-5	2-Nitrophenol		
105-67-9	2,4-Dimethylphenol		
120-83-2	2,4-Dichlorophenol		
120-82-1	1,2,4-Trichlorobenzene		
91-20-3	Naphthalene		
106-47-8	4-Chloroaniline		
87-68-3	Hexachlorobutadiene		
111-91-1	bis(2-Chloroethoxy)methane		
59-50-7	4-Chloro-3-methylphenol		
91-57-6	2-Methylnaphthalene		
77-47-4	Hexachlorocyclopentadiene		
88-06-2	2,4,6-Trichlorophenol		
95-95-4	2,4,5-Trichlorophenol		
91-58-7	2-Chloronaphthalene		
88-74-4	2-Nitroaniline		
131-11-3	Dimethylphthalate		
208-96-8	Acenaphthylene		
606-20-2	2,6-Dinitrotoluene		
99-09-2	3-Nitroaniline		
83-32-9	Acenaphthene		
51-28-5	2,4-Dinitrophenol		
100-02-7	4-Nitrophenol		
132-64-9	Dibenzofuran		

*** Validation Complete ***

000453

NSA Mid-South, Assembly A - SWMU 5
Initial Sampling Event
Fluvial Deposits Groundwater

SW846-SVOA

SAMPLE ID ------->	005-G-4BUF-00
ORIGINAL ID ----->	005GMW4BUF
LAB SAMPLE ID --->	120953
ID FROM REPORT -->	005GMW4BUF
SAMPLE DATE ----->	03/29/95
DATE EXTRACTED -->	04/05/95
DATE ANALYZED --->	04/28/95
MATRIX ---------->	Water
UNITS ----------->	UG/L

CAS #	Parameter	1354	VAL
121-14-2	2,4-Dinitrotoluene		
84-66-2	Diethylphthalate		
7005-72-3	4-Chlorophenylphenyl ether		
86-73-7	Fluorene		
100-01-6	4-Nitroaniline		
534-52-1	2-Methyl-4,6-Dinitrophenol		
86-30-6	N-Nitrosodiphenylamine		
101-55-3	4-Bromophenyl-phenylether		
118-74-1	Hexachlorobenzene		
87-86-5	Pentachlorophenol		
85-01-8	Phenanthrene		
120-12-7	Anthracene		
86-74-8	Carbazole		
84-74-2	Di-n-butylphthalate		
206-44-0	Fluoranthene		
129-00-0	Pyrene		
85-68-7	Butylbenzylphthalate		
91-94-1	3,3'-Dichlorobenzidine		
56-55-3	Benzo(a)anthracene		
218-01-9	Chrysene		
117-81-7	bis(2-Ethylhexyl)phthalate (BEHP)		
117-84-0	Di-n-octylphthalate		
205-99-2	Benzo(b)fluoranthene		
207-08-9	Benzo(k)fluoranthene		
50-32-8	Benzo(a)pyrene		
193-39-5	Indeno(1,2,3-cd)pyrene		
53-70-3	Dibenz(a,h)anthracene		
191-24-2	Benzo(g,h,i)perylene		
9999900-32-2	3-Methylphenol/4-Methylphenol	NR	
122-39-4	Diphenylamine	NR	

*** Validation Complete ***

NSA Mid-South, Assembly A - SWMU 5
Initial Sampling Event
Fluvial Deposits Groundwater

SW846-VOA													
	SAMPLE ID ------->	005-G-01UF-00		005-G-02UF-00		005-G-03UF-00		005-G-04UF-00		005-G-05LF-00		005-G-4AUF-00	
	ORIGINAL ID ----->	005GMW01UF		005GMW02UF		005GMW03UF		005GMW04UF		005GMW05LF		005GMW4AUF	
	LAB SAMPLE ID --->	120671		120765		120766		120950		120533		120952	
	ID FROM REPORT -->	005GMW01UF		005GMW02UF		005GMW03UF		005GMW04UF		005GMW05LF		005GMW4AUF	
	SAMPLE DATE ----->	03/27/95		03/28/95		03/28/95		03/29/95		03/23/95		03/29/95	
	DATE ANALYZED --->	04/04/95		04/07/95		04/05/95		04/06/95		04/03/95		04/06/95	
	MATRIX ---------->	Water		Water		Water		Water		Water		Water	
	UNITS ---------->	UG/L		UG/L		UG/L		UG/L		UG/L		UG/L	
CAS #	Parameter	1353	VAL	1354	VAL	1354	VAL	1354	VAL	1353	VAL	1354	VAL
74-87-3	Chloromethane												
74-83-9	Bromomethane												
75-01-4	Vinyl chloride												
75-00-3	Chloroethane												
75-09-2	Methylene chloride												
67-64-1	Acetone												
75-15-0	Carbon disulfide												
75-35-4	1,1-Dichloroethene												
75-34-3	1,1-Dichloroethane												
540-59-0	1,2-Dichloroethene (total)												
67-66-3	Chloroform												
107-06-2	1,2-Dichloroethane												
78-93-3	2-Butanone (MEK)												
71-55-6	1,1,1-Trichloroethane												
56-23-5	Carbon tetrachloride											3.	J
75-27-4	Bromodichloromethane												
78-87-5	1,2-Dichloropropane												
10061-01-5	cis-1,3-Dichloropropene												
79-01-6	Trichloroethene												
124-48-1	Dibromochloromethane												
79-00-5	1,1,2-Trichloroethane												
71-43-2	Benzene												
10061-02-6	trans-1,3-Dichloropropene												
75-25-2	Bromoform												
108-10-1	4-Methyl-2-Pentanone (MIBK)												
591-78-6	2-Hexanone												
127-18-4	Tetrachloroethene												
79-34-5	1,1,2,2-Tetrachloroethane												
108-88-3	Toluene												
108-90-7	Chlorobenzene												
100-41-4	Ethylbenzene												
100-42-5	Styrene												
1330-20-7	Xylene (Total)												
110-75-8	2-Chloroethylvinylether	NR		NR		NR		NR		NR		NR	
95-50-1	1,2-Dichlorobenzene	NR		NR		NR		NR		NR		NR	
541-73-1	1,3-Dichlorobenzene	NR		NR		NR		NR		NR		NR	
106-46-7	1,4-Dichlorobenzene	NR		NR		NR		NR		NR		NR	

*** Validation Complete ***

100460

NSA Mid-South, Assembly A - SWMU 5
Initial Sampling Event
Fluvial Deposits Groundwater

SW846-VOA

	SAMPLE ID ------->	005-G-01UF-00		005-G-02UF-00		005-G-03UF-00		005-G-04UF-00		005-G-05LF-00		005-G-4AUF-00	
	ORIGINAL ID ----->	005GMW01UF		005GMW02UF		005GMW03UF		005GMW04UF		005GMW05LF		005GMW4AUF	
	LAB SAMPLE ID --->	120671		120765		120766		120950		120533		120952	
	ID FROM REPORT -->	005GMW01UF		005GMW02UF		005GMW03UF		005GMW04UF		005GMW05LF		005GMW4AUF	
	SAMPLE DATE ----->	03/27/95		03/28/95		03/28/95		03/29/95		03/23/95		03/29/95	
	DATE ANALYZED --->	04/04/95		04/07/95		04/05/95		04/06/95		04/03/95		04/06/95	
	MATRIX ---------->	Water		Water		Water		Water		Water		Water	
	UNITS ---------->	UG/L		UG/L		UG/L		UG/L		UG/L		UG/L	
CAS #	Parameter	1353	VAL	1354	VAL	1354	VAL	1354	VAL	1353	VAL	1354	VAL
75-69-4	Trichlorofluoromethane	NR		NR		NR		NR		NR		NR	
108-05-4	Vinyl acetate	NR		NR		NR		NR		NR		NR	
108-38-3	m-Xylene	NR		NR		NR		NR		NR		NR	
95-47-6	o-Xylene	NR		NR		NR		NR		NR		NR	
106-42-3	p-Xylene	NR		NR		NR		NR		NR		NR	

*** Validation complete ***

NSA Mid-South, Assembly A - SWMU 5
Initial Sampling Event
Fluvial Deposits Groundwater

SW846-VOA

SAMPLE ID ------->	005-G-4BUF-00
ORIGINAL ID ----->	005GMW4BUF
LAB SAMPLE ID --->	120953
ID FROM REPORT -->	005GMW4BUF
SAMPLE DATE ----->	03/29/95
DATE ANALYZED --->	04/06/95
MATRIX ---------->	Water
UNITS ---------->	UG/L

CAS #	Parameter	1354	VAL
74-87-3	Chloromethane		
74-83-9	Bromomethane		
75-01-4	Vinyl chloride		
75-00-3	Chloroethane		
75-09-2	Methylene chloride		
67-64-1	Acetone		
75-15-0	Carbon disulfide		
75-35-4	1,1-Dichloroethene		
75-34-3	1,1-Dichloroethane		
540-59-0	1,2-Dichloroethene (total)		
67-66-3	Chloroform		
107-06-2	1,2-Dichloroethane		
78-93-3	2-Butanone (MEK)		
71-55-6	1,1,1-Trichloroethane		
56-23-5	Carbon tetrachloride	4.	J
75-27-4	Bromodichloromethane		
78-87-5	1,2-Dichloropropane		
10061-01-5	cis-1,3-Dichloropropene		
79-01-6	Trichloroethene		
124-48-1	Dibromochloromethane		
79-00-5	1,1,2-Trichloroethane		
71-43-2	Benzene		
10061-02-6	trans-1,3-Dichloropropene		
75-25-2	Bromoform		
108-10-1	4-Methyl-2-Pentanone (MIBK)		
591-78-6	2-Hexanone		
127-18-4	Tetrachloroethene		
79-34-5	1,1,2,2-Tetrachloroethane		
108-88-3	Toluene		
108-90-7	Chlorobenzene		
100-41-4	Ethylbenzene		
100-42-5	Styrene		
1330-20-7	Xylene (Total)		
110-75-8	2-Chloroethylvinylether	NR	
95-50-1	1,2-Dichlorobenzene	NR	
541-73-1	1,3-Dichlorobenzene	NR	
106-46-7	1,4-Dichlorobenzene	NR	

*** Validation Complete ***

000462

NSA Mid-South, Assembly A - SWMU 5
Initial Sampling Event
Fluvial Deposits Groundwater

SW846-VOA

SAMPLE ID ------->	005-G-4BUF-00
ORIGINAL ID ----->	005GMW4BUF
LAB SAMPLE ID --->	120953
ID FROM REPORT -->	005GMW4BUF
SAMPLE DATE ----->	03/29/95
DATE ANALYZED --->	04/06/95
MATRIX ---------->	Water
UNITS ----------->	UG/L

CAS #	Parameter	1354	VAL
75-69-4	Trichlorofluoromethane		NR
108-05-4	Vinyl acetate		NR
108-38-3	m-Xylene		NR
95-47-6	o-Xylene		NR
106-42-3	p-Xylene		NR

*** Validation Complete ***

NSA Mid-South, Assembly A - SWMU 5
Initial Sampling Event
Fluvial Deposits Groundwater

TPH													
	SAMPLE ID ------->	005-G-01UF-00		005-G-02UF-00		005-G-03UF-00		005-G-04UF-00		005-G-05LF-00		005-G-4AUF-00	
	ORIGINAL ID ----->	005GMW01UF		005GMW02UF		005GMW03UF		005GMW04UF		005GMW05LF		005GMW4AUF	
	LAB SAMPLE ID --->	120669		120759		120762		120943		120518		120944	
	ID FROM REPORT -->	005GMW01UF		005GMW02UF		005GMW03UF		005GMW04UF		005GMW05LF		005GMW4AUF	
	SAMPLE DATE ----->	03/27/95		03/28/95		03/28/95		03/29/95		03/23/95		03/29/95	
	DATE EXTRACTED -->	04/17/95		04/21/95		04/21/95		04/24/95		04/20/95		04/24/95	
	DATE ANALYZED --->	04/18/95		04/21/95		04/21/95		04/24/95		04/20/95		04/24/95	
	MATRIX ---------->	Water		Water		Water		Water		Water		Water	
	UNITS ---------->	mg/L		mg/L		mg/L		mg/L		mg/L		mg/L	
CAS #	Parameter	1353	VAL	1354	VAL	1354	VAL	1354	VAL	1353	VAL	1354	VAL
)999900-02-4	Petroleum Hydrocarbons, TPH												

*** Validation Complete ***

NSA Mid-South, Assembly A - SWMU 5
Initial Sampling Event
Fluvial Deposits Groundwater

TPH							
	SAMPLE ID ------->	005-G-4BUF-00					
	ORIGINAL ID ----->	005GMW4BUF					
	LAB SAMPLE ID --->	120945					
	ID FROM REPORT -->	005GMW4BUF					
	SAMPLE DATE ----->	03/29/95					
	DATE EXTRACTED -->	04/24/95					
	DATE ANALYZED --->	04/24/95					
	MATRIX ---------->	Water					
	UNITS ---------->	mg/L					
CAS #	Parameter	1354	VAL				
999900-02-4	Petroleum Hydrocarbons, TPH						

*** Validation Complete ***

DATALCP3
11/05/98

NSA MEMPHIS, Assembly A - SWMU 5
Event 1 of Long Term Monitoring
Fluvial Deposits Groundwater

SW846-VOA													
	SAMPLE ID ------->	005-G-01UF-01		005-G-02UF-01		005-G-03UF-01		005-G-04UF-01		005-G-05LF-01		005-G-4AUF-01	
	ORIGINAL ID ----->	005G1001UF		005G1002UF		005G1003UF		005G1004UF		005G1005LF		005G104AUF	
	LAB SAMPLE ID --->	139521		139596		139597		139522		139523		139524	
	ID FROM REPORT -->	005G1001UF		005G1002UF		005G1003UF		005G1004UF		005G1005LF		005G104AUF	
	SAMPLE DATE ----->	12/04/95		11/30/95		11/30/95		11/29/95		11/29/95		11/29/95	
	DATE ANALYZED --->	12/06/95		12/08/95		12/08/95		12/07/95		12/11/95		12/07/95	
	MATRIX ---------->	Water		Water		Water		Water		Water		Water	
	UNITS ---------->	UG/L		UG/L		UG/L		UG/L		UG/L		UG/L	
CAS #	Parameter	1635	VAL	1635	VAL	1635	VAL	1635	VAL	1635	VAL	1635	VAL
74-87-3	Chloromethane												
74-83-9	Bromomethane												
75-01-4	Vinyl chloride												
75-00-3	Chloroethane												
75-09-2	Methylene chloride												
67-64-1	Acetone	3.	J					54.					
75-15-0	Carbon disulfide												
75-35-4	1,1-Dichloroethene												
75-34-3	1,1-Dichloroethane												
540-59-0	1,2-Dichloroethene (total)												
67-66-3	Chloroform												
107-06-2	1,2-Dichloroethane												
78-93-3	2-Butanone (MEK)			27.									
71-55-6	1,1,1-Trichloroethane												
56-23-5	Carbon tetrachloride											5.	J
75-27-4	Bromodichloromethane												
78-87-5	1,2-Dichloropropane												
10061-01-5	cis-1,3-Dichloropropene												
79-01-6	Trichloroethene												
124-48-1	Dibromochloromethane												
79-00-5	1,1,2-Trichloroethane												
71-43-2	Benzene												
10061-02-6	trans-1,3-Dichloropropene												
75-25-2	Bromoform												
108-10-1	4-Methyl-2-Pentanone (MIBK)												
591-78-6	2-Hexanone												
127-18-4	Tetrachloroethene												
79-34-5	1,1,2,2-Tetrachloroethane												
108-88-3	Toluene												
108-90-7	Chlorobenzene												
100-41-4	Ethylbenzene												
100-42-5	Styrene												
1330-20-7	Xylene (Total)												

*** Validation Complete ***

NSA MEMPHIS, Assembly A - SWMU 5
Event 1 of Long Term Monitoring
Fluvial Deposits Groundwater

SW846-VOA

SAMPLE ID ------->	005-G-4BUF-01
ORIGINAL ID ----->	005G104BUF
LAB SAMPLE ID --->	139598
ID FROM REPORT -->	005G104BUF
SAMPLE DATE ----->	11/30/95
DATE ANALYZED --->	12/08/95
MATRIX ---------->	Water
UNITS ---------->	UG/L

CAS #	Parameter	1635	VAL
74-87-3	Chloromethane		
74-83-9	Bromomethane		
75-01-4	Vinyl chloride		
75-00-3	Chloroethane		
75-09-2	Methylene chloride		
67-64-1	Acetone		
75-15-0	Carbon disulfide		
75-35-4	1,1-Dichloroethene		
75-34-3	1,1-Dichloroethane		
540-59-0	1,2-Dichloroethene (total)		
67-66-3	Chloroform		
107-06-2	1,2-Dichloroethane		
78-93-3	2-Butanone (MEK)		
71-55-6	1,1,1-Trichloroethane		
56-23-5	Carbon tetrachloride	5.	J
75-27-4	Bromodichloromethane		
78-87-5	1,2-Dichloropropane		
10061-01-5	cis-1,3-Dichloropropene		
79-01-6	Trichloroethene		
124-48-1	Dibromochloromethane		
79-00-5	1,1,2-Trichloroethane		
71-43-2	Benzene		
10061-02-6	trans-1,3-Dichloropropene		
75-25-2	Bromoform		
108-10-1	4-Methyl-2-Pentanone (MIBK)		
591-78-6	2-Hexanone		
127-18-4	Tetrachloroethene		
79-34-5	1,1,2,2-Tetrachloroethane		
108-88-3	Toluene		
108-90-7	Chlorobenzene		
100-41-4	Ethylbenzene		
100-42-5	Styrene		
1330-20-7	Xylene (Total)		

*** Valida... Complete ***

000467

DATALCP3
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NSA Mid-South Assembly A - SWMU 5
Event 2 of Long Term Monitoring
Fluvial Deposits Groundwater

SW846-VOA													
	SAMPLE ID ------->	005-G-01UF-02		005-G-02UF-02		005-G-03UF-02		005-H-03UF-02		005-G-04UF-02		005-G-05LF-02	
	ORIGINAL ID ----->	005GB00102		005GB00202		005GB00302		005HB00302		005GB00402		005GD00502	
	LAB SAMPLE ID --->	145634		145635		145636		145641		145637		145640	
	ID FROM REPORT -->	005GB00102		005GB00202		005GB00302		005HB00302		005GB00402		005GD00502	
	SAMPLE DATE ----->	04/10/96		04/10/96		04/10/96		04/10/96		04/10/96		04/10/96	
	DATE ANALYZED --->	04/23/96		04/23/96		04/24/96		04/24/96		04/23/96		04/24/96	
	MATRIX ---------->	Water		Water		Water		Water		Water		Water	
	UNITS ---------->	ug/L		ug/L		ug/L		ug/L		ug/L		ug/L	
CAS #	Parameter	1749	VAL	1749	VAL	1749	VAL	1749	VAL	1749	VAL	1749	VAL
74-87-3	Chloromethane	5.	J					5.	J				
74-83-9	Bromomethane												
75-01-4	Vinyl chloride												
75-00-3	Chloroethane												
75-09-2	Methylene chloride												
67-64-1	Acetone												
75-15-0	Carbon disulfide												
75-35-4	1,1-Dichloroethene												
75-34-3	1,1-Dichloroethane												
540-59-0	1,2-Dichloroethene (total)												
67-66-3	Chloroform												
107-06-2	1,2-Dichloroethane												
78-93-3	2-Butanone (MEK)	11.											
71-55-6	1,1,1-Trichloroethane												
56-23-5	Carbon tetrachloride												
75-27-4	Bromodichloromethane												
78-87-5	1,2-Dichloropropane												
10061-01-5	cis-1,3-Dichloropropene												
79-01-6	Trichloroethene												
124-48-1	Dibromochloromethane												
79-00-5	1,1,2-Trichloroethane												
71-43-2	Benzene												
10061-02-6	trans-1,3-Dichloropropene												
75-25-2	Bromoform												
108-10-1	4-Methyl-2-Pentanone (MIBK)												
591-78-6	2-Hexanone												
127-18-4	Tetrachloroethene												
79-34-5	1,1,2,2-Tetrachloroethane												
108-88-3	Toluene												
108-90-7	Chlorobenzene												
100-41-4	Ethylbenzene												
100-42-5	Styrene												
1330-20-7	Xylene (Total)												

*** Validation Complete ***

1004468

NSA Mid-South Assembly A - SWMU 5
Event 2 of Long Term Monitoring
Fluvial Deposits Groundwater

SW846-VOA							
	SAMPLE ID ------->	005-G-4AUF-02		005-G-4BUF-02			
	ORIGINAL ID ----->	005GBA0402		005GBB0402			
	LAB SAMPLE ID --->	145638		145639			
	ID FROM REPORT -->	005GBA0402		005GBB0402			
	SAMPLE DATE ----->	04/10/96		04/10/96			
	DATE ANALYZED --->	04/23/96		04/25/96			
	MATRIX ---------->	Water		Water			
	UNITS ---------->	ug/L		ug/L			
CAS #	Parameter	1749	VAL	1749	VAL		
74-87-3	Chloromethane						
74-83-9	Bromomethane						
75-01-4	Vinyl chloride						
75-00-3	Chloroethane						
75-09-2	Methylene chloride						
67-64-1	Acetone						
75-15-0	Carbon disulfide						
75-35-4	1,1-Dichloroethene						
75-34-3	1,1-Dichloroethane						
540-59-0	1,2-Dichloroethene (total)						
67-66-3	Chloroform						
107-06-2	1,2-Dichloroethane						
78-93-3	2-Butanone (MEK)						
71-55-6	1,1,1-Trichloroethane						
56-23-5	Carbon tetrachloride	4.	J	4.	J		
75-27-4	Bromodichloromethane						
78-87-5	1,2-Dichloropropane						
10061-01-5	cis-1,3-Dichloropropene						
79-01-6	Trichloroethene						
124-48-1	Dibromochloromethane						
79-00-5	1,1,2-Trichloroethane						
71-43-2	Benzene						
10061-02-6	trans-1,3-Dichloropropene						
75-25-2	Bromoform						
108-10-1	4-Methyl-2-Pentanone (MIBK)						
591-78-6	2-Hexanone						
127-18-4	Tetrachloroethene						
79-34-5	1,1,2,2-Tetrachloroethane						
108-88-3	Toluene						
108-90-7	Chlorobenzene						
100-41-4	Ethylbenzene						
100-42-5	Styrene						
1330-20-7	Xylene (Total)						

*** Valid[illegible] Complete ***

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NSA Mid-South, Assembly A - SWMU 5
Event 3 of Long Term Monitoring
Fluvial Deposits Groundwater

SW846-VOA													
	SAMPLE ID ------->	005-G-01UF-03		005-G-02UF-03		005-G-03UF-03		005-H-03UF-03		005-G-04UF-03		005-G-05LF-03	
	ORIGINAL ID ----->	005G01UF03		005G02UF03		005G03UF03		005H03UF03		005G04UF03		005G05LF03	
	LAB SAMPLE ID --->	152797		152798		152799		152796		152800		152801	
	ID FROM REPORT -->	005g01uf03		005g02uf03		005g03uf03		005h03uf03		005g04uf03		005g05lf03	
	SAMPLE DATE ----->	08/16/96		08/16/96		08/16/96		08/16/96		08/16/96		08/16/96	
	DATE ANALYZED --->	08/22/96		08/21/96		08/23/96		08/22/96		08/22/96		08/26/96	
	MATRIX ---------->	Water		Water		Water		Water		Water		Water	
	UNITS ---------->	ug/L		ug/L		ug/L		ug/L		ug/L		ug/L	
CAS #	Parameter	1969	VAL	1969	VAL	1969	VAL	1969	VAL	1969	VAL	1969	VAL
74-87-3	Chloromethane												
74-83-9	Bromomethane												
75-01-4	Vinyl chloride												
75-00-3	Chloroethane												
75-09-2	Methylene chloride												
67-64-1	Acetone												
75-15-0	Carbon disulfide												
75-35-4	1,1-Dichloroethene												
75-34-3	1,1-Dichloroethane												
540-59-0	1,2-Dichloroethene (total)												
67-66-3	Chloroform												
107-06-2	1,2-Dichloroethane												
78-93-3	2-Butanone (MEK)												
71-55-6	1,1,1-Trichloroethane									1.	J		
56-23-5	Carbon tetrachloride												
75-27-4	Bromodichloromethane												
78-87-5	1,2-Dichloropropane												
10061-01-5	cis-1,3-Dichloropropene												
79-01-6	Trichloroethene												
124-48-1	Dibromochloromethane												
79-00-5	1,1,2-Trichloroethane												
71-43-2	Benzene												
10061-02-6	trans-1,3-Dichloropropene												
75-25-2	Bromoform												
108-10-1	4-Methyl-2-Pentanone (MIBK)												
591-78-6	2-Hexanone												
127-18-4	Tetrachloroethene												
79-34-5	1,1,2,2-Tetrachloroethane												
108-88-3	Toluene												
108-90-7	Chlorobenzene												
100-41-4	Ethylbenzene												
100-42-5	Styrene												
1330-20-7	Xylene (Total)												

*** Validation Complete ***

NSA Mid-South, Assembly A - SWMU 5
Event 3 of Long Term Monitoring
Fluvial Deposits Groundwater

SW846-VOA								
	SAMPLE ID ------->	005-G-4AUF-03		005-G-4BUF-03				
	ORIGINAL ID ----->	005G4AUF03		005G4BUF03				
	LAB SAMPLE ID --->	152794		152795				
	ID FROM REPORT -->	005g4auf03		005g4buf03				
	SAMPLE DATE ----->	08/16/96		08/16/96				
	DATE ANALYZED --->	08/21/96		08/21/96				
	MATRIX ---------->	Water		Water				
	UNITS ---------->	ug/L		ug/L				
CAS #	Parameter	1969	VAL	1969	VAL			
74-87-3	Chloromethane							
74-83-9	Bromomethane							
75-01-4	Vinyl chloride							
75-00-3	Chloroethane							
75-09-2	Methylene chloride							
67-64-1	Acetone							
75-15-0	Carbon disulfide							
75-35-4	1,1-Dichloroethene							
75-34-3	1,1-Dichloroethane							
540-59-0	1,2-Dichloroethene (total)							
67-66-3	Chloroform			1.	J			
107-06-2	1,2-Dichloroethane							
78-93-3	2-Butanone (MEK)							
71-55-6	1,1,1-Trichloroethane							
56-23-5	Carbon tetrachloride	6.	J	10.	J			
75-27-4	Bromodichloromethane							
78-87-5	1,2-Dichloropropane							
10061-01-5	cis-1,3-Dichloropropene							
79-01-6	Trichloroethene							
124-48-1	Dibromochloromethane							
79-00-5	1,1,2-Trichloroethane							
71-43-2	Benzene							
10061-02-6	trans-1,3-Dichloropropene							
75-25-2	Bromoform							
108-10-1	4-Methyl-2-Pentanone (MIBK)							
591-78-6	2-Hexanone							
127-18-4	Tetrachloroethene							
79-34-5	1,1,2,2-Tetrachloroethane							
108-88-3	Toluene							
108-90-7	Chlorobenzene							
100-41-4	Ethylbenzene							
100-42-5	Styrene							
1330-20-7	Xylene (Total)							

*** Validation Complete ***

NSA Mid-South, Assembly A - SWMU 5
Event 4 of Long Term Monitoring
Fluvial Deposits Groundwater

SW846-VOA													
	SAMPLE ID ------->	005-G-01UF-04		005-G-02UF-04		005-G-03UF-04		005-H-03UF-04		005-G-04UF-04		005-G-05LF-04	
	ORIGINAL ID ----->	005G01UF04		005G02UF04		005G03UF04		005H03UF04		005G04UF04		005G05LF04	
	LAB SAMPLE ID --->	S772088*6		S772088*7		S772088*8		S772088*10		S772088*9		S772562*2	
	ID FROM REPORT -->	005G01UF04		005G02UF04		005G03UF04		005H03UF04		005G04UF04		005G05LF04	
	SAMPLE DATE ----->	04/15/97		04/15/97		04/15/97		04/15/97		04/15/97		05/06/97	
	DATE ANALYZED --->	04/17/97		04/17/97		04/17/97		04/17/97		04/17/97		05/14/97	
	MATRIX ---------->	Water		Water		Water		Water		Water		Water	
	UNITS ---------->	UG/L		UG/L		UG/L		UG/L		UG/L		UG/L	
CAS #	Parameter	MEM07	VAL	MEM07	VAL	MEM07	VAL	MEM07	VAL	MEM07	VAL	MEM18	NV
74-87-3	Chloromethane												
75-01-4	Vinyl chloride												
74-83-9	Bromomethane												
75-00-3	Chloroethane												
75-35-4	1,1-Dichloroethene												
75-09-2	Methylene chloride												
75-34-3	1,1-Dichloroethane												
67-66-3	Chloroform												
71-55-6	1,1,1-Trichloroethane												
56-23-5	Carbon tetrachloride									1.2	J		
71-43-2	Benzene												
107-06-2	1,2-Dichloroethane												
79-01-6	Trichloroethene												
78-87-5	1,2-Dichloropropane												
75-27-4	Bromodichloromethane												
108-88-3	Toluene												
79-00-5	1,1,2-Trichloroethane												
127-18-4	Tetrachloroethene												
124-48-1	Dibromochloromethane												
108-90-7	Chlorobenzene												
100-41-4	Ethylbenzene												
100-42-5	Styrene												
75-25-2	Bromoform												
79-34-5	1,1,2,2-Tetrachloroethane												
67-64-1	Acetone												
75-15-0	Carbon disulfide												
78-93-3	2-Butanone (MEK)												
108-10-1	4-Methyl-2-Pentanone (MIBK)												
10061-01-5	cis-1,3-Dichloropropene												
10061-02-6	trans-1,3-Dichloropropene												
591-78-6	2-Hexanone												
1330-20-7	Xylene (Total)												
540-59-0	1,2-Dichloroethene (total)												

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NSA Mid-South, Assembly A - SWMU 5
Event 5 of Long Term Monitoring
Fluvial Deposits Groundwater

SW846-VOA													
	SAMPLE ID ------->	005-G-01UF-05		005-G-02UF-05		005-H-02UF-05		005-G-03UF-05		005-G-04UF-05		005-G-05LF-05	
	ORIGINAL ID ----->	005G01UF05		005G02UF05		005H02UF05		005G03UF05		005G04UF05		005G05LF05	
	LAB SAMPLE ID --->	S776275*6		S776275*7		S776275*8		S776296*6		S776296*7		S776275*3	
	ID FROM REPORT -->	005G01UF05		005G02UF05		005H02UF05		005G03UF05		005G04UF05		005G05LF05	
	SAMPLE DATE ----->	11/04/97		11/04/97		11/04/97		11/05/97		11/05/97		11/04/97	
	DATE ANALYZED --->	11/06/97		11/06/97		11/06/97		11/07/97		11/07/97		11/06/97	
	MATRIX ---------->	Water		Water		Water		Water		Water		Water	
	UNITS ---------->	UG/L		UG/L		UG/L		UG/L		UG/L		UG/L	
CAS #	Parameter	MEM32	VAL	MEM32	VAL	MEM32	VAL	MEM32	VAL	MEM32	VAL	MEM32	VAL
74-87-3	Chloromethane												
74-83-9	Bromomethane												
75-01-4	Vinyl chloride												
75-00-3	Chloroethane												
75-35-4	1,1-Dichloroethene												
75-09-2	Methylene chloride												
75-34-3	1,1-Dichloroethane												
67-66-3	Chloroform												
71-55-6	1,1,1-Trichloroethane												
56-23-5	Carbon tetrachloride									3.	J		
71-43-2	Benzene												
107-06-2	1,2-Dichloroethane												
79-01-6	Trichloroethene												
78-87-5	1,2-Dichloropropane												
75-27-4	Bromodichloromethane												
108-88-3	Toluene												
79-00-5	1,1,2-Trichloroethane												
127-18-4	Tetrachloroethene												
124-48-1	Dibromochloromethane												
108-90-7	Chlorobenzene												
100-41-4	Ethylbenzene												
100-42-5	Styrene												
75-25-2	Bromoform												
79-34-5	1,1,2,2-Tetrachloroethane												
67-64-1	Acetone												
75-15-0	Carbon disulfide												
78-93-3	2-Butanone (MEK)												
108-10-1	4-Methyl-2-Pentanone (MIBK)												
10061-01-5	cis-1,3-Dichloropropene												
10061-02-6	trans-1,3-Dichloropropene												
591-78-6	2-Hexanone												
1330-20-7	Xylene (Total)												
540-59-0	1,2-Dichloroethene (total)												

*** Validation Complete ***

Groundwater Data from 1998 DPT Investigation

DATALCP3
01/05/99

NSA Mid-South, Assembly A - SWMU 5
Loess Groundwater Data from Second DPT
Sampling Event (June 1998)

SW846-VOA											
	SAMPLE ID ------->	005-G-GB01-12		005-G-GB02-12		005-G-GB03-12		005-G-GB04-12		005-G-GB05-12	
	ORIGINAL ID ----->	005GGB0112		005GGB0212		005GGB0312		005GGB0412		005GGB0512	
	LAB SAMPLE ID --->	S883243A*1		S883313*1		S883313*3		S883313*5		S883313*7	
	ID FROM REPORT -->	005GGB0112		005GGB0212		005GGB0312		005GGB0412		005GGB0512	
	SAMPLE DATE ----->	06/03/98		06/04/98		06/04/98		06/04/98		06/05/98	
	DATE ANALYZED --->	06/11/98		06/11/98		06/13/98		06/15/98		06/15/98	
	MATRIX ---------->	Water		Water		Water		Water		Water	
	UNITS ---------->	UG/L		UG/L		UG/L		UG/L		UG/L	
CAS #	Parameter	MEM54	VAL	MEM54	VAL	MEM54	VAL	MEM54	VAL	MEM54	VAL
74-87-3	Chloromethane	10.	U	10.	U	10.	U	10.	U	10.	U
74-83-9	Bromomethane	10.	UR	10.	UR	10.	U	10.	UR	10.	UR
75-01-4	Vinyl chloride	10.	U	10.	U	10.	U	10.	U	10.	U
75-00-3	Chloroethane	10.	U	10.	U	10.	U	10.	U	10.	U
75-35-4	1,1-Dichloroethene	5.	U	5.	U	5.	U	5.	U	5.	U
75-09-2	Methylene chloride	0.74	U	0.78	U	1.8	U	5.	U	5.	U
75-34-3	1,1-Dichloroethane	5.	U	5.	U	5.	U	5.	U	5.	U
67-66-3	Chloroform	5.	U	5.	U	5.	U	5.	U	5.	U
71-55-6	1,1,1-Trichloroethane	5.	U	5.	U	5.	U	5.	U	5.	U
56-23-5	Carbon tetrachloride	5.	U	5.	U	5.	U	5.	U	5.	U
71-43-2	Benzene	5.	U	5.	U	5.	U	5.	U	5.	U
107-06-2	1,2-Dichloroethane	5.	U	5.	U	5.	U	5.	U	5.	U
79-01-6	Trichloroethene	5.	U	5.	U	1.6	J	5.	U	5.	U
78-87-5	1,2-Dichloropropane	5.	U	5.	U	5.	U	5.	U	5.	U
75-27-4	Bromodichloromethane	5.	U	5.	U	5.	U	5.	U	5.	U
108-88-3	Toluene	5.	U	5.	U	5.	U	5.	U	5.	U
79-00-5	1,1,2-Trichloroethane	5.	U	5.	U	5.	U	5.	U	5.	U
127-18-4	Tetrachloroethene	5.	U	5.	U	5.	U	5.	U	5.	U
124-48-1	Dibromochloromethane	5.	U	5.	U	5.	U	5.	U	5.	U
108-90-7	Chlorobenzene	5.	U	5.	U	5.	U	5.	U	5.	U
100-41-4	Ethylbenzene	5.	U	5.	U	5.	U	5.	U	5.	U
100-42-5	Styrene	5.	U	5.	U	5.	U	5.	U	5.	U
75-25-2	Bromoform	5.	U	5.	U	5.	U	5.	U	5.	U
79-34-5	1,1,2,2-Tetrachloroethane	5.	U	5.	U	5.	U	5.	U	5.	U
67-64-1	Acetone	50.	U	50.	U	50.	U	50.	U	50.	U
75-15-0	Carbon disulfide	5.	U	5.	U	5.	U	5.	U	5.	U
78-93-3	2-Butanone (MEK)	25.	U	25.	U	25.	U	25.	U	25.	U
108-10-1	4-Methyl-2-Pentanone (MIBK)	25.	U	25.	U	25.	U	25.	U	25.	U
10061-01-5	cis-1,3-Dichloropropene	5.	U	5.	U	5.	U	5.	U	5.	U
10061-02-6	trans-1,3-Dichloropropene	5.	U	5.	U	5.	U	5.	U	5.	U
591-78-6	2-Hexanone	25.	U	25.	U	25.	U	25.	U	25.	U
1330-20-7	Xylene (Total)	5.	U	5.	U	5.	U	5.	U	5.	U
540-59-0	1,2-Dichloroethene (total)	0.78	J	5.	U	5.	U	5.	U	5.	U

*** Validation Complete ***

DATALCP3
01/05/99

NSA Mid-South, Assembly A - SWMU 5
Fluvial Deposits Groundwater - Second
DPT Sampling Event (June 1998)

SW846-VOA

	SAMPLE ID ------->	005-G-GB01-47		005-G-GB02-48		005-G-GB03-47		005-G-GB04-47		005-H-GB04-47		005-G-GB05-47	
	ORIGINAL ID ----->	005GGB0147		005GGB0248		005GGB0347		005GGB0447		005HGB0447		005GGB0547	
	LAB SAMPLE ID --->	S883243A*2		S883313*2		S883313*4		S883313*6		S883313*9		S883313*8	
	ID FROM REPORT -->	005GGB0147		005GGB0248		005GGB0347		005GGB0447		005HGB0447		005GGB0547	
	SAMPLE DATE ----->	06/03/98		06/04/98		06/04/98		06/04/98		06/04/98		06/05/98	
	DATE ANALYZED --->	06/11/98		06/13/98		06/13/98		06/15/98		06/15/98		06/15/98	
	MATRIX ---------->	Water		Water		Water		Water		Water		Water	
	UNITS ---------->	UG/L		UG/L		UG/L		UG/L		UG/L		UG/L	
CAS #	Parameter	MEM54	VAL	MEM54	VAL	MEM54	VAL	MEM54	VAL	MEM54	VAL	MEM54	VAL
74-87-3	Chloromethane	10.	U	10.	U	10.	U	10.	U	10.	U	10.	U
74-83-9	Bromomethane	10.	UR	10.	U	10.	U	10.	UR	10.	UR	10.	UR
75-01-4	Vinyl chloride	10.	U	10.	U	10.	U	10.	U	10.	U	10.	U
75-00-3	Chloroethane	10.	U	10.	U	10.	U	10.	U	10.	U	10.	U
75-35-4	1,1-Dichloroethene	5.	U	5.	U	5.	U	5.	U	5.	U	5.	U
75-09-2	Methylene chloride	0.74	U	1.6	U	1.6	U	5.	U	5.	U	5.	U
75-34-3	1,1-Dichloroethane	5.	U	5.	U	5.	U	5.	U	5.	U	5.	U
67-66-3	Chloroform	5.	U	5.	U	5.	U	5.	U	5.	U	5.	U
71-55-6	1,1,1-Trichloroethane	5.	U	0.79	J	5.	U	5.	U	5.	U	5.	U
56-23-5	Carbon tetrachloride	2.8	U	5.	U	5.	U	6.7		6.9		5.	U
71-43-2	Benzene	5.	U	5.	U	5.	U	5.	U	5.	U	5.	U
107-06-2	1,2-Dichloroethane	5.	U	5.	U	5.	U	5.	U	5.	U	5.	U
79-01-6	Trichloroethene	5.	U	5.3		5.	U	5.	U	5.	U	5.	U
78-87-5	1,2-Dichloropropane	5.	U	5.	U	5.	U	5.	U	5.	U	5.	U
75-27-4	Bromodichloromethane	5.	U	5.	U	5.	U	5.	U	5.	U	5.	U
108-88-3	Toluene	5.	U	5.	U	5.	U	5.	U	5.	U	5.	U
79-00-5	1,1,2-Trichloroethane	5.	U	5.	U	5.	U	5.	U	5.	U	5.	U
127-18-4	Tetrachloroethene	5.	U	5.	U	5.	U	5.	U	5.	U	5.	U
124-48-1	Dibromochloromethane	5.	U	5.	U	5.	U	5.	U	5.	U	5.	U
108-90-7	Chlorobenzene	5.	U	5.	U	5.	U	5.	U	5.	U	5.	U
100-41-4	Ethylbenzene	5.	U	5.	U	5.	U	5.	U	5.	U	5.	U
100-42-5	Styrene	5.	U	5.	U	5.	U	5.	U	5.	U	5.	U
75-25-2	Bromoform	5.	U	5.	U	5.	U	5.	U	5.	U	5.	U
79-34-5	1,1,2,2-Tetrachloroethane	5.	U	5.	U	5.	U	5.	U	5.	U	5.	U
67-64-1	Acetone	50.	U	50.	U	50.	U	50.	U	50.	U	50.	U
75-15-0	Carbon disulfide	5.	U	5.	U	5.	U	5.	U	5.	U	5.	U
78-93-3	2-Butanone (MEK)	25.	U	25.	U	25.	U	25.	U	25.	U	25.	U
108-10-1	4-Methyl-2-Pentanone (MIBK)	25.	U	25.	U	25.	U	25.	U	25.	U	25.	U
10061-01-5	cis-1,3-Dichloropropene	5.	U	5.	U	5.	U	5.	U	5.	U	5.	U
10061-02-6	trans-1,3-Dichloropropene	5.	U	5.	U	5.	U	5.	U	5.	U	5.	U
591-78-6	2-Hexanone	25.	U	25.	U	25.	U	25.	U	25.	U	25.	U
1330-20-7	Xylene (Total)	5.	U	5.	U	5.	U	5.	U	5.	U	5.	U
540-59-0	1,2-Dichloroethene (total)	5.	U	5.	U	5.	U	5.	U	5.	U	5.	U

*** Validation Complete ***

RFI Soil Data

NSA Mid-South, Assembly A - SWMU 5
RFI Soil Data

APX9-METAL													
		SAMPLE ID ------->	005-S-0001-01		005-S-0001-08		005-S-0001-12		005-S-0002-01		005-S-0002-08		005-S-0002-10	
		ORIGINAL ID ----->	005S000101		005S000108		005S000112		005S000201		005S000208		005S000210	
		LAB SAMPLE ID --->	115989S		115990S		115991S		115992S		115993S		115994S	
		ID FROM REPORT -->	005S101		005S108		005S112		005S201		005S208		005S210	
		SAMPLE DATE ----->	01/28/95		01/28/95		01/28/95		01/28/95		01/28/95		01/28/95	
		MATRIX ---------->	Soil		Soil		Soil		Soil		Soil		Soil	
		UNITS ---------->	MG/KG		MG/KG		MG/KG		MG/KG		MG/KG		MG/KG	
CAS #	Parameter		FD1314	VAL	FD1314	VAL	FD1314	VAL	FD1314	VAL	FD1314	VAL	FD1314	VAL
7440-36-0	Antimony													
7440-38-2	Arsenic		7.2		10.3		7.8	J	6.7	J	12.2	J	10.1	J
7440-39-3	Barium		93.5	J	162.	J	123.	J	55.5	J	171.	J	116.	J
7440-41-7	Beryllium		0.56	J	0.51	J	0.4	J	0.43	J	0.55	J	0.44	J
7440-43-9	Cadmium		3.2		3.1		2.4		2.4		3.7		2.8	
7440-47-3	Chromium		13.		12.4		9.2		12.8		12.5		10.2	
7440-48-4	Cobalt		13.3		7.3	J	6.7	J	5.5	J	9.4	J	7.4	J
7440-50-8	Copper		14.1		16.5		13.8		13.3		18.9		16.3	
7439-92-1	Lead		11.4	J	10.8	J	6.6	J	12.	J	11.9	J	11.7	J
7439-97-6	Mercury		0.13											
7440-02-0	Nickel		11.3		19.		16.1		11.5		25.		14.8	
7782-49-2	Selenium		0.51	J										
7440-22-4	Silver		1.2	J										
7440-28-0	Thallium													
7440-62-2	Vanadium		36.		25.9		16.		28.7		26.2		19.2	
7440-66-6	Zinc		46.2		54.6		46.6		44.3		64.3		54.	
7440-31-5	Tin													

*** Validation Complete ***

NSA Mid-South, Assembly A - SWMU 5
RFI Soil Data

APX9-METAL

		SAMPLE ID ------->	005-S-0003-01		005-S-0003-07		005-S-0003-17		005-S-0004-01		005-C-0004-01		005-S-0004-05	
		ORIGINAL ID ----->	005S000301		005S000307		005S000317		005S000401		005C000401		005S000405	
		LAB SAMPLE ID --->	115995S		115996S		115997S		115998S		115999S		116000S	
		ID FROM REPORT -->	005S301		05S307		005S317		005S401		005C401		005S405	
		SAMPLE DATE ----->	01/28/95		01/28/95		01/28/95		01/29/95		01/29/95		01/28/95	
		MATRIX ---------->	Soil		Soil		Soil		Soil		Soil		Soil	
		UNITS ---------->	MG/KG		MG/KG		MG/KG		MG/KG		MG/KG		MG/KG	
CAS #	Parameter		FD1314	VAL	FD1314	VAL	FD1314	VAL	FD1314	VAL	FD1314	VAL	FD1314	VAL
7440-36-0	Antimony													
7440-38-2	Arsenic		6.6	J	8.1	J	9.5	J	11.	J	7.9	J	2.7	J
7440-39-3	Barium		164.	J	177.	J	104.	J	261.	J	238.	J	219.	J
7440-41-7	Beryllium		0.86	J	0.9	J	0.53	J	0.81	J	1.	J	0.77	J
7440-43-9	Cadmium		3.		2.3		2.7		3.4		4.		3.	
7440-47-3	Chromium		11.1		11.1		16.7		15.2		18.3		17.2	
7440-48-4	Cobalt		6.5	J	6.2	J	7.8	J	7.6	J	9.9	J	6.1	J
7440-50-8	Copper		14.3		16.2		16.1		16.1		19.6		18.7	
7439-92-1	Lead		16.7	J	18.2	J	10.7	J	22.8	J	26.8	J	8.	J
7439-97-6	Mercury								0.14					
7440-02-0	Nickel		14.4		11.4		18.4		16.1		20.7		15.1	
7782-49-2	Selenium													
7440-22-4	Silver													
7440-28-0	Thallium													
7440-62-2	Vanadium		23.3		20.1		26.1		27.3		34.2		24.6	
7440-66-6	Zinc		56.9		64.3		60.6		75.6		90.2		76.9	
7440-31-5	Tin													

*** Validation complete ***

NSA Mid-South, Assembly A - SWMU 5
RFI Soil Data

APX9-METAL													
		SAMPLE ID ------->	005-S-0004-10		005-S-0006-01		005-S-0006-07		005-S-0006-12		005-S-0007-01		005-S-0007-10	
		ORIGINAL ID ----->	005S000410		005S000601		005S000607		005S000612		005S000701		005S000710	
		LAB SAMPLE ID --->	116001S		116002S		6-116015S		6-116016S		6-116017S		6-116018S	
		ID FROM REPORT -->	005S410		005S601		005S607		005S612		005S701		005S710	
		SAMPLE DATE ----->	01/28/95		01/29/95		01/29/95		01/29/95		01/29/95		01/29/95	
		MATRIX ---------->	Soil		Soil		Soil		Soil		Soil		Soil	
		UNITS ---------->	MG/KG		MG/KG		MG/KG		MG/KG		MG/KG		MG/KG	
CAS #	Parameter		FD1314	VAL	FD1314	VAL	FD1315	VAL	FD1315	VAL	FD1315	VAL	FD1315	VAL
7440-36-0	Antimony													
7440-38-2	Arsenic		6.5	J	8.3	J	7.5		3.5		7.7		11.9	
7440-39-3	Barium		286.	J	192.	J	228.		104.		181.		375.	
7440-41-7	Beryllium		0.56	J	0.72	J	0.88	J	0.47	J	0.64	J	1.1	J
7440-43-9	Cadmium		3.6		3.2		4.		2.8		3.		8.1	J
7440-47-3	Chromium		15.1		20.		20.6		17.4		19.2		32.8	
7440-48-4	Cobalt		13.6		8.1	J	6.9	J	6.9	J	7.5	J	15.8	
7440-50-8	Copper		17.6		17.4		21.5		13.2		17.9		29.6	
7439-92-1	Lead		8.4	J	16.9	J	11.9		10.4		30.7		26.4	
7439-97-6	Mercury													
7440-02-0	Nickel		18.9		14.5		23.8		14.6		17.3		36.	
7782-49-2	Selenium				0.5	J								
7440-22-4	Silver				1.1	J								
7440-28-0	Thallium													
7440-62-2	Vanadium		25.9		24.8		29.6		29.9		26.9		46.5	
7440-66-6	Zinc		63.9		63.5		84.6		54.		73.1		121.	
7440-31-5	Tin													

004430

*** Validation Complete ***

NSA Mid-South, Assembly A - SWMU 5
RFI Soil Data

APX9-METAL								
	SAMPLE ID ------->	005-S-0007-12		005-C-0007-12				
	ORIGINAL ID ----->	005S000712		005C000712				
	LAB SAMPLE ID --->	6-116019S		6-116020S				
	ID FROM REPORT -->	005S712		005C712				
	SAMPLE DATE ----->	01/29/95		01/29/95				
	MATRIX ---------->	Soil		Soil				
	UNITS ---------->	MG/KG		MG/KG				
CAS #	Parameter	FD1315	VAL	FD1315	VAL			
7440-36-0	Antimony							
7440-38-2	Arsenic	2.6	J	26.	J			
7440-39-3	Barium	106.		106.				
7440-41-7	Beryllium	0.45	J	0.49	J			
7440-43-9	Cadmium	2.3		2.4				
7440-47-3	Chromium	15.3		18.				
7440-48-4	Cobalt	6.8	J	6.7	J			
7440-50-8	Copper	12.4		12.4				
7439-92-1	Lead	8.4		9.				
7439-97-6	Mercury							
7440-02-0	Nickel	15.7		18.1				
7782-49-2	Selenium							
7440-22-4	Silver							
7440-28-0	Thallium							
7440-62-2	Vanadium	30.1		34.6				
7440-66-6	Zinc	45.4		49.5				
7440-31-5	Tin							

*** Validation Complete ***

NSA Mid-South, Assembly A - SWMU 5
RFI Soil Data

HYDROCARBN													
	SAMPLE ID ------->	005-S-0001-01		005-S-0001-08		005-S-0001-12		005-S-0002-01		005-S-0002-08		005-S-0002-10	
	ORIGINAL ID ----->	005S000401		005S000108		005S000112		005S000201		005S000208		005S000210	
	LAB SAMPLE ID --->	115971		115972		115973		115974		115975		115976	
	ID FROM REPORT -->	005S000101		005S000108		005S000112		005S000201		005S000208		005S000210	
	SAMPLE DATE ----->	01/29/95		01/28/95		01/28/95		01/28/95		01/28/95		01/28/95	
	DATE ANALYZED --->	02/15/95		02/24/95		02/14/95		02/14/95		02/14/95		02/15/95	
	MATRIX ---------->	Soil		Soil		Soil		Soil		Soil		Soil	
	UNITS ---------->	UG/KG		UG/KG		UG/KG		UG/KG		UG/KG		UG/KG	
CAS #	Parameter	FD1314	VAL	FD1314	VAL	FD1314	VAL	FD1314	VAL	FD1314	VAL	FD1314	VAL
107-21-1	Ethylene Glycol												
111-46-6	Diethylene Glycol												
112-27-6	Triethylene Glycol												
112-60-7	Tetraethylene Glycol												

*** Validation Complete ***

NSA Mid-South, Assembly A - SWMU 5
RFI Soil Data

HYDROCARBN

000433

	SAMPLE ID ------->	005-S-0003-01		005-S-0003-07		005-S-0003-17		005-C-0004-01		005-S-0004-01		005-S-0004-05	
	ORIGINAL ID ----->	005S000301		005S000307		005S000317		005C000401		005S000401		005S000405	
	LAB SAMPLE ID --->	115977		115978		115979		115981		115980		115982	
	ID FROM REPORT -->	005S000301		005S000307		005S000317		005C000401		005S000401		005S000405	
	SAMPLE DATE ----->	01/28/95		01/28/95		01/28/95		01/29/95		01/29/95		01/28/95	
	DATE EXTRACTED -->							02/04/95					
	DATE ANALYZED --->	02/15/95		02/15/95		02/15/95		02/15/95		02/24/95		02/15/95	
	MATRIX ---------->	Soil		Soil		Soil		Soil		Soil		Soil	
	UNITS ---------->	UG/KG		UG/KG		UG/KG		UG/KG		UG/KG		UG/KG	
CAS #	Parameter	FD1314	VAL	FD1314	VAL	FD1314	VAL	FD1314	VAL	FD1314	VAL	FD1314	VAL
107-21-1	Ethylene Glycol												
111-46-6	Diethylene Glycol												
112-27-6	Triethylene Glycol												
112-60-7	Tetraethylene Glycol												

*** Validation Complete ***

NSA Mid-South, Assembly A - SWMU 5
RFI Soil Data

HYDROCARBN													
	SAMPLE ID ------->	005-S-0004-10		005-S-0006-01		005-S-0006-07		005-S-0006-12		005-S-0007-01		005-S-0007-10	
	ORIGINAL ID ----->	005S000410		005S000601		005S000607		005S000612		005S000701		005S000710	
	LAB SAMPLE ID --->	115983		115984		116003		116004		116005		116006	
	ID FROM REPORT -->	005S000410		005S000601		005S000607		005S000612		005S000701		005S000710	
	SAMPLE DATE ----->	01/28/95		01/28/95		01/29/95		01/29/95		01/29/95		01/29/95	
	DATE ANALYZED --->	02/15/95		02/15/95		02/24/95		02/24/95		02/24/95		02/24/95	
	MATRIX ---------->	Soil		Soil		Soil		Soil		Soil		Soil	
	UNITS ---------->	UG/KG		UG/KG		UG/KG		UG/KG		UG/KG		UG/KG	
CAS #	Parameter	FD1314	VAL	FD1314	VAL	FD1315	VAL	FD1315	VAL	FD1315	VAL	FD1315	VAL
107-21-1	Ethylene Glycol												
111-46-6	Diethylene Glycol												
112-27-6	Triethylene Glycol												
112-60-7	Tetraethylene Glycol												

*** Validation Complete ***

NSA Mid-South, Assembly A - SWMU 5
RFI Soil Data

HYDROCARBN

	SAMPLE ID ------->	005-S-0007-12		005-C-0007-12			
	ORIGINAL ID ----->	005S000712		005C000712			
	LAB SAMPLE ID --->	116007		116008			
	ID FROM REPORT -->	005S000712		005C000712			
	SAMPLE DATE ----->	01/29/95		01/29/95			
	DATE ANALYZED --->	02/24/95		02/24/95			
	MATRIX ---------->	Soil		Soil			
	UNITS ---------->	UG/KG		UG/KG			
CAS #	Parameter	FD1315	VAL	FD1315	VAL		
107-21-1	Ethylene Glycol						
111-46-6	Diethylene Glycol						
112-27-6	Triethylene Glycol						
112-60-7	Tetraethylene Glycol						

*** Validation Complete ***

000435

NSA Mid-South, Assembly A - SWMU 5
RFI Soil Data

METAL-CN													
		SAMPLE ID ------->	005-S-0001-01		005-S-0001-08		005-S-0001-12		005-S-0002-01		005-S-0002-08		005-S-0002-10	
		ORIGINAL ID ----->	005S000101		005S000108		005S000112		005S000201		005S000208		005S000210	
		LAB SAMPLE ID --->	115989		115990		115991		115992		115993		115994	
		ID FROM REPORT -->	005S000101		005S000108		005S000112		005S000201		005S000208		005S000210	
		SAMPLE DATE ----->	01/28/95		01/28/95		01/28/95		01/28/95		01/28/95		01/28/95	
		DATE EXTRACTED -->	02/01/95		02/01/95		02/02/95		02/02/95		02/02/95		02/02/95	
		DATE ANALYZED --->	02/02/95		02/02/95		02/10/95		02/10/95		02/10/95		02/10/95	
		MATRIX ---------->	Soil		Soil		Soil		Soil		Soil		Soil	
		UNITS ---------->	MG/KG		MG/KG		MG/KG		MG/KG		MG/KG		MG/KG	
CAS #	Parameter		FD1314	VAL	FD1314	VAL	FD1314	VAL	FD1314	VAL	FD1314	VAL	FD1314	VAL
57-12-5	Cyanide (CN)													

*** Validation Complete ***

NSA Mid-South, Assembly A - SWMU 5
RFI Soil Data

METAL-CN													
		SAMPLE ID ------->	005-S-0003-01		005-S-0003-07		005-S-0003-17		005-S-0004-01		005-C-0004-01		005-S-0004-05
		ORIGINAL ID ----->	005S000301		005S000307		005S000317		005S000401		005C000401		005S000405
		LAB SAMPLE ID --->	115995		115996		115997		115998		115999		116000
		ID FROM REPORT -->	005S000301		005S000307		005S000317		005S000401		005C000401		005S000405
		SAMPLE DATE ----->	01/28/95		01/28/95		01/28/95		01/29/95		01/29/95		01/28/95
		DATE EXTRACTED -->	02/02/95		02/02/95		02/02/95		02/02/95		02/02/95		02/02/95
		DATE ANALYZED --->	02/10/95		02/10/95		02/10/95		02/10/95		02/10/95		02/10/95
		MATRIX ---------->	Soil		Soil		Soil		Soil		Soil		Soil
		UNITS ---------->	MG/KG		MG/KG		MG/KG		MG/KG		MG/KG		MG/KG
CAS #	Parameter		FD1314	VAL	FD1314	VAL	FD1314	VAL	FD1314	VAL	FD1314	VAL	FD1314	VAL
57-12-5	Cyanide (CN)												

*** Validation complete ***

000437

NSA Mid-South, Assembly A - SWMU 5
RFI Soil Data

METAL-CN													
	SAMPLE ID ------->	005-S-0004-10		005-S-0006-01		005-S-0006-07		005-S-0006-12		005-S-0007-01		005-S-0007-10	
	ORIGINAL ID ----->	005S000410		005S000601		005S000607		005S000612		005S000701		005S000710	
	LAB SAMPLE ID --->	116001		116002		116015		116016		116017		116018	
	ID FROM REPORT -->	005S000410		005S000601		005S000607		005S000612		005S000701		005S000710	
	SAMPLE DATE ----->	01/28/95		01/29/95		01/29/95		01/29/95		01/29/95		01/29/95	
	DATE EXTRACTED -->	02/02/95		02/02/95		02/06/95		02/06/95		02/06/95		02/06/95	
	DATE ANALYZED --->	02/10/95		02/10/95		02/10/95		02/10/95		02/10/95		02/10/95	
	MATRIX ---------->	Soil		Soil		Soil		Soil		Soil		Soil	
	UNITS ---------->	MG/KG		MG/KG		MG/KG		MG/KG		MG/KG		MG/KG	
CAS #	Parameter	FD1314	VAL	FD1314	VAL	FD1315	VAL	FD1315	VAL	FD1315	VAL	FD1315	VAL
57-12-5	Cyanide (CN)												

*** Validation Complete ***

NSA Mid-South, Assembly A - SWMU 5
RFI Soil Data

METAL-CN

0004439

	SAMPLE ID ------->	005-S-0007-12		005-C-0007-12				
	ORIGINAL ID ----->	005S000712		005C000712				
	LAB SAMPLE ID --->	116019		116020				
	ID FROM REPORT -->	005S000712		005C000712				
	SAMPLE DATE ----->	01/29/95		01/29/95				
	DATE EXTRACTED -->	02/06/95		02/06/95				
	DATE ANALYZED --->	02/10/95		02/13/95				
	MATRIX ---------->	Soil		Soil				
	UNITS ---------->	MG/KG		MG/KG				
CAS #	Parameter	FD1315	VAL	FD1315	VAL			
57-12-5	Cyanide (CN)							

*** Validation Complete ***

NSA Mid-South, Assembly A - SWMU 5
RFI Soil Data

SW846-HERB													
	SAMPLE ID ------->	005-S-0001-01		005-S-0001-08		005-S-0001-12		005-S-0002-01		005-S-0002-08		005-S-0002-10	
	ORIGINAL ID ----->	005S000101		005S000108		005S000112		005S000201		005S000208		005S000210	
	LAB SAMPLE ID --->	115971		115972		115973		115974		115975		115976	
	ID FROM REPORT -->	005S000101		005S000108		005S000112		005S000201		005S000208		005S000210	
	SAMPLE DATE ----->	01/28/95		01/28/95		01/28/95		01/28/95		01/28/95		01/28/95	
	DATE ANALYZED --->	02/18/95		02/18/95		02/18/95		02/23/95		02/23/95		02/18/95	
	MATRIX ---------->	Soil		Soil		Soil		Soil		Soil		Soil	
	UNITS ---------->	UG/KG		UG/KG		UG/KG		UG/KG		UG/KG		UG/KG	
CAS #	Parameter	FD1314	VAL	FD1314	VAL	FD1314	VAL	FD1314	VAL	FD1314	VAL	FD1314	VAL
94-82-6	2,4-DB												
88-85-7	Dinoseb												
93-76-5	2,4,5-T									4.4	J		
93-72-1	2,4,5-TP (Silvex)												
75-99-0	Dalapon												
1918-00-9	Dicamba												
120-36-5	Dichlorprop												
94-74-6	MCPA	19000.	J							4500.	J		
93-65-2	MCPP												
94-75-7	2,4-D												

000490

*** Validation Complete ***

NSA Mid-South, Assembly A - SWMU 5
RFI Soil Data

SW846-HERB

	SAMPLE ID ------->	005-S-0003-01		005-S-0003-07		005-S-0003-17		005-S-0004-01		005-C-0004-01		005-S-0004-05	
	ORIGINAL ID ----->	005S000301		005S000307		005S000317		005S000401		005C000401		005S000405	
	LAB SAMPLE ID --->	115977		115978		115979		115980		115981		115982	
	ID FROM REPORT -->	005S000301		005S000307		005S000317		005S000401		005C000401		005S000405	
	SAMPLE DATE ----->	01/28/95		01/28/95		01/28/95		01/29/95		01/29/95		01/28/95	
	DATE ANALYZED --->	02/23/95		02/15/95				02/24/95					
	MATRIX ---------->	Soil		Soil		Soil		Soil		Soil		Soil	
	UNITS ---------->	UG/KG		UG/KG		UG/KG		UG/KG		UG/KG		UG/KG	
CAS #	Parameter	FD1314	VAL	FD1314	VAL	FD1314	VAL	FD1314	VAL	FD1314	VAL	FD1314	VAL
94-82-6	2,4-DB												
88-85-7	Dinoseb												
93-76-5	2,4,5-T												
93-72-1	2,4,5-TP (Silvex)												
75-99-0	Dalapon												
1918-00-9	Dicamba												
120-36-5	Dichlorprop												
94-74-6	MCPA												
93-65-2	MCPP												
94-75-7	2,4-D												

*** Validation Complete ***

NSA Mid-South, Assembly A - SWMU 5
RFI Soil Data

~~SW846-HERB~~

	SAMPLE ID ------->	005-S-0004-10		005-S-0006-01		005-S-0006-07		005-S-0006-12		005-S-0007-01		005-S-0007-10	
	ORIGINAL ID ----->	005S000410		005S000601		005S000607		005S000612		005S000701		005S000710	
	LAB SAMPLE ID --->	115983		115984		116003		116004		116005		116006	
	ID FROM REPORT -->	005S000410		005S000601		005S000607		005S000612		005S000701		005S000710	
	SAMPLE DATE ----->	01/28/95		01/29/95		01/29/95		01/29/95		01/29/95		01/29/95	
	DATE ANALYZED --->	02/24/95		02/24/95									
	MATRIX ---------->	Soil		Soil		Soil		Soil		Soil		Soil	
	UNITS ---------->	UG/KG		UG/KG		UG/KG		UG/KG		UG/KG		UG/KG	
CAS #	Parameter	FD1314	VAL	FD1314	VAL	FD1315	VAL	FD1315	VAL	FD1315	VAL	FD1315	VAL
94-82-6	2,4-DB												
88-85-7	Dinoseb												
93-76-5	2,4,5-T												
93-72-1	2,4,5-TP (Silvex)												
75-99-0	Dalapon												
1918-00-9	Dicamba												
120-36-5	Dichlorprop												
94-74-6	MCPA												
93-65-2	MCPP												
94-75-7	2,4-D												

*** Validation Complete ***

SW846-HERB

SAMPLE ID ------->	005-S-0007-12		005-C-0007-12				
ORIGINAL ID ----->	005S000712		005C000712				
LAB SAMPLE ID --->	116007		116008				
ID FROM REPORT -->	005S000712		005C000712				
SAMPLE DATE ----->	01/29/95		01/29/95				
MATRIX ---------->	Soil		Soil				
UNITS ---------->	UG/KG		UG/KG				
CAS # Parameter	FD1315	VAL	FD1315	VAL			
94-82-6 2,4-DB							
88-85-7 Dinoseb							
93-76-5 2,4,5-T							
93-72-1 2,4,5-TP (Silvex)							
75-99-0 Dalapon							
1918-00-9 Dicamba							
120-36-5 Dichlorprop							
94-74-6 NCPA							
93-65-2 NCPP							
94-75-7 2,4-D							

*** Validation Complete ***

NSA Mid-South, Assembly A - SWMU 5
RFI Soil Data

SW846-OP P													
	SAMPLE ID ------->	005-S-0001-01		005-S-0001-08		005-S-0001-12		005-S-0002-01		005-S-0002-08		005-S-0002-10	
	ORIGINAL ID ----->	005S000101		005S000108		005S000112		005S000201		005S000208		005S000210	
	LAB SAMPLE ID --->	115971		115972		115973		115974		115975		115976	
	ID FROM REPORT -->	005S000101		005S000108		005S000112		005S000201		005S000208		005S000210	
	SAMPLE DATE ----->	01/28/95		01/28/95		01/28/95		01/28/95		01/28/95		01/28/95	
	DATE EXTRACTED -->	02/04/95		02/04/95		02/04/95		02/04/95		02/04/95		02/04/95	
	DATE ANALYZED --->	02/14/95		02/14/95		02/14/95		02/14/95		02/14/95		02/14/95	
	MATRIX ---------->	Soil		Soil		Soil		Soil		Soil		Soil	
	UNITS ---------->	UG/KG		UG/KG		UG/KG		UG/KG		UG/KG		UG/KG	
CAS #	Parameter	FD1314	VAL	FD1314	VAL	FD1314	VAL	FD1314	VAL	FD1314	VAL	FD1314	VAL
86-50-0	Azinphos methyl												
35400-43-2	Sulprofos (Bolstar)												
2921-88-2	Chloropyrifos												
56-72-4	Coumaphos												
8065-48-3	Demeton,O												
333-41-5	Diazinon												
62-73-7	Dichlorvos												
298-04-4	Disulfoton												
13194-48-4	Ethoprop												
115-90-2	Fensulfothion												
55-38-9	Fenthion												
150-50-5	Merphos												
7786-34-7	Mevinphos, Alpha												
300-76-5	Naled												
298-00-0	Methyl parathion												
298-02-2	Phorate												
299-84-3	Ronnel												
22248-79-9	Stirophos (Tetrachlorovinphos)												
34643-46-4	Tokuthion												
327-98-0	Trichloronate												
126-75-0	Demeton,S												

000494

*** Validation Complete ***

SW846-OP P

	SAMPLE ID ------->	005-S-0003-01		005-S-0003-07		005-S-0003-17		005-S-0004-01		005-C-0004-01		005-S-0004-05	
	ORIGINAL ID ----->	005S000301		005S000307		005S000317		005S000401		005C000401		005S000405	
	LAB SAMPLE ID --->	115977		115978		115979		115980		115981		115982	
	ID FROM REPORT -->	005S000301		005S000307		005S000317		005S000401		005C000401		005S000405	
	SAMPLE DATE ----->	01/28/95		01/28/95		01/28/95		01/29/95		01/29/95		01/28/95	
	DATE EXTRACTED -->	02/04/95		02/04/95		02/04/95		02/04/95		02/04/95		02/04/95	
	DATE ANALYZED --->	02/14/95		02/14/95		02/15/95		02/15/95		02/15/95		02/15/95	
	MATRIX ---------->	Soil		Soil		Soil		Soil		Soil		Soil	
	UNITS ---------->	UG/KG		UG/KG		UG/KG		UG/KG		UG/KG		UG/KG	
CAS #	Parameter	FD1314	VAL	FD1314	VAL	FD1314	VAL	FD1314	VAL	FD1314	VAL	FD1314	VAL
86-50-0	Azinphos methyl												
35400-43-2	Sulprofos (Bolstar)												
2921-88-2	Chloropyrifos												
56-72-4	Coumaphos												
8065-48-3	Demeton,O												
333-41-5	Diazinon												
62-73-7	Dichlorvos												
298-04-4	Disulfoton												
13194-48-4	Ethoprop												
115-90-2	Fensulfothion												
55-38-9	Fenthion												
150-50-5	Merphos												
7786-34-7	Mevinphos, Alpha												
300-76-5	Naled												
298-00-0	Methyl parathion												
298-02-2	Phorate												
299-84-3	Ronnel												
22248-79-9	Stirophos (Tetrachlorovinphos)												
34643-46-4	Tokuthion												
327-98-0	Trichloronate												
126-75-0	Demeton,S												

*** Validation Complete ***

SW846-OP P													
	SAMPLE ID ------->	005-S-0004-10		005-S-0006-01		005-S-0006-07		005-S-0006-12		005-S-0007-01		005-S-0007-10	
	ORIGINAL ID ----->	005S000410		005S000601		005S000607		005S000612		005S000701		005S000710	
	LAB SAMPLE ID --->	115983		115984		116003		116004		116005		116006	
	ID FROM REPORT -->	005S000410		005S000601		005S000607		005S000612		005S000701		005S000710	
	SAMPLE DATE ----->	01/28/95		01/29/95		01/29/95		01/29/95		01/29/95		01/29/95	
	DATE EXTRACTED -->	02/04/95		02/04/95		02/07/95		02/07/95		02/07/95		02/07/95	
	DATE ANALYZED --->	02/15/95		02/15/95		02/23/95		02/23/95		02/23/95		02/23/95	
	MATRIX ---------->	Soil		Soil		Soil		Soil		Soil		Soil	
	UNITS ---------->	UG/KG		UG/KG		UG/KG		UG/KG		UG/KG		UG/KG	
CAS #	Parameter	FD1314	VAL	FD1314	VAL	FD1315	VAL	FD1315	VAL	FD1315	VAL	FD1315	VAL
86-50-0	Azinphos methyl												
35400-43-2	Sulprofos (Bolstar)												
2921-88-2	Chloropyrifos												
56-72-4	Coumaphos												
8065-48-3	Demeton,O												
333-41-5	Diazinon												
62-73-7	Dichlorvos												
298-04-4	Disulfoton												
13194-48-4	Ethoprop												
115-90-2	Fensulfothion												
55-38-9	Fenthion												
150-50-5	Merphos												
7786-34-7	Mevinphos, Alpha												
300-76-5	Naled												
298-00-0	Methyl parathion												
298-02-2	Phorate												
299-84-3	Ronnel												
22248-79-9	Stirophos (Tetrachlorovinphos)												
34643-46-4	Tokuthion												
327-98-0	Trichloronate												
126-75-0	Demeton,S												

000496

*** Validation Complete ***

SW846-OP P

000497

	SAMPLE ID ------->	005-S-0007-12		005-C-0007-12			
	ORIGINAL ID ----->	005S000712		005C000712			
	LAB SAMPLE ID --->	116007		116008			
	ID FROM REPORT -->	005S000712		005C000712			
	SAMPLE DATE ----->	01/29/95		01/29/95			
	DATE EXTRACTED -->	02/07/95		02/07/95			
	DATE ANALYZED --->	02/23/95		02/24/95			
	MATRIX ---------->	Soil		Soil			
	UNITS ---------->	UG/KG		UG/KG			
CAS #	Parameter	FD1315	VAL	FD1315	VAL		
86-50-0	Azinphos methyl						
35400-43-2	Sulprofos (Bolstar)						
2921-88-2	Chloropyrifos						
56-72-4	Coumaphos						
8065-48-3	Demeton,O						
333-41-5	Diazinon						
62-73-7	Dichlorvos						
298-04-4	Disulfoton						
13194-48-4	Ethoprop						
115-90-2	Fensulfothion						
55-38-9	Fenthion						
150-50-5	Merphos						
7786-34-7	Mevinphos, Alpha						
300-76-5	Naled						
298-00-0	Methyl parathion						
298-02-2	Phorate						
299-84-3	Ronnel						
22248-79-9	Stirophos (Tetrachlorovinphos)						
34643-46-4	Tokuthion						
327-98-0	Trichloronate						
126-75-0	Demeton,S						

*** Validation Complete ***

NSA Mid-South, Assembly A - SWMU 5
RFI Soil Data

SW846-PEST													
	SAMPLE ID ------->	005-S-0001-01		005-S-0001-08		005-S-0001-12		005-S-0002-01		005-S-0002-08		005-S-0002-10	
	ORIGINAL ID ----->	005S000101		005S000108		005S000112		005S000201		005S000208		005S000210	
	LAB SAMPLE ID --->	115989		115990		115991		115992		115993		115994	
	ID FROM REPORT -->	005S000101		005S000108		005S000112		005S000201		005S000208		005S000210	
	SAMPLE DATE ----->	01/28/95		01/28/95		01/28/95		01/28/95		01/28/95		01/28/95	
	DATE EXTRACTED -->	02/07/95		02/07/95		02/07/95		02/07/95		02/07/95		02/07/95	
	DATE ANALYZED --->	02/17/95		02/17/95		02/17/95		02/17/95		02/17/95		02/17/95	
	MATRIX ---------->	Soil		Soil		Soil		Soil		Soil		Soil	
	UNITS ---------->	UG/KG		UG/KG		UG/KG		UG/KG		UG/KG		UG/KG	
CAS #	Parameter	FD1314	VAL	FD1314	VAL	FD1314	VAL	FD1314	VAL	FD1314	VAL	FD1314	VAL
319-84-6	alpha-BHC												
319-85-7	beta-BHC												
319-86-8	delta-BHC												
58-89-9	gamma-BHC (Lindane)												
76-44-8	Heptachlor												
309-00-2	Aldrin												
1024-57-3	Heptachlor epoxide												
959-98-8	Endosulfan I												
60-57-1	Dieldrin	22.	J					43.	J				
72-55-9	4,4'-DDE												
72-20-8	Endrin												
33213-65-9	Endosulfan II												
72-54-8	4,4'-DDD												
1031-07-8	Endosulfan sulfate												
50-29-3	4,4'-DDT												
72-43-5	Methoxychlor												
53494-70-5	Endrin ketone												
7421-93-4	Endrin aldehyde												
5103-71-9	alpha-Chlordane												
5103-74-2	gamma-Chlordane												
8001-35-2	Toxaphene												
12674-11-2	Aroclor-1016												
11104-28-2	Aroclor-1221												
53469-21-9	Aroclor-1242												
12672-29-6	Aroclor-1248												
11097-69-1	Aroclor-1254												
11096-82-5	Aroclor-1260												
11141-16-5	Aroclor-1232												
12789-03-6	Technical Chlordane	NR		NR		NR		NR		NR		NR	

*** Validation Complete ***

000498

NSA Mid-South, Assembly A - SWMU 5
RFI Soil Data

SW846-PEST

000433

	SAMPLE ID ------->	005-S-0003-01		005-S-0003-07		005-S-0003-17		005-S-0004-01		005-C-0004-01		005-S-0004-05	
	ORIGINAL ID ----->	005S000301		005S000307		005S000317		005S000401		005C000401		005S000405	
	LAB SAMPLE ID --->	115995		115996		115997		115998		115999		116000	
	ID FROM REPORT -->	005S000301		005S000307		005S000317		005S000401		005C000401		005S000405	
	SAMPLE DATE ----->	01/28/95		01/28/95		01/28/95		01/29/95		01/29/95		01/28/95	
	DATE EXTRACTED -->	02/07/95		02/07/95		02/07/95		02/07/95		02/07/95		02/07/95	
	DATE ANALYZED --->	02/28/95		02/17/95		02/17/95		02/28/95		02/28/95		02/17/95	
	MATRIX ---------->	Soil		Soil		Soil		Soil		Soil		Soil	
	UNITS ---------->	UG/KG		UG/KG		UG/KG		UG/KG		UG/KG		UG/KG	
CAS #	Parameter	FD1314	VAL	FD1314	VAL	FD1314	VAL	FD1314	VAL	FD1314	VAL	FD1314	VAL
319-84-6	alpha-BHC												
319-85-7	beta-BHC												
319-86-8	delta-BHC												
58-89-9	gamma-BHC (Lindane)												
76-44-8	Heptachlor												
309-00-2	Aldrin												
1024-57-3	Heptachlor epoxide							2.8	J	6.8	J		
959-98-8	Endosulfan I												
60-57-1	Dieldrin	60.	JD	45.	J			290.	J	928.	J	8.3	J
72-55-9	4,4'-DDE												
72-20-8	Endrin									8.2	J		
33213-65-9	Endosulfan II												
72-54-8	4,4'-DDD												
1031-07-8	Endosulfan sulfate												
50-29-3	4,4'-DDT							11.	J	33.	J		
72-43-5	Methoxychlor												
53494-70-5	Endrin ketone												
7421-93-4	Endrin aldehyde												
5103-71-9	alpha-Chlordane												
5103-74-2	gamma-Chlordane												
8001-35-2	Toxaphene												
12674-11-2	Aroclor-1016												
11104-28-2	Aroclor-1221												
53469-21-9	Aroclor-1242												
12672-29-6	Aroclor-1248												
11097-69-1	Aroclor-1254												
11096-82-5	Aroclor-1260	57.	J					90.	J	223.	J		
11141-16-5	Aroclor-1232												
12789-03-6	Technical Chlordane	NR		NR		NR		NR		NR		NR	

*** Validation complete ***

NSA Mid-South, Assembly A - SWMU 5
RFI Soil Data

SW846-PEST													
	SAMPLE ID ------->	005-S-0004-10		005-S-0006-01		005-S-0006-07		005-S-0006-12		005-S-0007-01		005-S-0007-10	
	ORIGINAL ID ----->	005S000410		005S000601		005S000607		005S000612		005S000701		005S000710	
	LAB SAMPLE ID --->	116001		116002		116015		116016		116017		116018	
	ID FROM REPORT -->	005S000410		005S000601		005S000607		005S000612		005S000701		005S000710	
	SAMPLE DATE ----->	01/28/95		01/29/95		01/29/95		01/29/95		01/29/95		01/29/95	
	DATE EXTRACTED -->	02/07/95		02/07/95		02/10/95		02/10/95		02/10/95		02/10/95	
	DATE ANALYZED --->	02/17/95		02/17/95		02/27/95		02/27/95		02/27/95		02/28/95	
	MATRIX ---------->	Soil		Soil		Soil		Soil		Soil		Soil	
	UNITS ---------->	UG/KG		UG/KG		UG/KG		UG/KG		UG/KG		UG/KG	
CAS #	Parameter	FD1314	VAL	FD1314	VAL	FD1315	VAL	FD1315	VAL	FD1315	VAL	FD1315	VAL
319-84-6	alpha-BHC												
319-85-7	beta-BHC												
319-86-8	delta-BHC												
58-89-9	gamma-BHC (Lindane)												
76-44-8	Heptachlor												
309-00-2	Aldrin												
1024-57-3	Heptachlor epoxide					12.	J						
959-98-8	Endosulfan I												
60-57-1	Dieldrin			15.	J	103.	D			29.			
72-55-9	4,4'-DDE												
72-20-8	Endrin												
33213-65-9	Endosulfan II												
72-54-8	4,4'-DDD												
1031-07-8	Endosulfan sulfate												
50-29-3	4,4'-DDT									5.3	J		
72-43-5	Methoxychlor												
53494-70-5	Endrin ketone												
7421-93-4	Endrin aldehyde												
5103-71-9	alpha-Chlordane												
5103-74-2	gamma-Chlordane												
8001-35-2	Toxaphene												
12674-11-2	Aroclor-1016												
11104-28-2	Aroclor-1221												
53469-21-9	Aroclor-1242												
12672-29-6	Aroclor-1248												
11097-69-1	Aroclor-1254												
11096-82-5	Aroclor-1260									47.	J		
11141-16-5	Aroclor-1232												
12789-03-6	Technical Chlordane	NR		NR		NR		NR		NR		NR	

*** Validation Complete ***

SW846-PEST							
	SAMPLE ID ------->	005-S-0007-12		005-C-0007-12			
	ORIGINAL ID ----->	005S000712		005C000712			
	LAB SAMPLE ID --->	116019		116020			
	ID FROM REPORT -->	005S000712		005C000712			
	SAMPLE DATE ----->	01/29/95		01/29/95			
	DATE EXTRACTED -->	02/10/95		02/10/95			
	DATE ANALYZED --->	02/28/95		02/28/95			
	MATRIX ---------->	Soil		Soil			
	UNITS ---------->	UG/KG		UG/KG			
CAS #	Parameter	FD1315	VAL	FD1315	VAL		
319-84-6	alpha-BHC						
319-85-7	beta-BHC						
319-86-8	delta-BHC						
58-89-9	gamma-BHC (Lindane)						
76-44-8	Heptachlor						
309-00-2	Aldrin						
1024-57-3	Heptachlor epoxide						
959-98-8	Endosulfan I						
60-57-1	Dieldrin						
72-55-9	4,4'-DDE						
72-20-8	Endrin						
33213-65-9	Endosulfan II						
72-54-8	4,4'-DDD						
1031-07-8	Endosulfan sulfate						
50-29-3	4,4'-DDT						
72-43-5	Methoxychlor						
53494-70-5	Endrin ketone						
7421-93-4	Endrin aldehyde						
5103-71-9	alpha-Chlordane						
5103-74-2	gamma-Chlordane						
8001-35-2	Toxaphene						
12674-11-2	Aroclor-1016						
11104-28-2	Aroclor-1221						
53469-21-9	Aroclor-1242						
12672-29-6	Aroclor-1248						
11097-69-1	Aroclor-1254						
11096-82-5	Aroclor-1260						
11141-16-5	Aroclor-1232						
12789-03-6	Technical Chlordane	NR		NR			

*** Validation Complete ***

NSA Mid-South, Assembly A - SWMU 5
RFI Soil Data

SW846-SVOA													
	SAMPLE ID ------->	005-S-0001-01		005-S-0001-08		005-S-0001-12		005-S-0002-01		005-S-0002-08		005-S-0002-10	
	ORIGINAL ID ----->	005S000101		005S000108		005S000112		005S000201		005S000208		005S000210	
	LAB SAMPLE ID --->	115989		115990		115991		115992		115993		115994	
	ID FROM REPORT -->	005S000101		005S000108		005S000112		005S000201		005S000208		005S000210	
	SAMPLE DATE ----->	01/28/95		01/28/95		01/28/95		01/28/95		01/28/95		01/28/95	
	DATE EXTRACTED -->	02/05/95		02/05/95		02/05/95		02/13/95		02/05/95		02/05/95	
	DATE ANALYZED --->	02/09/95		02/09/95		02/09/95		02/15/95		02/09/95		02/10/95	
	MATRIX ---------->	Soil		Soil		Soil		Soil		Soil		Soil	
	UNITS ---------->	UG/KG		UG/KG		UG/KG		UG/KG		UG/KG		UG/KG	
CAS #	Parameter	FD1314	VAL	FD1314	VAL	FD1314	VAL	FD1314	VAL	FD1314	VAL	FD1314	VAL
108-95-2	Phenol												
111-44-4	bis(2-Chloroethyl)ether												
95-57-8	2-Chlorophenol												
541-73-1	1,3-Dichlorobenzene												
106-46-7	1,4-Dichlorobenzene												
95-50-1	1,2-Dichlorobenzene												
95-48-7	2-Methylphenol (o-Cresol)												
108-60-1	2,2'-oxybis(1-Chloropropane)												
106-44-5	4-Methylphenol (p-Cresol)												
621-64-7	N-Nitroso-di-n-propylamine												
67-72-1	Hexachloroethane												
98-95-3	Nitrobenzene												
78-59-1	Isophorone												
88-75-5	2-Nitrophenol												
105-67-9	2,4-Dimethylphenol												
120-83-2	2,4-Dichlorophenol												
120-82-1	1,2,4-Trichlorobenzene												
91-20-3	Naphthalene												
106-47-8	4-Chloroaniline												
87-68-3	Hexachlorobutadiene												
111-91-1	bis(2-Chloroethoxy)methane												
59-50-7	4-Chloro-3-methylphenol												
91-57-6	2-Methylnaphthalene												
77-47-4	Hexachlorocyclopentadiene												
88-06-2	2,4,6-Trichlorophenol												
95-95-4	2,4,5-Trichlorophenol												
91-58-7	2-Chloronaphthalene												
88-74-4	2-Nitroaniline												
131-11-3	Dimethylphthalate												
208-96-8	Acenaphthylene												
606-20-2	2,6-Dinitrotoluene												
99-09-2	3-Nitroaniline												
83-32-9	Acenaphthene												
51-28-5	2,4-Dinitrophenol												
100-02-7	4-Nitrophenol												
132-64-9	Dibenzofuran												

*** Validation Complete ***

000503

SW846-SVOA

	SAMPLE ID ------->	005-S-0001-01		005-S-0001-08		005-S-0001-12		005-S-0002-01		005-S-0002-08		005-S-0002-10	
	ORIGINAL ID ----->	005S000101		005S000108		005S000112		005S000201		005S000208		005S000210	
	LAB SAMPLE ID --->	115989		115990		115991		115992		115993		115994	
	ID FROM REPORT -->	005S000101		005S000108		005S000112		005S000201		005S000208		005S000210	
	SAMPLE DATE ----->	01/28/95		01/28/95		01/28/95		01/28/95		01/28/95		01/28/95	
	DATE EXTRACTED -->	02/05/95		02/05/95		02/05/95		02/13/95		02/05/95		02/05/95	
	DATE ANALYZED --->	02/09/95		02/09/95		02/09/95		02/15/95		02/09/95		02/10/95	
	MATRIX ---------->	Soil		Soil		Soil		Soil		Soil		Soil	
	UNITS ---------->	UG/KG		UG/KG		UG/KG		UG/KG		UG/KG		UG/KG	
CAS #	Parameter	FD1314	VAL	FD1314	VAL	FD1314	VAL	FD1314	VAL	FD1314	VAL	FD1314	VAL
121-14-2	2,4-Dinitrotoluene												
84-66-2	Diethylphthalate												
7005-72-3	4-Chlorophenylphenyl ether												
86-73-7	Fluorene												
100-01-6	4-Nitroaniline												
534-52-1	2-Methyl-4,6-Dinitrophenol												
86-30-6	N-Nitrosodiphenylamine												
101-55-3	4-Bromophenyl-phenylether												
118-74-1	Hexachlorobenzene												
87-86-5	Pentachlorophenol												
85-01-8	Phenanthrene												
120-12-7	Anthracene												
86-74-8	Carbazole												
84-74-2	Di-n-butylphthalate												
206-44-0	Fluoranthene												
129-00-0	Pyrene												
85-68-7	Butylbenzylphthalate												
91-94-1	3,3'-Dichlorobenzidine												
56-55-3	Benzo(a)anthracene												
218-01-9	Chrysene												
117-81-7	bis(2-Ethylhexyl)phthalate (BEHP)							140.	J				
117-84-0	Di-n-octylphthalate												
205-99-2	Benzo(b)fluoranthene												
207-08-9	Benzo(k)fluoranthene												
50-32-8	Benzo(a)pyrene												
193-39-5	Indeno(1,2,3-cd)pyrene												
53-70-3	Dibenz(a,h)anthracene												
191-24-2	Benzo(g,h,i)perylene												
9999900-32-2	3-Methylphenol/4-Methylphenol	NR		NR		NR		NR		NR		NR	
122-39-4	Diphenylamine	NR		NR		NR		NR		NR		NR	

*** Validation Complete ***

NSA Mid-South, Assembly A - SWMU 5
RFI Soil Data

SW846-SVOA													
	SAMPLE ID ------->	005-S-0003-01		005-S-0003-07		005-S-0003-17		005-S-0004-01		005-C-0004-01		005-S-0004-05	
	ORIGINAL ID ----->	005S000301		005S000307		005S000317		005S000401		005C000401		005S000405	
	LAB SAMPLE ID --->	115995		115996		115997		115998		115999		116000	
	ID FROM REPORT -->	005S000301		005S000307		005S000317		005S000401		005C000401		005S000405	
	SAMPLE DATE ----->	01/28/95		01/28/95		01/28/95		01/29/95		01/29/95		01/28/95	
	DATE EXTRACTED -->	02/05/95		02/05/95		02/05/95		02/05/95		02/05/95		02/05/95	
	DATE ANALYZED --->	02/10/95		02/10/95		02/10/95		02/10/95		02/13/95		02/10/95	
	MATRIX ---------->	Soil		Soil		Soil		Soil		Soil		Soil	
	UNITS ---------->	UG/KG		UG/KG		UG/KG		UG/KG		UG/KG		UG/KG	
CAS #	Parameter	FD1314	VAL	FD1314	VAL	FD1314	VAL	FD1314	VAL	FD1314	VAL	FD1314	VAL
108-95-2	Phenol												
111-44-4	bis(2-Chloroethyl)ether												
95-57-8	2-Chlorophenol												
541-73-1	1,3-Dichlorobenzene												
106-46-7	1,4-Dichlorobenzene												
95-50-1	1,2-Dichlorobenzene												
95-48-7	2-Methylphenol (o-Cresol)												
108-60-1	2,2'-oxybis(1-Chloropropane)												
106-44-5	4-Methylphenol (p-Cresol)												
621-64-7	N-Nitroso-di-n-propylamine												
67-72-1	Hexachloroethane												
98-95-3	Nitrobenzene												
78-59-1	Isophorone												
88-75-5	2-Nitrophenol												
105-67-9	2,4-Dimethylphenol												
120-83-2	2,4-Dichlorophenol												
120-82-1	1,2,4-Trichlorobenzene												
91-20-3	Naphthalene											130.	J
106-47-8	4-Chloroaniline												
87-68-3	Hexachlorobutadiene												
111-91-1	bis(2-Chloroethoxy)methane												
59-50-7	4-Chloro-3-methylphenol												
91-57-6	2-Methylnaphthalene											150.	J
77-47-4	Hexachlorocyclopentadiene												
88-06-2	2,4,6-Trichlorophenol												
95-95-4	2,4,5-Trichlorophenol												
91-58-7	2-Chloronaphthalene												
88-74-4	2-Nitroaniline												
131-11-3	Dimethylphthalate												
208-96-8	Acenaphthylene												
606-20-2	2,6-Dinitrotoluene												
99-09-2	3-Nitroaniline												
83-32-9	Acenaphthene												
51-28-5	2,4-Dinitrophenol												
100-02-7	4-Nitrophenol												
132-64-9	Dibenzofuran												

*** Validation Complete ***

SW846-SVOA													
	SAMPLE ID ------->	005-S-0003-01		005-S-0003-07		005-S-0003-17		005-S-0004-01		005-C-0004-01		005-S-0004-05	
	ORIGINAL ID ----->	005S000301		005S000307		005S000317		005S000401		005C000401		005S000405	
	LAB SAMPLE ID --->	115995		115996		115997		115998		115999		116000	
	ID FROM REPORT -->	005S000301		005S000307		005S000317		005S000401		005C000401		005S000405	
	SAMPLE DATE ----->	01/28/95		01/28/95		01/28/95		01/29/95		01/29/95		01/28/95	
	DATE EXTRACTED -->	02/05/95		02/05/95		02/05/95		02/05/95		02/05/95		02/05/95	
	DATE ANALYZED --->	02/10/95		02/10/95		02/10/95		02/10/95		02/13/95		02/10/95	
	MATRIX ---------->	Soil		Soil		Soil		Soil		Soil		Soil	
	UNITS ---------->	UG/KG		UG/KG		UG/KG		UG/KG		UG/KG		UG/KG	
CAS #	Parameter	FD1314	VAL	FD1314	VAL	FD1314	VAL	FD1314	VAL	FD1314	VAL	FD1314	VAL
121-14-2	2,4-Dinitrotoluene												
84-66-2	Diethylphthalate												
7005-72-3	4-Chlorophenylphenyl ether												
86-73-7	Fluorene												
100-01-6	4-Nitroaniline												
534-52-1	2-Methyl-4,6-Dinitrophenol												
86-30-6	N-Nitrosodiphenylamine												
101-55-3	4-Bromophenyl-phenylether												
118-74-1	Hexachlorobenzene												
87-86-5	Pentachlorophenol												
85-01-8	Phenanthrene							53.	J	110.	J		
120-12-7	Anthracene												
86-74-8	Carbazole												
84-74-2	Di-n-butylphthalate												
206-44-0	Fluoranthene	44.	J					150.	J	320.	J		
129-00-0	Pyrene							120.	J	270.	J		
85-68-7	Butylbenzylphthalate												
91-94-1	3,3'-Dichlorobenzidine												
56-55-3	Benzo(a)anthracene							60.	J	140.	J		
218-01-9	Chrysene							77.	J	170.	J		
117-81-7	bis(2-Ethylhexyl)phthalate (BEHP)					51.	J			45.	J		
117-84-0	Di-n-octylphthalate												
205-99-2	Benzo(b)fluoranthene							76.	J	170.	J		
207-08-9	Benzo(k)fluoranthene							78.	J	170.	J		
50-32-8	Benzo(a)pyrene							81.	J	170.	J		
193-39-5	Indeno(1,2,3-cd)pyrene							50.	J	120.	J		
53-70-3	Dibenz(a,h)anthracene									44.	J		
191-24-2	Benzo(g,h,i)perylene							57.	J	130.	J		
9999900-32-2	3-Methylphenol/4-Methylphenol	NR		NR		NR		NR		NR		NR	
122-39-4	Diphenylamine	NR		NR		NR		NR		NR		NR	

*** Validation Complete ***

SW846-SVOA													
	SAMPLE ID ------->	005-S-0004-10		005-S-0006-01		005-S-0006-07		005-S-0006-12		005-S-0007-01		005-S-0007-10	
	ORIGINAL ID ----->	005S000410		005S000601		005S000607		005S000612		005S000701		005S000710	
	LAB SAMPLE ID --->	116001		116002		116015		116016		116017		116018	
	ID FROM REPORT -->	005S000410		005S000601		005S000607		005S000612		005S000701		005S000710	
	SAMPLE DATE ----->	01/28/95		01/29/95		01/29/95		01/29/95		01/29/95		01/29/95	
	DATE EXTRACTED -->	02/05/95		02/05/95		02/13/95		02/13/95		02/13/95		02/13/95	
	DATE ANALYZED --->	02/10/95		02/13/95		02/15/95		02/15/95		02/15/95		02/15/95	
	MATRIX ---------->	Soil		Soil		Soil		Soil		Soil		Soil	
	UNITS ---------->	UG/KG		UG/KG		UG/KG		UG/KG		UG/KG		UG/KG	
CAS #	Parameter	FD1314	VAL	FD1314	VAL	FD1315	VAL	FD1315	VAL	FD1315	VAL	FD1315	VAL
108-95-2	Phenol												
111-44-4	bis(2-Chloroethyl)ether												
95-57-8	2-Chlorophenol												
541-73-1	1,3-Dichlorobenzene												
106-46-7	1,4-Dichlorobenzene												
95-50-1	1,2-Dichlorobenzene												
95-48-7	2-Methylphenol (o-Cresol)												
108-60-1	2,2'-oxybis(1-Chloropropane)												
106-44-5	4-Methylphenol (p-Cresol)												
621-64-7	N-Nitroso-di-n-propylamine												
67-72-1	Hexachloroethane												
98-95-3	Nitrobenzene												
78-59-1	Isophorone												
88-75-5	2-Nitrophenol												
105-67-9	2,4-Dimethylphenol												
120-83-2	2,4-Dichlorophenol												
120-82-1	1,2,4-Trichlorobenzene												
91-20-3	Naphthalene												
106-47-8	4-Chloroaniline												
87-68-3	Hexachlorobutadiene												
111-91-1	bis(2-Chloroethoxy)methane												
59-50-7	4-Chloro-3-methylphenol												
91-57-6	2-Methylnaphthalene												
77-47-4	Hexachlorocyclopentadiene												
88-06-2	2,4,6-Trichlorophenol												
95-95-4	2,4,5-Trichlorophenol												
91-58-7	2-Chloronaphthalene												
88-74-4	2-Nitroaniline												
131-11-3	Dimethylphthalate												
208-96-8	Acenaphthylene												
606-20-2	2,6-Dinitrotoluene												
99-09-2	3-Nitroaniline												
83-32-9	Acenaphthene												
51-28-5	2,4-Dinitrophenol												
100-02-7	4-Nitrophenol												
132-64-9	Dibenzofuran												

*** Validation Complete ***

SU846-SVOA													
	SAMPLE ID ------->	005-S-0004-10		005-S-0006-01		005-S-0006-07		005-S-0006-12		005-S-0007-01		005-S-0007-10	
	ORIGINAL ID ----->	005S000410		005S000601		005S000607		005S000612		005S000701		005S000710	
	LAB SAMPLE ID --->	116001		116002		116015		116016		116017		116018	
	ID FROM REPORT -->	005S000410		005S000601		005S000607		005S000612		005S000701		005S000710	
	SAMPLE DATE ----->	01/28/95		01/29/95		01/29/95		01/29/95		01/29/95		01/29/95	
	DATE EXTRACTED -->	02/05/95		02/05/95		02/13/95		02/13/95		02/13/95		02/13/95	
	DATE ANALYZED --->	02/10/95		02/13/95		02/15/95		02/15/95		02/15/95		02/15/95	
	MATRIX ---------->	Soil		Soil		Soil		Soil		Soil		Soil	
	UNITS ---------->	UG/KG		UG/KG		UG/KG		UG/KG		UG/KG		UG/KG	
CAS #	Parameter	FD1314	VAL	FD1314	VAL	FD1315	VAL	FD1315	VAL	FD1315	VAL	FD1315	VAL
121-14-2	2,4-Dinitrotoluene												
84-66-2	Diethylphthalate												
7005-72-3	4-Chlorophenylphenyl ether												
86-73-7	Fluorene												
100-01-6	4-Nitroaniline												
534-52-1	2-Methyl-4,6-Dinitrophenol												
86-30-6	N-Nitrosodiphenylamine												
101-55-3	4-Bromophenyl-phenylether												
118-74-1	Hexachlorobenzene												
87-86-5	Pentachlorophenol												
85-01-8	Phenanthrene												
120-12-7	Anthracene												
86-74-8	Carbazole												
84-74-2	Di-n-butylphthalate												
206-44-0	Fluoranthene									180.	J		
129-00-0	Pyrene									170.	J		
85-68-7	Butylbenzylphthalate												
91-94-1	3,3'-Dichlorobenzidine												
56-55-3	Benzo(a)anthracene									140.	J		
218-01-9	Chrysene									140.	J		
117-81-7	bis(2-Ethylhexyl)phthalate (BEHP)					57.	J	64.	J	67.	J	64.	J
117-84-0	Di-n-octylphthalate												
205-99-2	Benzo(b)fluoranthene									140.	J		
207-08-9	Benzo(k)fluoranthene									130.	J		
50-32-8	Benzo(a)pyrene									150.	J		
193-39-5	Indeno(1,2,3-cd)pyrene									67.	J		
53-70-3	Dibenz(a,h)anthracene												
191-24-2	Benzo(g,h,i)perylene									77.	J		
9999900-32-2	3-Methylphenol/4-Methylphenol	NR		NR		NR		NR		NR		NR	
122-39-4	Diphenylamine	NR		NR		NR		NR		NR		NR	

*** Validation Complete ***

NSA Mid-South, Assembly A - SWMU 5
RFI Soil Data

SW846-SVOA							
	SAMPLE ID ------->	005-S-0007-12		005-C-0007-12			
	ORIGINAL ID ----->	005S000712		005C000712			
	LAB SAMPLE ID --->	116019		116020			
	ID FROM REPORT -->	005S000712		005C000712			
	SAMPLE DATE ----->	01/29/95		01/29/95			
	DATE EXTRACTED -->	02/13/95		02/13/95			
	DATE ANALYZED --->	02/15/95		02/15/95			
	MATRIX ---------->	Soil		Soil			
	UNITS ---------->	UG/KG		UG/KG			
CAS #	Parameter	FD1315	VAL	FD1315	VAL		
108-95-2	Phenol						
111-44-4	bis(2-Chloroethyl)ether						
95-57-8	2-Chlorophenol						
541-73-1	1,3-Dichlorobenzene						
106-46-7	1,4-Dichlorobenzene						
95-50-1	1,2-Dichlorobenzene						
95-48-7	2-Methylphenol (o-Cresol)						
108-60-1	2,2'-oxybis(1-Chloropropane)						
106-44-5	4-Methylphenol (p-Cresol)						
621-64-7	N-Nitroso-di-n-propylamine						
67-72-1	Hexachloroethane						
98-95-3	Nitrobenzene						
78-59-1	Isophorone						
88-75-5	2-Nitrophenol						
105-67-9	2,4-Dimethylphenol						
120-83-2	2,4-Dichlorophenol						
120-82-1	1,2,4-Trichlorobenzene						
91-20-3	Naphthalene						
106-47-8	4-Chloroaniline						
87-68-3	Hexachlorobutadiene						
111-91-1	bis(2-Chloroethoxy)methane						
59-50-7	4-Chloro-3-methylphenol						
91-57-6	2-Methylnaphthalene						
77-47-4	Hexachlorocyclopentadiene						
88-06-2	2,4,6-Trichlorophenol						
95-95-4	2,4,5-Trichlorophenol						
91-58-7	2-Chloronaphthalene						
88-74-4	2-Nitroaniline						
131-11-3	Dimethylphthalate						
208-96-8	Acenaphthylene						
606-20-2	2,6-Dinitrotoluene						
99-09-2	3-Nitroaniline						
83-32-9	Acenaphthene						
51-28-5	2,4-Dinitrophenol						
100-02-7	4-Nitrophenol						
132-64-9	Dibenzofuran						

*** Validation Complete ***

SW846-SVOA

	SAMPLE ID ------->	005-S-0007-12		005-C-0007-12			
	ORIGINAL ID ----->	005S000712		005C000712			
	LAB SAMPLE ID --->	116019		116020			
	ID FROM REPORT -->	005S000712		005C000712			
	SAMPLE DATE ----->	01/29/95		01/29/95			
	DATE EXTRACTED -->	02/13/95		02/13/95			
	DATE ANALYZED --->	02/15/95		02/15/95			
	MATRIX ---------->	Soil		Soil			
	UNITS ---------->	UG/KG		UG/KG			
CAS #	Parameter	FD1315	VAL	FD1315	VAL		
121-14-2	2,4-Dinitrotoluene						
84-66-2	Diethylphthalate						
7005-72-3	4-Chlorophenylphenyl ether						
86-73-7	Fluorene						
100-01-6	4-Nitroaniline						
534-52-1	2-Methyl-4,6-Dinitrophenol						
86-30-6	N-Nitrosodiphenylamine						
101-55-3	4-Bromophenyl-phenylether						
118-74-1	Hexachlorobenzene						
87-86-5	Pentachlorophenol						
85-01-8	Phenanthrene						
120-12-7	Anthracene						
86-74-8	Carbazole						
84-74-2	Di-n-butylphthalate						
206-44-0	Fluoranthene						
129-00-0	Pyrene						
85-68-7	Butylbenzylphthalate						
91-94-1	3,3'-Dichlorobenzidine						
56-55-3	Benzo(a)anthracene						
218-01-9	Chrysene						
117-81-7	bis(2-Ethylhexyl)phthalate (BEHP)	96.	J	100.	J		
117-84-0	Di-n-octylphthalate						
205-99-2	Benzo(b)fluoranthene						
207-08-9	Benzo(k)fluoranthene						
50-32-8	Benzo(a)pyrene						
193-39-5	Indeno(1,2,3-cd)pyrene						
53-70-3	Dibenz(a,h)anthracene						
191-24-2	Benzo(g,h,i)perylene						
9999900-32-2	3-Methylphenol/4-Methylphenol	NR		NR			
122-39-4	Diphenylamine	NR		NR			

*** Validation Complete ***

SW846-VOA	SAMPLE ID ------->	005-S-0001-01		005-S-0001-08		005-S-0001-12		005-S-0002-01		005-S-0002-08		005-S-0002-10	
	ORIGINAL ID ----->	005S000101		005S000108		005S000112		005S000201		005S000208		005S000210	
	LAB SAMPLE ID --->	115989		115990		115991		115992		115993		115994	
	ID FROM REPORT -->	005S000101		005S000108		005S000112		005S000201		005S000208		005S000210	
	SAMPLE DATE ----->	01/28/95		01/28/95		01/28/95		01/28/95		01/28/95		01/28/95	
	DATE ANALYZED --->	02/02/95		02/02/95		02/03/95		02/03/95		02/03/95		02/03/95	
	MATRIX ---------->	Soil		Soil		Soil		Soil		Soil		Soil	
	UNITS ---------->	UG/KG		UG/KG		UG/KG		UG/KG		UG/KG		UG/KG	
CAS #	Parameter	FD1314	VAL	FD1314	VAL	FD1314	VAL	FD1314	VAL	FD1314	VAL	FD1314	VAL
74-87-3	Chloromethane												
74-83-9	Bromomethane												
75-01-4	Vinyl chloride												
75-00-3	Chloroethane												
75-09-2	Methylene chloride												
67-64-1	Acetone												
75-15-0	Carbon disulfide												
75-35-4	1,1-Dichloroethene												
75-34-3	1,1-Dichloroethane												
540-59-0	1,2-Dichloroethene (total)												
67-66-3	Chloroform												
107-06-2	1,2-Dichloroethane												
78-93-3	2-Butanone (MEK)												
71-55-6	1,1,1-Trichloroethane												
56-23-5	Carbon tetrachloride												
75-27-4	Bromodichloromethane												
78-87-5	1,2-Dichloropropane												
10061-01-5	cis-1,3-Dichloropropene												
79-01-6	Trichloroethene												
124-48-1	Dibromochloromethane												
79-00-5	1,1,2-Trichloroethane												
71-43-2	Benzene												
10061-02-6	trans-1,3-Dichloropropene												
75-25-2	Bromoform												
108-10-1	4-Methyl-2-Pentanone (MIBK)												
591-78-6	2-Hexanone												
127-18-4	Tetrachloroethene												
79-34-5	1,1,2,2-Tetrachloroethane												
108-88-3	Toluene												
108-90-7	Chlorobenzene												
100-41-4	Ethylbenzene												
100-42-5	Styrene												
1330-20-7	Xylene (Total)												
110-75-8	2-Chloroethylvinylether	NR		NR		NR		NR		NR		NR	
95-50-1	1,2-Dichlorobenzene	NR		NR		NR		NR		NR		NR	
541-73-1	1,3-Dichlorobenzene	NR		NR		NR		NR		NR		NR	
106-46-7	1,4-Dichlorobenzene	NR		NR		NR		NR		NR		NR	

*** Validation Complete ***

NSA Mid-South, Assembly A - SWMU 5
RFI Soil Data

SW846-VOA

	SAMPLE ID ------->	005-S-0001-01		005-S-0001-08		005-S-0001-12		005-S-0002-01		005-S-0002-08		005-S-0002-10	
	ORIGINAL ID ----->	005S000101		005S000108		005S000112		005S000201		005S000208		005S000210	
	LAB SAMPLE ID --->	115989		115990		115991		115992		115993		115994	
	ID FROM REPORT -->	005S000101		005S000108		005S000112		005S000201		005S000208		005S000210	
	SAMPLE DATE ----->	01/28/95		01/28/95		01/28/95		01/28/95		01/28/95		01/28/95	
	DATE ANALYZED --->	02/02/95		02/02/95		02/03/95		02/03/95		02/03/95		02/03/95	
	MATRIX ---------->	Soil		Soil		Soil		Soil		Soil		Soil	
	UNITS ---------->	UG/KG		UG/KG		UG/KG		UG/KG		UG/KG		UG/KG	
CAS #	Parameter	FD1314	VAL	FD1314	VAL	FD1314	VAL	FD1314	VAL	FD1314	VAL	FD1314	VAL
75-69-4	Trichlorofluoromethane	NR		NR		NR		NR		NR		NR	
108-05-4	Vinyl acetate	NR		NR		NR		NR		NR		NR	
108-38-3	m-Xylene	NR		NR		NR		NR		NR		NR	
95-47-6	o-Xylene	NR		NR		NR		NR		NR		NR	
106-42-3	p-Xylene	NR		NR		NR		NR		NR		NR	

*** Validation complete ***

NSA Mid-South, Assembly A - SWMU 5
RFI Soil Data

SW846-VOA													
	SAMPLE ID ------->	005-S-0003-01		005-S-0003-07		005-S-0003-17		005-S-0004-01		005-C-0004-01		005-S-0004-05	
	ORIGINAL ID ----->	005S000301		005S000307		005S000317		005S000401		005C000401		005S000405	
	LAB SAMPLE ID --->	115995		115996		115997		115998		115999		116000	
	ID FROM REPORT -->	005S000301		005S000307		005S000317		005S000401		005C000401		005S000405	
	SAMPLE DATE ----->	01/28/95		01/28/95		01/28/95		01/29/95		01/29/95		01/28/95	
	DATE ANALYZED --->	02/03/95		02/03/95		02/03/95		02/03/95		02/04/95		02/03/95	
	MATRIX ---------->	Soil		Soil		Soil		Soil		Soil		Soil	
	UNITS ---------->	UG/KG		UG/KG		UG/KG		UG/KG		UG/KG		UG/KG	
CAS #	Parameter	FD1314	VAL	FD1314	VAL	FD1314	VAL	FD1314	VAL	FD1314	VAL	FD1314	VAL
74-87-3	Chloromethane												
74-83-9	Bromomethane												
75-01-4	Vinyl chloride												
75-00-3	Chloroethane												
75-09-2	Methylene chloride									2.	J		
67-64-1	Acetone											110.	J
75-15-0	Carbon disulfide												
75-35-4	1,1-Dichloroethene												
75-34-3	1,1-Dichloroethane												
540-59-0	1,2-Dichloroethene (total)												
67-66-3	Chloroform												
107-06-2	1,2-Dichloroethane												
78-93-3	2-Butanone (MEK)											20.	J
71-55-6	1,1,1-Trichloroethane												
56-23-5	Carbon tetrachloride												
75-27-4	Bromodichloromethane												
78-87-5	1,2-Dichloropropane												
10061-01-5	cis-1,3-Dichloropropene												
79-01-6	Trichloroethene												
124-48-1	Dibromochloromethane												
79-00-5	1,1,2-Trichloroethane												
71-43-2	Benzene												
10061-02-6	trans-1,3-Dichloropropene												
75-25-2	Bromoform												
108-10-1	4-Methyl-2-Pentanone (MIBK)												
591-78-6	2-Hexanone												
127-18-4	Tetrachloroethene												
79-34-5	1,1,2,2-Tetrachloroethane												
108-88-3	Toluene												
108-90-7	Chlorobenzene												
100-41-4	Ethylbenzene											5.	J
100-42-5	Styrene												
1330-20-7	Xylene (Total)												
110-75-8	2-Chloroethylvinylether	NR		NR		NR		NR		NR		NR	
95-50-1	1,2-Dichlorobenzene	NR		NR		NR		NR		NR		NR	
541-73-1	1,3-Dichlorobenzene	NR		NR		NR		NR		NR		NR	
106-46-7	1,4-Dichlorobenzene	NR		NR		NR		NR		NR		NR	

*** Validation Complete ***

1005512

SW846-VOA

		SAMPLE ID ------->	005-S-0003-01		005-S-0003-07		005-S-0003-17		005-S-0004-01		005-C-0004-01		005-S-0004-05
		ORIGINAL ID ----->	005S000301		005S000307		005S000317		005S000401		005C000401		005S000405
		LAB SAMPLE ID --->	115995		115996		115997		115998		115999		116000
		ID FROM REPORT -->	005S000301		005S000307		005S000317		005S000401		005C000401		005S000405
		SAMPLE DATE ----->	01/28/95		01/28/95		01/28/95		01/29/95		01/29/95		01/28/95
		DATE ANALYZED --->	02/03/95		02/03/95		02/03/95		02/03/95		02/04/95		02/03/95
		MATRIX ---------->	Soil		Soil		Soil		Soil		Soil		Soil
		UNITS ---------->	UG/KG		UG/KG		UG/KG		UG/KG		UG/KG		UG/KG
CAS #	Parameter		FD1314	VAL	FD1314	VAL	FD1314	VAL	FD1314	VAL	FD1314	VAL	FD1314	VAL
75-69-4	Trichlorofluoromethane		NR		NR		NR		NR		NR		NR
108-05-4	Vinyl acetate		NR		NR		NR		NR		NR		NR
108-38-3	m-Xylene		NR		NR		NR		NR		NR		NR
95-47-6	o-Xylene		NR		NR		NR		NR		NR		NR
106-42-3	p-Xylene		NR		NR		NR		NR		NR		NR

000513

*** Validation complete ***

NSA Mid-South, Assembly A - SWMU 5
RFI Soil Data

SW846-VOA													
	SAMPLE ID ------->	005-S-0004-10		005-S-0006-01		005-S-0006-07		005-S-0006-12		005-S-0007-01		005-S-0007-10	
	ORIGINAL ID ----->	005S000410		005S000601		005S000607		005S000612		005S000701		005S000710	
	LAB SAMPLE ID --->	116001		116002		116015		116016		116017		116018	
	ID FROM REPORT -->	005S000410		005S000601		005S000607		005S000612		005S000701		005S000710	
	SAMPLE DATE ----->	01/28/95		01/29/95		01/29/95		01/29/95		01/29/95		01/29/95	
	DATE ANALYZED --->	02/03/95		02/03/95		02/02/95		02/02/95		02/02/95		02/02/95	
	MATRIX ---------->	Soil		Soil		Soil		Soil		Soil		Soil	
	UNITS ---------->	UG/KG		UG/KG		UG/KG		UG/KG		UG/KG		UG/KG	
CAS #	Parameter	FD1314	VAL	FD1314	VAL	FD1315	VAL	FD1315	VAL	FD1315	VAL	FD1315	VAL
74-87-3	Chloromethane												
74-83-9	Bromomethane												
75-01-4	Vinyl chloride												
75-00-3	Chloroethane												
75-09-2	Methylene chloride												
67-64-1	Acetone	10.	J										
75-15-0	Carbon disulfide												
75-35-4	1,1-Dichloroethene												
75-34-3	1,1-Dichloroethane												
540-59-0	1,2-Dichloroethene (total)												
67-66-3	Chloroform												
107-06-2	1,2-Dichloroethane												
78-93-3	2-Butanone (MEK)												
71-55-6	1,1,1-Trichloroethane												
56-23-5	Carbon tetrachloride												
75-27-4	Bromodichloromethane												
78-87-5	1,2-Dichloropropane												
10061-01-5	cis-1,3-Dichloropropene												
79-01-6	Trichloroethene												
124-48-1	Dibromochloromethane												
79-00-5	1,1,2-Trichloroethane												
71-43-2	Benzene												
10061-02-6	trans-1,3-Dichloropropene												
75-25-2	Bromoform												
108-10-1	4-Methyl-2-Pentanone (MIBK)												
591-78-6	2-Hexanone												
127-18-4	Tetrachloroethene												
79-34-5	1,1,2,2-Tetrachloroethane												
108-88-3	Toluene												
108-90-7	Chlorobenzene												
100-41-4	Ethylbenzene												
100-42-5	Styrene												
1330-20-7	Xylene (Total)												
110-75-8	2-Chloroethylvinylether	NR		NR		NR		NR		NR		NR	
95-50-1	1,2-Dichlorobenzene	NR		NR		NR		NR		NR		NR	
541-73-1	1,3-Dichlorobenzene	NR		NR		NR		NR		NR		NR	
106-46-7	1,4-Dichlorobenzene	NR		NR		NR		NR		NR		NR	

*** Validation Complete ***

SW846-VOA

000515

	SAMPLE ID ------->	005-S-0004-10		005-S-0006-01		005-S-0006-07		005-S-0006-12		005-S-0007-01		005-S-0007-10	
	ORIGINAL ID ----->	005S000410		005S000601		005S000607		005S000612		005S000701		005S000710	
	LAB SAMPLE ID --->	116001		116002		116015		116016		116017		116018	
	ID FROM REPORT -->	005S000410		005S000601		005S000607		005S000612		005S000701		005S000710	
	SAMPLE DATE ----->	01/28/95		01/29/95		01/29/95		01/29/95		01/29/95		01/29/95	
	DATE ANALYZED --->	02/03/95		02/03/95		02/02/95		02/02/95		02/02/95		02/02/95	
	MATRIX ---------->	Soil		Soil		Soil		Soil		Soil		Soil	
	UNITS ---------->	UG/KG		UG/KG		UG/KG		UG/KG		UG/KG		UG/KG	
CAS #	Parameter	FD1314	VAL	FD1314	VAL	FD1315	VAL	FD1315	VAL	FD1315	VAL	FD1315	VAL
75-69-4	Trichlorofluoromethane	NR		NR		NR		NR		NR		NR	
108-05-4	Vinyl acetate	NR		NR		NR		NR		NR		NR	
108-38-3	m-Xylene	NR		NR		NR		NR		NR		NR	
95-47-6	o-Xylene	NR		NR		NR		NR		NR		NR	
106-42-3	p-Xylene	NR		NR		NR		NR		NR		NR	

*** Validation Complete ***

NSA Mid-South, Assembly A - SWMU 5
RFI Soil Data

SW846-VOA							
	SAMPLE ID ------->	005-S-0007-12		005-C-0007-12			
	ORIGINAL ID ----->	005S000712		005C000712			
	LAB SAMPLE ID --->	116019		116020			
	ID FROM REPORT -->	005S000712		005C000712			
	SAMPLE DATE ----->	01/29/95		01/29/95			
	DATE ANALYZED --->	02/02/95		02/02/95			
	MATRIX ---------->	Soil		Soil			
	UNITS ---------->	UG/KG		UG/KG			
CAS #	Parameter	FD1315	VAL	FD1315	VAL		
74-87-3	Chloromethane						
74-83-9	Bromomethane						
75-01-4	Vinyl chloride						
75-00-3	Chloroethane						
75-09-2	Methylene chloride						
67-64-1	Acetone						
75-15-0	Carbon disulfide						
75-35-4	1,1-Dichloroethene						
75-34-3	1,1-Dichloroethane						
540-59-0	1,2-Dichloroethene (total)						
67-66-3	Chloroform						
107-06-2	1,2-Dichloroethane						
78-93-3	2-Butanone (MEK)						
71-55-6	1,1,1-Trichloroethane						
56-23-5	Carbon tetrachloride						
75-27-4	Bromodichloromethane						
78-87-5	1,2-Dichloropropane						
10061-01-5	cis-1,3-Dichloropropene						
79-01-6	Trichloroethene						
124-48-1	Dibromochloromethane						
79-00-5	1,1,2-Trichloroethane						
71-43-2	Benzene						
10061-02-6	trans-1,3-Dichloropropene						
75-25-2	Bromoform						
108-10-1	4-Methyl-2-Pentanone (MIBK)						
591-78-6	2-Hexanone						
127-18-4	Tetrachloroethene						
79-34-5	1,1,2,2-Tetrachloroethane						
108-88-3	Toluene						
108-90-7	Chlorobenzene						
100-41-4	Ethylbenzene						
100-42-5	Styrene						
1330-20-7	Xylene (Total)						
110-75-8	2-Chloroethylvinylether	NR		NR			
95-50-1	1,2-Dichlorobenzene	NR		NR			
541-73-1	1,3-Dichlorobenzene	NR		NR			
106-46-7	1,4-Dichlorobenzene	NR		NR			

*** Validation Complete ***

SW846-VOA

	SAMPLE ID ------->	005-S-0007-12		005-C-0007-12		005-S-3001-01	
	ORIGINAL ID ----->	005S000712		005C000712		5S300101	
	LAB SAMPLE ID --->	116019		116020		138533	
	ID FROM REPORT -->	005S000712		005C000712		5S300101	
	SAMPLE DATE ----->	01/29/95		01/29/95		11/06/95	
	DATE ANALYZED --->	02/02/95		02/02/95		11/15/95	
	MATRIX ---------->	Soil		Soil		Soil	
	UNITS ---------->	UG/KG		UG/KG		UG/KG	
CAS #	Parameter	FD1315	VAL	FD1315	VAL	1609	VAL
75-69-4	Trichlorofluoromethane	NR		NR		NR	
108-05-4	Vinyl acetate	NR		NR		NR	
108-38-3	m-Xylene	NR		NR		NR	
95-47-6	o-Xylene	NR		NR		NR	
106-42-3	p-Xylene	NR		NR		NR	

*** Validation complete ***

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NSA Mid-South, Assembly A - SWMU 5
RFI Soil Data

TPH													
	SAMPLE ID ------->	005-S-0001-01		005-S-0001-08		005-S-0001-12		005-S-0002-01		005-S-0002-08		005-S-0002-10	
	ORIGINAL ID ----->	005S000101		005S000108		005S000112		005S000201		005S000208		005S000210	
	LAB SAMPLE ID --->	115971		115972		115973		115974		115975		115976	
	ID FROM REPORT -->	005S000101		005S000108		005S000112		005S000201		005S000208		005S000210	
	SAMPLE DATE ----->	01/28/95		01/28/95		01/28/95		01/28/95		01/28/95		01/28/95	
	DATE EXTRACTED -->	02/23/95		02/23/95		02/23/95		02/23/95		02/23/95		02/23/95	
	DATE ANALYZED --->	02/23/95		02/23/95		02/24/95		02/24/95		02/24/95		02/24/95	
	MATRIX ---------->	Soil		Soil		Soil		Soil		Soil		Soil	
	UNITS ---------->	MG/KG		MG/KG		MG/KG		MG/KG		MG/KG		MG/KG	
CAS #	Parameter	FD1314	VAL	FD1314	VAL	FD1314	VAL	FD1314	VAL	FD1314	VAL	FD1314	VAL
999900-02-4	Petroleum Hydrocarbons, TPH												

*** Validation Complete ***

NSA Mid-South, Assembly A - SWMU 5
RFI Soil Data

TPH

000513

	SAMPLE ID ------->	005-S-0003-01		005-S-0003-07		005-S-0003-17		005-S-0004-01		005-C-0004-01		005-S-0004-05	
	ORIGINAL ID ----->	005S000301		005S000307		005S000317		005S000401		005C000401		005S000405	
	LAB SAMPLE ID --->	115977		115978		115979		115980		115981		115982	
	ID FROM REPORT -->	005S000301		005S000307		005S000317		005S000401		005C000401		005S000405	
	SAMPLE DATE ----->	01/28/95		01/28/95		01/28/95		01/29/95		01/29/95		01/28/95	
	DATE EXTRACTED -->	02/23/95		02/23/95		02/23/95		02/24/95		02/24/95		02/24/95	
	DATE ANALYZED --->	02/24/95		02/24/95		02/24/95		02/24/95		02/24/95		02/24/95	
	MATRIX ---------->	Soil		Soil		Soil		Soil		Soil		Soil	
	UNITS ---------->	MG/KG		MG/KG		MG/KG		MG/KG		MG/KG		MG/KG	
CAS #	Parameter	FD1314	VAL	FD1314	VAL	FD1314	VAL	FD1314	VAL	FD1314	VAL	FD1314	VAL
999900-02-4	Petroleum Hydrocarbons, TPH											280.	

*** Validation complete ***

NSA Mid-South, Assembly A - SWMU 5
RFI Soil Data

TPH													
	SAMPLE ID ------->	005-S-0004-10		005-S-0006-01		005-S-0006-07		005-S-0006-12		005-S-0007-01		005-S-0007-10	
	ORIGINAL ID ----->	005S000410		005S000601		005S000607		005S000612		005S000701		005S000710	
	LAB SAMPLE ID --->	115983		115984		116003		116004		116005		116006	
	ID FROM REPORT -->	005S000410		005S000601		005S000607		005S000612		005S000701		005S000710	
	SAMPLE DATE ----->	01/28/95		01/29/95		01/29/95		01/29/95		01/29/95		01/29/95	
	DATE EXTRACTED -->	02/24/95		02/24/95		02/25/95		02/25/95		02/25/95		02/25/95	
	DATE ANALYZED --->	02/24/95		02/24/95		02/25/95		02/25/95		02/25/95		02/25/95	
	MATRIX ---------->	Soil		Soil		Soil		Soil		Soil		Soil	
	UNITS ---------->	MG/KG		MG/KG		mg/Kg		mg/Kg		mg/Kg		mg/Kg	
CAS #	Parameter	FD1314	VAL	FD1314	VAL	FD1315	VAL	FD1315	VAL	FD1315	VAL	FD1315	VAL
)999900-02-4	Petroleum Hydrocarbons, TPH												

*** Validation Complete ***

NSA Mid-South, Assembly A - SWMU 5
RFI Soil Data

TPH

	SAMPLE ID ------->	005-S-0007-12		005-C-0007-12		005-S-0008-01		005-S-0009-01		005-S-0010-01		005-S-0011-01	
	ORIGINAL ID ----->	005S000712		005C000712		005S000801		005S000901		005S001001		005S001101	
	LAB SAMPLE ID --->	116007		116008		116981		116982		116983		116984	
	ID FROM REPORT -->	005S000712		005C000712		005S000801		005S000901		005S001001		005S001101	
	SAMPLE DATE ----->	01/29/95		01/29/95		02/14/95		02/14/95		02/15/95		02/15/95	
	DATE EXTRACTED -->	02/25/95		02/25/95		03/15/95		03/15/95		03/15/95		03/15/95	
	DATE ANALYZED --->	02/25/95		02/25/95		03/16/95		03/16/95		03/16/95		03/16/95	
	MATRIX ---------->	Soil		Soil		Soil		Soil		Soil		Soil	
	UNITS ---------->	mg/Kg		mg/Kg		mg/Kg		mg/Kg		mg/Kg		mg/Kg	
CAS #	Parameter	FD1315	VAL	FD1315	VAL	FD1329	VAL	FD1329	VAL	FD1329	VAL	FD1329	VAL
9999900-02-4	Petroleum Hydrocarbons, TPH												

*** Validation complete ***

NSA Mid-South, Assembly A
SWMU 5 RFI Soil Data
DIOXIN Data

DIOXIN											
	SAMPLE ID ------->	005-S-0001-01		005-S-0002-01		005-S-0003-01		005-S-0004-01		005-S-0005-01	
	ORIGINAL ID ----->	135807		135808		135809		135810		135811	
	LAB SAMPLE ID --->	23708.02		23708.03		23708.04		23708.05		23708.06	
	ID FROM REPORT -->	135807		135808		135809		135810		135811	
	SAMPLE DATE ----->	09/29/95		09/29/95		09/29/95		09/29/95		09/29/95	
	DATE EXTRACTED -->	10/02/95		10/02/95		10/02/95		10/02/95		10/02/95	
	DATE ANALYZED --->	10/27/95		10/27/95		10/27/95		10/27/95		10/27/95	
	MATRIX ---------->	Soil		Soil		Soil		Soil		Soil	
	UNITS ---------->	UG/KG		UG/KG		UG/KG		UG/KG		UG/KG	
CAS #	Parameter	1539	VAL	1539	VAL	1539	VAL	1539	VAL	1539	VAL
41903-57-5	Total Tetra-Dioxins	0.72	U	0.12	J	0.52	U	1.2	U	0.11	J
36088-22-9	Total Penta-Dioxins	0.35	U	0.38	U	0.42	U	0.62	U	0.14	U
34465-46-8	Total Hexa-Dioxins	0.2	U	0.082	U	0.16	U	0.08	U	0.14	U
37871-00-4	Total Hepta-Dioxins	4.4		2.7		0.3		0.65	J	1.3	
3268-87-9	OCDD	12.		7.4		2.3		8.4		4.6	
55722-27-5	Total Tetra-Furans	0.025	U	0.085	U	0.11	U	0.32	U	0.021	U
30602-15-4	Total Penta-Furans	0.24		0.035	U	0.045	U	0.37		0.15	J
55684-94-1	Total Hexa-Furans	0.092	U	0.19		0.028	U	0.16	U	0.048	U
38998-75-3	Total Hepta-Furans	0.18	U	0.18	U	0.082	U	0.41		0.18	UJ
39001-02-0	OCDF	0.3	U	0.35	U	0.2	U	0.72	U	0.3	U
1746-01-6	2378-TCDD	0.72	U	0.55	U	0.52	U	1.2	U	0.14	U
51207-31-9	2378-TCDF	0.025	U	0.085	U	0.11	U	0.32	U	0.021	U
57117-41-6	12378-PeCDF	0.32	U	0.07	U	0.05	U	0.28	U	0.11	U
40321-76-4	12378-PeCDD	0.35	U	0.38	U	0.42	U	0.62	U	0.14	U
57117-31-4	23478-PeCDF	0.17	U	0.035	U	0.045	U	0.25	U	0.06	U
70648-26-9	123478-HxCDF	0.4	U	0.12	U	0.028	U	0.2	U	0.12	U
57117-44-9	123678-HxCDF	0.16	U	0.062	U	0.13	U	0.62	U	0.048	U
39227-28-6	123478-HxCDD	0.2	U	0.082	U	0.16	U	0.08	U	0.24	U
57653-85-7	123678-HxCDD	0.58	U	0.48	U	0.3	U	1.4	U	0.38	U
19408-74-3	123789-HxCDD	0.8	U	0.3	U	0.18	U	0.52	U	0.14	U
60851-34-5	234678-HxCDF	0.092	U	0.05	U	0.045	U	0.23	U	0.1	U
72918-21-9	123789-HxCDF	0.12	U	0.042	U	0.1	U	0.16	U	0.12	U
67562-39-4	1234678-HpCDF	0.18	U	0.4	U	0.082	U	0.41	J	0.22	UJ
35822-46-9	1234678-HpCDD	2.5	J	1.4	J	1.2	U	1.3	J	0.83	J
55673-89-7	1234789-HpCDF	0.28	U	0.18	U	0.16	U	0.38	U	0.18	U

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*** Validation Complete ***

NSA Mid-South, Assembly A - SWMU 5
Soil Data from Second DPT Sampling
June 1998

SW846-VOA

SAMPLE ID ------->	005-S-GB01-10
ORIGINAL ID ----->	005SGB0110
LAB SAMPLE ID --->	S883243*1
ID FROM REPORT -->	005SGB0110
SAMPLE DATE ----->	06/03/98
DATE ANALYZED --->	06/12/98
MATRIX ---------->	Soil
UNITS ----------->	UG/KG

CAS #	Parameter	MEM53	VAL
74-87-3	Chloromethane	12.	U
74-83-9	Bromomethane	12.	U
75-01-4	Vinyl chloride	12.	U
75-00-3	Chloroethane	12.	UR
75-35-4	1,1-Dichloroethene	6.	U
75-09-2	Methylene chloride	1.1	U
75-34-3	1,1-Dichloroethane	6.	U
67-66-3	Chloroform	6.	U
71-55-6	1,1,1-Trichloroethane	5.	J
56-23-5	Carbon tetrachloride	6.	U
71-43-2	Benzene	1.7	J
107-06-2	1,2-Dichloroethane	6.	U
79-01-6	Trichloroethene	3.4	J
78-87-5	1,2-Dichloropropane	9.5	
75-27-4	Bromodichloromethane	6.	U
108-88-3	Toluene	2.	J
79-00-5	1,1,2-Trichloroethane	6.	U
127-18-4	Tetrachloroethene	25.	
124-48-1	Dibromochloromethane	6.	U
108-90-7	Chlorobenzene	6.	U
100-41-4	Ethylbenzene	3.9	J
100-42-5	Styrene	6.	U
75-25-2	Bromoform	6.	U
79-34-5	1,1,2,2-Tetrachloroethane	6.	U
67-64-1	Acetone	95.	
75-15-0	Carbon disulfide	6.	U
78-93-3	2-Butanone (MEK)	14.	J
108-10-1	4-Methyl-2-Pentanone (MIBK)	30.	U
10061-01-5	cis-1,3-Dichloropropene	6.	U
10061-02-6	trans-1,3-Dichloropropene	6.	U
591-78-6	2-Hexanone	5.6	J
1330-20-7	Xylene (Total)	18.	
540-59-0	1,2-Dichloroethene (total)	6.	U

+++ Validation Complete +++

Appendix G
Soil Physical Analysis

TRI STATE
TESTING SERVICES, INC.

Measurement of Hydraulic Conductivity

Client: EnSafe/Allen & Hoshall

Date of Report: 02/27/95 Project No.: E-2-837

Project Name: NAS Memphis, Tennessee

Sample I.D.: 005S000620

Soil Description: Gray Silty Clay

	Pre-Test	Post Test
Wet Density (Lbs/ft^3)	128.4	127.6
Dry Density (Lbs/ft^3)	101.3	98.4
Moisture (% Dry Wt)	26.7	29.7
Porosity (n)	.388	.379
Degree of Saturation (%)	.98	1.0

Permeability

Temperature Correction, R_t = 1.103

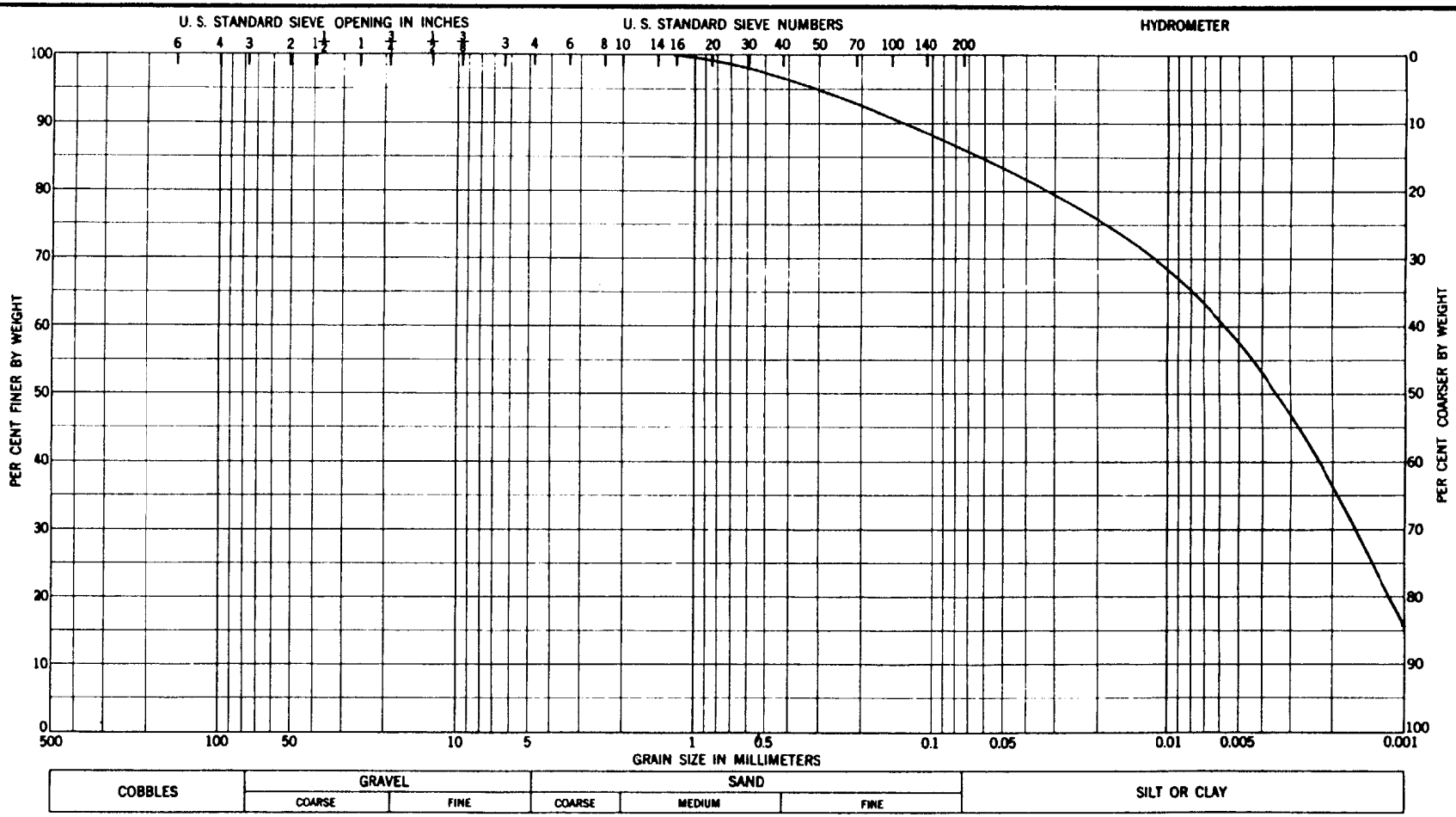
$K_1 = 1.5 \times 10^{-7}$ cm/sec
$K_2 = 1.2 \times 10^{-7}$ cm/sec
$K_3 = 1.1 \times 10^{-7}$ cm/sec
$K_4 = 1.3 \times 10^{-7}$ cm/sec

Coefficient of Permeability, $K_{20} = 1.4 \times 10^{-7}$ cm/sec

Tested in accordance with Method 9100 of Test Methods for evaluation Solid Waste, Third Addition (SW-846) and in general accordance with ASTM D-5084-90.

Lab No. P-95-0012 Reviewed By: David D. McCray

6756 BUCKLES COVE MEMPHIS, TN 38133 901-385-1199 FAX 901-386-6614



Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
--	--	CL	--	NP	NP	NP

Project: Naval Air Station Memphis, Tennessee

Area:

Boring No.: Sample ID 005S000620

Date: 02/28/95

GRADATION CURVES

Appendix H
Specific Capacity Data

****
DETERMINATION OF AQUIFER PROPERTIES BASED ON ANALYSIS OF
SPECIFIC CAPACITY TESTS
****

Copied from: Bradbury, K. R. and Rothschild, E. R., 1985. A computerized technique for estimating the hydraulic conductivity of aquifers from specific capacity data, Ground Water, 23(2), pp. 240-246.

WELL NUMBER 05MW01UF

WELL DIAMETER (IN) = 2
STATIC WATER LEVEL (FT) = 14.65
DEPTH TO WATER DURING TEST (FT) = 18
THE LENGTH OF THE TEST (HR) = .033
PUMPING RATE (GPM) = 2.5
THICKNESS OF AQUIFER (FT) = 25
OPEN INTERVAL (FT) = 10
STORAGE COEFFICIENT = .0001
WELL-LOSS COEFFICIENT = .75

SPECIFIC CAPACITY (GPM/FT) = .7462738

TRANSMISSIVITY: (FT*FT/SEC) = 3.521635E-03
(FT*FT/DAY) = 304.2693
(GAL/DAY/FT) = 2276.087
USING A STORAGE COEFFICIENT = .0001
NUMBER OF ITERATIONS = 3

HYDRAULIC CONDUCTIVITY: (FT/SEC) = 1.408654E-04
(FT/DAY) = 12.17077
(GAL/DAY/FT*FT) = 80.85675

SPEC. QAP			
DATE 3-27-95			
SWMU 5		WELL NO. 08MW01UF	
TIME	WATER LEVEL		
0 sec	14.65		
15 sec	16.93		
30 sec	17.65		
45 sec	17.9		
1 min.	18.0		
1.5	18.0		
2	18.0		
3	18.0		
5			
2 8:15	?		
2 8:30	15.1		
2 8:45	14.85		
3 8	14.8		
3 6:30	14.73		
4 7	14.70		
5 8	14.70		
7 10	14.65		

2.5 gpm

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Appendix I

Human Health Risk Assessment Technical Memorandum

TECHNICAL MEMORANDUM

TO: Mark Taylor/David Porter, SOUTHDIV
Tonya Barker/Rob Williamson, NSA Memphis
Brian Donaldson, USEPA
Jim Morrison, TDEC
Jack Carmichael, USGS
Brenda Duggar, MSCHD
E/A&H Project Team

FROM: Brian Mulhearn, E/A&H

DATE: November 15, 1996

RE: General Human Health Risk Assessment (HHRA) Approach for NSA Memphis

---

This memorandum discusses the general HHRA approach for NSA Memphis. It is proposed that this text not be reproduced in subsequent HHRAs, which would include only site-specific information and reference this memorandum, reducing the bulk necessary to present site-specific risk information to risk managers. Deviations from these general methods would be justified and discussed in site-specific HHRAs.

1 BASELINE RISK ASSESSMENT

1.1 Introduction

A baseline risk assessment (BRA) establishes a baseline of risk to facilitate risk management decisions. Risk is the estimated potential for toxic effects on actual or hypothetical human or ecological receptors, while baseline risk refers to risk arising from exposures to chemicals assuming site conditions remain unchanged. BRAs are used by risk managers to decide if remedial actions are necessary and to determine the extent of remediation necessary to reduce the risk to acceptable levels. Generally, a BRA is divided into two sections, one assessing human health risk, and a second addressing ecological risk. This section addresses generally applied HHRA methods, while ecological risk assessment methods will be addressed in the site-specific assessments. Data management and analysis methods which will be used to reach the conclusions of site-specific HHRAs are discussed below. The following sections describe the methods, procedures, considerations, toxicological information, and related uncertainties possibly affecting HHRAs at NSA Memphis.

1.2 Background

The site background will be summarized in this section of the site-specific HHRAs.

2 General Guidance

HHRAs will generally be prepared in accordance with the guidelines set forth in the following documents, although some may not apply to every site:

- *Provisional Guidance for Quantitative Risk Assessment of PAHs*, U.S. Environmental Protection Agency, ECAO-CIN-842, EPA/600/BP92/001C, July 1993.

- *Risk Assessment Guidance for Superfund (RAGS), Volume I — Human Health Evaluation Manual, Part A*, U.S. Environmental Protection Agency/Office of Emergency and Remedial Response (OERR), EPA/540/1-89/002, December 1989 (Interim).

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- *RAGS, Volume I — Human Health Evaluation Manual, (Part B, Development of Risk-Based Preliminary Remediation Goals)*, USEPA/OERR, EPA/540/R92/003, December 1991 (Interim).

- *RAGS, Volume I — Human Health Evaluation Manual, Supplemental Guidance — Standard Default Exposure Factors — Interim Final,* EPA/OERR, Office of Solid Waste and Emergency Response (OSWER) Directive: 9285.6-03, March 25, 1991. (RAGS Supplement).

- *RAGS, Volume I — Human Health Evaluation Manual, Supplemental Guidance-Dermal Risk Assessment — Interim Guidance,* EPA/OERR, August 18, 1992. (Supplemental Dermal Guidance).

- Supplemental Guidance to RAGS: Region IV Bulletin, *Development of Health-Based Preliminary Remediation Goals, Remedial Goal Options (RGO) and Remediation Levels* (Supplemental RGO Guidance).

- Supplemental Guidance to RAGS: Region IV Bulletin, *Provisional Guidance of Quantitative Risk Assessment of PAHs* (EPA Document EPA/600/R-93-089 July 1993).

- *Supplemental Guidance to RAGS: Calculating the Concentration Term*, May 1992.

- USEPA Region III *Selecting Exposure Routes and Contaminants of Concern by Risk-Based Table*, March 18, 1994, (RBC Screening Tables).

- USEPA Region III *Risk-Based Concentration Table*, January 1995, and subsequent versions (USEPA 1995).

2.1 Objectives

The objectives of the BRA will be to:

- Characterize the source media and determine the chemicals of potential concern (COPCs) for affected environmental media.

- Identify potential receptors and quantify their potential exposures under current and future conditions for all affected environmental media.

- Qualitatively and quantitatively evaluate the adverse effects associated with the site-specific COPCs in each medium.

- Characterize the baseline carcinogenic and noncarcinogenic risks associated with exposure to environmental media at the site(s) under current and future land use conditions.

- Evaluate the uncertainties related to exposure predictions, toxicological data, and resulting carcinogenic risk and noncarcinogenic hazard estimations.

- Establish Remedial Goal Options (RGOs) for chemicals of concern (COC) in each environmental medium based on risk/hazard to facilitate risk management decision-making.

The value of the risk assessment as a basis for making remedial decisions and determining whether detected site concentrations have the potential for toxic effects or increased cancer incidences depends upon adequately characterizing chemical contamination. Variables considered in characterizing the study area and its associated risk will include the amount, type, and location of sources; the pathways of exposure (media type and migration routes); and the

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type, sensitivities, exposure duration, and dynamics of the exposed populations (receptors). Sampling activities typically consist of collecting surface (0 to 1-foot interval) and subsurface soil samples, and groundwater samples from monitoring wells installed in various water-bearing zones.

2.2 Organization

A human health risk assessment, as defined by RAGS Part A, includes the following steps:

- *Site characterization*: evaluation of data regarding site geography, geology, hydrogeology, climate, and demographics.

- *Data collection*: analysis of environmental media samples, including background/reference samples.

- *Data evaluation*: statistical analysis of analytical data to identify the nature and extent of contamination and to establish a preliminary list of COPCs based on risk-based and background screening. This list will subsequently be refined to identify COCs.

- *Exposure assessment*: identification of potential receptors under current and predicted conditions and potential exposure pathways, and calculation/quantitation of exposure point concentrations and chemical intakes.

- *Toxicity assessment*: qualitative evaluation of the adverse effects of the COPCs, and quantitative estimate of the relationship between exposure and severity or probability of effect.

- *Risk characterization*: combination of the output of the exposure and the toxicity assessments to quantify the total noncancer and cancer risk to the hypothetical receptors.

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- *Uncertainty*: discussion and evaluation of the areas of recognized uncertainty in human health risk assessments in addition to medium - and exposure pathway-specific influences.

- *Risk/hazard summary*: presentation and discussion of the results of the quantification of exposure (risk and hazard) for the potential receptors and their exposure pathways identified under the current and future conditions.

- *RGOs*: computation of exposure concentrations corresponding to risk projections within the USEPA target risk range of 1E-6 to 1E-4 for carcinogenic COCs and hazard quotient goals of 0.1, 1, and 3 for noncarcinogenic COCs.

3 Site Characterization

When performing a HHRA, environmental media data are compiled to determine potential site-related chemicals and exposures as outlined in RAGS Part A. The steps identifying COPCs are discussed below.

3.1 Data Sources

The number of samples collected from each medium will be detailed in this section of the site-specific HHRAs, and tables will show which sample designations will be included and how data are grouped (when applicable). In addition, the analytical methods, the name of the analyzing laboratory, and data quality objectives will be referenced at this point in the HHRA.

3.2 Data Validation

Data validation is an after-the-fact, independent, systematic process of evaluating data and comparing them to established criteria to confirm they are of the technical quality necessary to support the decisions made in the RFI process. Parameters specific to the data are reviewed to determine whether they meet the stipulated DQOs. The quality objectives address five principal parameters: precision, accuracy, completeness, comparability, and representativeness. To

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verify that these objectives are met, field measurements, sampling and handling procedures, laboratory analysis and reporting, and nonconformances and discrepancies in the data are examined to determine compliance with appropriate and applicable procedures.

Data for NSA Memphis will be validated in accordance with the methods outlined in the *Comprehensive RFI Work Plan* (E/A&H, 1994b). The data validation report will be referenced in this section of the HHRA.

3.3 Management of Site-Related Data

All environmental sampling data will be evaluated for suitability for use in the quantitative BRA. Data obtained via the following methods will be considered inappropriate:

- Analytical methods that are not specific for a particular chemical, such as total organic carbon, total organic halogen, or TPH (design parameter samples).

- Field screening instruments including total organic vapor monitoring units and organic vapor analyzers.

Additional data excluded will be detailed in the site-specific HHRAs.

Limitations of analytical results will be addressed in HHRAs by including estimated concentration values for reported nondetects. A nondetect indicates that the analyte was not detected above the practical quantitation limit of the sample ("U" qualified results), which is determined by the analytical method, the instrument used, and possible matrix interferences. However, a nondetected analyte could exist at a concentration between zero and the quantitation limit. For this reason, one-half the "U" value could serve as an unbiased estimate of the nondetect. Because the estimated values of "J" qualified hits are frequently much lower than the sample quantitation limits of "U" qualified nondetects for organic compounds, one-half of

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each "U" value will be compared to one-half of the lowest hit (normally "J" qualified) at the same site. The lesser of these two values will be used as the best estimate of the concentration potentially present below the sample quantitation limit, and will be inserted into the adjusted dataset. For inorganic chemicals, the rule is simpler: One-half of each "U" value will be used to represent the concentration of the corresponding sample when compiling the adjusted dataset. If two nondetects are reported for any one location (a result of QA/QC samples), one-half the lesser of the "U" values will be compared to the lowest hit at the site (for organics, as above) or applied directly (for inorganics) to estimate a concentration value to be used in the NSA Memphis risk calculations. If a parameter is not detected at a site, neither data management method will be applied, and the parameter will not be considered in screening or formal assessment.

Once the dataset is complete, statistical methods will be used to evaluate the analytical results to (1) identify COPCs and (2) establish exposure point concentrations (EPCs) at potential receptor locations. The statistical methods used in data evaluation are discussed below. The rationale used to develop this methodology and the statistical techniques is based on the following sources:

- RAGS Part A
- *Supplemental Guidance to RAGS: Calculating the Concentration Term*, May 1992
- *Statistical Methods for Environmental Pollution Monitoring* (Gilbert, 1987)

Microsoft Fox Pro and Borland[1] Quattro Pro will typically be used for data management and statistical calculations. For each set of data used to describe the concentration of chemicals in a contaminated area, the following information will be tabulated in accordance with RAGS: frequency of detection, range of quantitation limits, range of detected values, and average of

1 *References to specific software products are not to be construed as an endorsement by the U.S. Navy or E/A&H.*

detected concentrations. For datasets of 10 or more, the upper confidence limit (UCL) on the mean of log-transformed values of the concentration will be presented. In accordance with RAGS, the lesser of either the maximum concentration detected or the UCL will be used to quantify potential exposure, as detailed in Section 4, Exposure Assessment.

3.4 Selection of COPCs

The substances detected (chemicals present in site samples, or CPSSs) will be screened to develop a list or group of COPCs. COPCs are, therefore, chemicals selected by comparison to screening concentrations, intrinsic toxicological properties, persistence, fate and transport characteristics, and cross-media transport potential. The nature and general extent of CPSSs will be referenced in this section of the site-specific HHRAs. To reduce the list of CPSSs and focus the risk assessment on COPCs, the following two comparisons will be performed.

3.4.1 Comparison of Site-Related Data to Risk-Based Screening Concentrations

The maximum concentrations of CPSSs detected during sampling will be compared to risk-based screening values. These values will be obtained from *Risk Based Screening Concentrations*, USEPA Region III, January through June, 1996 (and subsequent versions). As stated in the EPA Region III document, a risk goal of 1E-6 will be used to calculate screening concentrations for carcinogens. RBCs will be adjusted to reflect a target HQ of 0.1 for noncarcinogens, in accordance with USEPA Region IV *Supplemental Guidance to RAGS Bulletin 1* (USEPA, November 1995). Groundwater results will be compared to tap water screening values, and reported soil concentrations will be compared to residential soil screening values. CPSSs with maximum detected concentrations exceeding their corresponding concentrations, goals, levels, and/or standards will be evaluated further and compared to reference background concentrations. In addition, surrogate screening values based on toxicological similarities will be used if no screening value are available in USEPA's table, and surrogate screening values will be noted where applied.

The maximum concentration reported for each carcinogenic polycyclic aromatic hydrocarbon (PAH) will be compared to its corresponding screening value. In addition, all carcinogenic PAH concentrations reported at that location will be converted to the benzo(a)pyrene equivalent concentration (BEQ), which will be compared to the screening value for benzo(a)pyrene. PAH conversions will be performed using current Toxic Equivalency Factors (TEFs) for PAHs in accordance with USEPA Region IV *Supplemental Guidance to RAGS Bulletin 2* (USEPA, November 1995).

3.4.2 Comparison of Site-Related Data to Background Concentrations

Background data for NSA Memphis will be referenced in this section, or background reference concentrations from E/A&H's August 27, 1996 *Reference Concentrations* technical memorandum will be used. Following comparison to risk- and hazard-based screening values, CPSSs whose maximum detected concentrations exceeded corresponding background reference concentrations will be formally assessed in the HHRA, unless otherwise noted.

The maximum reported concentration of a CPSS will be compared to its reference background concentration (when applicable). This comparison helps account for naturally occurring elements, such as beryllium, manganese, and arsenic. Thus, risk and/or hazard associated with naturally occurring elements are not addressed where their concentrations are similar to corresponding background.

In the HHRA, if the maximum concentration of a CPSS is determined to be less than either two-times mean background or the risk-based screening values, then the CPSS will not be considered further unless deemed appropriate based on chemical-specific characteristics (e.g., degradation product with greater toxicity).

3.4.3 Elimination of Essential Elements: Calcium, Iron, Magnesium, Potassium, and Sodium

In accordance with RAGS Part A, essential elements that are potentially toxic only at extremely high concentrations may be eliminated as COPCs in a risk assessment. Specifically, an essential nutrient may be screened out if it is present at concentrations that are not associated with adverse health effects. Based on RAGS, the lack of risk-related data, and USEPA Region IV's recommendations, the following essential nutrients will not be included in HHRAs: calcium, iron, magnesium, potassium, and sodium.

Risk information usually obtained from the Integrated Risk Information System (IRIS) or Health Effects Assessment Summary Tables (HEAST) is necessary to calculate risk and hazard estimates (and risk-based screening values). This information is based on toxicological and epidemiological data which are critiqued and approved by the scientific and regulatory community (i.e., listed in IRIS and/or HEAST). Risk information (or surrogate risk information) is not always available for all CPSSs, so their risk and/or hazard will not be calculated. The results of the screening process will be tabulated in the HHRA. No risk-based screening values are available for TPH and chemical-specific analyses were performed on site samples, so exposure will not be quantified for this group of compounds. TPH constituents would be included in the chemical-specific analyses.

3.4.4 Summary of COPCs

The results of the screening evaluations will be tabulated on a medium-specific basis in the site-specific HHRAs.

3.5 Estimation of Risk and Hazard

COPCs will be identified, and exposure will be estimated for these compounds. Risk/hazard will be subsequently calculated based on exposure estimates, then exposure scenarios (e.g., soil exposure during commercial land use) exceeding USEPA acceptable limits will be identified.

An exposure scenario of concern will be identified as a scenario with incremental excess lifetime cancer risk (ILCR) estimated greater than 1E-4 or a hazard index (HI) estimated greater than 1. In the next step, COPCs exceeding 1E-6 ILCR or a HQ greater than 0.1 in a scenario of concern are retained as COCs. Section 5, Toxicity Assessment, discusses cancer risk thresholds and noncancer toxicity in detail.

4 Exposure Assessment

This section of the HHRAs will determine the magnitude of contact that a potential receptor may have with site-related COPCs. Exposure assessment involves four stages:

- Characterizing the physical setting and land use of the site.
- Identifying COPC release and migration pathway(s).
- Identifying the potential receptors, under various land use or site condition scenarios, and the pathways through which they might be exposed.
- Quantifying the intake rates, or contact rates, of COPCs.

4.1 Exposure Setting and Land Use

The site setting and land use will be detailed or referenced in this section of the site-specific HHRAs. This information is used to develop appropriate exposure estimates for different land use assumptions. If the future use of the area in question is known, this information will be used to define exposure assumptions used when calculating risk (e.g., sites known to be commercially zoned will not be assessed for residential land use).

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4.2 Potentially Exposed Populations

This section will describe who may be exposed to contaminants in environmental media. The populations typically addressed will be one or a combination of the following: current site workers, hypothetical current site trespassers, as well as hypothetical future site residents. Because current site workers at most sites within NSA Memphis would be expected to have limited contact with contaminated media at most sites, worker-related exposure may be addressed exclusively for maximally exposed site workers, assuming the future worker scenario would be protective of both current and future site workers. Specifics will be discussed in this section of the site-specific HHRAs.

4.3 Exposure Pathways

This section will summarize how potential human receptors may be exposed to site media. In general, soil matrix-related pathways will include incidental ingestion and dermal contact. Ingestion and inhalation of volatilized contaminants will be typical groundwater exposure pathways. The hypothetical future scenarios will assume continuous, uniform exposure to current surface soil conditions and the use of site groundwater as a potable water source, unless otherwise noted in the site-specific HHRA. A table in the site-specific HHRA will justify and summarize exposure pathways and potential human receptors.

4.4 Exposure Point Concentrations

The EPC is the estimated concentration of a contaminant in an exposure medium that will be contacted by a real or hypothetical receptor. Determining the exposure point concentration depends on factors such as:

- Availability of data
- Amount of data available to perform statistical analysis
- Reference concentrations not attributed to site impacts
- Location of the potential receptor

USEPA Region IV guidance calls for assuming lognormal distributions for environmental data and the calculation of 95% UCL on the mean for use in exposure quantification. Applying the UCL is generally inappropriate with less than 10 samples. Therefore, the maximum concentrations detected will be used for all datasets with less than 10 samples. In general, outliers have been included when calculating the UCL because high values seldom appear as outliers for a lognormal distribution. Including outliers increases the overall uncertainty of the calculated risks and conservatively biases exposure estimates.

For sample sets of 10 and greater, the UCL will be calculated for a lognormal distribution as follows:

$$UCL = e^{\left(\bar{a} + 0.5 s_a^2 + \frac{H_{0.95} \, x \, s_a}{\sqrt{n-1}}\right)}$$

where:

$\bar{a}$	=	$\Sigma a/n$ = sample arithmetic mean of the log-transformed data, $a = \ln(x)$
s_a	=	sample standard deviation of the log-transformed data
n	=	number of samples in the data set
$H_{0.95}$	=	value for computing the one-sided upper 95% confidence limit on the lognormal mean from standard statistical tables (Gilbert, 1987)

EPCs and UCLs will be summarized and tabulated when applicable in the site-specific HHRA.

4.5 Quantification of Exposure

This section describes the models, equations, and intake model variables used to quantify doses or intakes of the COPCs for the surface soil and groundwater exposure pathways. The models are designed to estimate route- and medium-specific factors, which are multiplied by the EPC

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to estimate chronic daily doses. The intake model variables generally reflect 50th or 95th percentile values which, when applied to the EPC, ensure that the estimated intakes represent the reasonable maximum exposure (RME, which is considered 95th percentile). Formulae are derived from RAGS, Part A unless otherwise indicated. Table 1 lists intake model variables used to compute chronic daily intake (CDI) for potential receptors exposed to surface soil and/or groundwater contaminants.

Because NSA Memphis is part of BRAC, future site use cannot be determined with any certainty. Therefore, the conservative assumptions will be used to account for any reasonable future use. Current reuse plans will be referenced and discussed in the site-specific HHRAs. NSA Memphis media analytical results and exposure methods have been formatted to allow exposure estimates to be fine-tuned based on actual conditions as base reuse plans materialize, and this information will be used on a site-specific basis, if known.

In accordance with USEPA's recommendations, the adult and child intake variables will be combined to estimate exposure to carcinogens. This factor is referred to as the lifetime weighted average, or LWA. The LWA considers the difference in daily ingestion rates for soil and drinking water, body weights, and exposure durations for children (ages 1 to 6) and adults (ages 7 to 31). The exposure frequency is assumed to be identical for the adult and child exposure groups, and an example is shown after the equations are presented below.

Before quantifying soil exposure, it will first be necessary to derive the appropriate fraction ingested (or contacted) (FI/FC) from contaminated area factors for each applicable COPC. These factors will be derived by evaluating the spatial distribution of COPCs. The FI/FC will be computed by estimating the maximum area of a hot spot and dividing it by the total site area. These computations will be performed conservatively to account for uncertainty associated with contaminant distributions.

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Table 1
Parameters Used to Estimate CDI

Pathway Parameters	Resident Adult	Resident Child	Adult Worker	Trespassing Child (age 7-16)	Units
Surface Soil Ingestion and Dermal Contact					
Ingestion Rate (soil)	100[a]	200[a]	50[a]	100[a]	mg/day
Ingestion Rate (water)	2	1	1	NA	L/day
Exposure Frequency	350[b]	350[b]	250[b]	52[f]	days/year
Exposure Duration	24[c]	6[c]	25[c]	10[g]	years
Dermal Contact Area	4,100[a]	2,900[a]	4,100[a]	4,100[a]	cm^2
Skin Adherence Factor	1	1	1	1	mg/cm^2
Absorption Factor	0.01 (organics) 0.001 (inorganics)	0.01 (organics) 0.001 (inorganics)	0.01 (organics) 0.001 (inorganics)	0.01 (organics) 0.001 (inorganics)	unitless
Oral Absorption Efficiency	0.8 (VOCs) 0.5 (other organic compounds) 0.2 (inorganics)	0.8 (VOCs) 0.5 (other organic compounds) 0.2 (inorganics)	0.8 (VOCs) 0.5 (other organic compounds) 0.2 (inorganics)	0.8 (VOCs) 0.5 (other organic compounds) 0.2 (inorganics)	unitless
Conversion Factor	1E-6	1E-6	1E-6	1E-6	kg/mg
Body Weight	70[a]	15[a]	70[a]	45[a]	kg
Averaging Time, Noncancer	8,760[d]	2,190[d]	9,125[d]	3,650[d]	days
Averaging Time, Cancer	25,550[e]	25,550[e]	25,550[e]	25,550[e]	days

Notes:
a — USEPA (1989a) *Risk Assessment Guidance for Superfund Vol. I, Human Health Evaluation Manual (Part A).*
b — USEPA (1991b) *Risk Assessment Guidance for Superfund Vol. I: Human Health Evaluation Manual Supplemental Guidance, Standard Default Exposure Factors, Interim Final,* OSWER Directive: 9285.6-03.EPA/600/8-89/043.
c — USEPA (1991a), *Risk Assessment Guidance for Superfund: Vol. I — Human Health Evaluation Manual (Part B, Development of Risk-Based Preliminary Remediation Goals),* OSWER Directive 9285.7-01B.
d — Calculated as the product of ED (years) x 365 days/year.
e — Calculated as the product of 70 years (assumed lifetime) x 365 days per year.
f — Assuming one day per week exposure.
g — Assuming trespassing occurs during the 10-year adolescent/teenage period.
NA — Not applicable.

The FI/FC factors modify the hot spot concentrations to more closely approximate site-wide exposure conditions. When the UCL is used as EPC, no FI/FC adjustments will be made. In addition, CPSSs not eliminated from the HHRAs based on the screening comparisons described in Section 3.4 may be eliminated as a COPC because the UCL concentration does not exceed the corresponding background concentration or RBC. This will be discussed on a site-specific basis.

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4.5.1 Surface Soil Pathway Exposure

Ingestion of COPCs in Surface Soil

Except CDI for a site resident's exposure to carcinogens, the following equation is used to estimate the ingestion of COPCs in soil:

$$CDI_s = (EPC_s)(IR)(EF)(ED)(F)(FI)/(BW)(AT)$$

where:

CDI_s	=	ingested dose (mg/kg-day)
EPC_s	=	exposure point concentration of contaminant in soil (mg/kg)
IR	=	ingestion rate (milligrams per day [mg/day])
EF	=	exposure frequency (days/year)
ED	=	exposure duration (years)
F	=	conversion factor (1E-6 kg/mg)
FI	=	fraction ingested from contaminated source (unitless)
BW	=	body weight (kg)
AT	=	averaging time (days)

The LWA is used to calculate carcinogenic CDI for site residents. An example of the LWA calculation is shown below for the soil ingestion pathway, and LWAs are similarly calculated for subsequent equations.

$$LWA = [(IR_a \times ED_a)/BW_a] + [(IR_c \times ED_c)/BW_c]$$

where:

LWA	=	lifetime weighted average
IR	=	ingestion rate (milligrams per day [mg/day])
ED	=	exposure duration (years)
BW	=	body weight (kg)
$_a$	=	adult
$_c$	=	child

Consequently, CDI for carcinogens would be calculated as follows for site residents:

$$CDI_s = (EPC_s)(EF)(LWA)(F)(FI)/(AT)$$

where:

CDI_s = ingested dose (mg/kg-day)

EPC_s = exposure point concentration of contaminant in soil (mg/kg)

EF = exposure frequency (days/year)

F = conversion factor (1E-6 kg/mg)

FI = fraction ingested from contaminated source (unitless)

AT = averaging time (days)

LWA = lifetime weighted average

Dermal Contact with COPCs in Surface Soil

The following equation is used to estimate intake due to dermal contact with COPCs in soil:

$$CDI_{sd} = (EPC_s)(CF)(EF)(ED)(F)(FC)(ABS)(AF)/(BW)(AT)$$

where:

CDI_{sd} = dermal dose (mg/kg-day)

EPC_s = exposure point concentration of contaminant in soil (mg/kg)

CF = contact factor (cm^2)

EF = exposure frequency (days/year)

ED = exposure duration (years)

F = conversion factor (1E-6 kg/mg)

FC = fraction contacted from contaminated source (unitless)

ABS = absorption factor (unitless value, specific to organic versus inorganic compounds)

AF = adherence factor (milligrams per square centimeter [mg/cm^2])

BW = body weight (kg)

AT = averaging time (days)

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4.5.2 Groundwater Pathway Exposure

Ingestion and Inhalation of COPCs in Groundwater

The following equation is used to estimate the ingestion and/or inhalation of COPCs in groundwater:

$$CDI_w = (EPC_w)(IR)(EF)(ED)(FI)/(BW)(AT)$$

where:

CDI_w = ingested/inhaled dose (mg/kg-day)

EPC_w = exposure point concentration of contaminant in water (milligrams per liter [mg/L])

IR = ingestion rate (L/day)

EF = exposure frequency (days/year)

ED = exposure duration (years)

FI = fraction ingested from contaminated source (unitless)

BW = body weight (kg)

AT = averaging time (days)

HHRAs are comprised of many tables, and intake tables serve only as an intermediate check when reviewing the document. The CDI equations above can be solved assuming a concentration of 1, and the result can be used as a universal multiplier. Multipliers were developed for each typical land use scenario and are shown in Table 2. Consequently, a significant number of the tables in HHRAs can be eliminated. An example of the abbreviated CDI method is shown below:

$$CDI = (EPC)(M)$$

where:

CDI = chronic daily intake (mg/kg-day)

EPC = exposure point concentration (mg/kg or mg/L)

M = multiplier specific to the exposure scenario, land use, and potential receptor selected

Table 2
Multipliers* Used to Estimate Chronic Daily Intake

		Soil		Groundwater
		Ingestion	*Dermal Contact*	*Ingestion*
Exposure Pathway	**Exposure Type**	**All Chemicals**	**Organics****	**All Chemicals*****
Resident	Noncarcinogens (adult)	1.37E-06	5.62E-07	2.74E-02
	Noncarcinogens (child)	1.28E-05	1.85E-06	6.39E-02
	Carcinogens (LWA)	1.57E-06	3.51E-07	1.49E-02
Trespasser (age 7-16)	Noncarcinogens	3.17E-07	1.30E-07	NA
	Carcinogens	4.52E-08	1.85E-08	NA
Site-Worker	Noncarcinogens	4.89E-07	4.01E-07	9.78E-03
	Carcinogens	1.75E-07	1.43E-07	3.49E-03

Notes:

LWA = Lifetime weighted average

* = The product of the multiplier and the exposure point concentration equals the chronic daily intake for a given chemical assuming a reasonable maximal exposure scenario

** = The multiplier for inorganics is multiplied by a factor of 0.1 to account for the dermal absorption factor of 0.001 for inorganics; the multiplier for organic compounds includes the 0.01 factor.

*** = The ingestion intake is also used to address inhalation risk in accordance with USEPA's Supplemental Guidance To RAGS Bulletin 3; ingestion risk is approximately equal to risk posed by dermal and inhalation exposure while showering, and this is applied to volatile organic compounds only.

NA = Not applicable

Because multipliers can be reviewed separately, CDI will be incorporated into the risk and hazard equations and will not be presented in separate tables.

5 Toxicity Assessment

5.1 Carcinogenicity and Noncancer Effects

USEPA has established a classification system for rating the potential carcinogenicity of environmental contaminants based on the weight of scientific evidence. The cancer classes are described below. Cancer weight-of-evidence class "A" (human carcinogens) means that human toxicological data have shown a proven correlation between exposure and the onset of cancer (in varying forms). The "B1" classification indicates some human exposure studies have implicated the compound as a probable carcinogen. Weight-of-evidence class "B2" indicates a possible human carcinogen based on confirmatory carcinogenic laboratory animal data. Weight-of-evidence class "C" identifies possible human carcinogens, and class "D" indicates a compound not classifiable with respect to its carcinogenic potential. A class "A" compound posing risk higher than USEPA's acceptable risk range has more weight than would a class "C" compound. There is more uncertainty in the lower classifications, so the weight-of-evidence should be used by risk managers when making risk management decisions based on cancer risk.

USEPA has established slope factors (SF) for carcinogenic compounds. The SF is defined as a "plausible upper-bound estimate of the probability of a response (cancer) per unit intake of a chemical over a lifetime" (RAGS, Part A). Upper-bound estimates are more likely to overestimate cancer potential.

In addition to potential carcinogenic effects, most substances also can produce other toxic responses at doses greater than experimentally derived threshold concentrations. USEPA has derived reference dose (RfD) values for these substances. A chronic RfD is defined as, "an estimate (with uncertainty spanning perhaps an order of magnitude or greater) of a daily exposure concentration for the human population, including sensitive subpopulations, that is likely to be without an appreciable risk of deleterious effects during a lifetime." These

toxicological values are used in risk formulae to assess the upper-bound level of cancer risk and noncancer hazard associated with exposure to a given chemical concentration.

For carcinogens, the potential risk posed by a chemical is computed by multiplying the CDI (as mg/kg-day) by the SF (in reciprocal mg/kg-day). The HQ (for noncarcinogens) is computed by dividing the CDI by the RfD. USEPA has set standard limits (or points of departure) for carcinogens and noncarcinogens to evaluate whether significant risk is posed by a chemical (or combination of chemicals). For carcinogens, the point-of-departure range is 1E-6, with a generally accepted range of 1E-6 to 1E-4. These risk values correlate with one in 10,000 (1E-4) and one in 1 million (1E-6) excess cancer incidence resulting from exposure to toxic compounds from outside the body.

For noncarcinogens, other toxic effects are generally considered possible if the HQ (or sum of HQs for a pathway-hazard index) exceeds the threshold value of 1. Although both cancer risk and noncancer hazard are generally additive only if the target organ is common to multiple chemicals, a most conservative estimate of each may be obtained by summing the individual risks or hazards, regardless of target organ. Site-specific HHRAs for NSA Memphis will take the universal summation approach for each class of toxicant. Details regarding the risk formulae applied to site data are provided in Section 6, Risk Characterization.

Critical studies used in establishing toxicity classifications by USEPA are shown in the IRIS database, which is the primary source for information necessary to estimate risk. HEAST, Fiscal Year 1995 is the secondary source for this information. In addition, USEPA's National Center for Environmental Assessment (NCEA) will be used as a source when necessary. In accordance with RAGS, a table will summarize toxicological data in the site-specific HHRAs in the form of RfDs and SFs obtained for COPCs identified in site media, as well uncertainty/modifying factors, target organs, and cancer classes (where available).

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5.2 Evaluating Dermal Exposure and the Resulting Toxicity

In accordance with USEPA Region IV's *Supplemental Guidance to RAGS Bulletin 2*, dermal RfD values and SFs are derived from the corresponding oral values. As described in the supplemental guidance, the oral RfD is multiplied by an oral absorption efficiency factor (OAF), expressed as a decimal. The resulting dermal RfD is based on the absorbed dose. The RfD based on absorbed dose is the appropriate value with which to compare a dermal dose, because dermal doses are expressed as absorbed rather than administered (intake) doses. For the same reasons, a dermal SF is derived by dividing the oral SF by the OAF. The oral SF is divided rather than multiplied because SFs are expressed as reciprocal doses.

Appendix A of RAGS, Part A states that in the absence of specific data, an assumption of 5% oral absorption would be relatively conservative. *Supplemental Guidance to RAGS: Region IV Bulletin 2* indicates that in the absence of specific data, USEPA Region IV suggests an oral absorption factor of 80% for volatile organics, 50% for semivolatile organics, and 20% for inorganic chemicals. These percentages (or associated fractions) will be used in the site-specific HHRAs

5.3 Toxicity Profiles for COPCs

In accordance with RAGS, toxicological summary paragraphs will be included in the body of the HHRA text for all COPCs. Most information for the profiles will be gleaned from IRIS and HEAST. Another source of information will be NCEA. Any additional references will be noted specifically in the text. The profiles will summarize adverse effects of COPCs and the amount associated with such effects.

6 Risk Characterization

Risk characterization combines the exposure assessment and toxicity assessment results to yield qualitative and quantitative expressions of risk and/or hazard for the exposed receptors. The quantitative component expresses the probability of developing cancer, or a threshold comparison of the estimated dose with a reference dose for noncancer effects. These quantitative estimates

are developed for individual chemicals, exposure pathways, transfer media, and source media, and for each receptor for all media to which one may be exposed. The qualitative component usually involves comparing COC concentrations in media with established criteria or standards for chemicals for which there are no corresponding toxicity values. The risk characterization helps guide risk-management decisions.

Generally, the risk characterization will follow the methodology prescribed by RAGS Part A, as modified by more recent information and supplemental guidance cited in the earlier sections of this memorandum. *The USEPA methods are designed to be health-protective and tend to overestimate risk rather than underestimate it. The risk results, therefore, are generally overly conservative, because risk characterization involves summing the overestimated risk estimates.*

6.1 Risk Characterization Methodology

Potential excess risks to humans following exposure to COPCs will be estimated using methods established by USEPA, when available. As discussed above, these methods are health-protective and are likely to overestimate risk. Risks from hazardous chemicals are calculated for either carcinogenic or noncarcinogenic effects. Some carcinogenic chemicals may also pose a noncarcinogenic hazard. The potential human health effects associated with chemicals that produce carcinogenic and other toxic effects will be characterized separately, as discussed below.

6.1.1 Carcinogenic Effects of Chemicals

The risk attributed to exposure to carcinogens is estimated as the probability of an individual developing cancer over a lifetime as a result of exposure to a potential carcinogen. In the low-dose range, which would be expected for most environmental exposures, cancer risk is estimated from the following linear equation (EPA, 1989a):

$$ILCR = (CDI)(SF)$$

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where:

ILCR	=	incremental lifetime excess cancer risk, a unitless expression of the probability of developing cancer, adjusted for reference incidence
CDI	=	chronic daily intake, averaged over 70 years (mg/kg-day)
SF	=	cancer slope factor $(mg/kg\text{-}day)^{-1}$

For a given pathway with simultaneous exposure of a receptor to several carcinogens, the following equation is used to sum cancer risks:

$$Risk_p = ILCR(chem_1) + ILCR(chem_2) + \ldots ILCR(chem_i)$$

where:

$Risk_p$	=	total pathway risk of cancer incidence
$ILCR(chem_i)$	=	incremental lifetime excess cancer risk for a specific chemical

Cancer risk for a given receptor across pathways and across media is summed in the same manner.

6.1.2 Noncarcinogenic Effects of Chemicals

The risks associated with the noncarcinogenic effects of chemicals are evaluated by comparing an exposure level or intake with a reference dose. The HQ, defined as the ratio of intake to RfD, is defined as (RAGS, Part A):

$$HQ = CDI/RfD$$

where:

HQ	=	hazard quotient (unitless)
CDI	=	intake of chemical (mg/kg-day)
RfD	=	reference dose (mg/kg-day)

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Chemical noncarcinogenic effects are evaluated on a chronic basis, using chronic RFD values. An HQ of 1 indicates that the estimated intake equals the RfD. If the HQ is greater than unity, there may be a concern for potential adverse health effects.

In the case of simultaneous exposure of a receptor to several chemicals, an HI will be calculated as the sum of the HQs by:

$$HI = HQ_1 + HQ_2 + \ldots HQ_i$$

where:

HI	=	Hazard Index (unitless)
HQ	=	Hazard Quotient (unitless)

Risk and hazard projections will be summarized in tabular format on a medium- and exposure pathway-specific basis in the HHRAs.

6.2 Surface Soil Pathways

Generally, the incidental ingestion and dermal contact pathways will be characterized for surface soil. Surface soil onsite will be evaluated under scenarios and exposure pathways outlined in the site-specific HHRAs.

6.3 Groundwater Pathways

Groundwater pathways will typically consist of ingestion and inhalation of volatilized chemicals in groundwater. The site-specific HHRAs will detail the pathways which will be addressed. Most groundwater pathways are not complete because municipal water supplies are used, and this will be discussed in the HHRAs.

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6.4 COCs Identified

COCs will be identified based on cumulative (all pathway) risk and hazard projected for the sites. USEPA has established a generally acceptable risk range of 1E-4 to 1E-6, and an HI threshold of 1.0. Any COPC that is carried through the risk assessment process and found to contribute to a scenario with an ILCR in excess of 1E-4 or HI greater than 1 for any of the exposure scenarios evaluated in this risk assessment, and has an individual exposure pathway risk greater than 1E-6 or exposure pathway HQ greater than 0.1, will be referred to as a COC. A table will present the COCs identified in site-specific HHRAs.

7 Risk Uncertainty

This section will discuss the uncertainty and variability inherent in the risk assessment process in addition to site-, medium-, and exposure pathway-specific influences. Overall, uncertainties associated with the initial stages of the risk assessment process become magnified when they are combined with other uncertainties. It is not possible to eliminate all uncertainties; however, recognizing the uncertainties is fundamental to understanding and subsequently using risk assessment results.

Where chronic RME estimates of risk/hazard indicated a significant threat (e.g., ILCR greater than 1E-4) would be posed to human health, central tendency (CT) analysis may be performed. RME estimates are based on the upper bound (90th or 95th percentile) exposure assumptions, while CT estimates are based on the 50th percentile (mean or median) values. CT exposure scenarios are constructed consistent with standard CT exposure assumptions provided in *Superfund's Standard Default Exposure Factors for the Central Tendency and Reasonable Maximum Exposure-Draft* (USEPA, November 1993). CT exposure assumptions will be presented in the site-specific HHRAs, when applicable.

8 Risk Summary

Risk estimates will be presented and summarized in table form in the site-specific HHRAs.

9 Remedial Goal Options

RGOs are chemical concentrations computed to equate with specific risk and/or hazard goals that may be established for a particular site. As previously discussed, COCs are identified as any COPC that significantly contributes to a scenario of concern. A pathway having a combined ILCR greater than 1E-4 or an HI greater than 1 is defined as a scenario of concern, and an individual chemical which contributes either 1E-6 ILCR or 0.1 HI to one exposure pathway is considered to significantly contribute to the scenario ILCR or HI. Based on this method, COCs may be identified, requiring RGO calculation. Inclusion in the RGO table does not necessarily indicate that remedial action will be required to address a specific chemical. Instead, RGOs are provided to facilitate risk-management decisions.

In accordance with USEPA Supplemental RGO Guidance, RGOs will be calculated at 1E-4, 1E-5, and 1E-6 risk levels for carcinogenic COCs and HI goals of 3, 1, and 0.1 for noncarcinogenic COCs. RGOs will be based on specific scenarios which will be identified in the site-specific HHRAs.