N00639.AR.000969
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CONFIRMATORY SAMPLING INVESTIGATION REPORT ASSEMBLY F SOLID WASTE MANAGEMENT UNITS 20, 22, 63, AND 39 MILLINGTON SUPPACT TN
7/31/1998
NAVFAC SOUTHERN

CONFIRMATORY SAMPLING INVESTIGATION REPORT
ASSEMBLY F
SWMUs 20, 22/63, 30, AND 39
NAVAL SUPPORT ACTIVITY MEMPHIS
MILLINGTON, TENNESSEE

VOLUME I of II
Sections 1 — 0

Revision: 2

CTO-106
Contract Number: N62467-89-D-0318

Prepared for:

Department of the Navy
Southern Division
Naval Facilities Engineering Command
North Charleston, South Carolina

Prepared by:

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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.

Date: July 31, 1998
Signature:
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Title: Task Order Manager

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EXECUTIVE SUMMARY

As part of the U.S. Navy Comprehensive Long-Term Environmental Action Navy (CLEAN) Program, the following Confirmation Sampling Investigation (CSI) Report has been prepared for the Assembly F Solid Waste Management Units (SWMUs) 20, 22/63, 30, and 39. Assembly F is composed of seven SWMUs. All seven SWMUs required CSIs to confirm whether contaminants are present or have been released, and, if so, whether full characterization under a Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI) would be required. Releases were confirmed at two of these — SWMUs 17 and 19 — during the Assembly G & H CSI and through voluntary corrective action tank removals, thus full RFI characterization will be conducted in during the Assembly F RFI. The five remaining SWMUs have been organized into four investigation groups: 20, 22/63, 30, and 39. The CSIs for these SWMUs, undertaken by EnSafe/Allen & Hoshall, adhered to the requirements of the Hazardous and Solid Waste Amendments portion (HSWA-TN002) of RCRA Permit No. TN2-170-0220600 and applicable regulations.

As part of the U.S. Navy Installation Restoration Program, the following CSI report has been prepared for the four SWMU groups in Assembly F. The following summarizes the conclusions and recommendations in this report.

Conclusions

SWMU 20, Underground Waste Tank 1594

SWMU 20 is abandoned underground waste tank (UWT) 1594 that reportedly received waste oil and hydraulic fluid generated by the Air Traffic Control School. The installation date of UWT 1594 is unknown; it was removed in May 1992. The SWMU 20 investigation focused on the potential for surface and subsurface soil contamination associated with UWT 1594. Analytical results for the soil samples collected from the tank pit at the time of the UWT removal exhibited total petroleum hydrocarbon (TPH)-diesel range organics (DRO) concentrations ranging from 21.6 parts per million (ppm) to 3,072 ppm, indicating that a release had occurred. It was unknown whether chlorinated solvents were disposed of in this UWT as the soil samples collected

at the time of the tank removal were analyzed only for petroleum and a few metals. Samples collected during this CSI were analyzed for volatile organic compounds (VOCs) to determine whether chlorinated solvents are present from any release from the UWT. Two surface soil samples were also analyzed for full scan analyses (FSA) to facilitate a preliminary risk evaluation (PRE).

- Dieldrin was detected in one of two surface soil samples collected for FSA. The detected concentration of 4 micrograms per kilogram (μg/kg) in this sample exceeded the 1 μg/kg soil screening level (SSL). However, this concentration does not exceed residential or industrial risk-based concentrations (RBCs) for dieldrin (40 μg/kg and 360 μg/kg, respectively), or the anthropogenic background reference concentration (RC) of 262 μg/kg at NSA Memphis.

- Methylene chloride was detected in one of two surface soil samples collected for FSA at a concentration of 13 μg/kg, exceeding the SSL of 10 μg/kg. However, the residential RBC of 85,000 μg/kg and the industrial RBC of 760,000 μg/kg for methylene chloride were not exceeded.

- TPH (Method 418.1) was detected in two surface soil samples collected for FSA at concentrations of 180,000 μg/kg and 680,000 μg/kg. TPH-gasoline range organics (GRO) were detected in these samples at concentrations of 63 μg/kg and 70 μg/kg. TPH-DRO was also detected in these surface soil samples at concentrations of 18,000 μg/kg and 69,000 μg/kg. The Tennessee Department of Environment and Conservation (TDEC) has established cleanup levels of 1,000,000 μg/kg, 500,000 μg/kg, 250,000 μg/kg, or 100,000 μg/kg, depending on the permeability of the site soil and whether the soil is part of an aquifer that is used as a drinking water supply. Permeability data are currently unavailable for SWMU 20. Soil samples for permeability analysis are proposed for the followup RFI. Once the data are available, the appropriate cleanup level can be selected. Based on permeability data previously collected at numerous locations across NSA Memphis, the cleanup level will likely be either 500,000 μg/kg or 1,000,000 μg/kg.

- Nickel was detected in both surface soil samples at concentrations of 15.7 milligrams per kilogram (mg/kg) and 22.3 mg/kg. One sample (15.7 mg/kg) did not exceed any screening criteria. However, the other (22.3 mg/kg) exceeded both the SSL of 21 mg/kg and the background RC of 20.62 mg/kg for nickel.

- 1,1-Dichloroethene exceeded the 30 μg/kg SSL in eight surface and subsurface soil samples from four boring locations at concentrations of 43 μg/kg, 92 μg/kg, 140 μg/kg, 150 μg/kg, 180 μg/kg, 220 μg/kg, 270 μg/kg, and 400 μg/kg.

- Methylene chloride exceeded its 10 μg/kg SSL in four surface and subsurface soil samples from three boring locations at concentrations of 12 μg/kg, 13 μg/kg, 16 μg/kg, and 32 μg/kg.

- 1,1-Dichloroethene exceeded the 0.044 μg/L tap water RBC and the 1 μg/L Maximum Contaminant Level (MCL) in one fluvial deposits groundwater sample at a concentration of 77 μg/L.

Although several compounds were detected at concentrations that exceed one or more screening criteria, only two were determined to be a health risk. A PRE conducted at SWMU 20 classified benzene, 1,1-dichloroethane and 1,1-dichloroethene, 1,2-dichloroethane, 1,1,2-trichloroethane as chemicals of potential concern (COPCs) in fluvial deposits groundwater. No COPCs were identified in site soil. The PRE concluded that the site was not suitable for lease or transfer because the cumulative risk threshold of 1E-4 was exceeded for carcinogens. The incremental lifetime excess cancer risk (ILCR) was estimated to be 2E-03 for the residential scenario and 4E-04 for the industrial scenario, both of which exceed the target ILCR of 1E-4. The hazard indices (HIs) for noncarcinogens were estimated to be 0.6 for the residential scenario and 0.2 for the industrial scenario. Both of these values are less than the target hazard quotient (HQ) of 1.0.

SWMUs 22 and 63, Building S-75 (SWMU 22) — Four Former USTs and Building S-75 (SWMU 63) — One UWT

SWMU 22 consists of four USTs west of Building S-75 (Boiler Plant) that were installed in approximately 1944 and have since been removed, according to NSA Memphis personnel in the Public Works Office, Environmental Division. Three USTs stored fuel oil for the boiler plant and one stored diesel fuel. USTs 1245 and 1246 each held 25,000 gallons, UST 1244 held 50,000 gallons, and the diesel UST held 280 gallons. The three large USTs were constructed of concrete with steel piping, while the diesel UST was steel.

The closure report for the diesel UST indicated that soil samples were collected from the four corners of the open tank pit and from the stockpiled soil. Tank-pit soil samples were analyzed for TPH-GRO and TPH-DRO, while the samples from the stockpiled soil was analyzed for benzene, toluene, ethylbenzene, and xylenes (BTEX); TPH-GRO and TPH-DRO; toxicity characteristic leaching procedure (TCLP) lead, benzene, and TPH and flash point. Results from the tank-pit samples exhibited TPH-DRO concentrations of 5,187 parts per million (ppm) in the northwest corner, 5,008 ppm in the northeast corner, 11,259 ppm in the southeast corner, and 3,692 ppm in the southwest corner. The analytical results for samples of the stockpiled soil indicated a TPH-DRO concentration of 755 ppm and a TCLP TPH-DRO of 0.697 ppm. All other analytical parameters for the tank pit were less than the method detection limits. The flash point of the stockpiled soil was greater than 160°F.

SWMU 63 is an approximately 7-foot x 7.5-foot area adjacent to Building S-75 that formerly contained a 65-gallon, stainless-steel UWT. The contents of the tank were analyzed prior to removal. Analysis indicated methyl ethyl ketone at 22,000 ppm, acetone at 16,000 ppm, ehtylbenzene at 20,000 ppm, toluene at 91,000 ppm, and xylenes at 110,000 ppm. Analytical results for soil samples collected from the open tank pit after the UWT was removed in April 1992, were less than detection limits for all analyses (BTEX, TCLP metals, and TCLP volatiles).

Because of their proximity, the investigations of SWMUs 22 and 63 were combined in one work plan, focusing on the potential for surface and subsurface soil, and groundwater contamination resulting from possible releases.

- Benzo(a)pyrene was detected in two surface soil samples. Only one sample exceeded the 88 μg/kg residential RBC at a concentration of 320 μg/kg. Neither exceeded the background RC of 565 μg/kg for B(a)P equivalent.

- Dibenz(a,h)anthracene was detected in one of two surface soil samples and exceeded the 88 μg/kg residential RBC with a concentration of 110 μg/kg.

- TPH was detected in one surface soil sample at 380,000 μg/kg. TPH-GRO was detected in two surface soil samples at concentrations of 77 μg/kg and 310,000 μg/kg. TPH-DRO was detected in two surface soil samples at 41,000 μg/kg and 340,000 μg/kg. TDEC-established cleanup levels depend on the permeability of the site soil and whether the soil comprises an aquifer that supplies drinking water. Permeability data are currently unavailable for SWMUs 22 and 63. Once the data are available, the appropriate cleanup level can be selected. Based on permeability data previously collected at numerous locations across NSA Memphis, the cleanup level will likely be either 500,000 μg/kg or 1,000,000 μg/kg.

- Arsenic was detected in both of the surface soil samples, exceeding the RC of 14.58 mg/kg in one sample at a concentration of 22.2 mg/kg.

- 1,1,2-Trichloroethane was detected in one soil sample exceeding the 10 μg/kg SSL at 29 μg/kg.

- Benzene was detected in one subsurface soil sample and exceeded the 20 μg/kg SSL at 60 μg/kg.

- Methylene chloride exceeded the 10 μg/kg SSL in six samples at 88 μg/kg, 48 μg/kg, 23 μg/kg, 34 μg/kg, 28 μg/kg, and 27 μg/kg.

- Methylene chloride exceeded the 4.1 μg/L tap water RBC and the 5 μg/L MCL in two fluvial deposits groundwater samples at 19 μg/L and 13 μg/L.

- m-Xylene exceeded the 10 μg/L MCL in one fluvial deposits groundwater sample at 50 μg/L. The tap water RBC was not exceeded.

Of the compounds detected at concentrations that exceed one or more screening criteria, three were identified in the PRE as COPCs in surface soil: benzo(a)pyrene, benzo(a)pyrene equivalents (BEQs), and arsenic. Three COPCs were identified in groundwater: ethylbenzene, methylene chloride, and m-xylene. The PRE concluded that the site is suitable for lease or transfer because the cumulative risk threshold of 10E-4 was not exceeded for carcinogens and the HI was not exceeded for noncarcinogens. The ILCRs were estimated to be 6E-05 for the residential scenario and 8E-06 for industrial scenarios. The HIs for noncarcinogens were estimated to be 1.0 for the residential scenario and 0.05 for the industrial scenario. Although an HI equal to the target hazard quotient of 1.0 was estimated for the residential scenario, two of the COPCs (arsenic and BEQs) target different organs. Therefore, it is unlikely that an individual would be at risk.

SWMU 30, Building S-420 — Park Field Waste-Treatment Tank

SWMU 30 is an inactive waste-treatment septic tank remaining from Park Field, a U.S. Army training facility that preceded NSA Memphis. A portion of the septic tank is underneath Building S-420, with the rest on the east and south sides of the building. The septic tank operated from 1917 to 1942, receiving waste from more than 60 buildings, including those where the aircraft and ground vehicles were serviced. The 80-foot by 20-foot, concrete septic tank was reportedly built to a depth of 9 feet and topped with 2 feet of soil. The septic tank was partially demolished, pushed in on itself, and covered with soil, but specific documents detailing the work performed are unavailable.

The CSI was conducted to determine whether the septic tank has impacted surface and subsurface soil or groundwater. Since the septic tank received waste from maintenance buildings, the wastestream may have included petroleum or solvents.

- Benzo(a)pyrene exceeded the 88 μg/kg residential RBC in two surface soil samples at concentrations of 90 μg/kg and 300 μg/kg.

- Dieldrin exceeded the 1 μg/kg SSL in one surface soil sample at a concentration of 7.3 μg/kg. The background RC of 262 μg/kg was not exceeded.

- TPH was detected in two surface soil samples at concentrations of 14,000 μg/kg and 14,000 μg/kg. The TDEC-established cleanup levels depend on the permeability of the site soil and whether the soil comprises an aquifer that supplies drinking water. These concentrations are less than the most stringent TDEC cleanup level for TPH.

Of the compounds detected at concentrations that exceed one or more screening criteria, only BEQ was identified in the PRE as a COPC in surface soil. No COPCs were identified in groundwater. The PRE concluded that the site is suitable for lease or transfer because the cumulative risk threshold of 10E-4 was not exceeded for carcinogens. The ILCRs were estimated to be 6E-06 for the residential scenario and 6E-07 for industrial scenarios. The HIs for noncarcinogens were not estimated because the PRE identified no noncarcinogenic compounds as COPCs.

SWMU 39, Building S-74 — Former Dry Cleaning Facility and PCB Transformer Storage Area

SWMU 39 is approximately 300 feet south of First Avenue and F Street, across from the Boiler Plant, Building S-75, on the NSA Memphis Southside. SWMU 39 consists of a concrete slab that was located outside Building S-74, a former dry cleaning facility. Transformers and drums of oil were stored on the slab until Building S-74 was demolished in 1995. The SWMU 39 investigation focused on the potential for polychlorinated biphenyl (PCB) contamination in

surface soil resulting from the transformer storage area, and the potential for surface and subsurface soil and groundwater contamination resulting from the dry cleaning activities onsite.

- Dieldrin exceeded both the 40 μg/kg residential RBC and the 1 μg/kg SSL in one surface soil sample at a concentration of 130 μg/kg. However, dieldrin did not exceed the 262 μg/kg background RC at NSA Memphis.

- Technical chlordane exceeded the 490 μg/kg residential RBC in one surface soil sample at 1,200 μg/kg.

- TPH was detected in two surface soil samples at 740,000 μg/kg and 240,000 μg/kg. TPH-DRO was detected in two samples at 120,000 μg/kg and 95,000 μg/kg. The TDEC has established cleanup levels of 1,000,000 μg/kg, 500,000 μg/kg, 250,000 μg/kg, or 100,000 μg/kg, depending on the permeability of the site soil and whether the soil comprises an aquifer that is a drinking-water supply. Permeability data are currently unavailable for SWMU 39. Once the data are available, the appropriate cleanup level can be selected. Based on permeability data previously collected at numerous locations across NSA Memphis, the cleanup level will likely be either 500,000 μg/kg or 1,000,000 μg/kg.

- 1,1,2,2-Tetrachloroethane concentrations exceeded the 1 μg/kg SSL in two subsurface soil samples at 30,000 μg/kg and 150 μg/kg.

- Ethylbenzene concentrations exceeded the 5,000 μg/kg SSL in one sample at 18,000 μg/kg.

- Methylene chloride concentrations exceeded the 10 μg/kg SSL in eight subsurface samples at 16 μg/kg, 70 μg/kg, 150 μg/kg, 160 μg/kg, 290 μg/kg, 450 μg/kg, 310 μg/kg, and 77,000 μg/kg.

- Methylene chloride concentrations exceeded both the 4.1 μg/L tap water RBC and the 5 μg/L MCL in one fluvial deposits groundwater sample at 11 μg/L.

- m-Xylene concentrations exceeded the 10 μg/L MCL in two loess groundwater samples at 1,050 μg/L and 36 μg/L. The tap water RBC of 1,400 μg/L was not exceeded.

- o-Xylene concentrations exceeded the 10 μg/L MCL in one loess groundwater sample at a concentration of 30 μg/L and in one fluvial deposits groundwater sample at a concentration of 64μg/L. The tap water RBC of 1,400 μg/L was not exceeded.

Of the compounds detected at concentrations that exceed one or more screening criteria, the PRE identified methylene chloride and trichloroethene as COPCs in fluvial deposits groundwater. Ethylbenzene and m-xylene were identified as a COPC in loess groundwater. No COPCs were identified in soil. The PRE concluded that the site is suitable for lease or transfer because the cumulative risk threshold of 10E-4 was not exceeded for carcinogens and the HI for noncarcinogens did not exceed the target HQ of 1.0. The ILCRs were estimated to be 6E-06 for the residential scenario and 1E-06 for industrial scenarios. The HIs for noncarcinogens were estimated to be 0.95 for residential and 0.2 for industrial scenarios.

Recommendations

A follow-up RFI is recommended for SWMUs 20, 22/63, and 39. The RFI will consist of the installation of at least four fluvial deposits monitoring wells per site to confirm the presence of chlorinated solvents detected in groundwater screening samples. The additional investigation at these SWMUs will address potentially elevated TPH concentrations detected in soil at each SWMU, and RBC and MCL exceedances. No additional sampling is recommended for SWMU 30, since the detected TPH concentrations are less than the most conservative TDEC cleanup level of 100,000 μg/kg.

Two Shelby tube samples will also be collected from each site at SWMUs 20, 22/63, and 39 for permeability analysis. The permeability data will be used to determine the appropriate cleanup level for TPH contamination. After the cleanup level has been determined, decisions can be made regarding the TPH in soil.

An Ecological Risk Assessment (ERA) at SWMUs 20, 22/63, and 39 should be conducted to assess the actual or potential effects to ecological receptors due to contaminants detected during this CSI. An ERA is not recommended for SWMU 30 because of the limited quality habitat available, very limited foraging area, and the nearly constant human presence.

1.0 INTRODUCTION

As part of the U.S. Navy Installation Restoration Program, the following Confirmatory Sampling Investigation (CSI) report has been prepared for five Solid Waste Management Units (SWMUs) in Assembly F at Naval Support Activity (NSA) Memphis, Millington, Tennessee. Figure 1.1 provides a vicinity map of Assembly F SWMUs.

As a result of the Base Closure and Realignment Act of 1990 (BRAC), a portion of NSA Memphis will be closed and prepared for transfer to the City of Millington. Eight SWMU assemblies (i.e., groups) have been defined for the NSA Memphis Resource Conservation and Recovery Act (RCRA) Corrective Action Program. Four of these assemblies (A, B, C, and D) are on portions of the base that will close. They have been categorized and ranked according to their BRAC status. The remaining four assemblies (E, F, G, and H) are on portions of the base that will remain under control by the Navy.

Assembly F is composed of seven SWMUs on the Southside. All seven SWMUs required CSIs to confirm whether contaminants are present or have been released, and, if so, whether full characterization under a RCRA Facility Investigation (RFI) would be required. Releases were confirmed at two of these — SWMUs 17 and 19 — during the Assembly G & H CSI and through voluntary corrective action tank removals, thus full RFI characterization will be conducted during the Assembly F RFI. The five remaining SWMUs have been organized into four investigation groups: 20, 22/63, 30, and 39 and are covered in this report. SWMUs 22 and 63 were investigated as one site because the two SWMUs are collocated and only one sample location was proposed for SWMU 63. All discussion and data for these two SWMUs are presented jointly. The CSI, undertaken by EnSafe Inc. 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 and applicable regulations. The Assembly F CSI consisted of the following SWMUs:

SWMU	Description
20	Building 1594 — Underground Waste Tank, No. 1594
22 and 63	Building S-75 (SWMU 22) — Four former Underground Storage Tanks Building S-75 (SWMU 63) — One Underground Waste Tank
30	Building S-420 — Park Field Waste Treatment Tank
39	Building S-74 — Former Dry Cleaning Facility and Polychlorinated Biphenyl (PCB) Transformer Storage Area

Purpose

The CSI was conducted to confirm whether contaminants are present or have been released, and, if so, whether full characterization under a RFI would be required. The potential for releases is suspected based on the following:

SWMU 20 — Past documented releases from underground waste tank (UWT) 1594

SWMUs 22/63 — Past documented releases from four underground storage tanks (USTs) and one UWT associated with Building S-75

SWMU 30 — Potential receipt and release of regulated wastes such as waste oil, paint, paint-thinner waste, mineral spirits, and solvents

SWMU 39 — Former use as a dry cleaning facility and former storage of PCB-containing transformers

Sections 2 through 4 describe the regional geology, background conditions, and general sampling and analysis methods used during the Assembly F CSI. Section 5 discusses the methods used to calculate risk estimates based on the contaminants detected. Section 6 describes chemical and physical properties that will affect the fate and transport of contaminants of potential concern (COPCs) detected at Assembly F SWMUs. Detailed sampling schemes, analytical results, fate and transport perspectives, and conclusions/recommendations for each Assembly F SWMU are presented in Section 7. Section 8 discusses Ecological Risk, and Section 9 summarizes the conclusions and recommendations for each SWMU. Analytical data and other information related to specific SWMUs are presented in the appendices of this report.

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2.0 PHYSICAL SETTING

2.1 Regional Geology and Hydrogeology

The general hydrogeology of the Memphis area and a conceptual model of NSA Memphis hydrogeology are presented in Sections 2.11 and 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). On the basis of this updated information, the regional geology and hydrogeology of NSA Memphis are summarized in this section.

The stratigraphic units of importance identified during the investigations at NSA Memphis are, in descending order: the alluvium of Holocene and Pleistocene age, the loess of Pleistocene age, the fluvial deposits of Pleistocene to Pliocene age, the Cockfield Formation, Cook Mountain Formation, and Memphis Sands of Eocene age. The loess — eolian deposits consisting of silt, silty clay, clay, and minor amounts of sand — is the principal unit at land surface within most of the NSA Memphis Southside, except for areas near stream valleys, where alluvium is present. Water-bearing zones have been encountered in each of the stratigraphic units investigated at NSA Memphis. The following sections discuss the geology and hydrogeology of each stratigraphic unit.

2.1.1 Alluvium

Alluvium, which is restricted to stream valleys, includes alluviated or reworked loess and possibly a portion or all of the fluvial deposits. The lateral and vertical extent of the alluvium at NSA Memphis have not been determined, because they are lithologically similar to the loess and fluvial deposits.

The lithology of the upper portion of the alluvium (called the "upper alluvium") is similar to the loess and is composed primarily of silt with varying clay content and some fine sand. Near the

Big Creek Drainage Canal, the upper alluvium is present from ground surface to depths between 22 and 41 feet bgs. Fine-grained, generally saturated sand lenses are common in the upper alluvium, but are encountered at greater depths than the first water-bearing zone in the loess. The lithology of the lower portion of the alluvium (called the "deep alluvium") is similar to the fluvial deposits and is composed of fine to very coarse-grained sand and gravel with varying clay and silt content. The sand coarsens and the gravel content increases with depth in the deep alluvium. Generally, a coarse sand and gravel mixture is present at the base of the alluvium just above the Cockfield Formation. Near the Big Creek Drainage Canal, the thickness of the deep alluvium ranges between 6 and 34 feet.

As previously mentioned, the lateral extent of the alluvium has not been determined at NSA Memphis. Due to the nature of alluvial deposition and the lithologic similarity of the lower fluvial deposits and deep alluvium, it is reasonable to assume that the lower fluvial deposits and deep alluvium are hydraulically connected laterally. It has not been determined if the water-bearing zones of the loess and upper alluvium are hydraulically connected.

2.1.2 Loess

The loess is typically 0 to 65 feet thick in the Memphis area; on the Southside of NSA Memphis it ranges from 30 to 39 feet thick. Water-bearing zones in the loess (if present) are generally in the upper part of the unit; however, yields are low (less than 1 gallon per minute), and groundwater from the loess does not meet select primary and secondary drinking-water standards (e.g., antimony, cadmium, chromium, iron, thallium, nickel, and turbidity), based on water quality analyses of samples from background monitoring wells throughout NSA Memphis and previous water use surveys performed during Northside UST investigations. Refer to the *Technical Memorandum — Background Concentrations* (E/A&H, 1996b) for metals concentrations in loess background monitoring wells. Refer to the *Final Site Specific Standard Request —*

Building N-126 (E/A&H, 1994b) for metals concentrations and turbidity measurements for groundwater samples collected from the Building N-126 UST loess monitoring wells.

Previous investigations at NSA Memphis have identified depth to water in the loess varying between 5 and 15 feet below ground surface (bgs), and vertical hydraulic conductivities of loess sample ranging from 10^{-6} to 10^{-8} centimeters per second (cm/sec). Although the loess may be considered an aquitard on the basis of the relatively low hydraulic conductivities, the shallowest water-bearing zone beneath NSA Memphis may be present within this interval. In some areas of NSA Memphis, there is no water-bearing zone in the loess; therefore, the zone is not laterally continuous throughout NSA Memphis and may be considered a "perched zone" where present. Groundwater in the loess, when present, most likely moves primarily downward to recharge the deep fluvial deposits, although locally, some groundwater in the loess may discharge to nearby streams, drainage ditches, and other surface-water bodies. Lateral groundwater movement in the loess is believed to be controlled by topography.

2.1.3 Fluvial Deposits

The fluvial deposits underlie the loess in upland areas; they consist of sand, gravel, and some clay, with thin layers of ferruginous sandstone and conglomerate, primarily at the base or the unit. This unit ranges from 0 to 100 feet thick in the Memphis area; on the Southside of NSA Memphis it ranges from 12 to 59 feet thick and represents the most significant component of the surficial aquifer. Shallow domestic wells in rural areas of Memphis are completed in the fluvial deposits. Relative groundwater elevations between wells completed in the loess 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. Groundwater flow in the fluvial deposits is generally to the southwest beneath the NSA Memphis Southside. 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 become increasingly less silty with

depth, grading into a fine to medium sand near the middle of the unit. Grain sizes typically coarsen below this interval, grading into a gravelly sand near the basal section of the fluvial deposits.

2.1.4 Cockfield Formation

The Cockfield Formation, a part of the Jackson-upper Claiborne confining unit, is a heterogeneous formation of very fine silty sand interbedded with clay and silt lenses or clay with interbedded fine sand lenses. It underlies the fluvial deposits and deep alluvium, which are the preferential zones of groundwater flow and the primary route for contaminant transport in NSA Memphis groundwater based on their higher permeability compared to the overlying loess/upper alluvium and underlying Cockfield Formation.

2.1.5 Cook Mountain Formation

The Eocene-age Cook Mountain Formation, which underlies the Cockfield Formation, consists predominantly of clay and silt; however, minor lenses of silty fine sand may be present locally. The Cook Mountain Formation, which contains the most areally extensive clay in the upper part of the Claiborne Group in Shelby County, serves as the lower confining unit for the Cockfield aquifer and the upper confining unit for the Memphis aquifer, which is the principal source of public drinking water in the Memphis area.

2.2 Site-Specific Geology and Hydrogeology

Due to the objectives of this investigation and the predetermined soil sampling depths (e.g., surface soil samples, and subsurface soil sample depths selected based on depth of tank bottoms), there was no need for thorough, site-specific lithologic characterization during this phase. Only one soil DPT location was continuously sampled for lithology during this CSI. A DPT location at SWMU 39, which was the first SWMU to be investigated, was sampled continuously at 2-foot intervals from ground surface to 36 feet bgs to determine the depth of the saturated interval within the loess and the depth of the loess/fluvial deposits contact. The findings of the SWMU 39 lithology samples are discussed in Section 7.4.

3.0 BACKGROUND REFERENCE CONCENTRATIONS

Thirteen background locations were sampled to assess ambient inorganic concentrations in soil and groundwater at NSA Memphis. As discussed in Section 2.9 of the *Comprehensive RFI Work Plan*, 13 soil types are recognized at NSA Memphis. Eleven are silty loam soils, and two are silty fill material. NSA Memphis soil was assumed to be homogeneous, and the reference concentrations (RCs) were assumed to represent basewide conditions. RCs however, do not account for different soil types. Background data for soil were established from 18 samples collected from 13 borings shown on Figure 3.1. Background RCs for groundwater from the loess, fluvial deposits, alluvium, and upper Cockfield water bearing zones were calculated from samples collected from the first and third quarterly groundwater sampling events. The data from the second event was omitted due to metals concentrations that were elevated relative to the first and third quarters. Omitting the second-quarter data makes the background RC values more conservative.

Background RCs were established for inorganics detected in soil for comparison to samples collected at Assembly F SWMUs. Due to the scope of this CSI, groundwater samples collected were not submitted for inorganics analysis.

3.1 Inorganics

The background RCs were calculated by doubling (2x) the mean concentrations of analytes detected at all the background locations, as recommended by the U.S. Environmental Protection Agency (USEPA) Region IV. Two RCs were established for soil:

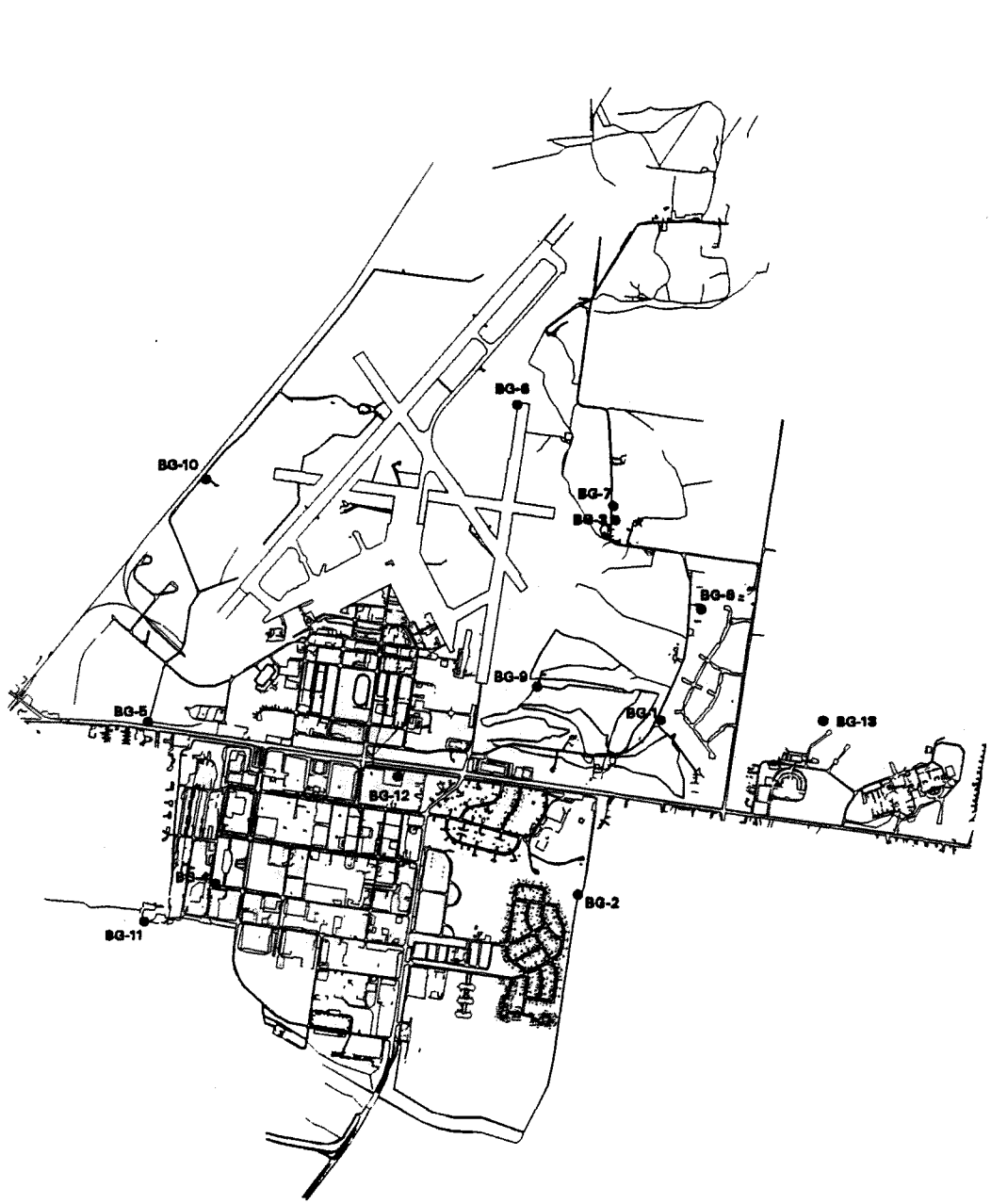
- RC_S, 2x the mean or average concentration detected from 0 to 1 foot (surface) for use in later health-risk evaluation;

The RCs and the methodologies used to calculate them are presented and described in *Reference Concentrations* (E/A&H, 1996). Data summary tables for each SWMU (Section 7) compare inorganic concentrations to background RCs, Risk-Based Concentrations (RBCs), and soil screening levels (SSLs) for potential transfer of contaminants from soil to groundwater. The RBCs and SSLs were obtained from USEPA Region III Risk-Based Concentration Tables (June, 1996).

3.2 Organics

Pesticides have been applied across NSA Memphis throughout its history. Background samples were also analyzed for chlorinated pesticides to determine average concentrations due to routine application for pest control. Background dieldrin sampling and evaluation were conducted as discussed in the technical memorandums *Discussion of Dieldrin Risk Management Issues* (E/A&H, 1995a), and the *Background Dieldrin Concentrations in Surface Soils* (E/A&H, 1997). The 1995 memorandum stated that dieldrin was ubiquitous at NSA Memphis as a result of aerial applications during a U.S. Department of Agriculture quarantine on the white-fringed beetle during the 1950s and 1960s. Dieldrin was also used in the pest-control trade along with chlordane for general subterranean termite control. Risk estimates based on the reported dieldrin concentrations in soil at NSA Memphis did not exceed 1E-4 Incremental Lifetime Cancer Risk (ILCR). As stated in the memorandum, "This finding indicates that dieldrin levels found at each SWMU do not necessitate remedial action in the absence of other significant carcinogenic risk contributors." Samples collected during background sampling exhibited dieldrin concentrations ranging from lss than quantitation limits to 311 micrograms per kilogram (μg/kg), with a mean of 131 μg/kg. The 1997 technical memorandum established a 2x mean background RC in surface soil for dieldrin of 262 μg/kg at NSA Memphis.

Dieldrin was detected in some of the surface samples collected during this CSI; however, most concentrations detected were less than the 262 μg/kg RC and most likely can be attributed to the applications discussed above.



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-6 AND BG-7.

ASSEMBLY F
CSI REPORT
NSA MEMPHIS
MILLINGTON, TENNESSEE

FIGURE 3.1

BACKGROUND SAMPLE LOCATIONS

AMIL: /home/ad2/memphis_dir/mapping_dir/back_dir/back

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4.0 GENERAL FIELD INVESTIGATION METHODS AND RATIONALE

This section summarizes the general sampling and analytical tasks conducted during the CSI. The field sampling activities followed the procedures outlined in the USEPA and Tennessee Department of Environment and Conservation — approved *Comprehensive RFI Work Plan* and *Assembly F CSI Site Investigation Plans* (SIPs); (E/A&H, 1995b).

The Assembly F SIPs required collecting surface and subsurface soil and groundwater samples for chemical analysis by either onsite or offsite laboratories. The descriptions of sample locations and intervals, the rationale for laboratory analyses, and any deviations from the general investigation approach are discussed in detail in the SWMU-specific discussions in Section 6. Deviations from the approved work plan were documented in the field logbook and are listed in the site-specific discussions. Table 4.1 summarizes sampling and analytical requirements for the first phase of the Assembly F CSI.

4.1 Sampling Rationale

Screening sampling was conducted at the Assembly F SWMUs to determine whether past activities have impacted surface soil, subsurface soil, or groundwater. Surface and subsurface soil samples were collected with a stainless-steel hand auger or direct push technology (DPT) sampling equipment. Groundwater samples were collected using a stainless-steel DPT groundwater sampler. The use of DPT sampling methods for subsurface soil and groundwater sample collection is a relatively quick and inexpensive alternative to installing groundwater monitoring wells during preliminary investigations. If contamination is not detected in DPT samples, there are no wells left to abandon, and little, if any, investigation-derived waste (IDW) is generated requiring disposal. If a release is confirmed, the screening data will facilitate selection of monitoring well locations and screen intervals.

Table 4.1
Assembly F — Sampling and Analysis Summary

SWMU	Description	Sampling Locations	Samples Collected	Medium Sampled	Interval Sampled	Laboratory Analyses
20	Building 1594 — UWT Number 1594	6	2	Soil	0-1'	FSA[a]
			3	Soil	0-1'	VOCs[b]
			6	Soil	5-7'	VOCs
			6	Soil	11-13'	VOCs
			3	Groundwater	Fluvial Deposit	VOCs
22	Building S-75 — Four former USTs	10	2	Soil	0-1'	FSA
			5	Soil	0-1'	VOCs
			1	Soil	9-11'	VOCs
			2	Soil	13-15'	VOCs
			5	Soil	14-16'	VOCs
			7	Groundwater	Fluvial Deposits	VOCs
63	Building S-75 — One UWT	1	1	Soil	0-1'	VOCs
			1	Soil	6-8'	VOCs
			1	Soil	14-16'	VOCs
			1	Groundwater	Fluvial Deposits	VOCs
30	Building S-420 — Park Field Waste Treatment Tank	5	2	Soil	0-1'	FSA
			3	Soil	0-1'	VOCs
			5	Soil	11-13'	VOCs
			4	Groundwater	Fluvial Deposits	VOCs
39	Building S-74 — Former Dry Cleaning Facility and PCB Transformer Storage Area	12	2	Soil	0-1'	FSA
			5	Soil	0-1'	VOCs, PCBs
			5	Soil	2-3'	VOCs, PCBs
			5	Soil	8-10'	VOCs
			1	Soil	9-11'	VOCs, PCBs
			4	Soil	11-13'	VOCs, PCBs
			5	Soil	11-13'	VOCs
			5	Soil	15-17'	VOCs
			2	Groundwater	Loess	VOCs
			7	Groundwater	Fluvial Deposits	VOCs

Notes:

a — FSA = Full Scan Analysis: Appendix IX Metals = USEPA Method 6010/7000 Series; Total cyanide = USEPA Method 9010; Chlorinated pesticides/PCBs = USEPA Method 8080; Organophosphorus pesticides = USEPA Method 8140; Chlorinated herbicides = USEPA Method 8150; Semi-volatile Organic Compounds = USEPA Method 8270; Total Petroleum Hydrocarbons (TPH) = Tennessee Modified Method 8015 for Gasoline Range Organics and Diesel Range Organics and TPH = USEPA Method 418.1; VOC = USEPA Method 8240. Analyzed offsite at National Environmental Testing (NET) in Cambridge, Massachusetts.

b — VOCs = Volatile Organic Compounds. Analyzed by an onsite laboratory during the first phase of the CSI or by Environmental Testing and Consulting (ETC), Memphis, Tennessee, during the second phase of the CSI.

All screening samples collected during the CSI were analyzed for volatile organic compounds (VOCs), because petroleum-related compounds were detected in previous investigations (i.e., tank removals) at SWMUs 20, 22/63, and 39, and because chlorinated solvents and petroleum constituents have been the most common groundwater contaminants at other NSA Memphis sites. VOC analyses should indicate the presence of either contaminant type in site soil or groundwater. Samples were analyzed in the field to expedite the investigation and to allow for sampling to continue uninterrupted.

In addition to the screening samples, two surface soil samples were collected at SWMUs 20, 22, 30 and 39 and analyzed for full scan analysis (FSA). No FSA surface soil samples were collected at SWMU 63, because SWMUs 22 and 63 were investigated as one site and locations were selected where surface spills were likely to have occurred and not where USTs were located. FSA included the following: VOCs, semivolatile organic compounds (SVOCs), chlorinated pesticides/PCBs, organophosphorus pesticides, chlorinated herbicides, metals, cyanide, Total Petroleum Hydrocarbons (TPH) — Diesel Range Organics (DRO), TPH-Gasoline Range Organics (GRO), and TPH. The chemical data obtained from the surface soil samples were used to inspect for surface spills and to prepare preliminary risk evaluations (PREs) for each SWMU. The specific methods and requirements for the referenced analyses are discussed in Section 4.2.

Subsurface soil sampling intervals varied between SWMUs. The sampling depths corresponded with the approximate depth of the particular UWT, UST, or septic tank. For example, based on the documentation for SWMU 20, the base of the UWT was estimated to be 5 to 6 feet bgs; therefore, that depth was sampled. Lower interval samples were collected to determine the vertical migration of contaminants released below the tanks. The SWMU 39 investigation was conducted to address possible surface spills only. Therefore, soil samples were proposed for collection from 0 to 1 foot bgs and 2 to 3 feet bgs.

Nineteen loess groundwater samples were proposed for collection at the Assembly F SWMUs. Of the 19, only 2 were collected due to limited recharge into the DPT sampler and limitations with the sample equipment (e.g., sample screen collapse or clogging). Instead, soil samples were collected from the loess at a depth approximate to that of the proposed loess groundwater sample interval. The remaining groundwater screening samples were collected from the fluvial deposits, which is the shallowest true aquifer and the most likely groundwater contaminant migration pathway beneath NSA Memphis.

4.2 Analytical Requirements

Soil samples were collected for either the screening of VOCs or FSA, while groundwater samples were collected for VOC screening only. VOC screening samples were analyzed by an onsite laboratory during the first phase of the CSI and by an offsite laboratory, Environmental Testing and Consulting (ETC) of Memphis, Tennessee, during the second phase of the CSI. All the VOC screening sample analytical results were performed using Level III-equivalent Data Quality Objectives (DQOs). Approximately 25% of all VOC screening samples were split for submittal to another offsite laboratory, National Environmental Testing Inc. (NET) of Bedford Massachusetts, for confirmatory VOC analysis to check the accuracy of the screening laboratory results. E/A&H and its subcontractor, Heartland Environmental Services Inc. of St. Charles, Missouri, validated the analytical data. Appendix A of this report contains the validation report, which indicates that the overall data quality of the analytical work for Assembly F is satisfactory.

FSA samples were analyzed at an offsite laboratory, NET, for the analytical suite described for each SWMU in the Assembly F SIPs using Level IV DQOs or equivalent. The FSA list consisted of the following analyses:

- VOCs, USEPA Method 8240
- SVOCs, USEPA Method 8270
- TPH, USEPA Method 418.1
- TPH-GRO, Tennessee (TN) Modified 8015/GRO
- TPH-DRO, TN Modified 8015/DRO
- Chlorinated pesticides/PCBs, USEPA Method 8080
- Organophosphorus pesticides, USEPA Method 8140
- Chlorinated herbicides, USEPA Method 8150
- RCRA Part 264, Appendix IX Total Metals, USEPA Method 6010/7000 series
- Total cyanide, USEPA Method 9010

The data from FSA samples was used in calculating health-based risk for each SWMU.

4.3 Sample Management

Sample management procedures during the CSI adhered to Sections 4.12 and 5 of the *Comprehensive RFI Work Plan*.

4.4 Sample Custody

Sample custody during the CSI adhered to Section 4.12.5 of the *Comprehensive RFI Work Plan*.

4.5 Quality Assurance/Quality Control

Quality assurance/quality control procedures followed during the CSI adhered to Section 4.14 of the *Comprehensive RFI Work Plan*.

4.6 Decontamination Procedures

Decontamination procedures during the CSI adhered to Section 4.11 of the *Comprehensive RFI Work Plan*.

4.7 Investigation-Derived Waste

IDW was handled as specified in Section 4.13 of the *Comprehensive RFI Work Plan* and the *NSA Memphis IDW Management Plan* (E/A&H, 1995b).

4.8 Sample Labeling

All samples were labeled as specified in Section 4.12.4 of the *Comprehensive RFI Work Plan.* All samples were labeled with a 10-digit alphanumeric code that identifies the site, sample type, sample location, sample depth, and QA sample type (as appropriate).

The labeling format was as follows:

ABC-D-EFGH-IJ

The following describes the specific information groups:

- **Site Location (ABC)** The three-character code ABC identifies the site location as follows: 020-SWMU 20, 022-SWMU 22, 030-SWMU 30, 039-SWMU 39, and 063-SWMU 63

- **Matrix/QC Code (D)** This character code identifies the sample matrix using the following letters:

Matrix Codes		QC Codes	
S	Soil (surface, borings, and trenches)	T	Trip blank
C	Soil duplicate sample	E	Equipment rinse blank
M	Sediment (settled, fluid-borne solid)	D	DI system blank
N	Sediment duplicate sample	P	Potable water blank

Matrix Codes		QC Codes	
G	Groundwater	F	Field blank
H	Groundwater duplicate sample	L	Filter blank
W	Surface water	B	USEPA blind spike sample
R	Surface water duplicate sample	2	Cement blank
U	Sludge	3	Drilling mud
Y	Sludge duplicate sample	4	Grout blank
Z	Liquid waste (including IDW drums)	5	Bentonite blank
V	Solid waste (including IDW drums)	6	Sand blank

- **Sample Location Identifier (EFGH)** This four character code identifies the sample location within a specific SWMU which was identified by the first three digits of the 10 digit labeling system. For example:

  GB01: Indicates Geoprobe boring (GB) number 01.

- **Depth, Interval, Serial Number (IJ)** This character code identifies a sampling location according to vertical depth, sample interval, or sample serial number. The recorded sample depth is the deepest point of the sample interval, for example, a sample collected from 0 to 1 foot bgs would be designated as 01.

Example: 020SGB0101 = NSA Memphis SWMU 20 soil sample from Geoprobe boring number 01 from a depth of 1 foot (0 to 1 foot interval).

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5.0 PRELIMINARY RISK EVALUATION

PREs were conducted for each SWMU group to determine if any human health risk exists as a result of contaminants released at the site. Risk was estimated using the surface soil samples collected at each SWMU group for FSA using Level IV DQO or equivalent.

In accordance with Supplemental Guidance to Risk Assessment Guidance for Superfund (RAGS) *Bulletin 1, Data Collection and Evaluation* (USEPA, November 1995), chemicals of potential concern (COPCs) were identified by comparing the maximum concentration of each detected chemical with its corresponding RBC value (January through June 1996 Risk-Based Concentration Table, USEPA Region III). Inorganics were also compared to background RCs. If the maximum detected concentration was greater than both the RC and the corresponding RBC, the chemical was retained as a COPC. This methodology was employed to focus the PRE on source contaminants that may pose a human health risk, while eliminating those that are naturally occurring (i.e., do not exceed the RC) or pose relatively low risk due to concentrations being less than RBCs. The RBCs are based on a target ILCR of 1E-06 and a target hazard quotient (HQ) of 1.0. Noncarcinogenic-based RBCs were adjusted from a target HQ of 1.0 to 0.1 in accordance with the previously cited USEPA Region IV Supplemental Guidance to RAGS, Bulletin 1. The cumulative ILCR threshold is 1E-04 and the cumulative hazard threshold is 1.0, in accordance with the previously cited November 1994 USEPA Region IV Memorandum.

Risk-based screening, as opposed to calculating risk and hazard for each chemical present in site samples, should not affect PRE conclusions. Carcinogens eliminated based on the target ILCR of 1E-06 would not be expected to contribute significantly to cumulative ILCR because the cumulative threshold is 1E-04. Likewise, noncarcinogens would not be expected to significantly contribute to the hazard index (HI) because the target HQ of 0.1 is less than the cumulative threshold of 1.0. In effect, this method provides insight into which contaminants pose the most significant threats to human receptors, helps to identify hot spots, and eliminates those chemicals

which are naturally occurring, are not source contaminants, or would not significantly affect the conclusions of the PRE. Risk was estimated for each COPC using the ratio between the maximum reported concentration and the corresponding RBC. A risk ratio is calculated for each contaminant by one of the following two equations:

Carcinogenic Risk Ratio:

$$RR = \frac{\text{media concentration} * TR}{\text{screening value}}$$

Noncarcinogenic Risk Ratio:

$$RR = \frac{\text{media concentration} * THQ}{\text{screening value}}$$

where:

RR	=	the risk ratio
Media Concentration	=	the maximum concentration of a site chemical
Screening Value	=	the RBC value for that particular chemical
TR	=	target risk used to calculate RBCs for carcinogens (1E-6)
THQ	=	target hazard quotient used to calculate RBCs for noncarcinogens (0.1)

The risk ratios for each chemical are summed separately for both residential and industrial scenarios to determine the overall site risk. Cumulative risk (for carcinogens) and cumulative HI (for noncarcinogens) are calculated separately, and the cumulative risk and HI are compared to the corresponding cumulative thresholds in accordance with USEPA Region IV's November 1995 Supplemental Guidance to RAGS and E/A&H's technical memorandum (E/A&H, 1997). Risk estimates for both land use scenarios include the following assumptions.

A residential scenario includes exposure during childhood and adulthood, and assumes exposure for 350 days per year for at least 30 total years. The future site resident scenario assumed dwellings would be constructed onsite. 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 scenario because of their limited soil contact and the fact that groundwater is not currently used onsite as drinking or process water.

Construction or maintenance worker exposure would be considered less than the hypothetical future worker assumed in this PRE because construction or maintenance workers would be exposed less frequently and for shorter durations. Consequently, future worker assessment is considered protective of both current site use and future construction/maintenance events. As previously mentioned, an ILCR greater than 1E-04 (USEPA's cumulative upper-bound acceptable risk threshold) or an HI greater than 1 (USEPA's cumulative HI threshold), indicates the site may require additional investigation for the corresponding land use scenario (USEPA Region IV Memorandum, November 1994). In accordance with USEPA Region IV's memorandum, the property is considered suitable to lease for the specified land use scenario if neither threshold is exceeded.

Uncertainty

The PRE for each SWMU is based on the maximum reported concentrations of each COPC and a future residential and industrial scenario. The conservative approach includes these assumptions regarding uncertainties:

- Exposure to maximum reported concentrations will be uniform, regardless of sample location, which creates a theoretical hot spot. The PRE was based on a minimum number of samples. Use of the maximum concentration potentially overestimates exposure, especially if the maximum detected concentration was in a hot spot. Likewise, exposure could be underestimated if a hot spot were missed during sampling.

- While the site will not be used for residential purposes, the residential scenario was incorporated into the PRE to provide a conservative representation of potential risk or hazard.

- Cumulative effects will occur, regardless of target organs and mechanisms of action, which could either overestimate or underestimate risk.

- Shallow (loess and fluvial deposits) groundwater will be used for potable purposes. This is not likely, as the current potable water supply sources are the much deeper Memphis and Fort Pillow aquifers.

- At each of the Assembly F SWMUs, only two surface soil samples were analyzed offsite with Level IV DQO or equivalent. Remaining soil and groundwater samples were analyzed with Level III DQO or equivalent. Since Level IV DQO or equivalent provides a more complete data package than Level III DQO or equivalent analysis, inherent uncertainty exists for groundwater data and remaining soil data as opposed to the samples analyzed with Level IV DQO or equivalent.

6.0 FATE AND TRANSPORT

This section provides guidance for evaluating the transport, transformation, and fate of contaminants in the environment. Specifically, fate and transport assessment seeks to evaluate a contaminant's ability to become mobile or change in the environment. To accomplish this, the chemical and physical properties that govern the contaminant's interaction within environmental media must be understood. Site characteristics, e.g., topography, geology, and hydrogeology, and characteristics of site soil, sediment, and water, as well as the contaminant's chemical and physical properties, play roles in evaluating the processes of fate and transport. In order to streamline the fate and transport discussion, this section focuses on understanding the properties that affect fate and transport. Site- and contaminant-specific discussions are included in Section 7 for each SWMU. Fate and transport evaluations will be predetermined for contaminants defined as COPCs in a PRE, any organic contaminant which exceeds its SSL (soil to groundwater), and any inorganic contaminant which exceeds both its SSL (soil to groundwater) and RC. Also, contaminants will be evaluated if they exceed the SSL for soil-to-air transport or if they co-exist in different media (e.g., a contaminant is found in both soil and groundwater).

Evaluation of Assembly F SWMUs with regard to the above characteristics identified four potential routes of contaminant migration:

- Air emissions resulting from VOCs released from surface soil.
- The leaching of contaminants from soil to groundwater.
- Surface soil erosion and transport of contaminants sorbed to sediment.
- The migration of contaminants from shallow groundwater into surface water bodies.

6.1 Properties Which Affect Fate and Transport

The persistence, transport, and fate of chemicals in the environment depend on individual chemical and physical properties as well as properties of the media in which the chemicals reside. These

properties are discussed briefly below, describing the significance of each property to volatilization, sorption, diffusion, dispersion, biodegradation, and other attenuation processes.

6.1.1 Chemical and Physical Properties

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, distribution coefficient, and half-life. Water solubility and adsorption coefficients are properties of interest for inorganic contaminants. After the properties are introduced, the impact on each relevant class of compounds is discussed. Table 6.1 provides an overview of chemical behavior based on these properties.

Water Solubility

The solubility of a chemical in water is the maximum amount that will dissolve in pure water at a specified temperature. Chemicals with high solubility are relatively mobile in water and are likely to leach from wastes and soils. These chemicals tend to have low volatilization potential, but do tend to be biodegradable. Conversely, chemicals with low solubility tend to adsorb onto soil and sediment and are not readily biodegraded. They also have a greater tendency to volatilize.

Vapor Pressure

Vapor pressure measures the tendency of a substance to pass from a solid or a liquid to a vapor state. It is measured as the pressure of the gas in equilibrium with the liquid or solid at a given temperature. From dry soil, the vapor pressure determines the volatilization of a given chemical to the atmosphere. From surface water and moist soil, volatilization depends upon vapor pressure and the Henry's law constant (discussed below). A compound with a vapor pressure less than 10^{-6} millimeters of mercury (mm Hg) tends to associate with particulate matter; a compound with a higher vapor pressure tends to associate with the vapor phase. Highly water-soluble compounds generally show little volatilization from water or moist soils unless they also have a high vapor pressure.

Table 6.1
Chemical and Physical Properties

Chemical Property	Critical Value[a]	A chemical with a higher value may....	A chemical with a lower value may....
Vapor Pressure	10^{-3} mmHg	be more volatile.	be less volatile.
Density[b]	water: 1.0 g/cm^3 air: 1.20 kg/m^3	sink in water or fall in the atmosphere.	float on water or rise in the atmosphere
Solubility	0 to 100 mg/l	leach from soil, is more mobile in water; and does not readily volatilize from water.	adsorb to soil, be immobile in water; and volatilizes from water.
Henry's Law Constant	10^{-3} to 10^{-5} atm-m^3/mole	volatilize easily from water.	not volatilize easily from water.
Half-Life	biologically dependent	not degrade readily.	degrade readily.
Organic Carbon Partition Coefficient	10 to 10,000 ml_{oc}/g_{water}	be more apt to remain in soil.	be more mobile and diffuse easily in water.

Notes:
[a] — Critical values are based on literature review and professional judgment.
[b] — Approximate density of air at standard temperature and pressure.
g/cm^3 — grams per cubic centimeter
kg/m^3 — kilograms per cubic meter

Henry's Law Constant

The Henry's law constant describes a linear relation between vapor pressure and water solubility, providing a measure of a chemical's ability to move from water or moist soil to air. Compounds with Henry's law constants greater than 10^{-3} atmospheres-cubic meter per mole (atm-m^3/mole) can be expected to readily volatilize from water. Compounds with values ranging from 10^{-3} to 10^{-5} atm-m^3/mole exhibit moderate volatilization. Compounds with values less than 10^{-5} atm-m^3/mole show limited ability to volatilize from water or moist soil.

Specific Gravity

The specific gravity (SG) of a substance is the ratio of the weight of a given volume of that substance to the weight of the same volume of water. The water weight is usually measured at 4°C; the other substance is often measured at some other temperature, typically 20°C. If the SG of a substance is less than 1.0, that substance will float on water; if the SG is greater than 1.0, the substance will sink. The SG can sometimes be used to predict the vertical distribution of the immiscible or insoluble portion of a chemical within an aquifer or other body of water.

Organic Carbon Partition Coefficient

The organic carbon partition coefficient (K_{oc}) measures the degree to which a substance will preferentially adsorb 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 adsorb or desorb from available organic matter in the soil matrix. The higher the K_{oc} values, the greater the tendency of a chemical to be attracted to the organic fraction of the soil and the lower its mobility in the subsurface environment.

Half-Life

A half-life is the time required for the concentration of a substance to decrease from its initial concentration to one-half that level. The apparent decrease may be caused by various processes including biodegradation, reactions with other substances, or mass removal from the media in question.

Chemical Behaviors

VOCs can be expected to be mobile in the environment based on their physical and chemical properties. They have the potential to volatilize to the atmosphere, leach to groundwater, or when sorbed to sediment, erode to surface water, and to move with groundwater flow. Relative to other categories of compounds, VOCs have low molecular weights and high water solubilities, vapor

pressures, and Henry's law constants, along with corresponding low K_{oc} values. These properties all enhance the potential for the mobility and degradability of VOCs. Relative to chemicals in other categories, many VOCs tend to have relatively short half-lives in groundwater and surface water. VOCs have a limited tendency to adsorb to solids and can be expected to be moderately to highly mobile in the environment. Especially in near-surface soil, VOCs can migrate via diffusion through soil-air pore spaces to the ground surface, where they can volatilize from the soil and be transported by wind.

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

Pesticides/PCBs have moderate molecular weights, generally high densities, high K_{oc} values, and generally low solubilities, vapor pressures, and Henry's law constants. Typical fate and transport characteristics of pesticides/PCBs include a tendency to sorb to soil particles. They are hydrophobic (avoid water), are immobile in the environment, and tend to degrade relatively slowly. Overall, pesticides/PCBs are anticipated to be immobile and persistent in the environment, not readily diffusing into groundwater.

Herbicides can leach from soil particles to groundwater and tend to be mobile in both soil and groundwater. They tend to degrade relatively slowly. The chemical property with the greatest influence on the fate and transport of herbicides is solubility. Herbicides have low Henry's law constants and vapor pressures, and moderate molecular weights, Koc and solubilities. Overall, herbicides are expected to be moderately mobile in groundwater with some retention in soil.

Inorganic compounds do not degrade in the environment, but they may change chemical form or speciation. They are generally considered to be indefinitely persistent. Inorganic metals may interact with soil or other solids by ion exchange, adsorption, precipitation, or complexation and can act as catalysts in biodegradation processes. These processes are affected by pH, composition of leachate or groundwater oxidation-reduction (redox) condition, and the type and amount of organic matter, minerals, clay, and hydrous oxides present. In general, the solubility of metals in potable groundwater is low, resulting in limited mobility in the environment. However, groundwater containing elevated concentrations of chloride, bicarbonate, sulfate, or phosphate can enhance the solubility and mobility of metals by forming aqueous complexes.

6.1.2 Media Properties

The properties of environmental media used to evaluate fate and transport are total organic carbon, soil sorptive capacity, cation exchange capacity (CEC), redox conditions, pH, and hydrogeology. The following is a brief discussion of these properties.

Total Organic Carbon

The abiotic process of sorption (accumulation of the contaminant at the surface of a solid surface) will slow down the movement of the contaminant as it accumulates on the subsurface medium. For organic contaminants and subsurface materials with organic carbon, hydrophobic chemicals are commonly sorbed into the soil organic carbon content. As the organic carbon content of the subsurface material increases, the soils total capacity to sorb the contaminant increases. In fate and transport calculations, organic carbon is typically expressed as a percent of organic carbon (f_{oc}).

Distribution Coefficient

The distribution coefficient (K_d) is a valid representation of the partitioning between liquid and solids, or the ratio of the mass of contaminant in soil to the mass of contaminant dissolved in the

groundwater, and is used in modeling contaminant movement through the subsurface. The larger the K_d value, the greater the sorption to the solid phase. The simplest method for acquiring a K_d value for a specific contaminant is to obtain it from a K_{oc} value listed in literature sources. K_{oc} is analogous to K_d, except that the adsorbing material is considered to be the organic carbon (oc) in the soil as opposed to the entire soil matrix. By normalizing K_d on the basis of the soil's oc content, a great deal of the variation observed among K_d values over different soils can be eliminated, thus, K_d can be estimated from the K_{oc} of the chemical and the f_{oc} in the soil, e.g., $K_d = K_{oc} \, x \, f_{oc}$.

Cation Exchange Capacity

CEC reflects the soil's capacity to adsorb ions by neutralizing an ionic deficiency on its surface. Certain compounds can either gain or lose a proton as a function of pH and thus transform from a neutral form to an ionic form. For organic compounds, this ionization will greatly increase the solubility of the chemical in the groundwater. The gain of a proton will yield a positive ion. In this case, the ionic compound may associate to a greater degree with the CEC of the clay minerals. The overall impact on sorption (mobility) will depend on the relative sorption of the neutral and ionic forms of the compound.

Redox Conditions

Redox refers to the transfer of electrons and species change of ions or compounds. Redox is the process that includes oxidation (the loss of electrons) and reduction (the gain of electrons). As an example, consider iron in groundwater. Groundwater which reaches the surface in a highly reduced state is exposed to the atmosphere (oxygen), which oxidizes the iron. Iron oxidation is a reverse process and causes the iron to go from its soluble to insoluble form.

pH

pH is a logarithmic measure of hydrogen ions in the soil and groundwater, indicating the medium's acidity or basicity. Chemicals react significantly different under different pHs. Low pH conditions tend to mobilize chemicals, especially inorganics, while high pH conditions may form immobile metal hydroxides.

Hydrogeology

The physical properties of soil (mineralogical composition, particle size distribution, etc.) dictate how a contaminant is transported in the subsurface. Some of the properties are porosity, hydraulic gradient, hydraulic conductivity, unsaturated flow, and saturated flow.

Porosity is defined as the ratio of openings (voids) to the total volume of a soil or rock. Typically, fine-grained materials tend to be better sorted and, thus, tend to have the largest porosities. Porosity indicates the maximum amount of water that a rock or soil can contain when it is saturated.

The direction of slope of the groundwater table or potentiometric surface indicates the direction of groundwater movement. All other factors being constant, the rate of groundwater movement depends on the hydraulic gradient. The hydraulic gradient is the change in head per unit distance in a given direction. The hydraulic gradient is important in the transport of contaminants because it may indicate the velocity and direction at which a contaminant may migrate in groundwater.

The factors controlling groundwater movement are largely dictated by the hydraulic conductivity of the aquifer media. Hydraulic conductivity depends on the size and arrangement of pores and on the dynamic characteristics of groundwater, such as viscosity and density. Hydraulic conductivity refers to the water-transmitting characteristics of soil and varies in different types of soil. If the hydraulic conductivity is essentially the same in any area of soil, it is said to be

homogeneous, otherwise it is heterogeneous. Hydraulic conductivity tends to be greater in sand and reduced in material containing clay.

Most aquifer recharge occurs during the percolation of water across the unsaturated zone. Movement of water in the unsaturated zone is controlled by both gravitational and capillary forces. Capillarity results from two forces: the mutual attraction (cohesion) between water molecules and the molecular attraction (adhesion) between water and different solid materials. As a consequence of these two forces, water is pulled upward into a capillary fringe above the water table. Flow in the unsaturated zone is important because contaminants released at the surface that percolate through the unsaturated zone may remain due to capillarity, or contaminants may arrive in the unsaturated zone due to a fluctuating water table.

In the saturated zone all interconnected openings are full of water and the groundwater moves through these openings in the direction controlled by the hydraulic gradient. Movement in this zone may be either laminar or turbulent. In laminar flow, water particles move in an orderly manner along streamlines. In turbulent flow, water particles move in a disordered, highly irregular manner, which results in a complete mixing of the particles. Dispersion is an important transport process of contaminants in the saturated zone. Dispersion is the process by which solutes are mixed with uncontaminated water, diluted, and transported due to the heterogeneity of the aquifer. Also, diffusion is the process by which solutes are transported from a region of high concentration to a region of low concentration. In very fine sediments, diffusive transport may be the dominant process. However, contaminant movement is typically advective. Advective flow is the process by which dissolved substances migrate with flowing groundwater. This is the dominant transport process for contaminant movement in groundwater.

6.2 Fate and Transport Approach for Assembly F

The fate and transport discussion for each SWMU begins by describing site characteristics that have the potential to promote or inhibit the migration of contaminants. As presented in Section 6.0, four potential routes of migration may exist. Each SWMU was evaluated as to site conditions that affect these migration pathways.

An individual contaminant's ability to migrate was evaluated based on the four cross-media transfer mechanisms — soil to groundwater, surface soil to air, groundwater to surface water, and surface soil to sediment (erosion of contaminants sorbed to sediments) — as described in Sections 6.2.1 through 6.2.4. The chemical and physical properties of the contaminant were evaluated, where necessary, in support of each transfer mechanism. Table 6.2 presents the chemical and physical properties used to evaluate fate and transport for all contaminants detected at Assembly F sites.

6.2.1 Soil-to-Groundwater Cross-Media Transport

To evaluate the potential for soil-to-groundwater migration of contaminants, a phased screening approach was used to focus on chemicals with the greatest potential for impacting the water-bearing zones. The screening process is summarized as follows:

- Qualitative — Analytical data for soil and groundwater were compared to determine which chemicals were present in both media.

- Quantitative — Soil results were compared to the leachability-based soil to groundwater screening levels (SSLs) as presented in the USEPA Region III January to June 1996 RBC Table, June 1996. For organic contaminants, if the maximum detected concentration exceeded its SSL, then that contaminant was considered a threat for impacting an underlying water-bearing zone. For inorganic contaminants, if the maximum detected concentration exceeded its SSL ***and*** its background RC, that inorganic contaminant was considered a threat for impacting an underlying water-bearing zone.

Table 6.2
Fate and Transport Properties for
Contaminants Detected in Soil and Groundwater
NSA Memphis, Assembly F

Parameter	Group	Mw[a] (g/mole)	Density[a] (g/cm^3)	Vapor Pressure[a,b] (mm Hg)	Solubility[a,b] (mg/l)	Henry's Law Constant[b,c] (atm-m^3/mole)	Koc[b,c] (ml/g)	SSL soil to gw[d] (mg/kg)	SSL soil to air[d] (mg/kg)
Acenaphthene	SVOC	154.21	1.02e+00	1.60e-03	3.50e+00	1.70e-04	1.78e+01	200	120
Acetone	VOC	58.08	7.90e-01	2.70e+02	1.00e+06	3.97e-05	3.70e-01	8	62,000
Aldrin	PEST	364.92	1.70e+00	6.00e-06	2.70e-02	2.67e-05	4.07e+02	0.005	0.5
Anthracene	SVOC	178.24	1.30e+00	2.00e-04	4.50e-02	6.50e-05	1.86e+04	4,300	6.8
Benzene	VOC	78.11	8.70e-01	9.50e+01	1.80e+03	5.40e-03	5.00e+01	0.02	0.5
Benzo(a)anthracene	SVOC	228.30	1.27e+00	5.00e-09	1.20e-02	2.30e-06	1.38e+06	0.7	27
Benzo(a)pyrene	SVOC	252.32	1.40e+00	5.60e-09	3.90e-03	2.40e-06	1.77e+06	4	11
Benzo(b)fluoranthene	SVOC	252.30	NDA	5.00e-07	1.40e-02	1.20e-05	5.50e+05	4	23
Benzo(g,h,i)perylene	SVOC	276.34	NDA	1.00e-10	2.60e-04	1.40e-07	7.76e+06	NDA	NDA
Benzo(k)fluoranthene	SVOC	252.30	NDA	9.59e-11	5.50e-04	1.04e-03	4.37e+06	4	0
2-Butanone (MEK)	VOC	72.11	8.10e-01	7.80e+01	2.70e+05	4.66e-05	1.23e+00	NDA	NDA
Carbazole	SVOC	167.20	1.10e+00	4.00e+02	3.80e-03	NDA	NDA	0.5	11
Carbon disulfide	VOC	76.13	1.30e+00	3.00e+02	2.10e+03	1.33e-02	2.95e+02	14	11
alpha-Chlordane	PEST	409.78	1.60e+00	1.00e-05	5.60e-02	4.80e-05	4.95e+04	NDA	NDA
gamma-Chlordane	PEST	409.80	1.60e+00	1.00e-05	5.60e-02	4.80e-05	4.95e+04	NDA	NDA
Chrysene	SVOC	228.30	1.27e+00	6.30e-09	1.80e-03	7.26e-20	2.45e+05	1	3.6
4,4'-DDD	PEST	320.05	1.50e+00	1.00e-06	2.00e-02	2.16e-05	4.37e+04	0.7	37
4,4'-DDE	PEST	319.03	6.49e-06	6.50e-06	4.00e-02	2.34e-05	2.45e+05	0.5	10
4,4'-DDT	PEST	354.49	1.60e+00	1.90e-07	5.00e-03	4.89e-05	3.87e+05	1	80

Table 6.2
Fate and Transport Properties for
Contaminants Detected in Soil and Groundwater
NSA Memphis, Assembly F

Parameter	Group	Mw[a] (g/mole)	Density[a] (g/cm^3)	Vapor Pressure[a,b] (mm Hg)	Solubility[a,b] (mg/l)	Henry's Law Constant[b,c] ($atm\text{-}m^3/mole$)	Koc[b,c] (ml/g)	SSL soil to gw[d] (mg/kg)	SSL soil to air[d] (mg/kg)
2,4,5-TP (Silvex)	HERB	269.51	NDA	5.20e-06	1.40e+02	1.31e-07	2.57e+03	NDA	NDA
Dibenz(a,h)anthracene	SVOC	278.36	1.28e+00	1.00e-10	5.00e-03	7.33e-09	1.66e+06	11	7.2
1,1-Dichloroethane	VOC	98.96	1.20e+00	1.80e+02	5.50e+03	5.45e-03	3.40e+01	11	980
1,1-Dichloroethene	VOC	96.94	1.20e+00	5.90e+02	2.30e+03	1.80e-02	6.50e+01	0.03	0.04
cis-1,2-Dichloroethene	VOC	96.94	1.20e+00	2.02e+02	8.00e+02	4.08e-03	4.90e-01	0.2	1,500
Dieldrin	PEST	380.93	1.80e+00	1.80e-07	2.00e-01	2.00e-05	1.34e+04	0.001	2
Di-n-butylphthalate	SVOC	278.35	1.00e+00	1.00e-05	1.30e+01	6.30e-05	1.38e+03	120	100
Endosulfan I	PEST	406.92	1.70e+00	1.00e-05	5.30e-01	1.01e-04	2.04e+03	3	1
Endosulfan sulfate	PEST	422.92	NDA	NDA	1.20e-01	NDA	2.34e+03	NDA	NDA
Endrin ketone	PEST	380.93	NDA	2.00e-07	2.60e-01	4.00e-07	NDA	0.4	16
Ethylbenzene	VOC	106.16	8.70e-01	7.10e+00	1.50e+02	6.60e-03	1.87e+02	5	260
bis(2-Ethylhexyl)phthalate (BEHP)	SVOC	340.57	9.90e-01	2.00e-07	3.00e-01	1.10e-05	1.00e+05	11	210
Fluoranthene	SVOC	202.26	1.30e+00	5.00e-06	2.40e-01	1.69e-02	4.17e+04	980	68
Heptachlor	PEST	373.32	1.70e+00	3.00e-04	1.80e-01	2.30e-03	2.69e+04	0.06	0.3
Heptachlor epoxide	PEST	389.32	NDA	2.60e-06	3.50e-01	3.20e-05	2.09e+04	0.03	1
Indeno(1,2,3-cd)pyrene	SVOC	276.34	6.20e-02	1.00e-10	6.20e-02	2.96e-20	3.09e+07	35	280
2-Methylnaphthalene	SVOC	142.21	1.00e+00	NDA	2.50e+01	NDA	8.51e+03	NDA	NDA
Methylene chloride	VOC	84.93	1.30e+00	3.50e+02	2.00e+04	2.00e-03	2.30e+01	0.01	7
Naphthalene	SVOC	128.18	1.10e+00	5.40e-02	3.00e+01	4.60e-04	7.92e+02	30	180

Table 6.2
Fate and Transport Properties for
Contaminants Detected in Soil and Groundwater
NSA Memphis, Assembly F

Parameter	Group	Mw[a] (g/mole)	Density[a] (g/cm^3)	Vapor Pressure[a,b] (mm Hg)	Solubility[a,b] (mg/l)	Henry's Law Constant[b,c] (atm-m^3/mole)	Koc[b,c] (ml/g)	SSL soil to gw[d] (mg/kg)	SSL soil to air[d] (mg/kg)
Phenanthrene	SVOC	178.24	1.20e+00	6.80e-04	1.00e+00	3.90e-05	2.29e+04	NDA	NDA
Pyrene	SVOC	202.26	1.30e+00	2.50e-06	1.40e-01	1.09e-05	6.46e+04	1,400	56
TPH-DRO		NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
TPH-GRO		NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Toluene	VOC	92.13	8.70e-01	2.20e+01	5.20e+02	6.70e-03	1.29e+02	5	520
Technical chlordane	PEST	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
1,1,2,2-Tetrachloroethane	VOC	167.85	1.60e+00	5.00e+00	2.90e+03	3.80e-04	1.17e+02	0.001	0.4
Trichloroethene	VOC	131.40	1.50e+00	5.80e+01	1.10e+03	9.10e-03	8.70e+01	0.02	3
1,1,1-Trichloroethane	VOC	133.40	1.30e+00	1.00e+02	1.60e+03	1.62e-02	1.28e+02	0.9	980
1.1.2-Trichloroethane	VOC	133.40	1.44e+00	1.90e+01	4.50e+03	7.40e-04	5.60e+01	0.01	0.8
Xylene	VOC	106.17	8.80e-01	8.70e+00	2.00e+02	7.10e-03	2.34e+02	74	320
Arsenic	INO	74.90	NDA	NDA	NDA	NDA	NDA	15	380
Barium	INO	137.33	NDA	NDA	NDA	NDA	NDA	32	350000
Beryllium	INO	9.01	NDA	NDA	NDA	NDA	NDA	180	690
Chromium	INO	52.00	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Cobalt	INO	58.93	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Copper	INO	63.55	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Lead	INO	207.20	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Mercury	INO	200.60	NDA	NDA	NDA	NDA	NDA	3	7
Nickel	INO	58.71	NDA	NDA	NDA	NDA	NDA	21	6,900

Table 6.2
Fate and Transport Properties for
Contaminants Detected in Soil and Groundwater
NSA Memphis, Assembly F

Parameter	Group	Mw[a] (g/mole)	Density[a] (g/cm^3)	Vapor Pressure[a,b] (mm Hg)	Solubility[a,b] (mg/l)	Henry's Law Constant[b,c] ($atm\text{-}m^3/mole$)	Koc[b,c] (ml/g)	SSL soil to gw[d] (mg/kg)	SSL soil to air[d] (mg/kg)
Selenium	INO	78.96	NDA	NDA	NDA	NDA	NDA	3	NDA
Silver	INO	107.90	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Tin	INO	118.69	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Vanadium	INO	50.94	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Zinc	INO	65.38	NDA	NDA	NDA	NDA	NDA	4,200	NDA

Notes:

[a] — Merck & Co., *The Merck Index*, Merck & Co., Rahway NJ, 1983.
— Lide, *CRC Handbook of Chemistry and Physics*, CRC Press, Boca Raton, Florida 1994.
USEPA, *Treatability Database*, USEPA Risk Reduction Engineering Laboratory, Cincinnati Ohio, 1992.
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] — SSL considered protective of contaminant transfer from soil to groundwater (from USEPA Region III Risk-Based Concentration Table, January to June 1996).
NDA — No Data Available
INSOL — Compound practically insoluble in water
VOC — Volatile organic compound
SVOC — Semivolatile organic compound
PCB — Polychlorinated biphenyl
PEST — Pesticide
HERB — Herbicide
INO — Inorganic
mg/l — milligrams per liter
mg/kg — milligrams per kilogram

Due to the nature and age of most SWMU operations, it was assumed that any impacts from compounds that could migrate from soil would be currently manifested in either the loess or fluvial deposits groundwater. The number and placement of monitoring wells or DPT groundwater samples were considered adequate to detect the presence of groundwater contamination. As a result, the qualitative comparison was used to identify those chemicals with reported concentrations in both media.

6.2.2 Soil-to-Air Cross-Media Transport

To evaluate the potential for soil-to-air migration of VOCs, a screening approach was used to focus on contaminants having the greatest potential to volatilize in sufficient quantities to create a human-health threat in ambient air. The screening process is summarized as follows:

- Quantitative — The maximum concentrations of VOCs detected in surface soil at each SWMU were compared to soil-to-air screening levels as presented in the USEPA Region III January to June 1996 RBC Table, June 1996.

No qualitative screening was performed because ambient air sampling was not part of the field sampling procedure at any Assembly F SWMU.

If soil concentrations did not exceed soil-to-air volatilization screening levels, it was assumed no significant migration potential exists and current surface soil conditions are protective of human health relative to potential inhalation exposure pathways. Other factors included: type of cover (vegetation, asphalt, etc.); physical properties of the surface soil which might limit or enhance mobility of contaminants; and physical/chemical properties of the class of contaminants (e.g., VOCs are more likely to volatilize from soil to air than SVOCs).

6.2.3 Groundwater-to-Surface Water Cross-Media Transport

The principal focus of this evaluation was determining whether contaminants identified in groundwater have the potential to extend their impacts or discharge to surface water. This transport mechanism is not discussed in detail due to the lack of water bodies at or near any of the Assembly F SWMUs, and the unlikelihood that shallow groundwater in the loess will impact surface water based on the lithology of the soil matrix.

6.2.4 Surface Soil-to-Sediment Cross-Media Transport

To evaluate the potential for surface soil-to-sediment erosional migration, the following approach was taken:

- Qualitative — Analytical data from both soil and sediment were compared to determine which chemicals were present in both media.

Also, to evaluate the potential for sorbed contaminants in near-surface soil to migrate by soil erosional processes, contaminants were identified which exhibited characteristics which would render them mobile under erosional processes such as surface-water drainage and wind erosion. The most influential process by which sediments are formed, involves the erosion of surface soil containing no vegetation which eventually collects in depositional areas. Therefore, topography at each SWMU is also used as a screening process in evaluating this transport mechanism as a migration pathway.

7.0 CONFIRMATORY SAMPLING INVESTIGATIONS

For each Assembly F SWMU or SWMU group investigated during this CSI, this section details the following: the available background information; the CSI sampling activities and analytical results; a site-specific PRE; a site-specific fate and transport discussion; and site-specific conclusions and recommendations. The analytical results for all screening and FSA samples are provided in Appendix B.

7.1 SWMU 20 — Underground Waste Tank 1594

SWMU 20, abandoned UWT 1594, is approximately 200 feet west of Fifth Avenue and C Street on the NSA Memphis Southside, southeast of Building 1594 (see Figure 1.1). UWT 1594 reportedly stored waste oil and waste hydraulic fluid generated by the Air Traffic Control School. The estimated size of the tank was 100 gallons. The installation date of UWT 1594 is unknown; it was removed in May 1992. The information obtained for SWMU 20 during the 1990 RCRA Facility Assessment (RFA) is in Attachment 1 of the Assembly F CSI Work Plan.

SWMU 20 and the surrounding area are characterized by relatively level, low-relief topography. The immediate area is covered by asphalt, while surrounding areas have grass cover. Surface drainage is toward the south and west to an east-west oriented drainage ditch (SWMU 38) which flows into Big Creek Drainage Canal.

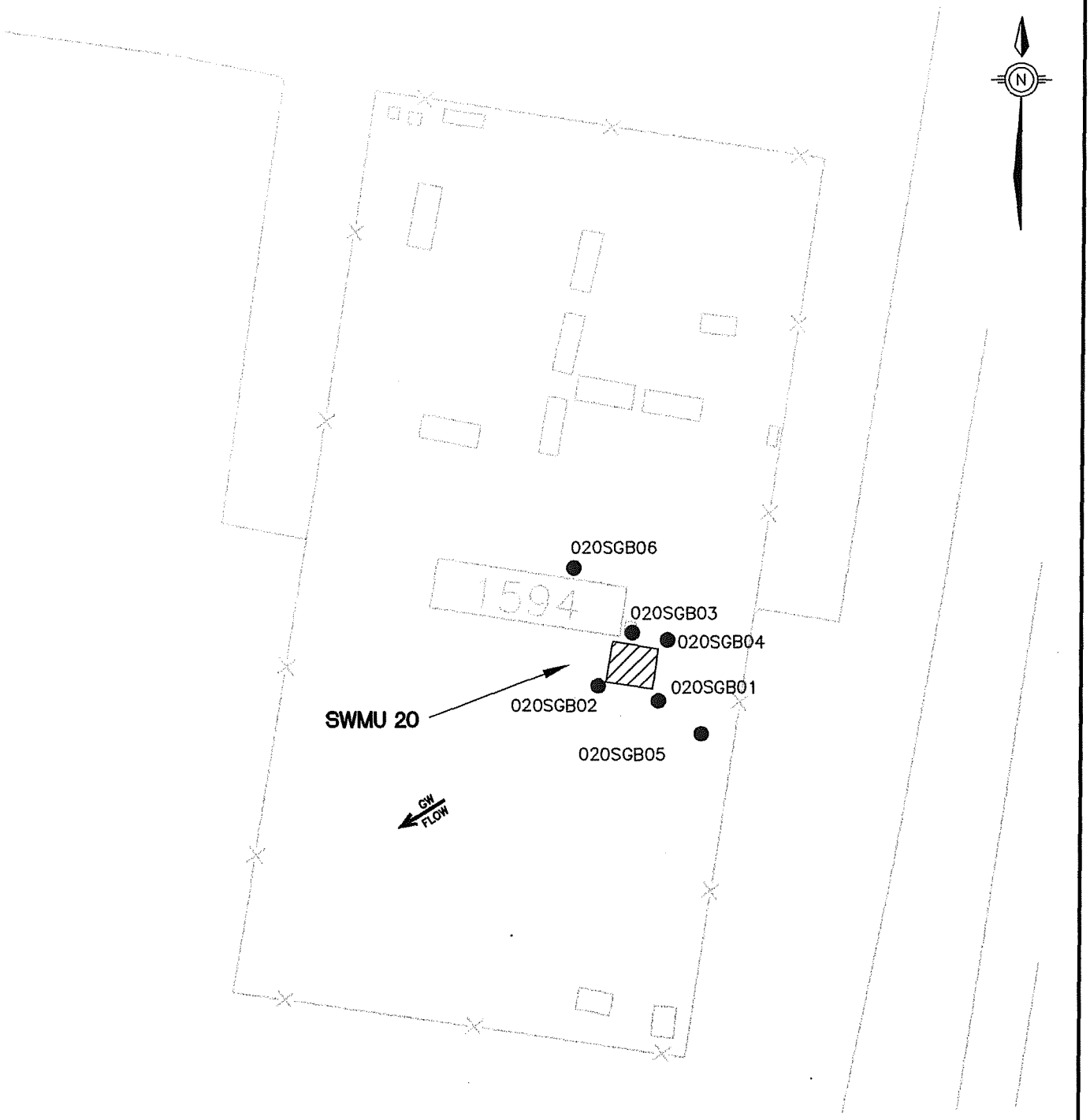
The regional and local hydrogeology are described in Sections 2.11 and 2.12, respectively, of the *Comprehensive RFI Work Plan*. Site-specific geologic and hydrogeologic information and references are in Section 2 of this report and in Section 2.2 of the Assembly F CSI Work Plan. Because soil and groundwater samples were collected by "blind" pushing of DPT sampling tools to a predetermined sampling depth without lithologic characterization, no additional site-specific information was collected during this investigation.

7.1.1 Previous Sampling Activities

The *Underground Storage Tank Closure Report, Tank No. 1594* (National Salvage, 1992), contains information concerning the removal of UWT 1594. When the tank was removed, the excavated soil was stockpiled. Afterward, confirmation soil samples were collected from the four corners of the open tank pit and a disposal sample was collected from the stockpiled soil. The tank-pit soil samples were analyzed for benzene, toluene, ethylbenzene, and xylenes (BTEX), TPH-GRO and TPH-DRO, while the stockpiled soil sample was analyzed for BTEX; TPH; TPH-GRO and TPH-DRO; toxicity characteristic leaching procedure (TCLP) lead, benzene, and flash point. Analysis of the tank-pit samples identified TPH-DRO concentrations of 21.6 parts per million (ppm) in the northeast corner, 298 ppm in the southeast corner, 1,089 ppm in the southwest corner, and 3,072 ppm in the northwest corner. Analysis of the stockpiled soil sample indicated a TPH-DRO concentration of 20,288 ppm and a TCLP TPH-DRO of 1.89 ppm. All other analytical parameters from both the tank-pit and the stockpiled-soil sample were less than method detection limits. The flash point of the stockpiled soil sample was greater than 160°F. The stockpiled soil was transported to the Browning-Ferris Industries Inc. landfill in Millington, Tennessee, for disposal as petroleum-contaminated soil.

7.1.2 Field Investigation

The CSI at SWMU 20 was completed by collecting soil and groundwater samples from six locations around the former tank pit (Figure 7.1.1). All soil and groundwater samples were collected using DPT sampling equipment and techniques. Surface soil samples were collected from 0 to 1 foot bgs at the four locations nearest the tank pit (020SGB01 through 020SGB04). For this discussion, ground surface is considered the soil surface beneath the asphalt. As discussed in Section 4.1, two surface samples (020-S-GB01-01 and 020-S-GB02-01) were collected for FSA under Level IV DQOs or equivalent. The results from these FSA samples were used in the SWMU 20 PRE.



LEGEND

- ● SAMPLE LOCATION
- 020SGB01 BORING NUMBER
- ▨ LOCATION OF FORMER TANK
- GW FLOW → GROUNDWATER FLOW DIRECTION IN FLUVIAL DEPOSITS

50 0 50

SCALE FEET

ASSEMBLY F
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FIGURE 7.1.1
SWMU 20
SAMPLE LOCATIONS

DWG DATE: 10/20/97 | DWG NAME: 106TVC20

Three surface soil screening samples were collected for VOC screening analysis from DPT locations 020SGB01, 020SGB03, and 020SGB04 to determine whether surface releases had occurred. The surface soil sample from DPT location 020SGB01 was analyzed for both FSA under Level IV DQOs or equivalent and for VOC screening at the onsite laboratory for results comparison.

Subsurface soil samples were collected from DPT locations 020SGB01 through 020SGB04 at intervals of 5 to 7 feet bgs, which corresponds to the bottom of the former UWT, and from 11 to 13 feet bgs, which is within the saturated interval of the loess. Four loess groundwater samples were proposed in the CSI work plan, but because of poor recharge and problems with the sampling equipment, the loess groundwater samples were substituted with saturated soil samples.

Groundwater samples were collected from the upper portion of the fluvial deposits aquifer at DPT locations 020SGB01, 020SGB02, and 020SGB04 to determine whether the contents of the UWT had impacted groundwater in this unit.

1,1-Dichloroethene was detected in subsurface soil samples collected in DPT locations 020SGB01 through 020SGB04 at the 5- to 7- and the 11- to 13-foot soil sampling intervals. Due to these detections, subsurface soil samples were collected for VOC screening analysis at DPT locations 020SGB05 and 020SGB06 at depths of 5 to 7 feet and 11 to 13 feet to determine whether the 1,1-dichloroethene had migrated horizontally away from the former UWT.

Some variations to the proposed sampling scheme were necessary, as listed below:

- Surface soil samples were collected from 0 to 1 foot bgs beneath asphalt. These samples were proposed to be collected with a stainless-steel hand auger; however, the paved surface prevented true sampling of surface soil. Therefore, these samples were collected using the DPT equipment proposed for deeper intervals. The sampling tool had to be pushed several times at each location to collect the required sample volume.

- Subsurface samples were proposed for collection from 1-foot intervals (e.g., 5 to 6 feet). Instead, 2-foot intervals were sampled by pushing the 2-foot DPT soil sampler its entire length.

- Groundwater samples were to be collected with a DPT stainless-steel, groundwater sampling tool from both the loess and the fluvial deposits aquifers. However, the loess did not produce sufficient quantities of water for samples. Therefore, soil samples were collected from the saturated interval where loess groundwater samples had been proposed.

- Due to a mechanical failure of the DPT rig, no fluvial deposits groundwater sample was collected from location 020SGB03. No attempt was made to return and collect this sample because four other sampling locations are within (20 feet) and because the location was hydraulically upgradient of the former tank pit.

7.1.3 Confirmatory Sampling Results

Tables and figures in this section present the analytical results for all soil and groundwater samples collected during this CSI. The tables present the compound or analyte, sample collection depths, frequency of detection, and minimum, maximum, and mean of all concentrations detected that exceeds the practical quantitation limit (PQL). Values for organic analyses of soil are compared to each compound's corresponding RBC for both residential and industrial scenarios, and with the SSL for protection of groundwater as published in the USEPA Region III January to June 1996 RBC Table (June 1996). Inorganic results are compared to RCs from NSA Memphis, residential and industrial RBCs, and SSLs. Groundwater results are compared to tap water RBCs from the USEPA Region III tables and to maximum contaminant levels (MCLs) published in the Drinking Water Regulations and Health Advisories Table (USEPA, October 1996).

The results for the FSA samples analyzed under Level IV DQOs or equivalent, collected for use in the PRE are presented in Tables 7.1.1 through 7.1.4. VOC screening sample results for both soil and groundwater samples analyzed under Level III DQOs are presented in tables 7.1.5 through 7.1.8. The VOC results for the FSA samples are not compared with the results for the VOC screening samples because they have different DQOs, different analytical methods and different analyte lists. Both data sets were used to identify COPCs in the PRE. The VOC split screening samples were analyzed as quality control (QC) samples to check the reproducibility of the data are presented with the screening sample results. The data are also presented on Figures 7.1.2 through 7.1.4, which show sampling locations where applicable RBCs, RCs, SSLs, or MCLs were exceeded. Results for both the FSA surface soil samples and the VOC screening surface soil samples are presented on Figure 7.1.3.

Organics in Surface Soil Samples analyzed under Level IV DQOs

As indicated in Tables 7.1.1 and 7.1.2, eight organic compounds were detected in FSA surface soil samples from SWMU 20. Of these eight, none exceeded its residential or industrial RBCs, while two exceeded their SSLs.

- Dieldrin exceeded its SSL (1 μg/kg) in one surface soil sample 020SGB0201 (4 μg/kg) .

- Methylene chloride exceeded its SSL (10 μg/kg) in one surface soil sample 020SGB0101 (13 μg/kg).

Although the SSL for dieldrin is exceeded in the surface soil sample from location 020SGB02, the concentrations detected at SWMU 20 are less than the 262 μg/kg RC for dieldrin.

No RBC values exist for TPH or TPH-GRO/DRO. Therefore, TDEC soil-cleanup values were used for comparison. TDEC has established three cleanup concentrations for TPH; these are 250,000 μg/kg, 500,000 μg/kg and 1,000,000 μg/kg, depending on the permeability of the site

soil. Currently, there are no permeability data for SWMU 20. However, based on other sites investigated on the NSA Memphis Southside, either the 500,000 μg/kg or the 1,000,000 μg/kg cleanup standard will most likely apply to this site. Future sampling at SWMU 20 should include permeability analysis to confirm the appropriate TDEC cleanup standard.

- TPH was detected in samples 020SGB0101 (680,000 μg/kg) and 020SGB0201 (180,000 μg/kg). The TPH detected in these samples may have resulted from the overlying asphalt.

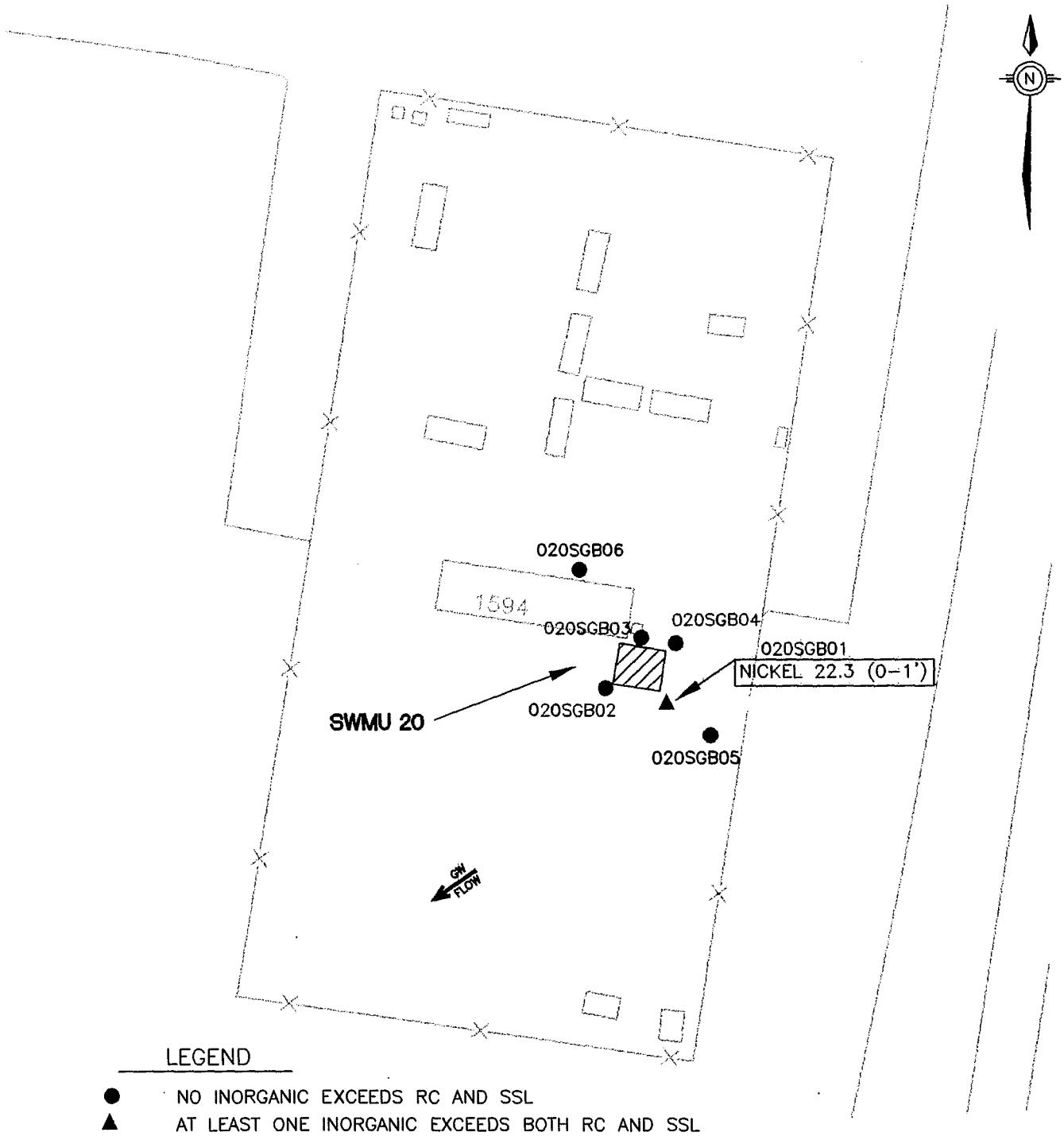
- TPH-GRO was detected in samples 020SGB0101 (63 μg/kg) and 020SGB0201 (70 μg/kg).

- TPH-DRO was detected in samples 020SGB0101 (18,000 μg/kg) and 020SGB0201 (69,000 μg/kg).

Table 7.1.1
SWMU 20
Organics Detected in Surface Soil
Results in μg/kg

Parameter	020SGB0101	020SGB0201
Acetone	**120**	**41**
Aldrin	1	4
bis(2-Ethylhexyl)phthalate (BEHP)	**ND**	**780**
1,1-Dichloroethane	6	ND
1,1-Dichloroethene	**8**	**ND**
Dieldrin [a]	ND	**4**
Methylene chloride [a]	**13**	**ND**
Total petroleum hydrocarbons (418.1)	680,000	180,000
Toluene	**ND**	**1**
TPH - diesel range organics	18,000	69,000
TPH - gasoline range organics	63	70

Notes:
a — Exceeds SSL
ND — Not detected above the PQL
bold — Bold text indicates a compound that exceeds a screening criterion.



LEGEND

- ● NO INORGANIC EXCEEDS RC AND SSL
- ▲ AT LEAST ONE INORGANIC EXCEEDS BOTH RC AND SSL
- LOCATION OF FORMER TANK
- 020SGB01 — BORING NUMBER
- NICKEL 22.3 (0-1') — CONSTITUENT EXCEEDING THE RC AND SSL, REPORTED CONCENTRATION IN mg/kg, AND SAMPLE DEPTH.
- GW FLOW — GROUNDWATER FLOW DIRECTION IN FLUVIAL DEPOSITS

50 0 50

SCALE FEET

ASSEMBLY F
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FIGURE 7.1.2
SWMU 20
RC AND SSL EXCEEDANCES FOR INORGANICS IN SURFACE SOIL

DWG DATE: 10/20/97 | DWG NAME: 106RCSSL

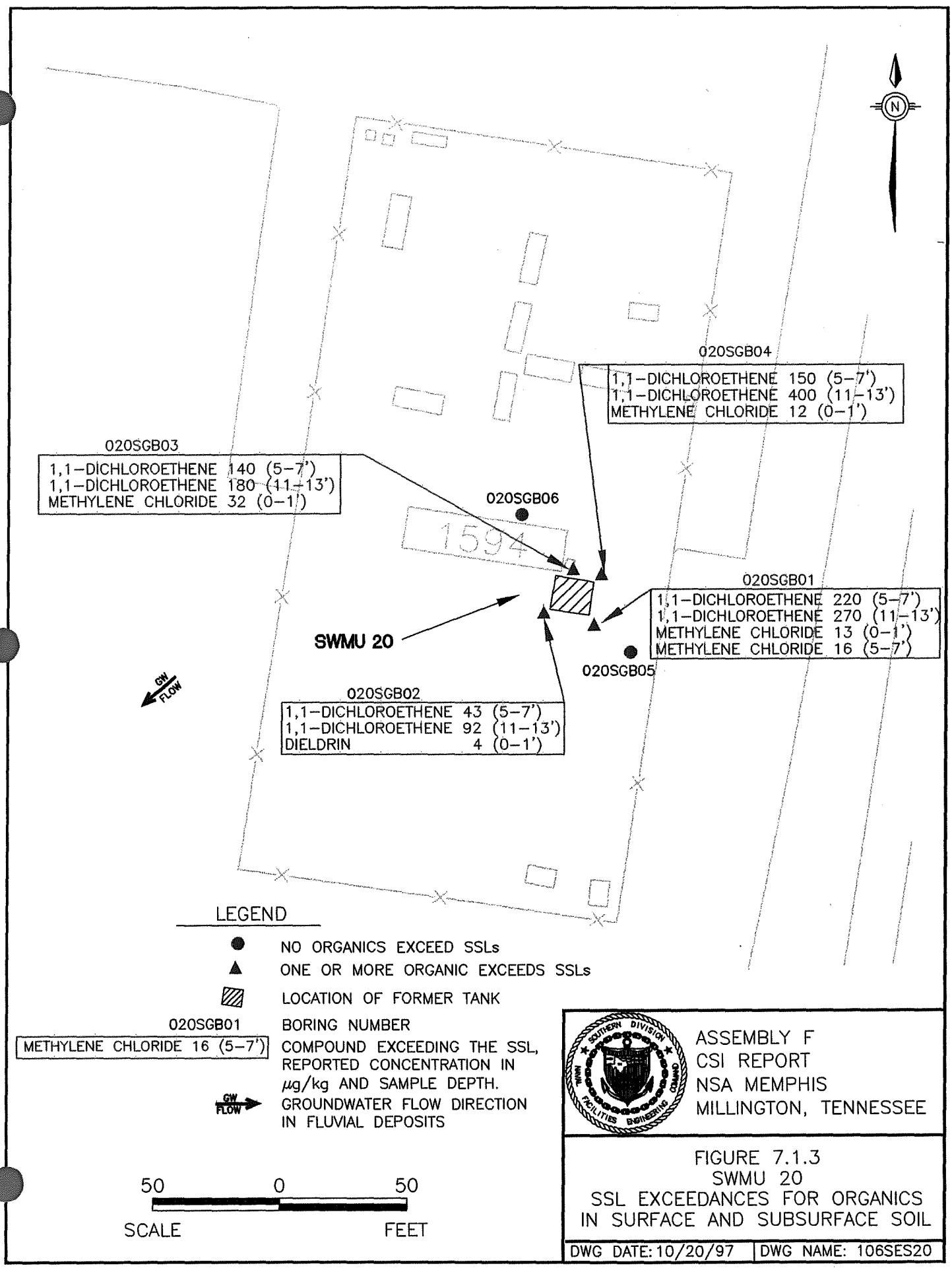

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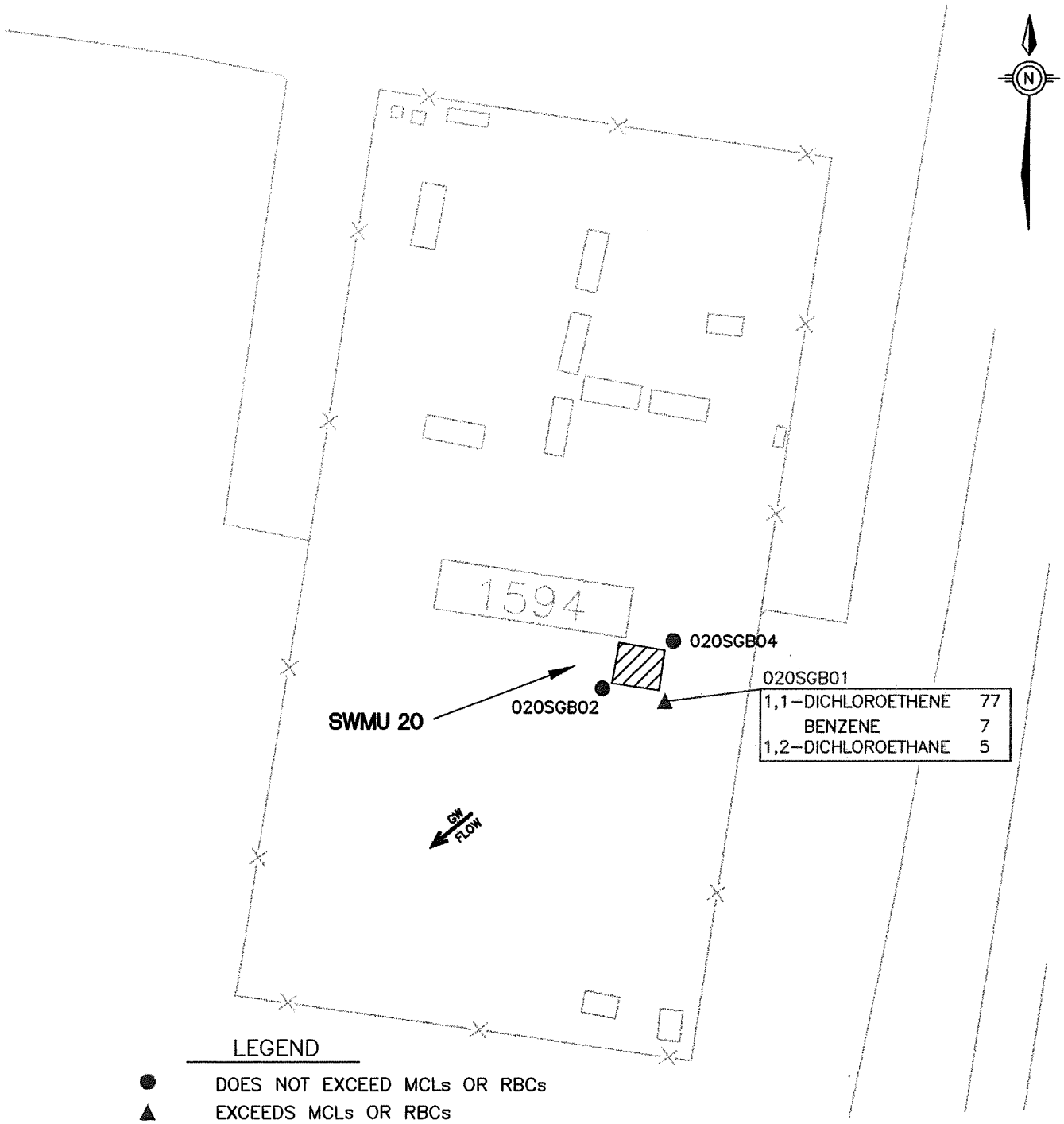
FIGURE 7.1.3
SWMU 20
SSL EXCEEDANCES FOR ORGANICS
IN SURFACE AND SUBSURFACE SOIL

DWG DATE: 10/20/97 | DWG NAME: 106SES20



LEGEND

- ● DOES NOT EXCEED MCLs OR RBCs
- ▲ EXCEEDS MCLs OR RBCs
- 1,1-DICHLOROETHENE 77 — VOC THAT EXCEEDS ITS MCL OR RBC AND REPORTED CONCENTRATION IN $\mu g/L$
- LOCATION OF FORMER TANK
- 020SGB01 — BORING NUMBER
- GW FLOW — GROUNDWATER FLOW DIRECTION IN FLUVIAL DEPOSITS

50 0 50

SCALE FEET

ASSEMBLY F
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FIGURE 7.1.4
SWMU 20
MCL AND RBC EXCEEDANCES
FOR VOCs IN FLUVIAL
DEPOSITS GROUNDWATER

DWG DATE: 10/20/97 | DWG NAME: 106REXFN

Table 7.1.2
SWMU 20
Summary of Organics Detected in Surface Soil
Results in μg/kg

Parameter	Sample Interval [a]	Frequency of Detection	Range of Detection [b]	Mean [c]	Residential Soil RBC [d]		RBC - Res. Exceedances [d]	Industrial Soil RBC		RBC-Ind. Exceedances	SSL [e]	SSL Exceedance [f]
Acetone	0-1'	2/2	41 - 120	81	7,800,000	N	0	200,000,000	N	0	8,000	No
Aldrin	0-1'	2/2	1 - 4	3	38	C	0	340	C	0	5	No
bis(2-Ethylhexyl)phthalate (BEHP)	0-1'	½	780 - 780	780	46,000	C	0	410,000	C	0	11,000	No
1,1-Dichloroethane	0-1'	½	6 - 6	6	7,800,000	N	0	200,000,000	N	0	11,000	No
1,1-Dichloroethene	0-1'	½	8 - 8	8	1,100	C	0	9,500	C	0	30	No
Dieldrin [g]	0-1'	½	4 - 4	4	40	C	0	360	C	0	1	Yes
Methylene chloride	0-1'	½	13 - 13	13	85,000	C	0	760,000	C	0	10	Yes
Petroleum Hydrocarbons, TPH	0-1'	2/2	180,000 - 680,000	430,000	NA [h]	NA	NA	NA [h]	NA	NA	NA	NA
Toluene	0-1'	½	1 - 1	1	16,000,000	N	0	410,000,000	N	0	5,000	No
TPH - Diesel Range Organics	0-1'	2/2	18,000 - 69,000	43,500	NA [h]	NA	NA	NA [h]	NA	NA	NA	NA
TPH - Gasoline Range Organics	0-1'	2/2	63 - 70	67	NA [h]	NA	NA	NA [h]	NA	NA	NA	NA

Notes:

a — Feet below ground surface
b — Range lower limit is the lowest detected concentration.
c — Mean is based on detected concentrations only.
d — Residential and industrial screening values (RBC-Res., RBC-Ind.) are from USEPA Region III Risk-Based Concentration Table, January to June 1996.
e — SSL considered protective of contaminant transfer from soil to groundwater (from USEPA Region III Risk-Based Concentration Table, January to June 1996)
f — A "Yes" in this column indicates that at least one sample result exceeded the SSL for this analyte; a "No" indicates no sample results exceeding the SSL.
g — Dieldrin concentrations reported at SWMU 20 do not exceed dieldrin's RC of 262 μg/kg as shown in the January 9, 1997, Surface Soil (0 to 1 foot) Background Dieldrin Concentrations at NSA Memphis Technical Memorandum.
h — RBC value does not exist for TPH. Cleanup levels have been established by TDEC. Either 250,000 μg/kg, 500,000 μg/kg or 1,000,000 μg/kg is applicable depending on soil permeabilities. The appropriate level will be determined during subsequent investigation of this site (if applicable.)
NA — Not applicable
N — noncarcinogen-based RBC
C — carcinogen-based RBC

Inorganics in Surface Soil

As presented in Tables 7.1.3 and 7.1.4, only one of 14 inorganics detected at SWMU 20 exceeded both its RC and SSL. None of the inorganics detected at SWMU 20 exceeded both its RC and residential or industrial RBC.

- Nickel exceeded its surface soil RC [20.62 milligrams per kilogram (mg/kg)] and SSL (21 mg/kg) in sample 020SGB0101 (22.3 mg/kg).

Table 7.1.3
SWMU 20
Inorganics Detected in Surface Soil
Results in mg/kg

Parameter	020SGB0101	020SGB0201
Arsenic	**8.8**	**12**
Barium	140	82.4
Beryllium	**0.5**	**0.4**
Chromium	11.4	10.8
Cobalt	**8.6**	**6.4**
Copper	14.2	15.1
Lead	**13.3**	**12.7**
Mercury	0.03	0.03
Nickel	**22.3**	**15.7**
Selenium	0.3	0.2
Silver	**ND**	**2.1**
Tin	19.6	8.3
Vanadium	**21.9**	**20.7**
Zinc	41.8	44.1

Notes:
bold — Exceeds its RC and SSL
ND — Not detected above the instrument detection limit (IDL).
mg/kg — milligrams per kilogram

Table 7.1.4
SWMU 20
Summary of Inorganics Detected in Surface Soil
Results in mg/kg

Parameter	Sampling Interval [a]	Frequency of Detection	Range of Detection [b]	Mean [c]	Inorganic RC [d]	RC Exceedances	Residential Soil RBC [e]		RBC-Res. Exceedances	Industrial Soil RBC [e]		RBC-Ind. Exceedances	SSL [f]	SSL Exceeded [g]
Arsenic	0-1'	2/2	8.8 - 12	10	14.58	0	0.48	C	2	3.8	C	2	15	No
Barium	0-1'	2/2	82.4 - 140	111	223.46	0	5,500	N	0	140,000	N	0	32	Yes
Beryllium	0-1'	2/2	0.38 - 0.47	0.43	1.0	0	0.15	C	2	1.3	C	0	180	No
Chromium	0-1'	2/2	10.8 - 11.4	11.1	23.89	0	390 [h]	N	0	10,000 [h]	N	0	19 [h]	No
Cobalt	0-1'	2/2	6.4 - 8.6	7.5	15.98	0	4,700	N	0	120,000	N	0	NA	NA
Copper	0-1'	2/2	14.2 - 15.1	14.7	24.19	0	3,100	N	0	82,000	N	0	NA	NA
Lead	0-1'	2/2	12.7 - 13.3	13.0	26.03	0	400 [i]	NA	0	1,300 [i]	NA	0	NA [i]	NA
Mercury	0-1'	2/2	0.03 - 0.03	0.03	0.46	0	23	N	0	610	N	0	3	No
Nickel	0-1'	2/2	15.7 - 22.3	19.0	20.62	1	1,600	N	0	41,000	N	0	21	Yes
Selenium	0-1'	2/2	0.18 - 0.27	0.23	BDL	NA	390	N	0	10,000	N	0	3	No
Silver	0-1'	1/2	2.1 - 2.1	2.1	2.05	1	390	N	0	10,000	N	0	NA	NA
Tin	0-1'	2/2	8.3 - 19.6	14.0	33.56	2	47,000	N	0	1,000,000	N	0	NA	NA
Vanadium	0-1'	2/2	20.7 - 21.9	21.3	45.11	0	550	N	0	14,000	N	0	NA	NA
Zinc	0-1'	2/2	41.8 - 44.1	43.0	98	0	23,000	N	0	610,000	N	0	42,000	No

Notes:

a — Feet below ground surface
b — Range lower limit is the lowest detected concentration.
c — Mean is based on detected concentrations only.
d — Background reference concentration.
e — Residential and industrial screening values (RBC-Res., RBC-Ind.) are from USEPA Region III Risk-Based Concentration Table, January to June 1996.
f — SSL considered protective of contaminant transfer from soil to groundwater (from USEPA Region III Risk-Based Concentration Table, January to June 1996)
g — A "Yes" in this column indicates that at least one sample result exceeded the SSL for this analyte; a "No" indicates no sample results exceeding the SSL.
h — RBC for hexavalent chromium (VI).
i — Value is soil cleanup level for total lead (USEPA OSWER Directive, 9355.4-12).
NA — Not applicable
BDL — Below detection limit
N — noncarcinogen-based RBC
C — carcinogen-based RBC
mg/kg — milligrams per kilogram

Table 7.1.5
SWMU 20
VOCs Detected in Surface and Subsurface Soil Screening Samples
Results in μg/kg

Parameter	Sample Interval	020SGB01	020SGB02	020SGB03	Split Sample 020SGB03	020SGB04	Split Sample 020SGB04	020SGB05	020SGB06
	0-1	NS	NS	ND	NS	ND	NS	NS	NS
Benzene	5-7	ND	ND	ND	3.0	ND	5.0	ND	ND
	11-13	NS	NS	ND	NS	ND	NS	NS	NS
	0-1	ND	ND	14	NS	22	NS	ND	ND
1,1-Dichloroethane	5-7	290	35	140	120	68	290	ND	ND
	11-13	1100	68	212	NS	280	NS	1.4	ND
	0-1	24	ND	23	NS	77	NS	ND	ND
1,1-Dichloroethene	5-7	**220**	**43**	**140**	**50**	**150**	**210**	ND	ND
	11-13	**270**	**92**	**180**	NS	**400**	NS	ND	ND
	0-1	NS	NS	ND	NS	ND	NS	NS	NS
1,2-Dichloroethene (total)	5-7	ND	ND	ND	ND	ND	2.0	ND	ND
	11-13	NS	NS	ND	NS	ND	NS	NS	NS
	0-1	**13**	ND	**32**	NS	**12**	NS	ND	ND
Methylene chloride	5-7	**16**	ND	ND	**32**	ND	ND	ND	ND
	11-13	ND	ND	ND	NS	ND	NS	ND	ND
	0-1	ND	ND	ND	NS	ND	NS	ND	NS
1,1,1-Trichloroethane	5-7	34	ND	28	46	25	160	ND	ND
	11-13	ND	45	14	NS	140	NS	ND	ND
	0-1	NS	NS	ND	NS	ND	NS	NS	NS
1,1,2-Trichloroethane	5-7	ND	ND	ND	ND	ND	7.0	ND	ND
	11-13	NS	NS	ND	NS	ND	NS	NS	NS
	0-1	NS	NS	ND	NS	ND	NS	NS	NS
Trichloroethene	5-7	ND	ND	ND	ND	ND	4.0	ND	ND
	11-13	NS	NS	ND	NS	ND	NS	NS	NS
	0-1	NS	NS	ND	NS	ND	NS	NS	NS
Xylene (Total)	5-7	ND	ND	ND	18	ND	5.0	ND	ND
	11-13	NS	NS	ND	NS	ND	NS	NS	NS

Notes:
Bold — Bold text indicates an SSL exceedance.
ND — Compound was not detected above the PQL.
NS — Interval was not sampled

Table 7.1.6
SWMU 20
VOC Screening Results Summary for Surface and Subsurface Soil
Results in μg/kg

Parameter	Sample Interval[a]	Frequency of Detection[b]	Range of Detection[c]	Mean[d]	Residential Soil RBC[e]		RBC Res. Exceedances	Industrial Soil RBC[d]		RBC Ind. Exceedances	SSL[e]	SSL Exceedance[g]
Benzene	5-7'	2/8	3 - 5	4	NA		NA	NA		NA	20	No
	0-1'	2/6	1.4 - 22	18	7,800,000	N	0	200,000,000	N	0	NA	NA
1,1-Dichloroethane	5-7'	6/8	2 - 290	157	NA		NA	NA		NA	11,000	No
	11-13'	5/6	68 - 1100	332	NA		NA	NA		NA	11,000	No
Total 1,2-Dichloroethane	5-7'	1/8	2 - 2	2	NA		NA	NA		NA	10	No
	0-1'	3/4	23 - 77	41	9,500	C	0	1,100	C	0	NA	NA
1,1-Dichloroethene	5-7'	6/8	43 - 220	136	NA		NA	NA		NA	30	Yes
	11-13'	4/6	92 - 400	236	NA		NA	NA		NA	30	Yes
	0-1'	3/6	12 - 32	19	85,000	C	0	760,000	C	0	NA	NA
Methylene chloride	5-7'	2/6	16 - 32	16	NA		NA	NA		NA	10	Yes
	11-13'	0/6	0 - 0	ND	NA		NA	NA		NA	10	No
	0-1'	0/6	0 - 0	ND	2,700,000	N	0	72,000,000	N	0	NA	NA
1,1,1-Trichloroethane	5-7'	5/8	25 - 160	59	NA		NA	NA		NA	900	No
	11-13	3/6	14 - 140	66	NA		NA	NA		NA	900	No
1,1,2-Trichloroethane	5-7'	1/8	7 - 7	7	NA		NA	NA		NA	10	No
Trichloroethene	5-7'	1/8	4 - 4	4	NA		NA	NA		NA	20	No
Total Xylenes	5-7'	2/8	5 - 18	12	NA		NA	NA		NA	74,000	No

Notes:

a — Feet below ground surface
b — Total number of samples varies due to split samples. A total of six locations were sampled at this site, for a total of six samples per sampling interval. Split samples were collected at the 5-to 7-foot interval of two borings, for a total of 8 samples at this sampling interval.
c — Range lower limit is the lowest detected concentration.
d — Mean is based on detected concentrations only.
e — Residential and industrial screening values (RBC-Res., RBC-Ind.) are from the January to June 1996 Risk-Based Concentration Table (from USEPA Region III Risk-Based Concentration Table, January to June 1996).
f — SSL considered protective of contaminant transfer from soil to groundwater (from USEPA Region III Risk-Based Concentration Table, January to June 1996).
A "Yes" in this column indicates that at least one sample result exceeded the SSL for this analyte; a "No" indicates no sample results exceeding the SSL.
NA — Not applicable
N — noncarcinogen-based RBC
C — carcinogen-based RBC

VOCs in Surface and Subsurface Soil

As presented in Tables 7.1.5 and 7.1.6, nine VOCs were detected in the 15 screening samples analyzed onsite. Of these nine compounds, two exceeded SSLs.

- 1,1-Dichloroethene exceeded its SSL (30 μg/kg) in eight samples from four DPT locations: 020SGB0107 (220 μg/kg), 020SGB0113 (270 μg/kg), 020SGB0207 (43 μg/kg), 020SGB0213 (92 μg/kg), 020SGB0307 (140 μg/kg), 020SGB0313 (180 μg/kg), 020SGB0407 (150 μg/kg), and 020SGB0413 (400 μg/kg).

- Methylene chloride exceeded its SSL (10 μg/kg) in five samples from three DPT locations: 020SGB0101 (13 μg/kg), 020SGB0107 (16 μg/kg), 020SGB0301 (32 μg/kg), 020SGB0307 (32 μg/kg), and 020SGB0401 (12 μg/kg).

Table 7.1.7
SWMU 20
VOCs Detected in Fluvial Deposits Groundwater
Screening Samples
Results in μg/L

Parameter	020GGB01-47	Split Sample 020GGB0147
Benzene	**ND**	**7**
1,1-Dichloroethane	520	600
1,1-Dichloroethene	**77**	**70**
1,2-Dichloroethane	ND	**5**
1,1,1-Trichloroethane	**ND**	**21**
1,1,2-Trichloroethene	ND	17

Notes:
bold — Bold text indicates an MCL exceedance.
μg/L — micrograms per liter

Table 7.1.8
SWMU 20
VOC Screening Results Summary for Fluvial Deposits Groundwater
Results in μg/L

Parameter	Sample Interval [a]	Frequency of Detection [b]	Range of Detection [c]	Mean [d]	Tap Water RBC [e]		Tap Water RBC Exceedances	MCL [f]	MCL Exceedances
Benzene	47'	1/4	7 - 7	7	0.36	C	1	5	1
1,1-Dichloroethane	47'	2/4	520 - 600	560	810	C	0	NA	NA
1,1-Dichloroethene	47'	2/4	70 - 77	74	0.044	C	2	7	2
1,2-Dichloroethane	47'	1/4	5 - 5	5	0.12	C	1	5	1
1,1,1-Trichloroethane	47'	1/4	21 - 21	21	790	N	0	200	0
1,1,2-Trichloroethene	47'	1/4	17 - 17	17	NA		NA	NA	NA

Notes:

a — Feet below ground surface
b — Total number of samples includes the split sample.
c — Range lower limit is the lowest detected concentration.
d — Mean is based on detected concentrations only.
e — Tap water RBCs are from USEPA Region III Risk-Based Concentration Table, January to June 1996.
f — MCL values are from the Drinking Water Regulations and Health Advisories Table (October 1996, USEPA).
C — carcinogen-based RBC
N — noncarcinogen-based RBC
NA — not available
μg/L — micrograms per liter

VOCs in Groundwater

Six VOCs were detected in fluvial deposits groundwater at SWMU 20, as presented in Tables 7.1.7 and 7.1.8, three of which exceeded its tap water RBC and MCL.

- Benzene exceeded its tap water RBC (0.36 μg/L) and MCL (5 μg/L) in split groundwater sample 020GGB0147 (7 μg/L)

- 1,1-Dichloroethene exceeded its tap water RBC (0.044μg/L) and MCL (7 μg/L) in groundwater sample 020GGB0147 (77 μg/L), and its split sample (70 μg/L).

- 1,2-Dichloroethane exceeded its tap water RBC (0.12 μg/L) and MCL (5 μg/L) in split groundwater sample 020GGB0147 (5 μg/L)

7.1.4 Preliminary Risk Evaluation

In accordance with *Guidance on Preliminary Risk Evaluations for the Purpose of Reaching a Finding of Suitability to Lease* (USEPA Region IV memorandum, November 1994), a PRE was conducted for SWMU 20 using data from surface soil and groundwater samples collected during the CSI. Subsurface soil data are addressed in Section 7.1.5. Soil and groundwater samples were analyzed for VOCs; two surface soil samples were submitted to an offsite laboratory for FSA; and approximately 25% of all samples analyzed for VOCs were split for Level IV DQO or equivalent confirmatory analysis at an offsite laboratory. The PRE was conducted by identifying COPCs from the original set of detected chemicals, calculating the risk ratio for each COPC, and interpreting those results, as described in Section 5.

Tables 7.1.3, 7.1.5, and 7.1.7 show screening results for organic compounds detected in surface soil, inorganics detected in surface soil, and VOCs detected in fluvial deposits groundwater, respectively. The COPCs identified at SWMU 20, based on the method described in Section 5, are benzene, 1,1-dichloroethane, 1,1-dichloroethene, 1,2-dichloroethane, and 1,1,2-trichloroethane in fluvial deposits groundwater, and nickel in surface soil. Table 7.1.9 summarizes PRE results for both COPCs.

Conclusions and Recommendations

Based on the information gathered during the investigation, the following conclusions and recommendations have been reached based on a PRE performed on data from surface soil and fluvial deposits groundwater:

Residential Land Use

- Carcinogens: The cumulative risk for the residential scenario was estimated to be approximately 2E-03, indicating that further discussion and/or investigation may be warranted to determine the suitability of the SWMU 20 area for lease for residential land use, in accordance with USEPA Region IV's November 1994 memorandum.

- Noncarcinogens: The cumulative residential HI was estimated to be approximately 0.7, which is less than the risk threshold of 1 for a residential land use scenario in accordance with USEPA Region IV's November 1994 memorandum.

Table 7.1.9
SWMU 20
Preliminary Risk Evaluation

Chemical	Maximum Reported Concentration	Units	Residential RBC	Residential Hazard Quotient	Residential ILCR	Industrial RBC	Industrial Hazard Quotient	Industrial ILCR
Fluvial Deposits Groundwater								
Benzene	7	µg/L	0.36C	NA	1.39E-5	1.44C	NA	3.44E-6
1,1-Dichloroethane	600	µg/L	81 N	0.74	NA	324 N	0.185	NA
1,2-Dichloroethane	5	µg/L	0.12C	NA	4.17E-5	0.48C	NA	1.04E-5
1,1-Dichloroethene	77	µg/L	0.044 C	NA	1.75E-03	0.176 C	NA	4.4E-04
1,1,2-Trichloroethane	17	µg/L	0.19C	NA	8.95E-5	0.76C	NA	2.23E-5
Sum				0.74	1.76E-3		0.185	4.76E-4

Notes:

RBC — Risk-based concentration from USEPA Region III's June 1996 RBC Table; in accordance with USEPA Region IV's Supplemental Guidance to RAGS Bulletin 1, noncarcinogen RBCs above were conservatively adjusted to reflect a hazard quotient of 0.1; residential RBCs were divided by 0.25 for VOCs and were divided by 0.5 for all other compounds to calculate RBCs for nonresidential (industrial) groundwater, in accordance with USEPA Region IV PRE Guidance.

N — Noncarcinogen

C — Carcinogen

NA — Not applicable

ILCR — Incremental lifetime excess cancer risk

Industrial Land Use

- Carcinogens: The cumulative risk for the industrial scenario was estimated to be approximately 5E-04, indicating that further discussion and/or investigation may be warranted to determine the suitability of the property for lease for industrial land use, in accordance with USEPA Region IV's November 1994 memorandum.

- Noncarcinogens: The cumulative HI for the industrial scenario was estimated to be approximately 0.2, which is less than the risk threshold for an industrial land use scenario in accordance with USEPA Region IV's November 1994 memorandum.

7.1.5 Fate and Transport

The approach for evaluating the fate and transport of Assembly F contaminants was discussed in Section 6.2. This section applies that approach to contaminants detected at SWMU 20. Transport processes for analytes other than those designated as COPCs will also be discussed if they occur in multiple environmental media, or have the potential to migrate to other media.

Potential migration pathways for contaminants at SWMU 20 include leaching from soil to groundwater and erosion of surface soil containing sorbed contaminants from the unpaved, grass-covered areas, forming sediments in drainage ways. The soil-to-sediment transport mechanism is limited since most of SWMU 20 is covered with asphalt. Surface soil analytical data indicate that no VOCs exceeded their respective soil-to-air SSL, therefore the soil-to-air cross-media transport process is not discussed.

SWMU 20 COPCs include:

- Dieldrin, which exceeded its soil-to-groundwater SSL in soil.
- 1,1-Dichloroethene exceeded its soil-to-groundwater SSL in soil.
- Methylene chloride, which exceeded its soil-to-groundwater SSL in soil.
- Nickel, which exceeded its soil-to-groundwater SSL and background RC in soil.
- 1,1-Dichloroethene, which was identified as a COPC in groundwater in the PRE and exceeded its MCL in groundwater.
- 1,1-Dichloroethane, which was identified as a COPC in groundwater in the PRE and exceeded its MCL in groundwater.

7.1.5.1 Soil-to-Groundwater Cross-Media Transport

Two contaminants, 1,1-dichloroethane and 1,1-dichloroethene, were detected in both soil and groundwater at SWMU 20. These compounds were found in fluvial deposits groundwater, and were also detected in soil at 0 to 1 foot bgs, 5 to 7 feet bgs, and 11 to 13 feet bgs. Of these compounds, only 1,1-dichloroethene exceeded its SSL for soil-to-groundwater transfer. 1,1-Dichloroethene was detected at one of two FSA surface soil sample locations, three of three VOC screening surface sample locations, four of six VOC screening sample locations from depths of 5 to 7 feet bgs, and four of six VOC screening sample locations from depths of 11 to 13 feet bgs. Based on the frequency of detections of 1,1-dichloroethene, and the SSL exceedances in the subsurface sampling intervals, the potential exists for leaching to groundwater. However, only one of three groundwater sample locations indicated the presence of 1,1-dichloroethene in

groundwater, and this one detection was greater than its MCL. Since 1,1-dichloroethene is a VOC, its chemical and physical properties promote the possibility for soil-to-groundwater leaching.

SWMU 20 contaminants that exhibit the potential for soil-to-groundwater transport, based on comparison of soil concentrations to the groundwater-protection soil-screening criteria, are the VOC methylene chloride, the pesticide dieldrin, and the inorganic nickel.

Methylene chloride was detected in two sample depths (0 to 1 and 5 to 7 feet bgs) at four locations in concentrations ranging from 12 to 32 μg/kg. Presently, methylene chloride has not been detected in groundwater at SWMU 20. Although the conservative screening process has indicated the potential for isolated soil-to-groundwater migration of methylene chloride, widespread impacts to the fluvial deposits aquifer are not expected based on the concentrations in surface and subsurface soil.

Dieldrin was detected in one of two surface soil sample locations, but was not detected in subsurface soil samples. Dieldrin may be attributed to basewide aerial application during the 1950s and 1960s. The potential for dieldrin to migrate to groundwater is not likely due to its low solubility, vapor pressure, and Henry's law constant. Overall, dieldrin is anticipated to be immobile and persistent in the environment because of its effinity for binding to soil grains, not readily diffusing into groundwater. This hypothesis is supported by its absence in SWMU 20 groundwater.

Nickel exceeded its soil-to-groundwater SSLs as well as its background RC in surface soil at one location. Current groundwater results indicate that nickel is not a soil-to-groundwater migration concern; however, the potential exists for leaching to groundwater based on the SSL exceedance.

7.1.5.2 Soil-to-Sediment Cross-Media Transport

Contaminants detected in near-surface soil were evaluated to determine their potential for transport by erosional processes in areas with vegetation or asphalt, should this cover be removed. Drainage patterns and topography at SWMU 20 were also examined to determine whether site features would support contaminant transport.

Contaminants detected in surface soil consist of VOCs, SVOCs, pesticides, and inorganics. Only the VOC methylene chloride, the pesticide dieldrin, and the inorganic nickel are considered to be contaminants of concern in SWMU 20 surface soil. As described in Section 6, VOCs have a limited tendency to adsorb to soil solids and are more likely to volatilize to the atmosphere or leach to groundwater before being transported with soil particles. In general, pesticides tend to sorb to soil particles and are relatively immobile in the environment, leading to a likelihood of greater persistence in the environment than VOCs. Inorganic chemicals do not degrade, but may change chemical form or speciation in the environment. Like pesticides, inorganics tend to sorb to soil particles, rendering them immobile except when the particles become mobile.

Drainage patterns and the vegetation/asphalt cover at SWMU 20 leave little potential for surface soil to erode and form sediments that can become mobile via surface water. Therefore, the soil-to-sediment transport process at SWMU 20 is not considered significant.

7.1.6 Conclusions and Recommendations

Based on the data gathered during this investigation, the following conclusions and recommendations have been reached:

Conclusions

- SWMU 20 will be developed for commercial use according to the Base Reuse Plan.

- Eight organic compounds were detected in surface (0 to 1 foot) soil. Of these,

  — Dieldrin was detected in one surface soil sample at a concentration of 4 μg/kg that exceeded its SSL of 1 μg/kg. However, the detected concentrations did not exceed the RC of 262 μg/kg established for NSA Memphis in the 1996 technical memorandum, *Background Dieldrin Concentrations in Surface Soils.*

  — Methylene chloride was detected in one FSA surface soil sample at a concentration of 13 μg/kg, and one surface soil screening sample at a concentrations of 32 μg/kg, both exceeding its SSL of 10 μg/kg.

- TPH, TPH/GRO and TPH/DRO were detected in surface soil.

  — A cleanup standard will be established once the permeability of site soil has been determined. TPH concentrations exceed the more conservative cleanup standard of 100,000 mg/kg, but do not exceed the least stringent 1,000,000 mg/kg standard.

- Fourteen metals were detected in surface soil at SWMU 20. Of these,

  — only nickel exceeded both its background RC and SSL.

- Four organic compounds were detected in surface and subsurface screening samples. Of these,
  - 1,1-dichloroethene and methylene chloride were detected at concentrations that exceeded their SSLs.
- Six organic compounds were detected in one of the three fluvial deposits groundwater sampling locations. Of these,
  - 1,1-dichloroethene, 1,2-dichloroethane, and benzene exceeded their MCLs and tap water RBCs.
- Based on a PRE performed on data from samples collected from the surface interval, the following conclusions are made for:
  - Carcinogens: Cumulative soil cancer risk estimates for the residential and industrial scenarios were greater than the cumulative risk threshold of 1E-4 for PREs, indicating that the site is suitable for lease.
  - Noncarcinogens: Cumulative soil noncancer risk estimates for the residential and industrial scenarios were less than the cumulative HI threshold of 1.0 for PREs, indicating that the site is suitable for lease.

Recommendations

- Based on surface and subsurface soil, and groundwater data, a follow-up RFI is recommended at SWMU 20, including:

- Collecting permeability data to determine the appropriate cleanup standard for TPH, TPH-GRO, and TPH-DRO.

- Installing at least four monitoring wells to better define the nature and extent of chlorinated solvents identified in fluvial deposits groundwater and to confirm the direction of groundwater flow beneath the site.

- Conducting an ecological risk assessment

7.2 SWMUs 22 and 63 — Four Former USTs (SWMU 22) and One Former UWT (SWMU 63)

SWMU 22 consists of four USTs west of Building S-75 (Boiler Plant; Figure 7.2.1) that were installed in approximately 1944. According to NSA Memphis personnel in the Public Works Office, Environmental Division the tanks have since been removed but the removal date is unknown. Three of the USTs (1244, 1245, and 1246) stored fuel oil for the boiler plant and one (unnumbered) stored diesel fuel. USTs 1245 and 1246 each held 25,000 gallons, UST 1244 held 50,000 gallons, and the diesel UST held 280 gallons. The three large USTs were constructed of concrete with steel piping, while the diesel UST piping was steel.

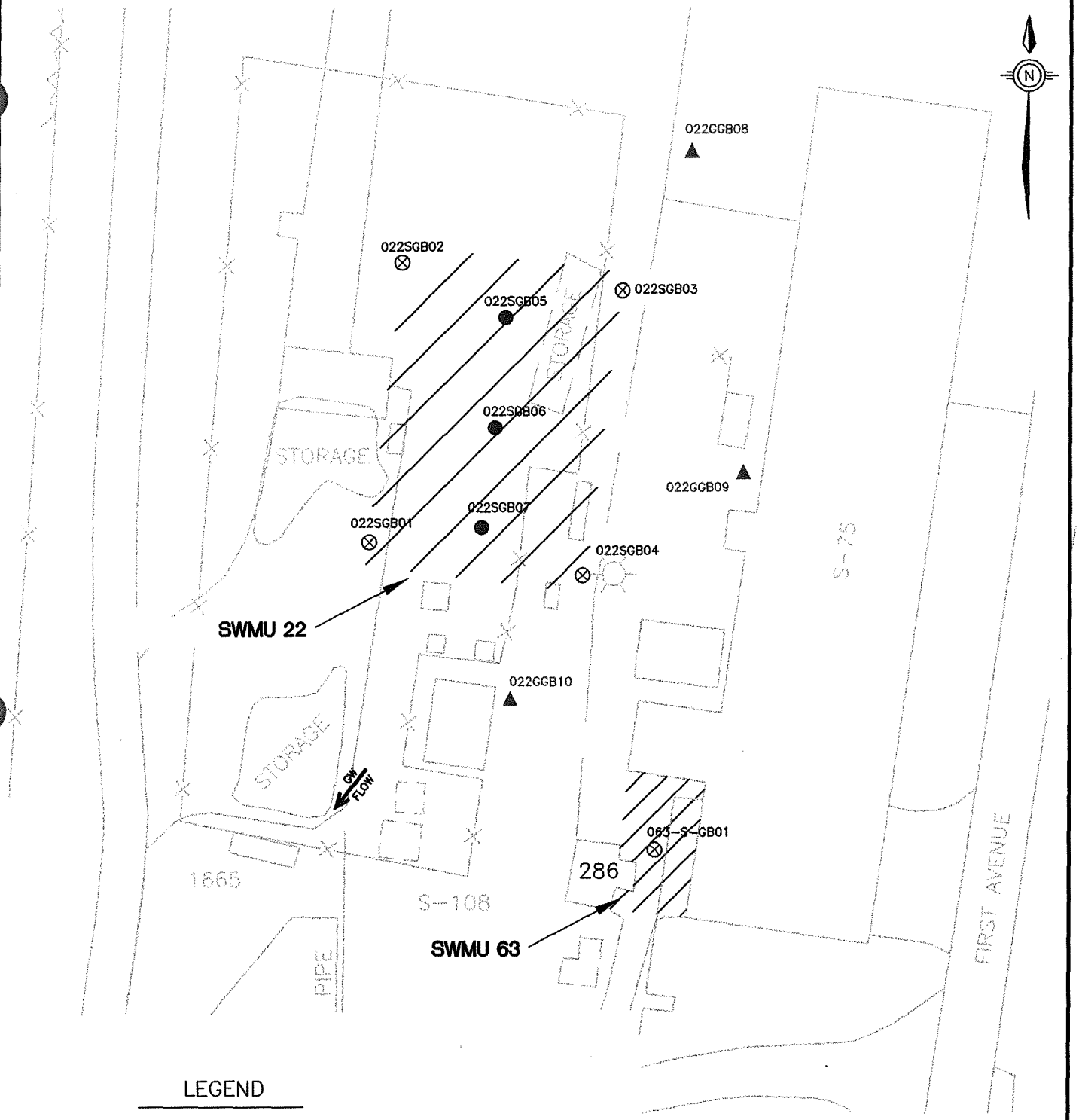
SWMU 63 consists of an approximately 7-foot by 7.5-foot area adjacent to the south west corner of Building S-75 (Figure 7.2.1) that formerly contained a 65-gallon, stainless-steel UWT. The UWT was removed in April 1992 and no soil contamination was evident. Because of their proximity, the investigation of SWMUs 22 and 63 were combined into one work plan.

SWMUs 22/63 and the surrounding area are characterized by relatively level, low-relief topography. The SWMU areas are covered by gravel, concrete or asphalt and surrounding areas have grass cover. Surface drainage is toward the west to a north-south oriented drainage ditch (SWMU 38) which flows into Big Creek Drainage Canal.

The regional and local hydrogeology are described in Sections 2.11 and 2.12, respectively, of the *Comprehensive RFI Work Plan*. Site-specific geologic and hydrogeologic information and references can be found in Section 2 of this report and in Section 2.2 of the Assembly F CSI Work Plan. Since soil and groundwater samples were collected by "blind" pushing of DPT tools to a predetermined depth without lithologic characterization, no additional site-specific information is available.

7.2.1 Previous Sampling Activities

The *Underground Storage Tank Closure Report, Tank No. S-75W* (National Salvage, 1992), contains information concerning the removal of the diesel UST at SWMU 22. When the diesel UST was removed, the excavated soil was stockpiled and sampled. Afterwards, confirmation soil samples were collected from the four corners of the open tank pit and a disposal sample was collected from the stockpiled soil. The tank-pit soil samples were analyzed for TPH-GRO and TPH-DRO, while the stockpiled soil was analyzed for BTEX; TPH; TPH-GRO and TPH-DRO; TCLP lead, benzene and flash point. Results for the four tank-pit samples indicated TPH-DRO concentrations of 5,187 ppm in the northwest corner, 5,008 ppm in the northeast corner, 11,259 ppm in the southeast corner, and 3,692 ppm in the southwest corner. The results for the stockpiled-soil sample indicated a TPH-DRO concentration of 755 ppm and a TCLP TPH-DRO of 0.697 ppm. All other analytical parameters for the tank-pit and the stockpiled-soil samples were less than method detection limits. The flash point of the stockpiled soil sample was greater than 160°F.



LEGEND

- ● SAMPLE LOCATION FOR SOIL ONLY
- ⊗ SAMPLE LOCATION FOR SOIL AND GROUNDWATER
- ▲ SAMPLE LOCATION FOR GROUNDWATER ONLY
- 022SGB01 BORING NUMBER
- GW FLOW → GROUNDWATER FLOW DIRECTION IN FLUVIAL DEPOSITS

50 0 50

SCALE FEET

ASSEMBLY F
CSI REPORT
NSA MEMPHIS
MILLINGTON, TENNESSEE

FIGURE 7.2.1
SWMUs 22 AND 63
SAMPLE LOCATIONS

DWG DATE: 07/16/97 | DWG NAME: 106V2263

Prior inspection reports for USTs 1244, 1245, and 1246 at SWMU 22 indicate they stored fuel oil and had no visible evidence of surface contamination or operational deficiencies.

The 65-gallon UWT at SWMU 63 was removed in April 1992 and had no visible evidence of surface contamination. Analysis of the contents removed from the UWT prior to its removal detected the following compounds and concentrations: methyl ethyl ketone at 22,000 ppm, acetone at 16,000 ppm, ethylbenzene at 20,000 ppm, toluene at 91,000 ppm, and xylenes at 110,000 ppm. Four soil samples collected from the SWMU 63 tank pit were analyzed for BTEX, TCLP metals, and TCLP volatiles. Analytical results for the soil samples were less than the detection limit for all parameters tested, but the RFA noted the soil in the tank pit would be analyzed for a more comprehensive list of VOCs and SVOCs to confirm whether hazardous substances were present.

7.2.2 Field Investigation

The CSI at SWMUs 22 and 63 was completed by collecting soil and groundwater samples from 10 DPT locations at SWMU 22 and one DPT location at SWMU 63 (Figure 7.2.1). All soil and groundwater samples were collected using DPT sampling equipment and techniques. Surface soil samples (0 to 1 foot bgs) were collected for VOC screening from DPT locations 022SGB01, 022SGB02, 022SGB03, 022SGB04, and 022SGB07 to detect possible surface spills. Surface soil samples were not collected from locations 022SGB05 or 022SGB06 because they were within the backfill material of the former tank pit. Surface soil samples collected from DPT locations 022SGB03 and 022SGB04 were submitted for both VOC screening analysis and FSA under Level IV DQOs or equivalent. The results from the FSA surface soil samples were used in the PRE for SMWUs 22 and 63.

Subsurface soil samples were collected from seven of the 10 DPT locations (022SGB01 through 022SGB07) at SWMU 22. Collection intervals for these subsurface soil samples were either 13 to

15 feet bgs or 14 to 16 feet bgs, which is the estimated depth of the former USTs. These samples also served as replacements for the five loess groundwater samples proposed for collection at these SWMUs. The loess groundwater samples were not collected due to limited recharge and problems with the sampling equipment. One subsurface soil sample was collected from 9 to 11 feet bgs at location 022SGB03, the first DPT location sampled at SWMU 22. This interval was not sampled at subsequent locations. As stated earlier, the bottoms of the tanks were estimated to be around 15 to 16 feet bgs, therefore, the 9- to 11-foot sampling interval would provide little useful information regarding possible releases from the USTs. Additionally, the 9- to 11-foot interval at three of the SWMU 22 location is within the fill material of the abandoned USTs. Subsurface soil samples were collected from 6 to 8 feet bgs and 14 to 16 feet bgs at SWMU 63. All subsurface soil samples were submitted for VOC screening analysis.

Groundwater samples were collected from the upper portion of the fluvial deposits aquifer at DPT locations 022SGB01 through 022SGB04 and at 063SGB01 to determine whether the contents of the SWMU 22 USTs or the SWMU 63 UWT had impacted fluvial deposits groundwater.

Ethylbenzene, methylene chloride, and m-xylene were detected in the fluvial deposits groundwater sample collected from DPT location 022SGB003, and methylene chloride was detected in the fluvial deposits groundwater sample from location 022SGB04. Due to these VOC detections, three additional DPT locations (022GGB08, 022GGB09, and 022GGB10; Figure 7.2.1) were sampled for VOC screening analysis to delineate the extent of these compounds in groundwater

7.2.3 Confirmatory Sampling Results

This section provides tables and figures presenting the analytical results for all soil and groundwater samples collected during this CSI at SWMUs 22/63. The tables present the compound or analyte, sample collection depths, frequency of detection, and minimum, maximum, and mean of all concentrations detected above the method PQL. Organic results are compared to

each compound's corresponding RBC for both residential and industrial scenarios, and to the SSL for protection of groundwater as published in the USEPA Region III Risk-Based Concentration Table. Inorganic results were also compared to RCs for NSA Memphis, residential and industrial RBCs, and SSLs. If the maximum detected concentration of a particular inorganic exceeded both its RC and RBC, it was retained as a COPC. Groundwater results are compared to tap water RBCs from the USEPA Region III tables and to MCLs published in the Drinking Water Regulations and Health Advisories Table (October 1996).

The results for the FSA samples analyzed under Level IV DQOs or equivalent, collected for use in the PRE are presented in Tables 7.2.1 through 7.2.4. VOC screening sample results for both soil and groundwater samples analyzed under Level III DQOs are presented in tables 7.2.5 through 7.2.8. The VOC results for the FSA samples are not compared with the results for the VOC screening samples because they have different DQOs, different analytical methods and different analyte lists. Both data sets were used to identify COPCs in the PRE. The VOC split screening samples were analyzed as quality control (QC) samples to check the reproducibility of the data are presented with the screening sample results. The data are also presented on Figures 7.2.2 through 7.2.5, which show sampling locations where applicable RBCs, RCs, SSLs, or MCLs were exceeded. Both the FSA surface soil sample results and the VOC screening surface soil sample results are presented on Figure 7.2.2.

Organics in Surface Soil

As indicated in Tables 7.2.1 and 7.2.2, 21 organic compounds and TPH, and TPH-DRO/GRO were detected in surface soil samples from SMWUs 22/63. Of these 21, two compounds exceeded residential RBCs. None exceeded industrial RBCs or SSLs.

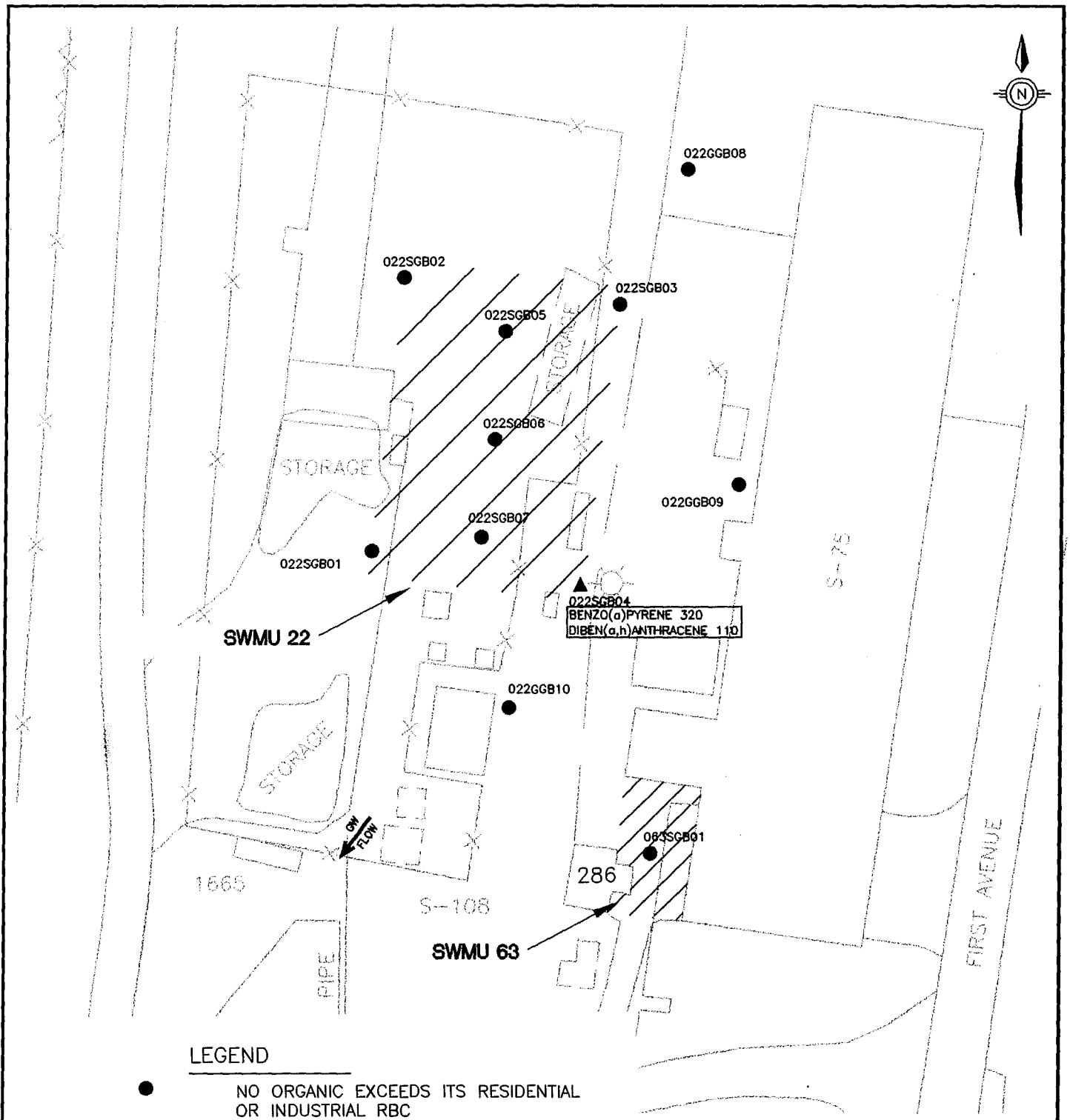
- Benzo(a)pyrene exceeded its residential RBC (88 μg/kg) in sample 022SGB0401 (320 μg/kg).

- Dibenz(a,h)anthracene exceeded its residential RBC (88 μg/kg) in sample 022SGB0401 (110 μg/kg).

Table 7.2.1
SWMUs 22 and 63
Organics Detected in Surface Soil
Results in μg/kg

Parameter	022SGB0301	022SGB0401
2,4,5-TP (Silvex)	ND	2
2-Methylnaphthalene	360	ND
4,4'-DDT	ND	4
Acenaphthylene	ND	110
Acetone	76	31
Anthracene	ND	77
Benzene	ND	ND
Benzo(a)anthracene	ND	140
Benzo(a)pyrene *	**58**	**320**
Benzo(b)fluoranthene	77	400
Benzo(g,h,i)perylene	61	40
Benzo(k)fluoranthene	60	330
Carbon disulfide	ND	ND
Chrysene	53	240
Dibenz(a,h)anthracene *	**ND**	**110**
Fluoranthene	75	140
Heptachlor epoxide	ND	2
Indeno(1,2,3-cd)pyrene	48	290
Naphthalene	280	ND
Total Petroleum Hydrocarbons (418.1)	380,000	ND
Pyrene	65	240
TPH - Diesel Range Organics	340,000	41,000
TPH - Gasoline Range Organics	310,000	77
bis(2-Ethylhexyl)phthalate (BEHP)	ND	74

Notes:
a — exceeds RBC
Bold — Bold text indicates at least one screening criteria has been exceeded.
ND — not detected above the PQL



LEGEND

●	NO ORGANIC EXCEEDS ITS RESIDENTIAL OR INDUSTRIAL RBC
▲	AT LEAST ONE ORGANIC EXCEEDS ITS RBC
022SGB01	BORING NUMBER
BENZO(a)PYRENE 320	COMPOUND THAT EXCEEDS ITS RBC AND THE REPORTED CONCENTRATIONS IN $\mu g/kg$
GW FLOW →	GROUNDWATER FLOW DIRECTION IN FLUVIAL DEPOSITS

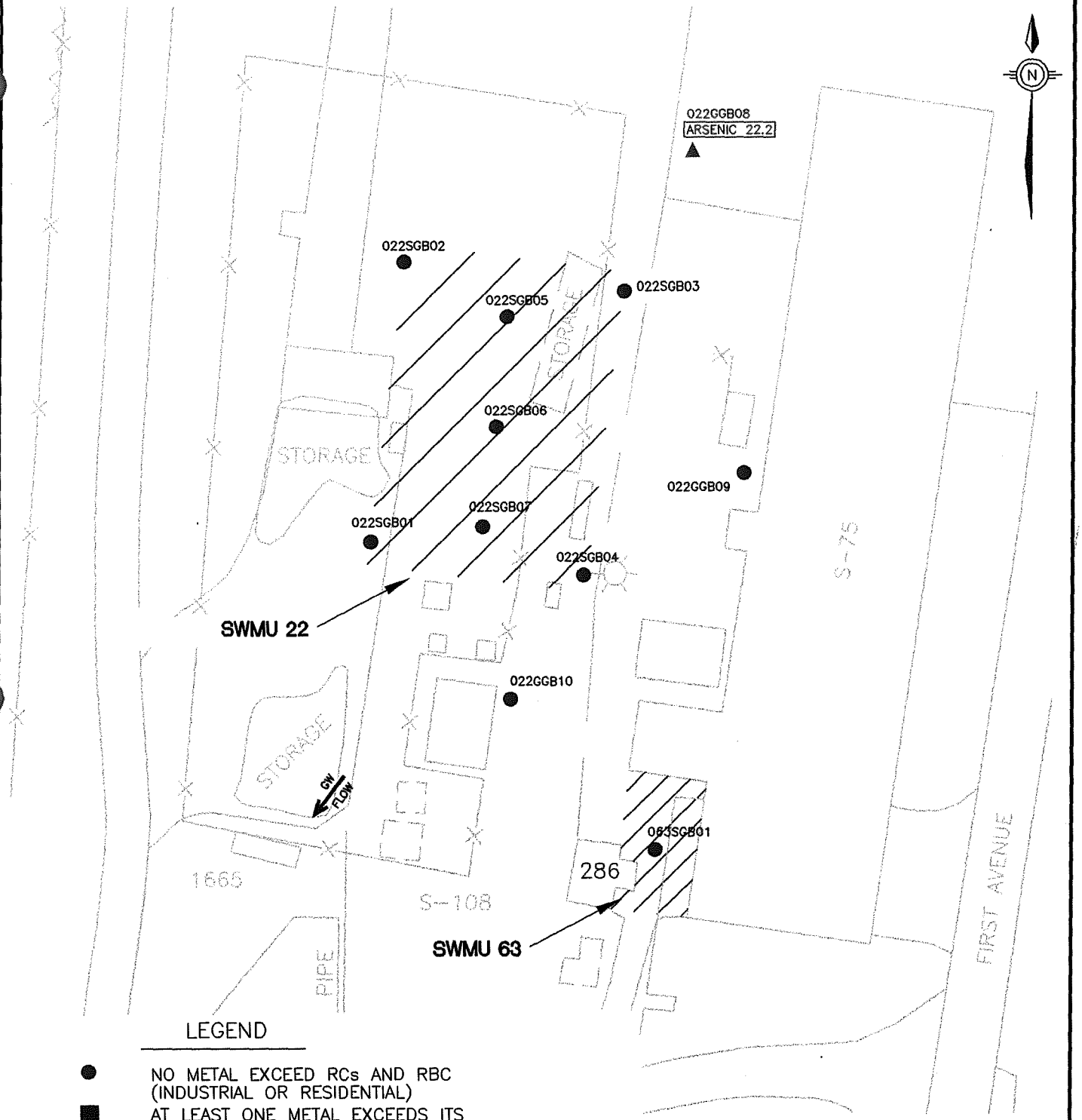
50 0 50

SCALE FEET

ASSEMBLY F
CSI REPORT
NSA MEMPHIS
MILLINGTON, TENNESSEE

FIGURE 7.2.2
SWMUs 22 AND 63
RBC EXCEEDANCES FOR
ORGANICS IN SURFACE SOIL

DWG DATE: 07/29/98 | DWG NAME: 106S2201



LEGEND

- ● NO METAL EXCEED RCs AND RBC (INDUSTRIAL OR RESIDENTIAL)
- ■ AT LEAST ONE METAL EXCEEDS ITS RC AND RESIDENTIAL RBC
- ▲ AT LEAST ONE METAL EXCEEDS ITS RC, AND RESIDENTIAL RBC, INDUSTRIAL RBC, OR SSL
- 022-S-GB01 BORING NUMBER
- ARSENIC 22.2 ANALYTE THAT EXCEEDS AND REPORTED CONCENTRATION IN mg/kg
- GW FLOW → GROUNDWATER FLOW DIRECTION IN FLUVIAL DEPOSITS

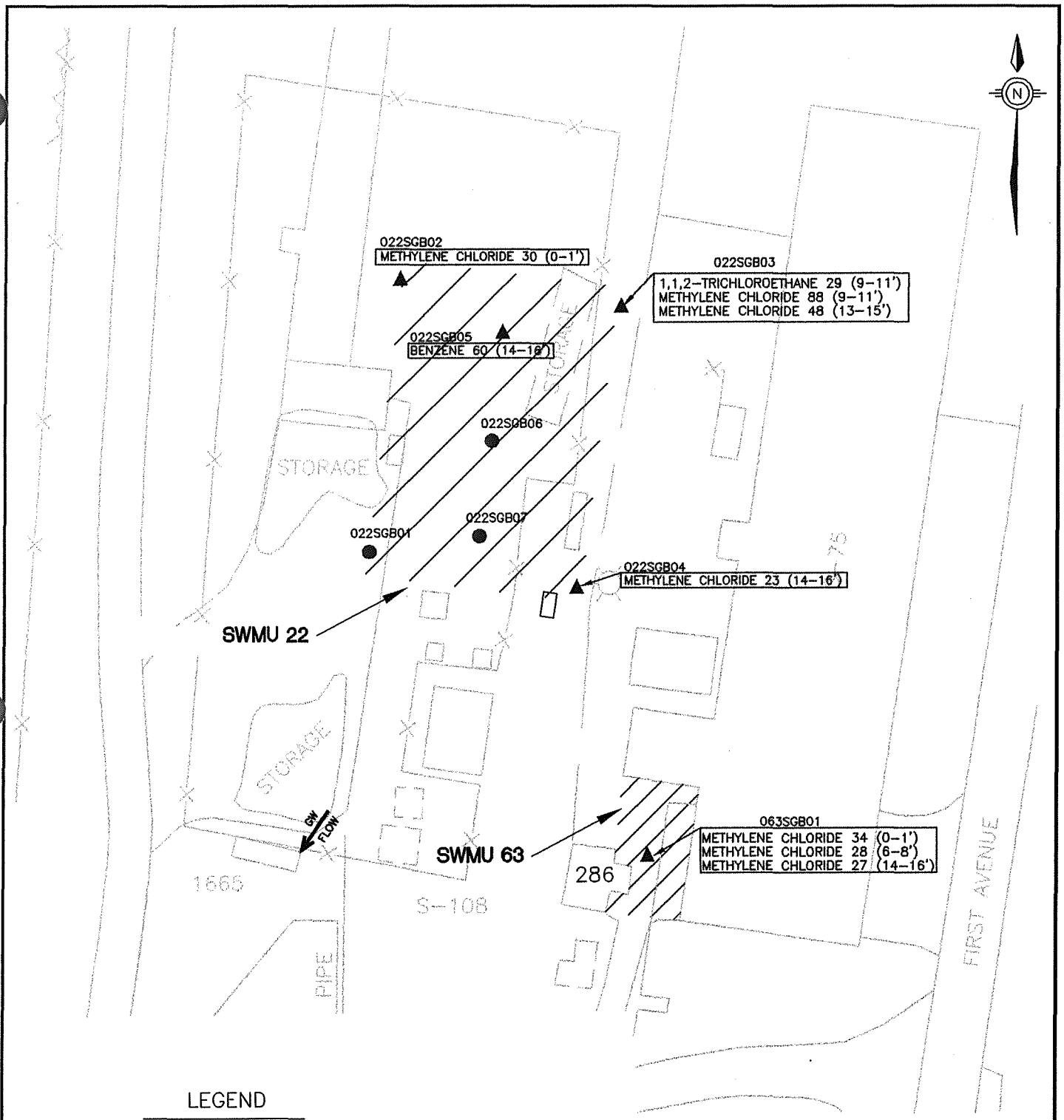
50 0 50

SCALE FEET

ASSEMBLY F
CSI REPORT
NSA MEMPHIS
MILLINGTON, TENNESSEE

FIGURE 7.2.3
SWMUs 22 AND 63
RC, RBC, AND SSL EXCEEDANCES
FOR INORGANICS IN SURFACE SOIL

DWG DATE: 10/22/97 | DWG NAME: 106S2203



LEGEND

● DOES NOT EXCEEDS SSLs

▲ EXCEEDS SSLs

022SGB01 BORING NUMBER

METHYLENE CHLORIDE 23 (14-16') – COMPOUND EXCEEDING CONCENTRATION IN $\mu g/kg$, AND SAMPLE DEPTH

GW FLOW → GROUNDWATER FLOW DIRECTION IN FLUVIAL DEPOSITS

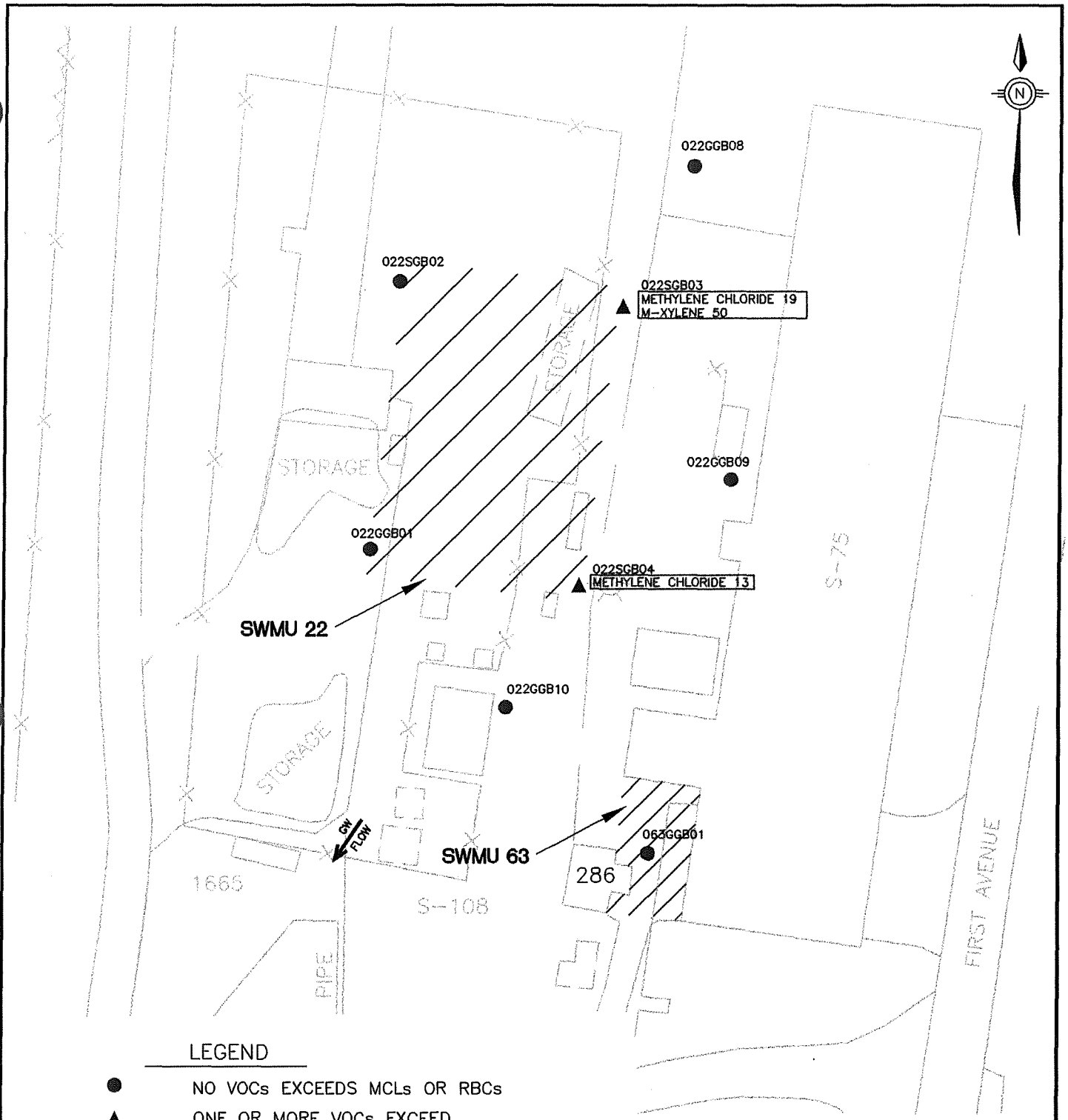
50 0 50

SCALE FEET

ASSEMBLY F
CSI REPORT
NSA MEMPHIS
MILLINGTON, TENNESSEE

FIGURE 7.2.4
SWMUs 22 AND 63
SSL EXCEEDANCES FOR ORGANICS IN SURFACE AND SUBSURFACE SOIL

DWG DATE: 10/20/97 | DWG NAME: 1060SASS



LEGEND

● NO VOCs EXCEEDS MCLs OR RBCs

▲ ONE OR MORE VOCs EXCEED MCLs OR RBCs

022SGB01 BORING NUMBER

METHYLENE CHLORIDE 13 COMPOUND EXCEEDING ITS RBCs OR MCL AND REPORTED CONCENTRATION IN $\mu g/L$

GW FLOW GROUNDWATER FLOW DIRECTION IN FLUVIAL DEPOSITS

50 0 50

SCALE FEET

ASSEMBLY F
CSI REPORT
NSA MEMPHIS
MILLINGTON, TENNESSEE

FIGURE 7.2.5
MCL AND RBC EXCEEDANCES FOR VOCs IN FLUVIAL DEPOSITS GROUNDWATER

DWG DATE: 10/20/97 | DWG NAME: 106S2202

Table 7.2.2
SWMUs 22 and 63
Summary of Organics Detected in Surface Soil
Results in μg/kg

Parameter	Sample Interval [a]	Frequency of Detection	Range of Detection [b]	Mean [c]	Residential Soil RBC [d]		RBC - Res. Exceedances	Industrial Soil RBC [d]		RBC-Ind. Exceedances	SSL [e]	SSL Exceedances [f]
2,4,5-TP (Silvex)	0-1'	1/2	1.9 - 1.9	1.9	630,000	N	0	16,000,000	N	0	NA	NA
2-Methylnaphthalene	0-1'	1/2	360 - 360	360	3,100,000 [g]	N	0	82,000,000 [g]	N	0	30,000[gi]	No
4,4'-DDT	0-1'	1/2	4.3 - 4.3	4.3	1,900	C	0	17,000	C	0	1,000	No
Acenaphthylene	0-1'	1/2	110 - 110	110	4,700,000 [h]	N	0	120,000,000 [h]	N	0	200,000	No
Acetone	0-1'	2/2	31 - 76	54	7,800,000	N	0	200,000,000	N	0	8,000	No
Anthracene	0-1'	1/2	77 - 77	77	23,000,000	N	0	610,000,000	N	0	4,300,000	No
Benzo(a)anthracene	0-1'	1/2	140 - 140	140	880	C	0	7,800	C	0	700	No
Benzo(a)pyrene*	0-1'	2/2	58 - 320	189	88	C	1	780	C	0	4,000	No
Benzo(b)fluoranthene	0-1'	2/2	77 - 400	239	880	C	0	7,800	C	0	4,000	No
Benzo(g,h,i)perylene	0-1'	2/2	40 - 61	51	2,300,000 [i]	N	0	61,000,000 [i]	N	0	1,400,000 [i]	No
Benzo(k)fluoranthene	0-1'	2/2	60 - 330	195	8,800	C	0	78,000	C	0	4,000	No
Chrysene	0-1'	2/2	53 - 240	147	88,000	C	0	780,000	C	0	1,000	No
Dibenz(a,h)anthracene	0-1'	1/2	110 - 110	110	88	C	1	780	C	0	11,000	No
Fluoranthene	0-1'	2/2	75 - 140	108	3,100,000	N	0	82,000,000	N	0	980,000	No
Heptachlor epoxide	0-1'	1/2	2.3 - 2.3	2.3	70	C	0	630	C	0	30	No
Indeno(1,2,3-cd)pyrene	0-1'	2/2	48 - 290	169	880	C	0	7,800	C	0	35,000	No
Naphthalene	0-1'	1/2	280 - 280	280	3,100,000	N	0	82,000,000	N	0	30,000	No
Total Petroleum Hydrocarbons	0-1'	1/2	380,000 - 380,000	380,000	NA [j]		NA	NA [j]		NA	NA	NA
Pyrene	0-1'	2/2	65 - 240	153	2,300,000	N	0	61,000,000	N	0	1,400,000	No
TPH - Diesel Range Organics	0-1'	2/2	41,000 - 340,000	190,500	NA [j]		NA	NA [j]		NA	NA	NA
TPH - Gasoline Range Organics	0-1'	2/2	77 - 310,000	155,039	NA [j]		NA	NA [j]		NA	NA	NA

Table 7.2.2
SWMUs 22 and 63
Summary of Organics Detected in Surface Soil
Results in μg/kg

Parameter	Sample Interval [a]	Frequency of Detection	Range of Detection [b]	Mean [c]	Residential Soil RBC [d]		RBC - Res. Exceedances	Industrial Soil RBC [d]		RBC-Ind. Exceedances	SSL [e]	SSL Exceedances [f]
bis(2-Ethylhexyl)phthalate (BEHP)	0-1'	1/2	74 - 74	74	46,000	C	0	410,000	C	0	11,000	No

Notes:

a — Feet below ground surface
b — Range lower limit is based on lowest detected concentration.
c — Mean is based on detected concentrations only.
d — Residential and industrial screening values (RBC-Res., RBC-Ind.) are from USEPA Region III Risk-Based Concentration Table, January to June 1996.
e — SSL considered protective of contaminant transfer from soil to groundwater (from USEPA Region III Risk-Based Concentration Table, January to June 1996)
f — A "Yes" in this column indicates that at least one sample result exceeded the SSL for this analyte; a "No" indicates that no sample result exceeded the SSL.
g — Naphthalene used as a surrogate
h — Acenaphthene RBC used as a surrogate
i — Risk-based data are not available. Data for naphthalene were used as a surrogate.
j — An RBC value does not exist for TPH. Cleanup levels ranging from 100,000 μg/kg to 1,000,000 μg/kg have been established by TDEC. Either 1,000,000 μg/kg or 500,000 μg/kg is likely to apply to this site depending on soil permeabilities. The appropriate level will be determined during subsequent investigation of this site (if applicable.)
NA — Not Available
N — noncarcinogen-based RBC
C — carcinogen-based RBC
* — Identified as a COPC during the PRE. BEQ was also identified.

Table 7.2.3
SWMUs 22 and 63
Inorganics Detected in Surface Soil
Results in mg/kg

Parameter	022SGB0301	022SGB0401
Arsenic [a]	**22.2**	**12.5**
Barium	51.9	45.2
Beryllium	**0.36**	**0.34**
Chromium	13.8	12.3
Cobalt	**6.7**	**4.9**
Copper	12.5	11.2
Lead	**35.1**	**12.4**
Mercury	0.04	0.04
Nickel	**12.1**	**8.9**
Selenium	ND	0.51
Thallium	**0.33**	**ND**
Vanadium	26.7	25.4
Zinc	**37.6**	**35.3**

Notes:
a — Exceeds its RC, RBC-res., RBC-ind., and SSL
Bold — Bold text indicates an analyte that exceeds its RC and at least one other screening criterion
ND — Not detected above instrument detection limit

As discussed in Section 7.1.3 there are no RBC or SSL screening values for TPH, TPH-GRO, or TPH-DRO, and no permeability data was collected for SWMUs 22/63. Permeability data will be required prior to determining the appropriate TDEC cleanup standard.

- TPH was detected in sample 022SGB0301 (380,000 μg/kg).

- TPH-GRO was detected in samples 022SGB0301 (310,000 μg/kg) and 022SGB0401 (77 μg/kg).

- TPH-DRO was detected in samples 022SGB0301 (340,000 μg/kg) and 022SGB0401 (41,000 μg/kg).

Table 7.2.4
SWMUs 22 and 63
Summary of Inorganics Detected in Surface Soil
Results in mg/kg

Parameter	Sampling Interval [a]	Frequency of Detection	Range of Detection [b]	Mean [c]	Inorganic RC [d]	RC Exceedances	Residential Soil RBC [e]		RBC-Res. Exceedances	Industrial Soil RBC [e]		RBC-Ind. Exceedances	SSL [f]	SSL Exceeded [g]
Arsenic *	0-1'	2/2	12.5 - 22.2	17.4	14.58	1	0.48 [h]	C	2	3.8 [h]	C	2	15 [h]	Yes
Barium	0-1'	2/2	45.2 - 51.9	48.6	223.46	0	5,500	N	0	140,000	N	0	32	Yes
Beryllium	0-1'	2/2	0.34 - 0.36	0.35	1	0	0.15	C	2	1.3	C	0	180	No
Chromium	0-1'	2/2	12.3 - 13.8	13.1	23.89	0	390 [i]	N	0	10,000 [i]	N	0	19 [i]	No
Cobalt	0-1'	2/2	4.9 - 6.7	5.8	15.98	0	4,700	N	0	120,000	N	0	NA	NA
Copper	0-1'	2/2	11.2 - 12.5	11.9	24.19	0	3,100	N	0	82,000	N	0	NA	NA
Lead	0-1'	2/2	12.4 - 35.1	23.8	26.03	1	400 [j]		0	1,000 [j]		0	NA	NA
Mercury	0-1'	2/2	0.04 - 0.04	0.04	0.46	0	23	N	0	610	N	0	3	No
Nickel	0-1'	2/2	8.9 - 12.1	10.5	20.62	0	1,600	N	0	41,000	N	0	21	No
Selenium	0-1'	1/2	0.51 - 0.51	0.51	BDL	1	390	N	0	10,000	N	0	3	No
Thallium	0-1'	½	0.33 - 0.33	0.33	BDL	1	6.3 [k]	N	0	160 [k]	N	0	0.4	No
Vanadium	0-1'	2/2	25.4 - 26.7	26.1	45.11	0	550	N	0	14,000	N	0	NA	NA
Zinc	0-1'	2/2	35.3 - 37.6	36.5	98	0	23,000	N	0	610,000	N	0	42,000	No

Notes:

a — Feet below ground surface
b — Range lower limit is the lowest detected concentration.
c — Mean is based on detected concentrations only.
d — Background reference concentration (2x mean background).
e — Residential and industrial screening values (RBC-Res., RBC-Ind.) are from USEPA Region III Risk-Based Concentration Table, January to June 1996.
f — SSL considered protective of contaminant transfer from soil to groundwater (from USEPA Region III Risk-Based Concentration Table, January to June 1996)
g — A "Yes" in this column indicates that at least one sample result exceeded the SSL for this analyte; a "No" indicates no sample results exceeding the SSL.
h — RBC for arsenic as a carcinogen
i — RBC for hexavalent chromium (VI)
j — Value is soil cleanup level for total lead (USEPA OSWER Directive, 9355.4-12).
k — RBC for thallium carbonate was used as a surrogate RBC.
NA — Not applicable
BDL — Below detection limit
N — Noncarcinogen-Based RBC
C — Carcinogen-Based RBC
* — Identified as a COPC in the PRE

Table 7.2.5
SWMUs 22 and 63
VOCs Detected in Surface and Subsurface Soil Screening Samples
Results in μg/kg

Parameter	Sample Interval	022SGB02	022SGB03	022SGB04	022SGB05	022SGB06	022SGB07	063SGB01	Split Sample 063SGB0108
1,1,2-Trichloroethane	9-11'	NS	**29**	NS	NS	NS	NS	NS	NS
2-Butanone (MEK)	9-11'	NS	200	NS	NS	NS	NS	NS	NS
Acetone	6-8'	NS	NS	NS	NS	NS	NS	ND	120
Benzene	14-16'	ND	ND	ND	**60**	ND	ND	ND	NS
Carbon disulfide	14-16'	ND	ND	ND	ND	51	77	ND	NS
Methylene chloride	0-1'	**30**	ND	ND	NS	NS	ND	**34**	NS
	6-8'	NS	NS	NS	NS	NS	NS	**28**	ND
	9-11'	NS	**88**	NS	NS	NS	NS	NS	NS
	13-15'	NS	**48**	NS	NS	NS	NS	NS	NS
	14-16'	ND	NS	23	ND	ND	ND	27	NS

Notes:
Bold — Bold text indicates an SSL exceedance.
ND — Not detected above the PQL
NS — Not Sampled

Table 7.2.6
SWMUs 22 and 63
VOC Screening Results Summary for Surface and Subsurface Soil
Results in μg/kg

Parameter	Depth [a]	Frequency of Detection	Range of Detection [b]	Mean [c]	Residential Soil RBC [d]		RBC - Res. Exceedances	Industrial Soil RBC [d]		RBC-Ind. Exceedances	SSL [e]	SSL Exceeded [f]
Acetone	6-8'	1/2	120 - 120	120	NA		NA	NA		NA	8000	No
1,1,2-Trichloroethane	9-11'	1/1	29 - 29	29	NA	C	NA	NA	C	NA	10	Yes
2-Butanone (MEK)	9-11'	1/1	200 - 200	200	NA	N	NA	NA	N	NA	NA	NA
Benzene	14-16'	1/6	60 - 60	60	NA	C	NA	NA	C	NA	20	Yes
Carbon disulfide	14-16'	2/6	51 - 77	64	NA	N	NA	NA	N	NA	14,000	No
Methylene chloride	0-1'	2/8	30 - 34	32	85,000	C	0	760,000	C	0	10	Yes
	6-8'	1/2	28 - 28	28	NA		NA	NA		NA	10	Yes
	9-11'	1/1	88 - 88	88	NA		NA	NA		NA	10	Yes
	13-15'	1/1	48 - 48	48	NA		NA	NA		NA	10	Yes
	14-16'	2/6	23 - 27	25	NA		NA	NA		NA	10	Yes

Notes:

a — Feet below ground surface
b — Range lower limit is the lowest detected concentration.
c — Mean is based on detected concentrations only.
d — Residential and industrial screening values (RBC-Res., RBC-Ind.) are from USEPA Region III Risk-Based Concentration Table, January to June 1996.
e — SSL considered protective of contaminant transfer from soil to groundwater (from USEPA Region III Risk-Based Concentration Table, January to June 1996)
f — A "Yes" in this column indicates that at least one sample result exceeded the SSL for this analyte; a "No" indicates no sample results exceeding the SSL.
NA — Not applicable
N — noncarcinogen-based RBC
C — carcinogen-based RBC

Table 7.2.7
SWMUs 22 and 63
VOC Screening Results for Fluvial Deposits Groundwater
Results in μg/L

Parameter	022GGB0347	022GGB0447
Ethylbenzene	**35**	ND
Methylene chloride	**19**	**13**
m-Xylene	**50**	ND

Notes:
Bold — Bold text indicates a parameter that exceeds its MCL or tap water RBC.
ND — Not detected above PQLs

Inorganics in Surface Soil

As presented in Tables 7.2.3 and 7.2.4, 13 inorganics were detected in surface soil samples at SWMUs 22/63. Of these 13, one inorganic exceeded its RC, residential and industrial RBCs, and SSL.

- Arsenic exceeded its surface soil RC (14.58 μg/kg), residential RBC (0.48 μg/kg), industrial RBC (3.8 μg/kg), and SSL (15 μg/kg) in sample 022SGB0301(22.2 μg/kg).

VOCs in Surface and Subsurface Soil

As presented in Tables 7.2.5 and 7.2.6, six compounds were detected in the VOC screening samples collected from 8 locations at SWMU 22/63. Of these six compounds, three exceeded their SSL.

- 1,1,2-Trichloroethane exceeded its SSL (10 μg/kg) in sample 022SGB0311 (29 μg/kg).

- Benzene exceeded its SSL (20 μg/kg) in sample 022SGB0516 (60 μg/kg).

Table 7.2.8
SWMUs 22 and 63
VOC Screening Results Summary for Fluvial Deposits Groundwater
Results in μg/L

Parameter	Sample Interval [a]	Frequency of Detection	Range of Detection [b]	Mean [c]	Tap Water RBC [d]		Tap Water RBC Exceedances	MCL [e]	MCL Exceedances
Ethylbenzene	47'	1/6	35 - 35	35	1,300	N	0	700	0
Methylene chloride	47'	2/6	13 - 19	16	4.1	C	2	5	2
m-Xylene	47'	1/6	50 - 50	50	1400	N	0	10	1

Notes:

a — Feet below ground surface
b — Range lower limit is the lowest detected concentration.
c — Mean is based on detected concentrations only.
d — Tap water RBCs are from USEPA Region III Risk-Based Concentration Table, January to June 1996.
e — MCL values are from the Drinking Water Regulations and Health Advisories Table (October 1996, USEPA).
N — noncarcinogen-based RBC
C — carcinogen-based RBC

- Methylene chloride exceeded its SSL (10 μg/kg) in samples 022SGB0201 (30 μg/kg), 022SGB0311 (88 μg/kg), 022SGB0315 (48 μg/kg), 022SGB0416 (23 μg/kg), 063SGB0101 (34 μg/kg), 063SGB0108 (28 μg/kg), and 063SGB0116 (27 μg/kg).

One VOC screening soil split sample (063SGB0108) indicated acetone in sample at a concentration of 120 μg/kg.

VOCs in Groundwater

As presented in Tables 7.2.7 and 7.2.8, three VOCs were detected in fluvial deposits groundwater of SMWUs 22/63. Of these three compounds, one exceeded both its tap water RBC and MCL, and another exceeded only its MCL.

- Methylene chloride exceeded its tap water RBC (4.1 μg/L) and MCL (5 μg/L) in samples 022GGB0347 (19 μg/L) and 022GGB0447 (13 μg/L).

- m-Xylene exceeded its MCL (10 μg/L) in sample 022GGB0347 (50 μg/L).

One VOC screening groundwater sample from SWMU 22 was split and submitted for analysis at an offsite lab. The results were non-detect for VOCS.

7.2.4 Preliminary Risk Evaluation

In accordance with *Guidance on Preliminary Risk Evaluations for the Purpose of Reaching a Finding of Suitability to Lease* (USEPA Region IV Memorandum, November 1994), a PRE was conducted for SWMUs 22/63 using data from surface soil and groundwater samples collected during the CSI, as described in Section 7.2.8. Surface soil, subsurface soil, and groundwater samples were analyzed onsite for VOCs and two surface soil samples were submitted to an offsite laboratory for FSA. As discussed in Section 5, the PRE was conducted by identifying COPCs

from the original set of detected analytes, calculating the risk ratio for each COPC, and interpreting those results.

Tables 7.2.2, 7.2.4, 7.2.6, and 7.2.8 show results for organic compounds detected in surface soil, inorganics detected in surface soil, VOCs detected in surface and subsurface soil, and VOCs detected in fluvial deposits groundwater, respectively. Arsenic and benzo(a)pyrene equivalents (BEQ) were identified as COPCs in surface soil. BEQs were estimated in accordance with USEPA Region IV's November 1995 *Supplemental Guidance to RAGS Bulletin 2,* as presented in Table 7.2.9 and discussed below. COPCs identified in fluvial deposits groundwater were: ethylbenzene, methylene chloride, and m-xylene.

All PAHs listed below are classified by USEPA as B2 carcinogens, and their carcinogenicity is addressed relative to that of benzo(a)pyrene, which has a slope factor (SF) of 7.3 kilograms per day per milligram (kg-day/mg). Toxicity Equivalence Factors (TEFs), also determined by USEPA, are multipliers that are applied to the detected concentrations, which are subsequently summed and used to estimate cancer risk posed by benzo(a)pyrene and other PAHs with similar toxicology.

Table 7.2.9
Benzo(a)pyrene Equivalent (BEQ*) Concentrations
SWMUs 22 and 63
(in μg/kg)

		022SGB0301		022SGB0401	
Chemical	**TEF**	**Reported Concentration**	**Equivalent Concentration**	**Reported Concentration**	**Equivalent Concentration**
Benzo(a)pyrene	1	58	58	320	320
Benzo(a)anthracene	0.1	ND	NA	140	14
Benzo(b)fluoranthene	0.1	77	7.7	400	40
Benzo(k)fluoranthene	0.01	60	0.6	330	3.3
Chrysene	0.001	53	0.053	240	0.24
Dibenz(a,h)anthracene	1	ND	NA	110	110

Table 7.2.9
Benzo(a)pyrene Equivalent (BEQ*) Concentrations
SWMUs 22 and 63
(in μg/kg)

		022SGB0301		022SGB0401	
Chemical	**TEF**	**Reported Concentration**	**Equivalent Concentration**	**Reported Concentration**	**Equivalent Concentration**
Indeno(123-cd)pyrene	0.1	48	4.8	290	29
		BEQ =	*71.153*	*BEQ =*	*516.54*

Notes:
* — BEQ was calculated in accordance with USEPA Region IV November 1995 Supplemental Guidance to RAGS Bulletin 2.
TEF — Toxicity equivalence factor
ND — Not detected
NA — Not applicable

BEQ includes the following:

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

Table 7.2.10 summarizes PRE results for each COPC.

Uncertainty

The PRE for SWMUs 22/63 is based on the maximum reported concentrations of each COPC and a future residential and industrial scenario. This conservative approach includes these assumptions regarding uncertainties:

Table 7.2.10
Preliminary Risk Evaluation
SWMUs 22 and 63

Chemical	Maximum Reported Concentration	Units	Residential RBC	Residential Hazard Quotient	Residential ILCR	Industrial RBC	Industrial Hazard Quotient	Industrial ILCR
Fluvial Deposits Groundwater								
Ethylbenzene	35	µg/L	130 N	0.027	NA	520 N	0.007	NA
Methylene chloride	19	µg/L	4.1 C	NA	4.63E-06	16.4 C	NA	1.16E-06
m-Xylene	50	µg/L	140 N	0.036	NA	560 N	0.009	NA
Summation of Groundwater				0.063	4.6E-06		0.016	1.2E-06
Surface Soil								
Arsenic a	22.2	mg/kg	0.43 C	NA	5.16E-05	3.8 C	NA	5.84E-06
Arsenic a	22.2	mg/kg	2.3 N	0.97	NA	61 N	0.036	NA
BEQ	516.54	µg/kg	88 C	NA	5.87E-06	780 C	NA	6.62E-07
Summation of Soil				0.97	5.7E-05		0.036	6.5E-06
Summation of Both Media				1.0	6E-05		0.05	8E-06

Notes:

RBC — Risk-based concentration from USEPA Region III's June 1996 RBC Table; in accordance with USEPA Region IV's Supplemental Guidance to RAGS Bulletin 1, RBCs for noncarcinogens above were conservatively adjusted to reflect a hazard quotient of 0.1; Residential RBCs were divided by 0.25 for VOCs and were divided by 0.5 for all other compounds to calculate RBCs for nonresidential (industrial) groundwater, in accordance with USEPA guidance.

N — Noncarcinogen

C — Carcinogen

NA — Not applicable

ILCR — Incremental lifetime excess cancer risk

a — Arsenic was assessed as both a carcinogen and as a noncarcinogen.

- Cumulative effects will occur, regardless of target organs and mechanisms of action, which could either overestimate or underestimate risk. If target organs and mechanisms of action are similar, cumulative effects can occur. If they are not similar and risks are summed together, risk could be overestimated. However, if target organs are the same, risk estimates should be added together to more accurately account for the mixture of chemicals.

  Underestimation is possible because toxic effects of chemical mixtures are sometimes exponential rather than additive. Carbon tetrachloride and alcohol are a classic example of exponential or synergistic effects. If the risks are summed and an exponential effect could occur, the cumulative risk estimate could be an underestimate. Because of these potentials for overestimating or underestimating risk, separate HQs should be considered for arsenic and BEQ.

- 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).

Conclusions and Recommendations

Based on the information gathered during the investigation, the following conclusions and recommendations have been reached based on a PRE performed on data from surface soil and fluvial deposits groundwater samples:

Residential Land Use — Suitable for Lease

- Carcinogens: The cumulative risk for soil and fluvial deposits groundwater for the residential scenario was estimated to be 6E-05, indicating suitability for lease of the SWMUs 22/63 area for a residential land use scenario in accordance with USEPA Region IV's November 1994 memorandum.

- Noncarcinogens: The residential HI for soil and fluvial deposits groundwater was estimated to be 1.0. However, target organs of the two COPCs identified (arsenic and BEQ) would be different, so it is unlikely that an individual would be at risk. Therefore, this indicates suitability for lease for a residential land use scenario in accordance with USEPA Region IV's November 1994 memorandum.

Industrial Land Use — Suitable for Lease

- Carcinogens: The cumulative risk for soil and fluvial deposits groundwater for the industrial scenario was estimated to be 8E-06, indicating suitability for lease of the SWMUs 22/63 are for an industrial land use scenario in accordance with USEPA Region IV's November 1994 memorandum.

- Noncarcinogens: The industrial scenario HI for soil and fluvial deposits groundwater was estimated to be 0.05, indicating suitability for lease for an industrial land use scenario in accordance with USEPA Region IV's November 1994 memorandum.

7.2.5 Fate and Transport

The approach for evaluating the fate and transport of Assembly F contaminants was discussed in Section 6.2. The following sections apply that approach to contaminants detected at SWMUs 22/63. Transport processes for analytes other than those designated as COPCs will also

be discussed if they occur in multiple environmental media, or have the potential to migrate to other media.

Migration of contaminants in surface soil by surface water erosion should be insignificant for SWMUs 22/63 due to the grass-covered and asphalt/concrete-covered areas, and the low relief of the site. The lack of any significant VOC contamination in surface soil indicates that the soil-to-air cross-media transport process is not important. Also, no VOC in surface soil exceeded its soil-to-air SSL, so this pathway is not discussed. The groundwater-to-surface-water cross-media transport mechanism was also not discussed in the absence of this pathway.

SWMUs 22/63 COCs include:

- Arsenic, which exceeded its soil-to-groundwater SSL and background RC in soil.
- 1,1,2-trichloroethane, which exceeded its soil-to-groundwater SSL in soil.
- Benzene, which exceeded its soil-to-groundwater SSL soil.
- Methylene chloride, which exceeded its soil-to-groundwater SSLs and its MCL in fluvial deposits groundwater.
- m-Xylene, which exceeded its MCLs in fluvial deposits groundwater.

7.2.5.1 Soil-to-Groundwater Cross-Media Transport

Three contaminants (methylene chloride, ethylbenzene, and m-xylene) were detected in groundwater at SWMUs 22/63. Of these compounds, only methylene chloride was also detected in soil. Methylene chloride was detected at two of the six surface soil sampling locations, in the

one 6- to 8-foot interval location, in the one 9- to 11-foot sampling interval location, one of the two the 13- to 15-foot interval locations, and two of six locations in the 14- to 16-foot interval. All sampling locations exceeded the SSL for methylene chloride. Methylene chloride contamination apparently is not isolated at SWMUs 22 and 63 based on the frequency of detections. However, it was detected in only two of six groundwater sample locations. Methylene chloride, being a VOC, has a relatively higher potential for mobility in soil, thus increasing the chances for soil-to-groundwater transport.

The relatively high solubility values for methylene chloride, ethylbenzene, and m-xylene make them very mobile upon reaching groundwater. These contaminants will tend to move with groundwater flow; however, the chemical and physical properties of VOCs in general increase the potential for degradability of these compounds and each tends to have a relatively short half-life in groundwater.

1,1,2-Trichloroethane, benzene, and arsenic were detected in soil at concentrations exceeding the groundwater protection risk-based SSL, but were not detected in groundwater at SWMUs 22/63. Benzene was detected at only one of eight sample locations, and 1,1,2-trichloroethane was detected in the one split sample and not in the primary sample. Arsenic was detected at both of the two FSA sampling locations, but only exceeded its background RC at one of them. Based on the frequency of detection of these contaminants and their absence in groundwater, widespread impact to the shallow aquifer is not expected.

7.2.5.2 Soil-to-Sediment Cross-Media Transport

Contaminants detected in surface soil from SWMUs 22/63 include VOCs, SVOCs, and inorganics. Of these, only benzo(a)pyrene, arsenic, 1,1,2-trichloroethane, benzene, and methylene chloride are considered COCs based on their detected concentrations and exceedance of screening criteria. Some of these contaminants have a strong tendency to sorb to soil particles and are relatively

immobile in the environment. Transport is more likely to occur in the solid phase than the dissolved phase. Also, several of these contaminants are persistent in the environment and do not degrade readily. As described earlier, the low relief at SWMUs 22/63 precludes an obvious surface water runoff pathway and suggest the formation of sediment due to erosion is minimal.

7.2.6 Conclusions and Recommendations

Based on the data gathered during this investigation, the following conclusions and recommendations have been reached:

Conclusions

- SWMUs 22/63 will be developed for commercial use according to the Base Reuse Plan.

- 21 organic compounds were detected in surface (0 to 1-foot) soil. Of these,

  — benzo(a)pyrene and dibenz(a,h)anthracene were detected at concentrations that exceeded residential RBCs.

- TPH, TPH/GRO and TPH/DRO were detected in surface soil.

  — A cleanup standard will be established once permeability of site soil has been determined. TPH concentrations at SWMUs 22/63 exceed the more conservative cleanup standard (100,000 μg/kg), but do not exceed the less stringent standard (1,000,000 μg/kg).

- 13 inorganics were detected in surface soil. Of these,

  — One sample contained arsenic exceeding its RC, residential and industrial RBCs, and SSL.

- Six VOCs were detected in surface and subsurface screening samples. Of these,

  — 1,1,2-trichloroethane, benzene, and methylene chloride were detected at concentrations exceeding their SSLs.

- Three organic compounds were detected in fluvial deposits groundwater. Of these,

  — methylene chloride exceeded its tap water RBC and MCL in two samples.
  — m-xylene exceeded its MCL in one sample.

- Based on a PRE performed on data from surface soil samples, the following has been concluded:

— Carcinogens: Cumulative soil cancer risk estimates for the residential and industrial scenarios were less than the cumulative risk threshold of 1E-4 for PREs, indicating that the site is suitable for lease.

— Noncarcinogens: The HI for the residential land use scenario was estimated to be 1.0. However, the two COPCs identified at this site (arsenic and BEQ) target different organs; therefore it is unlikely that an individual would be at risk. The HI for the industrial scenarios was estimated to be 0.05.

Recommendations

- Based on surface and subsurface soil and groundwater data, a follow-up RFI is recommended at SWMUs 22/63, including:

  — Installing at least four monitoring wells in the fluvial deposits to determine groundwater flow direction and the extent of contamination.

  — Collecting site-specific permeability data to determine the appropriate cleanup standard for TPH, TPH/GRO, and TPH/DRO.

  — Conducting an ecological risk assessment.

7.3 SWMU 30 — Park Field Inactive Waste Treatment Septic Tank System

SWMU 30 is an inactive waste treatment septic tank remaining from Park Field, a U.S. Army training facility that preceded NSA Memphis. A portion of the septic tank is beneath Building S-420 with the rest on the east and south sides of the building within the NSA Memphis Southside (Figure 7.3.1). The septic tank operated from 1917 to 1942 and received waste from more than 60 buildings, including those where aircraft and ground vehicles were serviced. The 80- x 20-foot, concrete septic tank was reportedly built 9 feet deep and topped by 2 feet of soil. The septic tank was partially demolished, pushed in on itself, and covered with soil, but specific documents detailing the work performed are unavailable. The information obtained on SWMU 30 during the 1990 RFA and 1968 drawings of the septic tank are in Attachment 2 of the Assembly F CSI Work Plan.

SWMU 30 and the surrounding area are characterized by relatively level, low-relief topography. The immediate area is covered by grass, concrete sidewalks, and/or Building S-420. Surface drainage flows into storm drains, then into an east-west oriented drainage ditch (SWMU 38), and ultimately into Big Creek Drainage Canal.

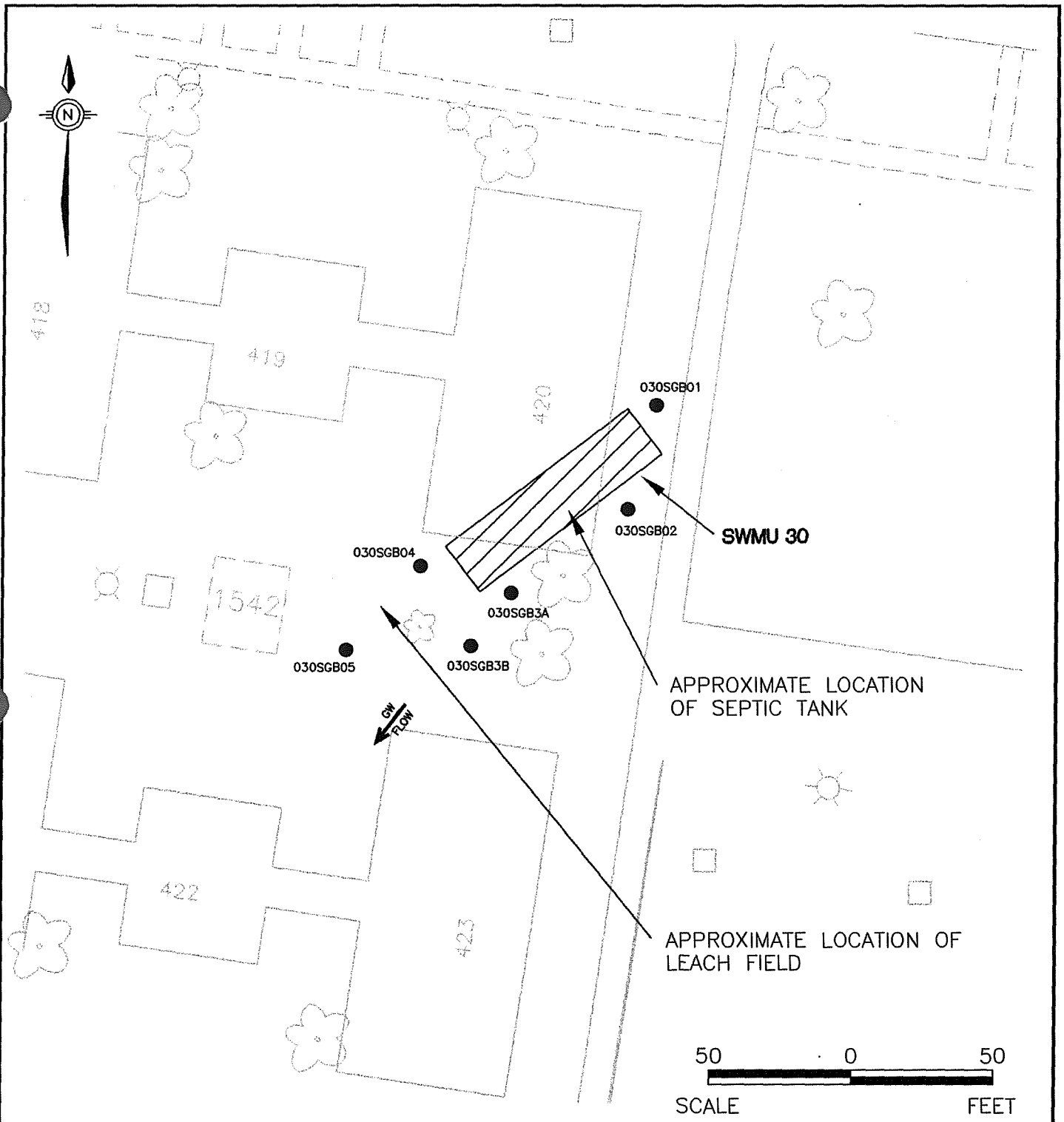
The regional and local hydrogeology are described in Sections 2.11 and 2.12, respectively, of the *Comprehensive RFI Work Plan*. Site-specific geologic and hydrogeologic information and references are in Section 2 of this report and in Section 2.2 of the Assembly F CSI Work Plan. Because soil and groundwater samples were collected by "blind" pushing of DPT sampling tools to a predetermined sampling depth without lithologic characterization, no additional site-specific information was collected during this investigation.

7.3.1 Previous Sampling Activities

Records were not available from any previous investigations of SWMU 30. The septic tank reportedly received sewage from more than 60 buildings, possibly including oils, solvents, paints, and other chemicals used to service aircraft and ground vehicles. However, because the septic tank was abandoned in 1942, synthetic organic chemicals should not have been a significant portion of the industrial waste.

7.3.2 Field Investigation

The CSI at SWMU 30 was completed by collecting soil samples from five locations around the former septic tank (Figure 7.3.1). Fluvial deposits groundwater samples were collected from four of the five locations. All soil and groundwater samples were screened in the field for VOCs. Figure 7.3.1 shows six sample locations. Sample locations 030ASGB3A and 030SGB3B are considered one location even though the surface soil sample was collected at the 030SGB3A location and the subsurface soil sample was collected at 030SGB3B. While pushing the rods to collect the subsurface sample at location 030SGB3A, an impenetrable obstruction was encountered a few feet above the required sampling depth. As a result, the subsurface soil sample location was changed and completed at the 030SGB3B location.



LEGEND

● SAMPLE LOCATION

030SGB04 BORING NUMBER

GW FLOW → GROUNDWATER FLOW DIRECTION IN FLUVIAL DEPOSITS

SWMU 30

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FIGURE 7.3.1
SWMU 30
SAMPLE LOCATIONS

DWG DATE: 10/20/97 | DWG NAME: 106TVC30

Locations 030SGB01 through 030SGB04 were sampled along the boundary of the former septic tank not covered by Building S-420 and location 030SGB05 was sampled within the suspected former leach field.

Surface soil samples were collected from each of the five locations with stainless-steel hand augers for VOC screening analysis. As discussed in Section 4.1, two of the five surface samples (030SGB01 and 030SGB04) were collected for FSA under Level IV DQOs or equivalent to be used in the SWMU 30 PRE.

Five subsurface soil screening samples were collected using DPT from 11 to 13 feet bgs, which approximates to the reported bottom of the former septic tank. These samples were collected for VOC screening analysis to determine whether the septic tank had leaked and impacted subsurface soil.

Five loess groundwater samples were proposed for collection. However, due to low recharge of the loess to the groundwater sampling tool, these samples were not collected. The data from the 11-to 13-foot interval soil samples were substituted for the loess groundwater data.

Fluvial groundwater samples were collected from four of the five locations. One fluvial deposits sample was omitted from location 030-S-GB3B due to mechanical failure of the sampling equipment. Before deciding to omit the location, the site and site map were inspected to determine if existing sample coverage was sufficient to detect any contamination if present.

All soil and groundwater screening samples were analyzed for VOCs by the onsite laboratory using GC/MS with approximately 25% of the samples split and sent to an offsite laboratory for confirmatory analysis for comparison with the data generated by the onsite laboratory. Two of

the surface soil samples were submitted to an offsite laboratory for FSA. The data from the FSA samples aided in calculating health-based risk values for SWMU 30.

Some necessary variations to the proposed sampling scheme are listed below:

- Groundwater samples were to be collected from both the loess and the fluvial deposits aquifer. However, the loess was not sampled due to insufficient volume. Soil samples collected at depths corresponding to the septic tank base equaled the approximate depth of the perched zone in the loess, so no additional soil samples were collected to substitute for loess groundwater samples, as occurred at SWMU 20.

- No fluvial groundwater sample was collected from location 030SGB03 due to mechanical failures of the sampling rig and the proximity of the sampling locations.

7.3.3 Confirmatory Sampling Results

Tables and figures in this section present the analytical results for all soil and groundwater samples collected during this CSI. The tables present the compound or analyte, sample collection depths, frequency of detection, and minimum, maximum, and mean of all concentrations detected that exceeded the PQL. Values for organic analyses of soil are compared to each compound's corresponding RBC for both residential and industrial scenarios, and with the SSL for protection of groundwater as published in the USEPA Region III January to June 1996 RBC Table (June 1996). Inorganic results are compared to RCs for NSA Memphis, residential and industrial RBCs, and SSLs. Groundwater results are compared to tap water RBCs from the USEPA Region III tables and to MCLs published in the Drinking Water Regulations and Health Advisories Table (USEPA, October 1996).

The results for the FSA samples analyzed under Level IV DQOs or equivalent, collected for use in the PRE are presented in Tables 7.3.1 through 7.3.4. VOC screening sample results for both soil and groundwater samples analyzed under Level III DQOs are presented in Tables 7.3.5 through 7.3.7. The VOC results for the FSA samples are not compared with the results for the VOC screening samples because they have different DQOs, different analytical methods and different analyte lists. Both data sets were used to identify COPCs in the PRE. The VOC split screening samples were analyzed as quality control (QC) samples to check the reproducibility of the data are presented with the screening sample results. The data are also presented on Figures 7.3.2 through 7.3.4, which show sampling locations where applicable RBCs, RCs, SSLs, or MCLs were exceeded. Results for both the FSA surface soil samples and the VOC screening surface soil samples are presented on Figure 7.3.2.

Organics in Surface Soil

As indicated in Tables 7.3.1 and 7.3.2, 21 organics compounds and TPH-DRO were detected in surface soil of SWMU 30. Of these 21 compounds, two exceeded either residential RBCs or SSLs.

- Benzo(a)pyrene exceeded its residential RBC (88 μg/kg) in sample 030SGB0101 (300 μg/kg) and sample 030SGB0401 (90 μg/kg).

- Dieldrin exceeded its SSL (1 μg/kg) in sample 030SGB0401 (7.3 μg/kg).

The June 3, 1997, Surface Soil (0 to 1 foot) Background Dieldrin Concentrations at NSA Memphis Technical Memorandum has been included as Attachment 2 of this CSI report. This memorandum established a background dieldrin concentration (RC) of 262 μg/kg at the NSA Memphis. The dieldrin concentration detected in soil at SWMU 30 is less than this background concentration.

As discussed in Section 7.1.8, TPH has no RBC or SSL. Permeability data has not been collected at SWMU 30 to determine the appropriate TDEC cleanup standard.

- TPH-DRO was detected in sample 030SGB0101 (14,000 μg/kg) and sample 030SGB0401 (14,000 μg/kg).

Inorganics in Surface Soil

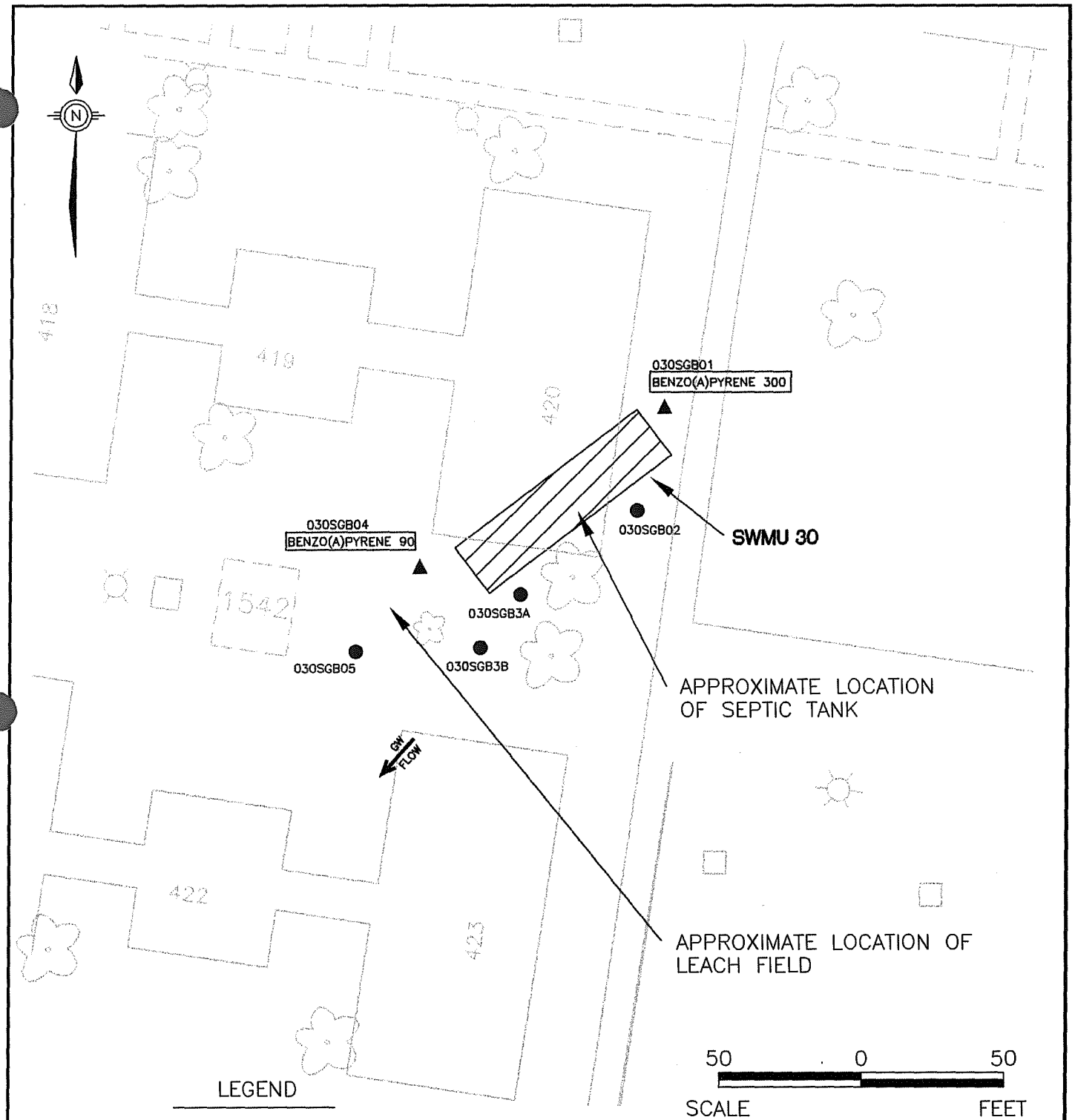
As presented in Tables 7.3.3 and 7.3.4, 11 inorganics were detected at SWMU 30. None of the detected metals exceeded both its background RC and its RBC.

VOCs in Surface and Subsurface Soil

As presented in Table 7.3.5, two VOCs (acetone and carbon disulfide) were detected in the screening samples. Neither compound exceeded its SSL.

VOCs in Groundwater

One VOC was detected in fluvial deposits groundwater at SWMU 30. Acetone was detected at 120 μg/L. This concentration does not exceed either the tap water RBC or the MCL.



LEGEND

- ● NO ORGANIC EXCEEDS ITS RESIDENTIAL OR INDUSTRIAL RBC
- ▲ AT LEAST ONE EXCEEDS ITS RESIDENTIAL RBC
- 030SGB01 BORING NUMBER
- SWMU 30
- BENZO(a)PYRENE 90 ORGANIC THAT EXCEEDS ITS RBC AND THE REPORTED CONCENTRATION IN $\mu g/kg$
- GW FLOW → GROUNDWATER FLOW DIRECTION IN FLUVIAL DEPOSITS

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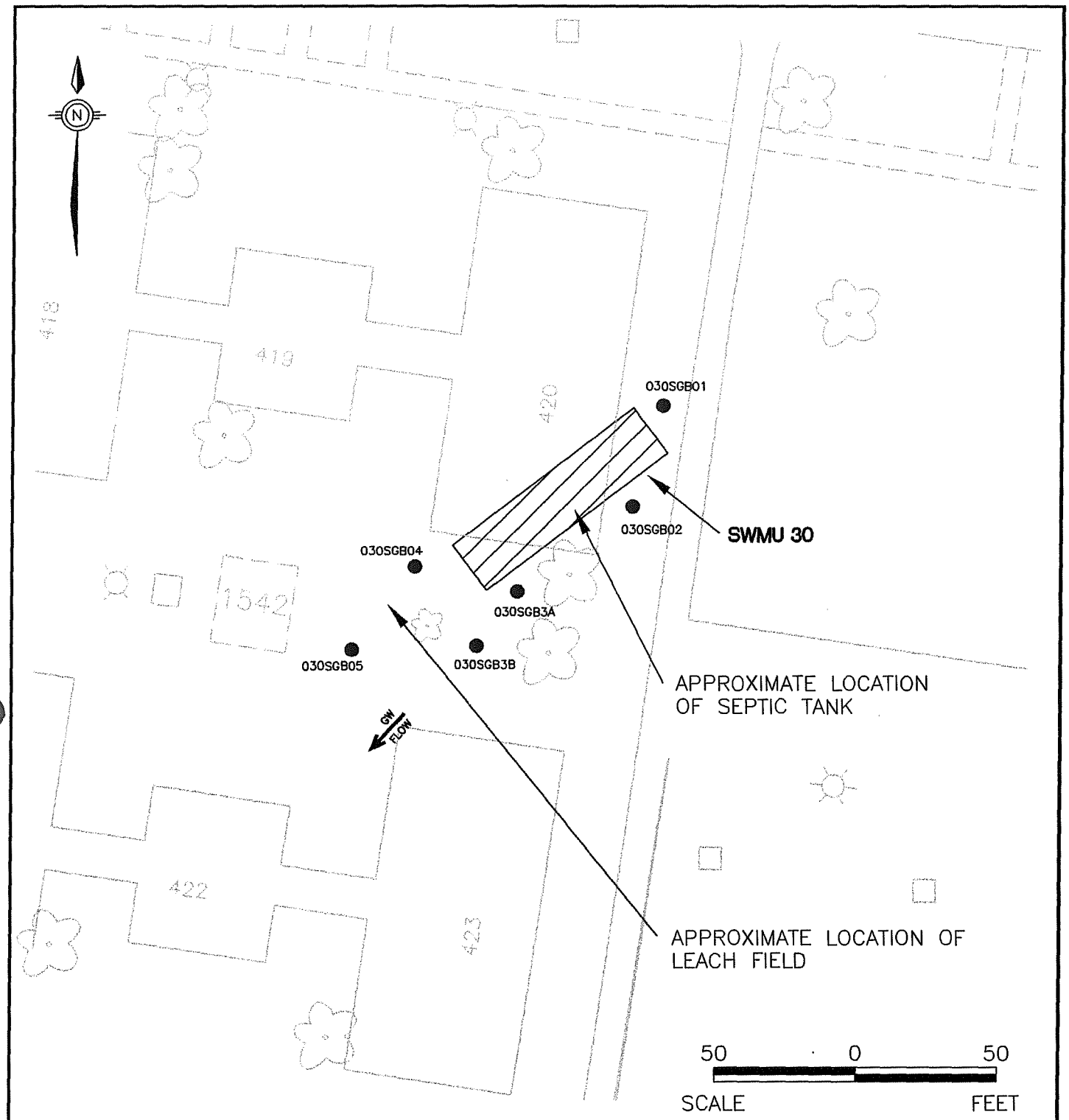
FIGURE 7.3.2
SWMU 30
RBC EXCEEDANCES FOR ORGANICS IN SURFACE SOIL

DWG DATE: 10/20/97 | DWG NAME: 106FS302



LEGEND

● NO INORGANIC EXCEEDS ITS RCs AND ITS RESIDENTIAL OR INDUSTRIAL RBC

030SGB01 BORING NUMBER

GW FLOW → GROUNDWATER FLOW DIRECTION IN FLUVIAL DEPOSITS

SWMU 30

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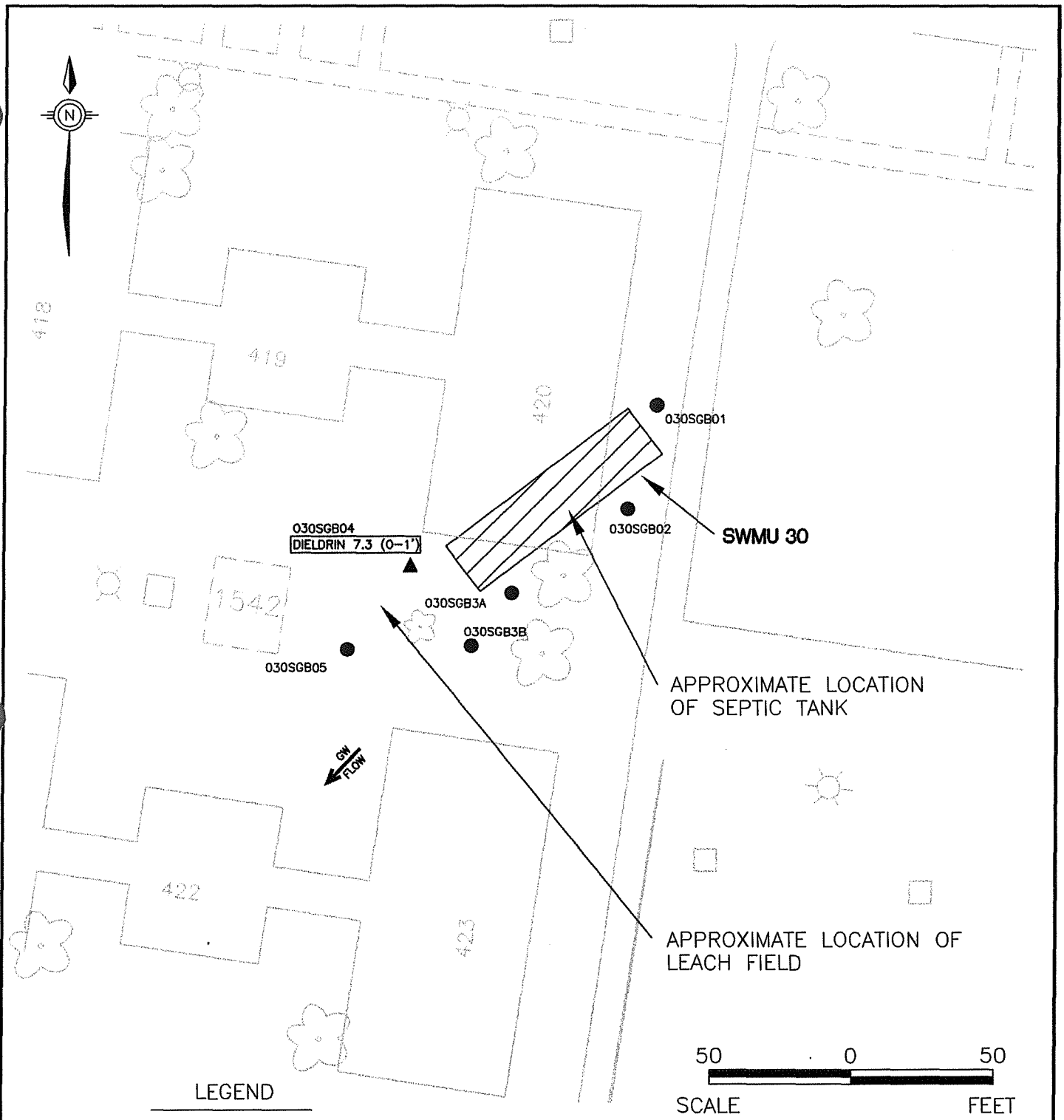
FIGURE 7.3.3
SWMU 30
RC AND RBC EXCEEDANCES FOR INORGANIC IN SURFACE SOIL

DWG DATE: 10/20/97 | DWG NAME: 106RCRBC



LEGEND

- ● NO ORGANICS EXCEED SSLs
- ▲ AT LEAST ONE ORGANIC EXCEEDS ITS SSL
- 030SGB01 BORING NUMBER
- DIELDRIN 7.3 (0-1') ORGANIC THAT EXCEEDS ITS SSL, THE REPORTED CONCENTRATION IN $\mu g/kg$, AND THE SAMPLE DEPTH
- GW FLOW GROUNDWATER FLOW DIRECTION IN FLUVIAL DEPOSITS
- SWMU 30

ASSEMBLY F
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MILLINGTON, TENNESSEE

FIGURE 7.3.4
SWMU 30
SSL EXCEEDANCES FOR ORGANICS IN SURFACE AND SUBSURFACE SOIL

DWG DATE: 10/20/97 | DWG NAME: 1060ISS4

Table 7.3.1
SWMU 30
Organics Detected in Surface Soil
Results in μg/kg

Parameter	030SGB0101	030SGB0401
4,4'-DDE	**4.60**	**5.70**
4,4'-DDT	2.50	7.40
Anthracene	**88**	**ND**
Benzo(a)anthracene	280	76
Benzo(a)pyrene [a]	**300**	**90**
Benzo(b)fluoranthene	300	71
Benzo(g,h,i)perylene	**240**	**71**
Benzo(k)fluoranthene	250	70
Carbazole	**66**	**ND**
Chrysene	300	86
Di-n-butylphthalate	**ND**	**210**
Dibenz(a,h)anthracene	70	ND
Dieldrin [b]	**ND**	**7.3**
Endosulfan I	ND	1
Endosulfan sulfate	**2**	**ND**
Fluoranthene	660	160
Indeno(1,2,3-cd)pyrene	**200**	**62**
Phenanthrene	340	61
Pyrene	**720**	**190**
TPH - Diesel Range Organics	14000	14000
alpha-Chlordane	**ND**	**1.5**
bis(2-Ethylhexyl)phthalate (BEHP)	ND	140

Notes:
a — Exceeds RBC
b — Exceeds SSL
Bold — Bold text indicates a compound exceeding a screening criterion.
ND — Not detected above PQL

Table 7.3.2
SWMU 30
Summary of Organics Detected in Surface Soils
Results in μg/kg

Parameter	Sample Interval [a]	Frequency of Detection	Range of Detection [b]	Mean [c]	Residential Soil RBC [d]		RBC - Res. Exceedances	Industrial Soil RBC [d]		RBC-Ind. Exceedances	SSL [e]	SSL Exceedance [f]
4,4'-DDE	0-1'	2/2	4.6 - 5.7	5.2	1,900	C	0	17,000	C	0	500	No
4,4'-DDT	0-1'	2/2	2.5 - 7.4	5.0	1,900	C	0	17,000	C	0	1,000	No
Anthracene	0-1'	1/2	88 - 88	88	23,000,000	N	0	610,000,000	N	0	4,300,000	No
Benzo(a)anthracene	0-1'	2/2	76 - 280	178	880	C	0	7,800	C	0	700	No
Benzo(a)pyrene	0-1'	2/2	90 - 300	195	88	C	2	780	C	0	4,000	No
Benzo(b)fluoranthene	0-1'	2/2	71 - 300	186	880	C	0	7,800	C	0	4,000	No
Benzo(g,h,i)perylene	0-1'	2/2	71 - 240	156	2,300,000 [h]	N	0	61,000,000 [h]	N	0	1,400,000 [h]	No
Benzo(k)fluoranthene	0-1'	2/2	70 - 250	160	8,800	C	0	78,000	C	0	4,000	No
Carbazole	0-1'	1/2	66 - 66	66	32,000	C	0	290,000	C	0	500	No
Chrysene	0-1'	2/2	86 - 300	193	88,000	C	0	780,000	C	0	1,000	No
Di-n-butylphthalate	0-1'	1/2	210 - 210	210	7,800,000	N	0	200,000,000	N	0	120,000	No
Dibenz(a,h)anthracene	0-1'	1/2	70 - 70	70	88	C	0	780	C	0	11,000	No
Dieldrin [i]	0-1'	1/2	7.3 - 7.3	7.3	40	C	0	360	C	0	1	Yes
Endosulfan I	0-1'	1/2	1 - 1	1	470,000	N	0	12,000,000	N	0	3,000	No
Endosulfan sulfate	0-1'	1/2	2 - 2	2	470,000 [h]	N	0	12,000,000 [h]	N	0	3,000	No
Fluoranthene	0-1'	2/2	160 - 660	410	3,100,000	N	0	82,000,000	N	0	980,000	No
Indeno(1,2,3-cd)pyrene	0-1'	2/2	62 - 200	131	880	C	0	7,800	C	0	35,000	No
Phenanthrene	0-1'	2/2	61 - 340	201	2,300,000 [g]	N	0	61,000,000 [g]	N	0	1,400,000	No
Pyrene	0-1'	2/2	190 - 720	455	2,300,000	N	0	61,000,000	N	0	1,400,000	No
TPH - Diesel Range Organics	0-1'	2/2	14,000 - 14,000	14,000	NA [g]		NA	NA [g]		NA	NA	NA

Table 7.3.2
SWMU 30
Summary of Organics Detected in Surface Soils
Results in μg/kg

Parameter	Sample Interval [a]	Frequency of Detection	Range of Detection [b]	Mean [c]	Residential Soil RBC [d]		RBC - Res. Exceedances	Industrial Soil RBC [d]		RBC-Ind. Exceedances	SSL [e]	SSL Exceedance [f]
alpha-Chlordane	0-1'	1/2	1.5 - 1.5	1.5	490	C	0	4,400	C	0	2,000	No
bis(2-Ethylhexyl)phthalate	0-1'	1/2	140 - 140	140	46,000	C	0	410,000	C	0	11,000	No

Notes:

a — Feet below ground surface
b — Range lower limit is the lowest detected concentration
c — Mean is based on detected concentrations only.
d — Residential and industrial screening values (RBC-Res., RBC-Ind.) are from USEPA Region III Risk-Based Concentration Table, January to June 1996.
e — SSL considered protective of contaminant transfer from soil to groundwater (from USEPA Region III Risk-Based Concentration Table, January to June 1996)
f — A "Yes" in this column indicates that at least one sample result exceeded the SSL for this analyte; a "No" indicates that no sample result exceeded the SSL.
g — Risk-based data are not available. Data for naphthalene was used as a surrogate.
h — RBC for endosulfan used as a surrogate RBC for endosulfan sulfate.
i — Dieldrin concentrations reported above do not exceed the corresponding background dieldrin concentration, 262 μg/kg, excerpted from the January 9, 1997 Background Dieldrin Concentrations in Surface Soils (0 to 1') technical memorandum.
NA — not available
N — noncarcinogen-based RBC
C — carcinogen-based RBC

Table 7.3.3
SWMU 30
Inorganics Detected in Surface Soil
Results in mg/kg

Parameter	030SGB0101	030SGB0401
Arsenic	7.2	4.2
Barium	105	99.9
Chromium	7.4	7.6
Cobalt	5.5	5.1
Copper	11.7	17
Lead	25.6	30.4
Mercury	0.1	0.1
Nickel	13.2	12.6
Selenium	0.1	ND
Vanadium	15.1	13.1
Zinc	50	52.8

Notes:
ND — Not detected above the IDL
mg/kg — milligrams per kilogram

7.3.4 Preliminary Risk Evaluation

In accordance with USEPA guidance, a PRE was conducted for SWMU 30 using data from surface soil, and groundwater samples collected during the CSI. Subsurface soil data is addressed in Section 7.3.5. Soil and groundwater samples were analyzed onsite for VOCs; two surface soil samples were also submitted to an offsite laboratory for FSA; and approximately 25% of all samples analyzed onsite for VOCs were split for confirmatory analysis offsite. As discussed in Section 5, the PRE was conducted by identifying COPCs from the original set of detected chemicals, calculating the risk ratio for each COPC, and interpreting those results.

Tables 7.3.1, 7.3.2, 7.3.4, 7.3.5, and 7.3.6 present results for organic compounds detected in surface soil, inorganics detected in surface soil, VOCs detected in surface soil, and VOCs detected in fluvial deposits groundwater, respectively. BEQ was the only COPC identified in surface soil. Consequently, surface soil was the only medium evaluated in this PRE.

Table 7.3.4
SWMU 30
Summary of Inorganics Detected in Surface Soil
Results in mg/kg

Parameter	Sampling Interval [a]	Frequency of Detection	Range of Detection [b]	Mean [c]	Inorganic RC [d]	RC Exceedances	Residential Soil RBC [e]		RBC-Res. Exceedances	Industrial Soil RBC [e]		RBC-Ind. Exceedances	SSL [f]	SSL Exceeded [g]
Arsenic	0-1'	2/2	4.2 - 7.2	5.7	14.58	0	0.48	C	2	3.8	C	2	15	No
Barium	0-1'	2/2	99.9 - 105	102	223.46	0	5,500	N	0	140,000	N	0	32	Yes
Chromium	0-1'	2/2	7.4 - 7.6	7.5	23.89	0	390 [h]	N	0	10,000 [h]	N	0	19 [h]	No
Cobalt	0-1'	2/2	5.1 - 5.5	5.3	15.98	0	4,700	N	0	120,000	N	0	NA	NA
Copper	0-1'	2/2	11.7 - 17	14	24.19	0	3,100	N	0	82,000	N	0	NA	NA
Lead	0-1'	2/2	25.6 - 30.4	28	26.03	1	400 [i]		0	1,000 [i]		0	NA	NA
Mercury	0-1'	2/2	0.1 - 0.1	0.1	0.46	0	23	N	0	610	N	0	3	No
Nickel	0-1'	2/2	12.6 - 13.2	12.9	20.62	0	1,600	N	0	41,000	N	0	21	No
Selenium	0-1'	1/2	0.13 - 0.13	0.13	BDL	NA	390	N	0	10,000	N	0	3	No
Vanadium	0-1'	2/2	13.1 - 15.1	14.1	45.11	0	550	N	0	14,000	N	0	NA	NA
Zinc	0-1'	2/2	50 - 52.8	51	98	0	23,000	N	0	610,000	N	0	42,000	No

Notes:
a — Feet below ground surface
b — Range lower limit is the lowest detected concentration.
c — Mean is based on detected concentrations only.
d — Residential and industrial screening values (RBC-Res., RBC-Ind.) are from USEPA Region III Risk-Based Concentration Table, January to June 1996.
e — Residential and industrial screening values (RBC-Res., RBC-Ind.) are from USEPA Region III Risk-Based Concentration Table, January to June 1996.
f — SSL considered protective of contaminant transfer from soil to groundwater (from USEPA Region III Risk-Based Concentration Table, January to June 1996)
g — A "Yes" in this column indicates that at least one sample result exceeded the SSL for this analyte; a "No" indicates no sample results exceeding the SSL.
h — RBC for hexavalent chromium (VI).
i — Value is soil cleanup level for total lead (USEPA OSWER Directive, 9355.4-12).
NA — Not applicable
BDL — Below detection limit
N — noncarcinogen-based RBC
C — carcinogen-based RBC

Table 7.3.5
SWMU 30
VOCs Detected in Surface and Subsurface Soil Screening Samples
Results in μg/kg

Parameter	Sample Interval	030SGB04	Split Sample 030SGB03	Split Sample 030SGB05
Acetone	0-1'	ND	400	NS
	11-13'	ND	NS	23
Carbon Disulfide	11-13'	13	NS	NS

Notes:
ND — Not detected above the instrument PQL
NS — Not Sampled

BEQ estimations were calculated in accordance with USEPA Region IV's November 1995 *Supplemental Guidance to RAGS Bulletin 2* and are presented in Table 7.3.7. All PAHs listed below are classified by USEPA as B2 carcinogens, and their carcinogenicity is addressed relative to that of benzo(a)pyrene, which has a SF of 7.3 kg-day/mg. TEFs, also determined by USEPA, are multipliers that are applied to the detected concentrations, which are subsequently summed and used to estimate cancer risk posed by benzo(a)pyrene and other PAHs with similar toxicology.

BEQ includes the following:

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

Table 7.3.6
SWMU 30
VOCs Detected in Surface and Subsurface Soil Screening Samples
Results in μg/kg

Parameter	Sample Interval [a]	Frequency of Detection	Range of Detection [b]	Mean [c]	Residential Soil RBC [d]		RBC - Res. Exceedances	Industrial Soil RBC [d]		RBC-Ind. Exceedances	SSL [e]	SSL Exceedance [f]
Acetone	0 - 1'	1/5	400 - 400	400	7,800,000	N	0	200,000,000	N	0	8,000	0
	11-13'	1/7	23 - 23	23	NA		0	NA	N	0	8,000	0
Carbon disulfide	11-13'	1/7	13 - 13	13	NA	N	0	NA	N	0	14,000	No

Notes:

a — Feet below ground surface
b — Range lower limit is the lowest detected concentration.
c — Mean is based on detected concentrations only.
d — Residential and industrial screening values (RBC-Res., RBC-Ind.) are from USEPA Region III Risk-Based Concentration Table, January to June 1996.
e — SSL considered protective of contaminant transfer from soil to groundwater (from USEPA Region III Risk-Based Concentration Table, January to June 1996)
f — A "Yes" in this column indicates that at least one sample result exceeded the SSL for this analyte; a "No" indicates that no sample result exceeded the SSL.
N — noncarcinogen-based RBC

Table 7.3.7
SWMU 30
VOC Screening Results Summary for Fluvial Deposits Groundwater
Results in μg/L

Parameter	Sample Interval [a]	Frequency of Detection	Range of Detection [b]	Mean [c]	Tap Water RBC [d]	Tap Water RBC Exceedances	MCL [d]	MCL Exceedances
Acetone	47'	1/3	120 - 120	120	3,700	0 N	NA	NA

Notes:
a — Feet below ground surface
b — Range lower limit is the lowest detected concentration.
c — Mean is based on detected concentrations only.
d — Tap Water RBCs are from USEPA Region III Risk-Based Concentration Table, January to June 1996.
e — Maximum Contaminant Level from Drinking Water Regulations and Health Advisories (USEPA, October 1996).
N — noncarcinogen-based RBC

Table 7.3.8 includes the BEQ for SWMU 30, and Table 7.3.9 summarizes PRE results for BEQ. The risk ratios for BEQ are summed separately for both residential and industrial scenarios to determine the overall site risk. Cumulative risk (for carcinogens) is calculated, and the cumulative risk is compared to the corresponding cumulative threshold in accordance with USEPA Region IV's November 1994 memorandum.

Uncertainty

The PRE for SWMU 30 is based on the maximum reported concentrations of each COPC and a future residential and industrial scenario. This conservative approach includes these assumptions regarding uncertainties:

- Cumulative effects will occur, regardless of target organs and mechanisms of action, which could either overestimate or underestimate risk.

- 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).

Table 7.3.8
Benzo(a)pyrene Equivalent Concentrations
SWMU 30
(in μg/kg)

		030SGB0101		030SGB0401	
Chemical	**TEF**	**Reported Concentration**	**Equivalent Concentration**	**Reported Concentration**	**Equivalent Concentration**
Benzo(a)pyrene	1	300	300	90	90
Benzo(a)anthracene	0.1	280	28	76	7.6
Benzo(b)fluoranthene	0.1	300	30	71	7.1
Benzo(k)fluoranthene	0.01	250	2.5	70	0.7
Chrysene	0.001	300	0.3	86	0.086
Dibenz(a,h)anthracene	1	70	70	ND	NA
Indeno(123-cd)pyrene	0.1	200	20	62	6.2
		BEQ =	***450.8***	***BEQ =***	***111.7***

Notes:
* — BEQ was calculated in accordance with USEPA Region IV November 1995 *Supplemental Guidance to RAGS: Bulletin 2*
TEF — Toxicity equivalence factor
ND — Not detected
NA — Not applicable

Table 7.3.9
Preliminary Risk Evaluation
SWMU 30

			Residential			Industrial		
Chemical	**Maximum Reported Concentration**	**Units**	**RBC**	**Hazard Quotient**	**ILCR**	**RBC**	**Hazard Quotient**	**ILCR**
				Surface Soil				
BEQ	450.8	μg/kg	88 C	NA	5.12E-06	780 C	NA	5.8E-07

Notes:
RBC — Risk-based concentration from USEPA Region III's June 1996 RBC Table.
C — Carcinogen
NA — Not applicable
ILCR — Incremental lifetime excess cancer risk

Conclusions and Recommendations

Based on the information gathered during the investigation, the following conclusions and recommendations have been reached based on a PRE performed on data from surface soil samples:

Residential Land Use — Suitable for Lease

- Carcinogens: The cumulative risk for soil for the residential scenario was estimated to be 5E-06, indicating suitability for lease of the SWMU 30 area for a residential land use scenario in accordance with USEPA Region IV's November 1994 memorandum.

- Noncarcinogens: Since no noncarcinogenic COPCs were detected, and HQs were not calculated, the land surrounding SWMU 30 is assumed to be suitable for lease for a residential land use scenario in accordance with USEPA Region IV's November 1994 memorandum.

Industrial Land Use — Suitable for Lease

- Carcinogens: The cumulative risk for the industrial scenario was estimated to be 6E-07, indicating suitability for lease for an industrial land use scenario in accordance with USEPA Region IV's November 1994 memorandum.

- Noncarcinogens: Since no noncarcinogenic COPCs were detected, and HQs were not calculated, the land surrounding SWMU 30 is assumed to be suitable for lease for an industrial land use scenario in accordance with USEPA Region IV's November 1994 memorandum.

7.3.5 Fate and Transport

The approach for evaluating the fate and transport of Assembly F contaminants was discussed in Section 6.2. The following sections apply that approach to contaminants detected at SWMU 30. Transport processes for analytes other than those designated as COPCs will also be discussed if they are in multiple environmental media, or can migrate to other media.

The migration pathway for analytes detected at SWMU 30 is predominantly soil to groundwater. However, the potential for soil-to-sediment cross-media transport is more prominent at this SWMU than others in this Assembly based on the type of cover and relief in the immediate area. No contaminant detected at SWMU 30 exceeded its SSL for soil-to-air transport, therefore, this pathway is not discussed. SWMU 30 COPCs include:

- Dieldrin, which exceeded its soil-to-groundwater SSL.

7.3.5.1 Soil-to-Groundwater Cross-Media Transport

Only two contaminants exceeded their soil-to-groundwater SSLs in surface soil at SWMU 30 — the inorganic barium and the pesticide dieldrin. Although barium exceeded its SSL, it did not exceed its background RC, indicating it is naturally occurring at SWMU 30. Also, dieldrin did not exceed its background RC and has been found to be ubiquitous across NSA Memphis.

Other analytes detected in soil at SWMU 30 predominantly include SVOCs, inorganics, and pesticides. Two VOCs were detected, carbon disulfide and acetone. Acetone was detected in fluvial deposits groundwater and in soil samples split for confirmatory analysis, but its presence in groundwater is suspect since it is a common laboratory artifact. Based on the chemical properties of these three classes of contaminants, it is unlikely that they pose a threat to the underlying groundwater.

Based on the low concentrations of contaminants detected in soil and groundwater, the soil-to-groundwater cross-media transport mechanism should not be an important process at SWMU 30 and a significant impact to groundwater is not likely.

7.3.5.2 Soil-to-Sediment Cross-Media Transport

Contaminants detected in surface soil at SWMU 30 are either SVOCs or pesticides. As described earlier, these classes of contaminants are relatively immobile in the environment and tend to associate with soil particles. They only become mobile when the soil particles are also mobilized by some erosional process. The immediate SWMU 30 area is grass-covered. Surface drainage should flow toward the storm drains and ultimately into an east-west oriented drainage ditch, associated with SWMU 38. Although these ditches have been sampled, it may not be possible to associate contamination in the ditches with SWMU 30 activities. It is unlikely that erosion is an important process at SWMU 30 given the types of cover and the relatively low level topography.

7.3.6 Conclusions and Recommendations

Based on the information gathered during this investigation, the following conclusions and recommendations have been reached.

Conclusions

- SWMU 30 will be developed for commercial use according to the Base Reuse Plan.

- Twenty-two organic compounds were detected in the surface soil interval.

  — Benzo(a)pyrene was detected at concentrations exceeding its residential RBC.

  — Dieldrin was detected at a concentration exceeding its SSL. However, the reported detection was less than the 262 μg/kg RC established for the base.

- TPH/DRO was detected in surface soil.

  — A cleanup standard will be established once permeability of site soil has been determined. TPH concentrations do not exceed the more conservative TDEC cleanup standard (100,000 μg/kg).

- Eleven inorganics were detected in surface soil at SWMU 30. None of the inorganics detected exceeded both its RC or its RBC.

- Two organics were detected in surface and subsurface screening samples. Neither exceeded its SSL.

- Based on a PRE performed on data from soil samples collected from the surface interval, the following has been concluded:

  — Carcinogens: Cumulative soil cancer risk estimates for the residential and industrial scenarios were below the cumulative risk threshold of 1E-4 for PREs, indicating that the site is suitable for lease.

  — Noncarcinogens: No noncarcinogenic COPCs were detected, so HIs were not calculated.

Even though solvents were listed as type of waste received by the septic tank, none were detected at notable concentrations. The use of chlorinated solvents was limited prior to World War II. If solvents had been used at either of the maintenance facilities discussed above, they may have been petroleum compounds, alcohols or a biologically produced solvents. In the early 1900's acetone and butanol were manufactured using a bacteriological fermentation process. The reactions

involved in the fermentation process are reversible; therefore the compounds produced by this type of process are more readily broken down in nature than chlorinated solvents. Petroleum compounds and alcohols are also more susceptible to biodegredation than chlorinated solvents. Based on the above, it is possible that over the past 56 years, any solvents that may have been introduced into the septic system may have been completely biodegraded.

Recommendation

- No further action is recommended at SWMUs 30. An ERA is not recommended based on the discussion in Section 8.

7.4 SWMU 39 — Former Dry Cleaner and PCB Storage Facility

SWMU 39 is approximately 300 feet south of First Avenue and F Street across from the boiler plant, Building S-75, on the NSA Memphis Southside (Figure 7.4.1). SWMU 39 consists of a concrete slab that was outside Building S-74. Transformers and drums of oil were stored on the slab until Building S-74 was demolished in 1995. Building S-74 was built in 1943 and operated as a laundry until 1981 (38 years). Building S-212 also occupied the area. It was constructed in 1947 to store solvent for S-74.

SWMU 39 and the surrounding area are characterized by relatively level, low-relief topography. The remaining building foundation is concrete while surrounding areas are covered with grass. Surface drainage is toward the south and west to a north-south oriented drainage ditch (SWMU 38) which flows into Big Creek Drainage Canal.

The regional and local hydrogeology are described in Sections 2.11 and 2.12, respectively, of the *Comprehensive RFI Work Plan;* Section 2.2 of the *Assembly F CSI Work Plan;* and Section 2 of this report. Site-specific geologic and hydrogeologic information and references can be found in the *Assembly F CSI Work Plan*. One DPT location was sampled continuously for lithologic characterization at SWMU 39. The lithology was as follows:

0 to 8 feet bgs	—	Silt, gray and brown. Tight and dry with some iron staining.
8 to 12 feet bgs	—	Silt with some very fine-grained sand, gray and brown. Wet from 8 to 10 feet, saturated from 10 to 12 feet.
12 to12.25 feet bgs	—	Silt, gray, loose, saturated.
12.25 to 18.3 feet bgs	—	Silt, gray, wet.
18.3 to 24 feet bgs	—	Clayey silt with trace amounts of very fine-grained sand, gray. Moist, tight.
24 to 25.2 feet bgs	—	Clayey silt, gray. Soft, saturated.
25.2 to 31.5 feet bgs	—	Clayey silt with clay with some very fine-grained sand, gray. Moist.
31.5 to 34 feet bgs	—	Silt with some clay, gray. Some very fine-grained sand. Sand content increases with depth. Saturated.

34 to 36 feet bgs — No recovery. Formation material forced into the annulus between the push rods and the sampler (flowing sands). Terminated boring at 34 feet.

When the DPT rods and sampler were retrieved from the 36-foot deep borehole, there was sand in the annulus between the inner wall of the DPT rods and the sampler. Based on the flowing sands encountered, the top of the fluvial aquifer is estimated to be approximately 35 feet bgs.

7.4.1 Previous Sampling Activities

Limited information is available on the past use of SWMU 39 as a dry cleaning facility. However, building plans show the layout of the building including the location of both the dry cleaning area and the chemical storage area. Documentation from visual inspections of Building S-74 and an adjacent PCB transformer storage area reported no apparent surface contamination or spills. The 1990 RFA stated the transformers stored outside Building S-74 either were tested and found negative for PCBs or were awaiting testing.

Groundwater samples were collected at SWMU 39 during a preliminary assessment in December 1995. A groundwater sample from the upper fluvial deposits, collected using DPT, was submitted to an onsite laboratory for VOC analysis. The results indicated the presence of petroleum products, presumed to be Stoddard solvent, a common dry cleaning solution. See Table 7.4.1 for a summary of the results for sample S7446.

In May 1996, a UST adjacent to and south of the Building S-74 concrete foundation was removed by a Navy subcontractor and soil contamination from the UST was visible.

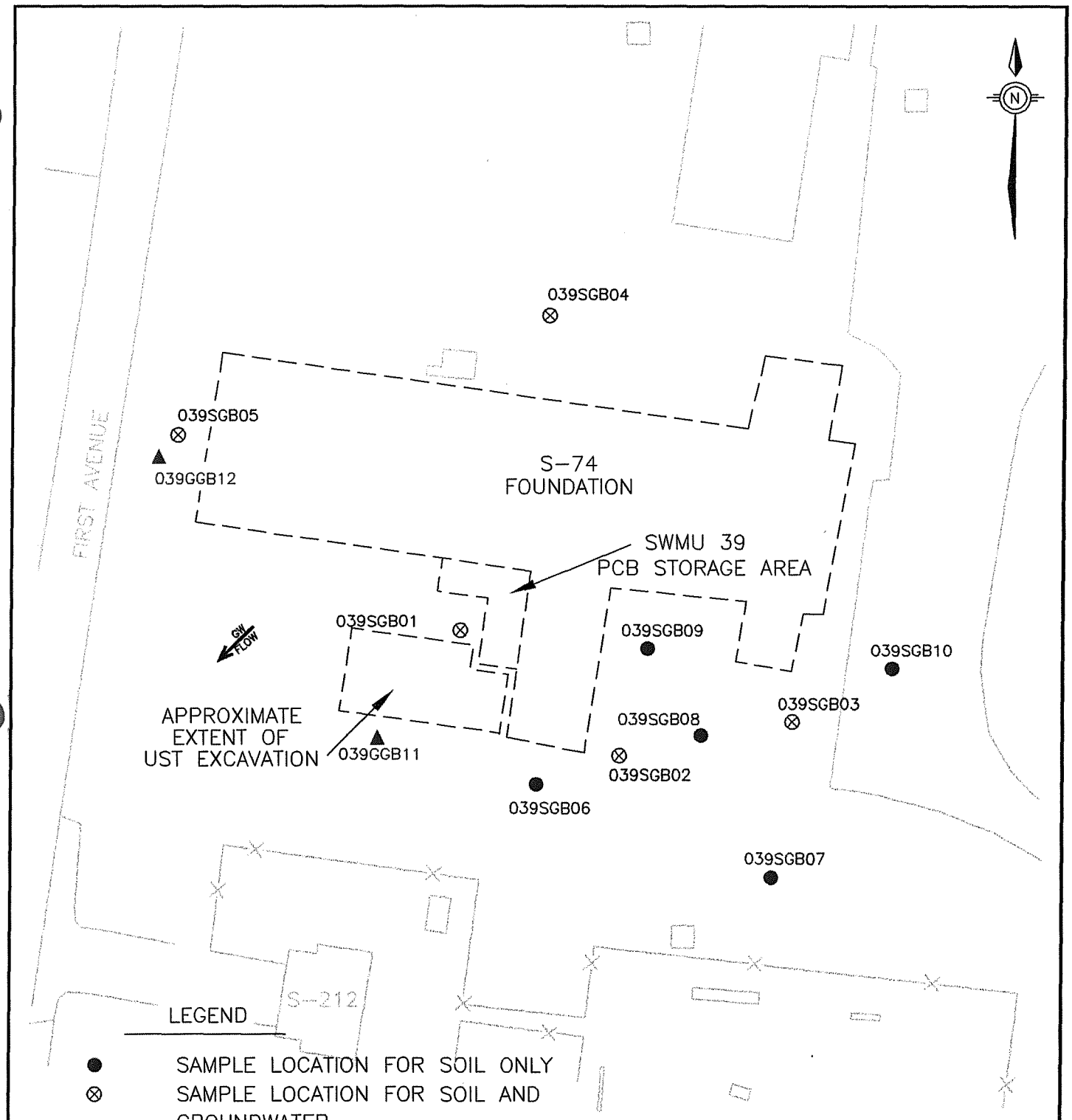
Table 7.4.1
Previous Investigations Data Summary
Volatile Organic Compounds in Groundwater
Results in μg/L

Parameter	Sample S7446
m&p-xylene	4.3
δ-xylene	7.36
1,3,5-trimethylbenzene	9.53
1,2,4-trimethylbenzene	7.49
n-butylbenzene	2.24

7.4.2 Field Investigation

The CSI at SWMU 39 was completed by sampling 12 borings outside the perimeter of the building foundation and former PCB transformer storage area (Figure 7.4.1). Surface soil samples and 2-to 3-foot bgs interval subsurface soil samples were collected using stainless-steel hand augering equipment. All other subsurface soil and groundwater samples were collected using DPT sampling equipment and techniques. As discussed in Section 4.1, two surface samples (039SGB01 and 039SGB02) were collected for FSA under Level IV DQOs or equivalent. The results for these FSA samples were used in the SWMU 39 PRE.

Initially, soil and groundwater screening samples were collected from five locations (039SGB01 through 039SGB05). These locations were selected based on a concern that dry cleaning fluids could have been disposed of on the ground around Building S-74. Five upper-interval soil screening samples were collected from 0 to 1 foot bgs and analyzed by an onsite laboratory for VOCs using the methods described in Section 4. The samples were also split for PCB analysis at an offsite laboratory using Method 8080. Two of the five surface samples (039SGB0101 and 039SGB0201) were also submitted to an offsite laboratory for FSA. Sample 039SGB0101 was collected near the former PCB storage area, while sample 039SGB0201 was collected near an exit door of the former dry cleaning facility.



LEGEND

- ● SAMPLE LOCATION FOR SOIL ONLY
- ⊗ SAMPLE LOCATION FOR SOIL AND GROUNDWATER
- ▲ SAMPLE LOCATION FOR GROUNDWATER ONLY
- GW FLOW → GROUNDWATER FLOW DIRECTION IN FLUVIAL DEPOSITS
- 039SGB01 BORING NUMBER
- ---------- CONCRETE FOUNDATION OF BUILDING S-74

50 0 50

SCALE FEET

ASSEMBLY F
CSI REPORT
NSA MEMPHIS
MILLINGTON, TENNESSEE

FIGURE 7.4.1
SWMU 39
SAMPLE LOCATIONS

DWG DATE: 10/22/97 | DWG NAME: 106TVC39

Subsurface soil screening samples were also collected at each of the five locations from 2 to 3 feet bgs and analyzed for VOCs at an onsite laboratory. These lower-interval soil samples were collected to inspect the area and depth where a release from the transformer storage area would have presumably occurred.

Groundwater samples were proposed for collection from the loess and fluvial deposits at each of the five sample locations. The loess water samples were proposed to be analyzed onsite for VOCs and split for offsite PCB analysis. However, only two loess groundwater samples (039GGB02 and 039GGB04) were collected due to insufficient groundwater recharge and sampling equipment limitations. The limited water volume collected at these locations was sufficient for VOC analysis only. Therefore, soil samples were collected at each of the five locations and analyzed onsite for VOCs and split for offsite analysis for PCBs to determine if contaminants had migrated to the approximate depth of the perched water zone in the loess.

During the initial sampling event, fluvial groundwater samples were collected at each of the five sample locations. Samples were collected from approximately 46 feet bgs and analyzed by the onsite laboratory for VOCs. The samples were not split for PCB analysis, since PCBs were not expected to have migrated very deep into the loess.

1,1,2,2-Tetrachloroethane was detected at concentrations exceeding SSLs in samples collected from DPT locations 039SGB02 and 039SGB03. The samples were collected at 9 to 11 feet bgs and 11- 13 feet bgs respectively. Ethylbenzene, and methylene chloride were also detected at concentrations exceeding SSLs in the 9 to 11 foot interval in sample 039SGB02. Acetone was detected in a fluvial deposits groundwater sample collected at DPT location 039GGB05.

As a result of the compounds detected in these samples seven additional DPT locations (039SGB06 through 039SGB12) were sampled to delineate and/or confirm the detected VOCs. Five soil

borings (039SGB06 through 039SGB10) were sampled from 8 to 10-feet bgs, 11 to 13-feet bgs and 15 to 17-feet bgs analyzed for VOCs at an offsite laboratory. Fluvial groundwater samples were collected from two of the seven DPT locations for VOC screening; 039GGB11 to delineate detected contamination and another to confirm an acetone detected in fluvial deposites groundwater sample from DPT location 039GGB05.

The investigation at SWMU 39 required variations to the Assembly F CSI Work Plan's proposed sampling scheme as discussed below:

- Loess groundwater samples were collected from only two (039GGB02 and 039GGB04) of the five sample locations. Several attempts were made to collect loess groundwater with the DPT groundwater sampling tool, but silt clogged the sampler screen each time preventing water from entering the tool. The wire-wrapped screen was eventually compressed while being pushed into the loess. The compressed screen further impeded the flow of water into the sampling tool.

  Other attempts to sample the loess groundwater, not discussed in the Assembly F CSI Work Plan, were made at three locations using 1-inch diameter, polyvinylchloride (PVC) temporary well screen and riser. Both the inner and outer rods of the sampling rig were advanced into the loess. The rods were removed, the temporary well was lowered through the open hole into the loess, and left overnight to recharge. The following day, the temporary wells had failed to produce a sufficient volume of water for even the VOC analysis, leading to a decision to omit loess groundwater from the sampling scheme. A soil sample from the saturated zone of the loess was then substituted at each location. SWMU 39 was the first site investigated during this CSI and this change in sampling strategy was used at SWMUs 20, 22/63, and 30.

- As previously discussed, subsurface soil samples from SWMU 39 exhibited detectable concentrations of VOCs, so seven additional DPT locations were selected and sampled. Five of the additional borings were sampled to delineate contaminants detected in subsurface soil, and two additional borings were advanced to delineate or confirm contaminants detected in fluvial deposits groundwater.

7.4.3 Confirmatory Sampling Results

This section provides tables and figures presenting the analytical results for all soil and groundwater samples collected during this CSI. The tables present the compound or analyte, sample collection depths, frequency of detection, and minimum, maximum, and mean of all concentrations detected that exceeded the method PQL. Organic results are compared to each compound's corresponding RBC for both residential and industrial scenarios, and to the SSL for protection of groundwater as published in the USEPA Region III January to June 1996 RBC Table (June 1996). Inorganic results are compared to R.C.S., residential and industrial RBCs, and SSLs. Groundwater results are compared to tap water RBCs from the RBC tables and to MCLs published in the Drinking Water Regulations and Health Advisories Table (USEPA, October 1996).

The results for the FSA samples analyzed under Level IV DQOs or equivalent, collected for use in the PRE are presented in Tables 7.4.2 through 7.4.5. VOC screening sample results for both soil and groundwater samples analyzed under Level III DQOs are presented in Tables 7.4.6 through 7.4.9. The VOC results for the FSA samples are not compared with the results for the VOC screening samples because they have different DQOs, different analytical methods and different analyte lists. Both data sets were used to identify COPCs in the PRE. The VOC split screening samples were analyzed as quality control (QC) samples to check the reproducibility of the data are presented with the screening sample results. The data are also presented on Figures 7.4.2 through 7.4.4, which show sampling locations where applicable RBCs, R.C.S.,

SSLs, or MCLs were exceeded. Results for both the FSA surface soil samples and the VOC screening surface soil samples are presented on Figure 7.4.2.

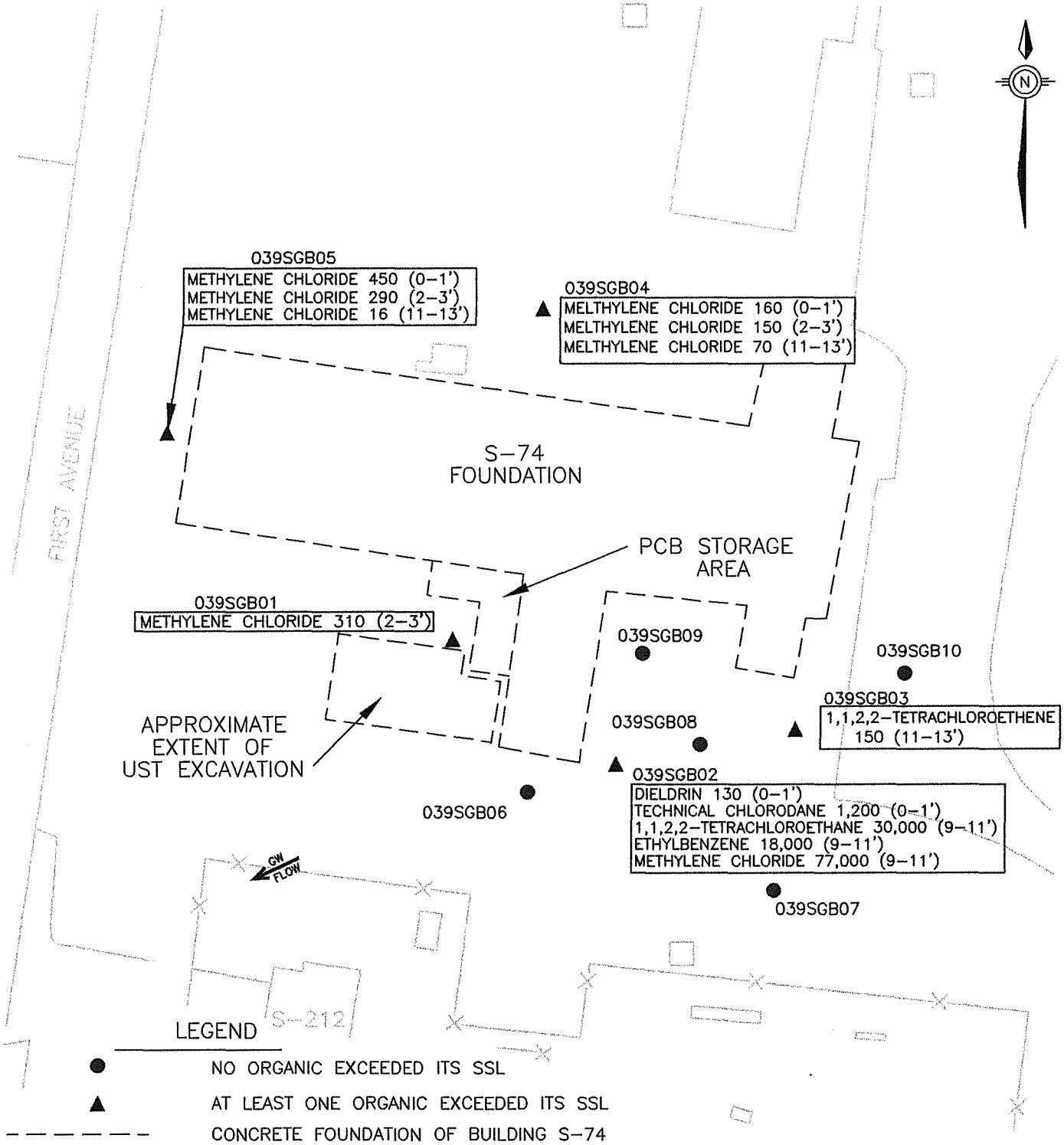
Organics in Surface Soil

As presented in Tables 7.4.2 and 7.4.3, 10 organic compounds and TPH and TPH-DRO were detected in surface soil samples at SWMU 39. Of these 10 compounds, one exceeded both its residential RBC and SSL, and another exceeded its residential RBC only.

Table 7.4.2
SWMU 39 Organics Detected in Surface Soil
Results in μg/kg

Parameter	039SGB0101	039SGB0201
4,4'-DDD	ND	**88**
4,4'-DDE	5.6	260
4,4'-DDT	**18**	**380**
Dieldrin [a]	ND	**130**
Endosulfan I	**ND**	**15**
Endrin ketone	ND	2.5
Heptachlor	**ND**	**4.6**
Total Petroleum Hydrocarbons (418.1)	740,000	240,000
TPH - Diesel Range Organics	**120,000**	**95,000**
Technical chlordane [b]	ND	**1,200**
alpha-Chlordane	**ND**	**140**
gamma-Chlordane	2.6	170

Notes:
a — Exceeds RBC-res. and SSL
b — Exceeds RBC-res.
ND — Not detected above the method PQL
bold — Bold text indicates a screening criterion exceedance.



LEGEND

●	NO ORGANIC EXCEEDED ITS SSL
▲	AT LEAST ONE ORGANIC EXCEEDED ITS SSL
– – – – – –	CONCRETE FOUNDATION OF BUILDING S–74
039GGB01	BORING NUMBER
DIELDRIN 130 (0–1')	COMPOUND EXCEEDING ITS SSL, REPORTED CONCENTRATION IN $\mu g/kg$, AND SAMPLE DEPTH
GW FLOW →	GROUNDWATER FLOW DIRECTION IN FLUVIAL DEPOSITS

50 0 50

SCALE FEET

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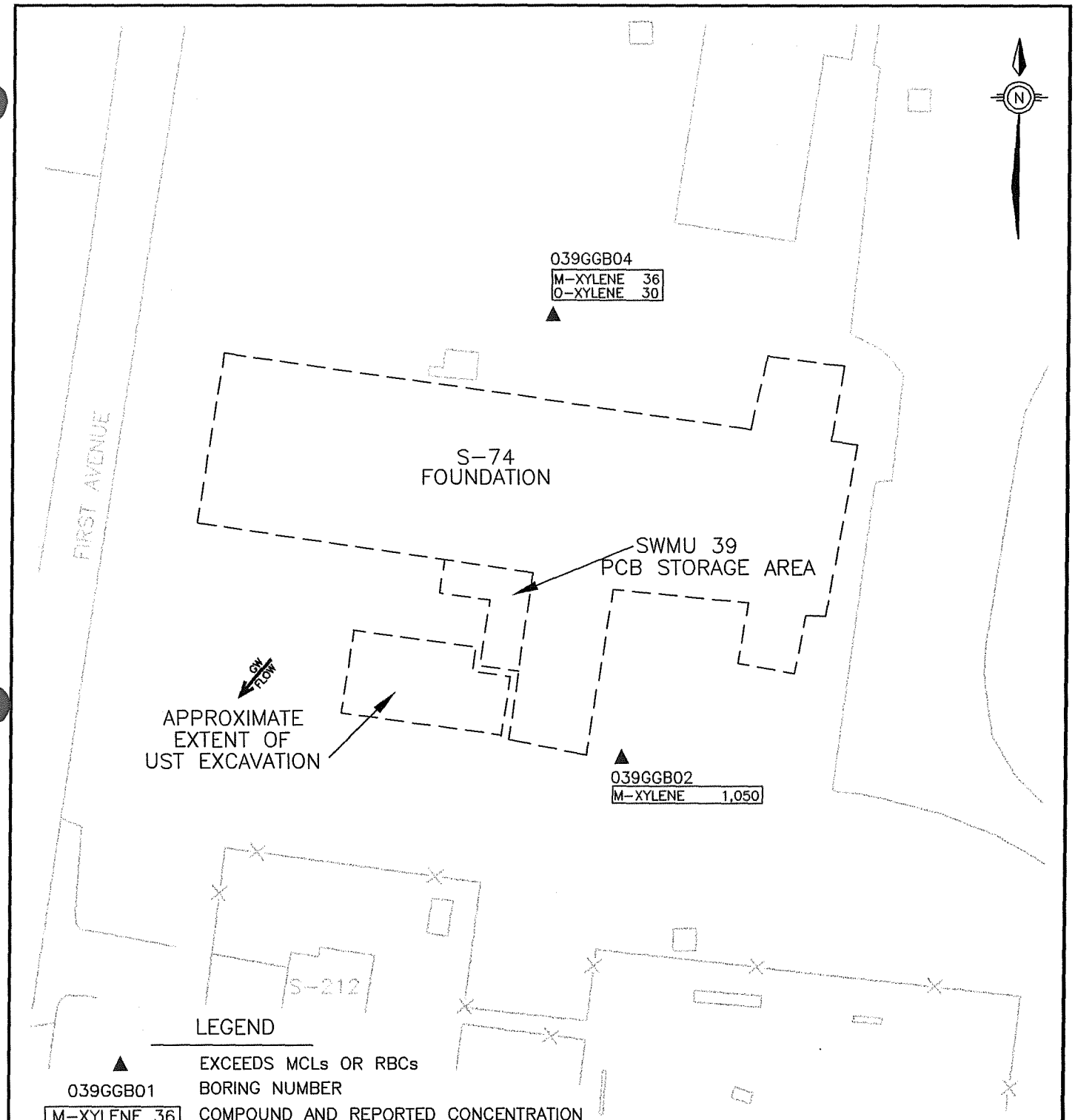
FIGURE 7.4.2
SWMU 39
SSL EXCEEDANCES FOR VOCs
IN SURFACE AND SUBSURFACE SOIL

DWG DATE: 10/20/97 | DWG NAME: 106SSLEX



LEGEND

▲	EXCEEDS MCLs OR RBCs
039GGB01	BORING NUMBER
M-XYLENE 36	COMPOUND AND REPORTED CONCENTRATION THAT EXCEEDED MCLS OR TAP WATER RBCs IN $\mu g/L$
— — — — — —	CONCRETE FOUNDATION OF BUILDING S-74
GW FLOW →	GROUNDWATER FLOW DIRECTION IN FLUVIAL DEPOSITS

*NOTE: LOESS GROUNDWATER SAMPLES WERE ONLY COLLECTED AT THE LOCATIONS DEPICTED ON THIS FIGURE.

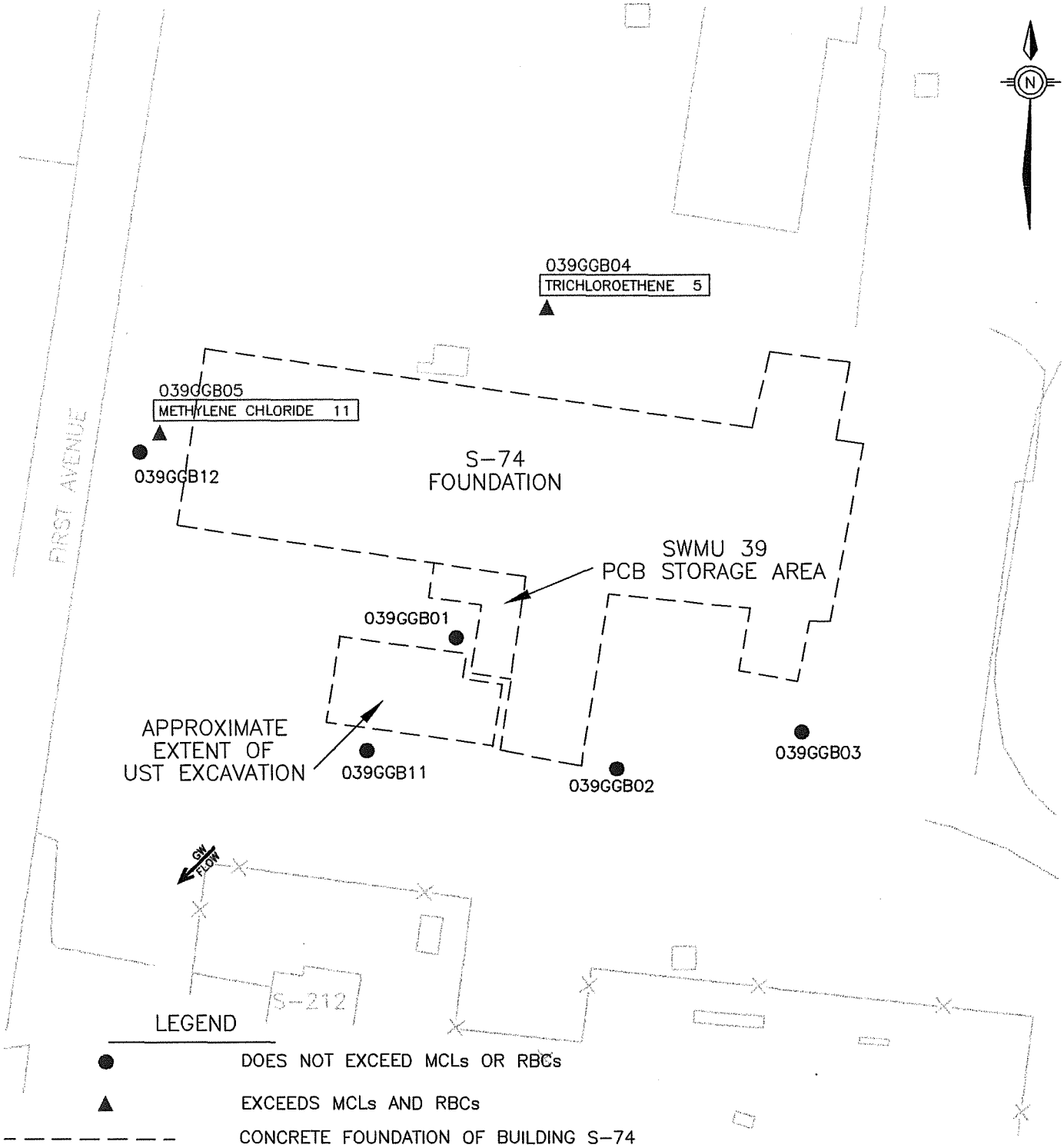
50 0 50

SCALE FEET

ASSEMBLY F
CSI REPORT
NSA MEMPHIS
MILLINGTON, TENNESSEE

FIGURE 7.4.3
SWMU 39
MCL AND RBC EXCEEDANCES
FOR VOCs LOESS GROUNDWATER

DWG DATE: 10/22/97 | DWG NAME: 106MAREV



LEGEND

- ● DOES NOT EXCEED MCLs OR RBCs
- ▲ EXCEEDS MCLs AND RBCs
- — — — — — CONCRETE FOUNDATION OF BUILDING S-74
- 039GGB01 BORING NUMBER
- METHYLENE CHLORIDE 11 COMPOUND THAT EXCEEDS ITS MCL OR RBC AND CONCENTRATION IN $\mu g/L$
- GW FLOW GROUNDWATER FLOW DIRECTION IN FLUVIAL DEPOSITS

50 0 50

SCALE FEET

ASSEMBLY F
CSI REPORT
NSA MEMPHIS
MILLINGTON, TENNESSEE

FIGURE 7.4.4
SWMU 39
MCL AND RBC EXCEEDANCES
FOR VOCs IN FLUVIAL
DEPOSITS GROUNDWATER

DWG DATE: 10/20/97 | DWG NAME: 106FDGMR

Table 7.4.3
SWMU 39 Summary of Organics Detected in Surface Soil
Results in μg/kg

Parameter	Sample Interval [a]	Frequency of Detection	Range of Detection [b]	Mean [c]	Residential Soil RBC [d]		RBC Res. Exceedances	Industrial Soil RBC [d]		RBC Ind. Exceedances	SSL [e]	SSL Exceedance [f]
4,4'-DDD	0-1'	½	88 - 88	88	2,700	C	0	24,000	C	0	700	No
4,4'-DDE	0-1'	2/2	5.6 - 260	133	1,900	C	0	17,000	C	0	500	No
4,4'-DDT	0-1'	2/2	18 - 380	199	1,900	C	0	17,000	C	0	1,000	No
Dieldrin [g]	0-1'	1/2	130 - 130	130	40	C	1	360	C	0	1	Yes
Endosulfan I	0-1'	1/2	15 - 15	15	470,000	N	0	12,000,000	N	0	3,000	No
Endrin ketone [h]	0-1'	1/2	2.5 - 2.5	2.5	23,000	N	0	610,000	N	0	400	No
Heptachlor	0-1'	1/2	4.6 - 4.6	4.6	140	C	0	1,300	C	0	60	No
Total Petroleum Hydrocarbons (418.1)	0-1'	2/2	240,000 - 740,000	490,000	NA [i]		NA	NA [i]		NA	NA	NA
TPH - Diesel Range Organics	0-1'	2/2	95,000 - 120,000	107,500	NA [i]		NA	NA [i]		NA	NA	NA
Technical chlordane	0-1'	1/2	1,200 - 1,200	1,200	490	C	1	4,400	C	0	2,000	No
alpha-Chlordane	0-1'	1/2	140 - 140	140	490	C	0	4,400	C	0	2,000	No
gamma-Chlordane	0-1'	2/2	2.6 - 170	86	490	C	0	4,400	C	0	2,000	No

Notes:

a — Feet below ground surface
b — Range lower limit is the lowest detected concentration.
c — Mean is based on detected concentrations only.
d — Residential and industrial screening values (RBC-Res., RBC-Ind.) are from USEPA Region III Risk-Based Concentration Table, January to June 1996.
e — SSL considered protective of contaminant transfer from soil to groundwater (from USEPA Region III Risk-Based Concentration Table, January to June 1996)
f — A "Yes" in this column indicates that at least one sample result exceeded the SSL for this analyte; a "No" indicates no sample results exceeding the SSL.
g — Dieldrin concentrations reported above do not exceed the corresponding background dieldrin concentration, 262 μg/kg, excerpted from the January 9, 1997, Background Dieldrin Concentrations in Surface Soils (0 to 1') technical memorandum.
h — RBC for endrin was used as a surrogate RBC for endrin ketone.
i — An RBC value does not exist for TPH. Cleanup levels ranging from 100,000 μg/kg to 1,000,000 μg/kg have been established by TDEC. Either 1,000,000 μg/kg or 500,000 μg/kg is likely to apply to this site depending on soil permeabilities. The appropriate level will be determined during subsequent investigation of this site (if applicable.)
NA — Not applicable
N — noncarcinogen-based RBC
C — carcinogen-based RBC

Table 7.4.4
SWMU 39 Inorganics Detected in Surface Soil
Results in mg/kg

Parameter	039SGB0101	039SGB0201
Arsenic	2.9	5.4
Barium	68.4	157
Cadmium	1	ND
Chromium	10.3	8.5
Cobalt	5	11.6
Copper	16.2	12.4
Lead	155	44
Mercury	0.07	0.08
Nickel	14.3	16.4
Vanadium	15.4	22.8
Zinc	172	60.3

Notes:
ND — Not detected above the instrument detection limit
mg/kg — milligrams per kilogram

- Dieldrin exceeded both it residential RBC (40 μg/kg) and its SSL (1 μg/kg) in sample 039-S-GB02-01 (130 μg/kg). However, dieldrin did not exceed the 262 μg/kg background RC at NSA Memphis.

- Technical chlordane exceeded its residential RBC (490 μg/kg) in sample 039SGB0201 (1,200 μg/kg).

As discussed in Section 7.1.8, there are no RBC or SSL values for TPH, TPH-GRO, or TPH-DRO. Permeability data is not available for SWMU 39 to determine the appropriate TDEC cleanup standard for TPH.

- TPH was detected in sample 039SGB0101 (740,000 μg/kg) and sample 039SGB0201 (240,000 μg/kg).

Table 7.4.5
SWMU 39 Summary of Inorganics Detected in Surface Soil
Results in mg/kg

Parameter	Sampling Interval [a]	Frequency of Detection	Range of Detection [b]	Mean [c]	Inorganic RC [d]	RC Exceedances	Residential Soil RBC [e]		RBC-Res. Exceedances	Industrial Soil RBC [e]		RBC-Ind. Exceedances	SSL [f]	SSL Exceeded [g]
Arsenic	0-1'	2/2	2.9 - 5.4	4.2	14.58	0	0.48	C	2	3.8	C	1	15	No
Barium	0-1	2/2	68.4 - 157	113	223.46	0	5,500	N	0	140,000	N	0	32	Yes
Cadmium	0-1'	1/2	1 - 1	1	1.54	0	39	N	0	1,000	N	0	6	No
Chromium	0-1	2/2	8.5 - 10.3	9.4	23.89	0	390 [h]	N	0	10,000 [h]	N	0	19 [h]	No
Cobalt	0-1'	2/2	5 - 11.6	8	15.98	0	4,700	N	0	120,000	N	0	NA	NA
Copper	0-1	2/2	12.4 - 16.2	14.3	24.19	0	3,100	N	0	82,000	N	0	NA	NA
Lead	0-1'	2/2	44 - 155	100	26.03	2	400 [i]		0	1,000 [i]		0	NA [i]	NA
Mercury	0-1	2/2	0.07 - 0.08	0.08	0.46	0	23	N	0	610	N	0	3	No
Nickel	0-1'	2/2	14.3 - 16.4	15.4	20.62	0	1,600	N	0	41,000	N	0	21	No
Vanadium	0-1	2/2	15.4 - 22.8	19.1	45.11	0	550	N	0	14,000	N	0	NA	NA
Zinc	0-1'	2/2	60.3 - 172	116	98	1	23,000	N	0	610,000	N	0	42,000	No

Notes:

a — Feet below ground surface
b — Range lower limit is the lowest detected concentration.
c — Mean is based on detected concentrations only.
d — Background reference concentration
e — Residential and industrial screening values (RBC-Res., RBC-Ind.) are from USEPA Region III Risk-Based Concentration Table, January to June 1996.
f — SSL considered protective of contaminant transfer from soil to groundwater (from USEPA Region III Risk-Based Concentration Table, January to June 1996)
g — A "Yes" in this column indicates that at least one sample result exceeded the SSL for this analyte; a "No" indicates no sample results exceeding the SSL.
h — RBC for hexavalent chromium (VI).
i — Value is soil cleanup level for total lead (USEPA OSWER Directive, 9355.4-12)
NA — Not applicable
BDL — Below detection limit

Table 7.4.6
SWMU 39 VOCs Detected in Surface and Subsurface Soil Screening Samples
Results in $\mu g/kg$

Parameter	Sample Interval	039SGB01	039SGB02	039SGB03	039SGB04	039SGB05	039SGB06	039SGB07	Split Sample 039SGB07	Split Sample 039SGB08	Split Sample 039SGB09
1,1,2,2-Tetrachloroethane	9-11'	NS	**30,000**	NS	NS	NS	NS	NS	NS	NS	NS
	11-13'	ND	ND	**150**	ND	ND	ND	ND	NS	NS	ND
Acetone	11-13'	ND	NS	ND	ND	ND	ND	ND	26	NS	ND
	15-17'	NS	NS	NS	NS	NS	ND	ND	NS	39	25
Carbon disulfide	2-3'	ND	ND	39	ND	NS	NS	NS	NS	NS	NS
	11-13'	ND	NS	28	ND	ND	ND	ND	ND	NS	ND
cis-1,2-Dichloroethene	15-17'	NS	NS	NS	NS	NS	1.9	5.2	NS	ND	ND
Ethylbenzene	8-10'	NS	NS	NS	NS	NS	55.3	2,270	NS	NS	NS
	9-11'	NS	**18,000**	NS	NS	NS	NS	NS	NS	NS	NS
	11-13'	ND	NS	ND	ND	ND	58.4	10.8	10	NS	ND
	15-17'	NS	NS	NS	NS	NS	24.8	21.6	NS	ND	ND
Methylene chloride	0-1'	ND	ND	ND	**160**	**450**	NS	NS	NS	NS	NS
	2-3'	**310**	ND	ND	**150**	**290**	NS	NS	NS	NS	NS
	9-11'	NS	**77,000**	NS	NS	NS	NS	NS	NS	NS	NS
	11-13'	ND	NS	ND	**70**	**16**	ND	ND	ND	NS	ND
m-Xylene	9-11'	NS	110,000	NS	NS	NS	NS	NS	NS	NS	NS
o-Xylene	9-11'	NS	56,000	NS	NS	NS	NS	NS	NS	NS	NS
Xylene (Total)	8-10'	NS	NS	NS	NS	NS	ND	3,310	NS	NS	NS
	11-13'	ND	NS	ND	ND	ND	ND	NS	2	NS	ND
	15-17'	NS	NS	NS	NS	NS	33.1	30.7	NS	14	ND

Notes:

Bold — Bold text indicates an SSL exceedance
ND — Not detected
NS — Not Sampled

Table 7.4.7
SWMU 39 VOC Screening Results Summary for Surface and Subsurface Soil
Results in μg/kg

Parameter	Sample Interval [a]	Frequency of Detection	Range of Detection [b]	Mean [c]	Residential Soil RBC [d]		RBC Res. Exceedances	Industrial Soil RBC [d]		RBC Ind. Exceedances	SSL [e]	SSL Exceedance [f]
1,1,2,2-Tetrachloroethane	9-11'	1/1	30,000 - 30,000	30,000	NA	C	NA	NA	C	NA	1	Yes
	11-13'	1/10	150 - 150	150	NA	C	NA	NA	C	NA	1	Yes
Acetone	11-13'	1/10	26 - 26	26	NA	N	NA	NA	N	NA	800	No
	15-17'	2/7	25 - 39	32	NA	N	NA	NA	N	NA	800	No
Carbon disulfide	2-3'	1/5	39 - 39	39	NA	N	NA	NA	N	NA	14,000	No
	11-13'	1/11	28 - 28	28	NA	N	NA	NA	N	NA	14,000	No
cis-1,2-Dichloroethene	15-17'	2/7	1.9 - 5.2	3.6	NA	N	NA	NA	N	NA	200	No
Ethylbenzene	8-10'	2/5	55.3 - 2,270	1,163	NA	N	NA	NA	N	NA	5,000	No
	9-11'	1/1	18,000 - 18,000	18,000	NA	N	NA	NA	N	NA	5,000	Yes
	11-13'	3/9	10 - 58.4	26	NA	N	NA	NA	N	NA	5,000	No
	15-17'	2/7	22.6 - 24.8	23.7	NA	N	NA	NA	N	NA	5,000	No
Methylene chloride	0-1'	2/2	160 - 450	305	85,000	C	0	760,000	C	0	10	Yes
	2-3'	35	150 - 310	250	NA	C	NA	NA	C	NA	10	Yes
	9-11'	1/1	77,000 - 77,000	77,000	NA	C	NA	NA	C	NA	10	Yes
	11-13'	2/11	16 - 70	43	NA	C	NA	NA	C	NA	10	Yes
m-Xylene	9-11'	1/1	110,000 - 110,000	110,000	NA	N	NA	NA	N	NA	240,000	No
o-Xylene	9-11'	1/1	56,000 - 56,000	56,000	NA	N	NA	NA	N	NA	150,000	No
	8-10'	1/5	3,310 - 3,310	3,310	NA	N	NA	NA	N	NA	74,000	No
Xylene (Total)	11-13'	1/11	2 - 2	2	NA	N	NA	NA	N	NA	74,000	No
	15-17'	37	14 - 33.1	26	NA	N	NA	NA	N	NA	74,000	No

Notes:

a — Feet below ground surface
b — Range lower limit is the lowest detected concentration.
c — Mean is based on detected concentrations only.
d — Residential and industrial screening values (RBC-Res., RBC-Ind.) are from USEPA Region III Risk-Based Concentration Table, January to June 1996.
e — SSL considered protective of contaminant transfer from soil to groundwater (from USEPA Region III Risk-Based Concentration Table, January to June 1996)
f — A "Yes" in this column indicates that at least one sample result exceeded the SSL for this analyte; a "No" indicates no sample results exceeding the SSL.
NA — Not applicable
N — noncarcinogen-based RBC
C — carcinogen-based RBC

Table 7.4.8
SWMU 39 VOC Screening Results for Groundwater
Results in μg/L

Parameter	Sample Interval	039GGB02	039GGB04	039GGB05	Split Sample 039GGB04
Ethylbenzene	Loess	260	ND	NS	NS
	Fluvial Deposits	33	ND	ND	ND
Methylene chloride	Fluvial Deposits	ND	ND	**11**	ND
Trichloroethene	Fluvial Deposits	ND	ND	ND	**5**
m-Xylene	Loess	**1,050**	**36**	NS	NS
	Fluvial Deposits	130	ND	ND	ND
o-Xylene	Loess	ND	**30**	NS	NS
	Fluvial Deposits	64	ND	ND	ND

Notes:
Bold — Bold text indicates an MCL or tap water RBC exceedance.
NS — Not sampled. Groundwater was not collected from the loess at this location due to insufficient groundwater recharge to sampling tool.
ND — Not detected above PQL

Table 7.4.9
SWMU 39 VOC Screening Results Summary for Loess and Fluvial Deposits Groundwater
Results in μg/L

Parameter	Sample Interval	Frequency of Detection	Range of Detection [a]	Mean [b]	Tap Water RBC [c]	Tap Water RBC Exceedances	MCL [d]	MCL Exceedances
Ethylbenzene	Loess	1/2	260 - 260	260	1300	0	700	0
	Fluvial	1/8	33 - 33	33	1300	0	700	0
Methylene chloride	Fluvial	1/8	11 - 11	11	4.1	1	5	1
Trichloroethene	Fluvial	1/8	5 - 5	5	1.6	0	5	1
m-Xylene	Loess	2/2	36 - 1050	543	1400	0	10	2
	Fluvial	1/8	130 - 130	130	1400	0	NA	0
o-Xylene	Loess	1/2	30 - 30	30	1400	0	10	1
	Fluvial	1/8	64 - 64	64	1400	0	NA	0

Notes:
a — Range lower limit is the lowest detected concentration.
b — Mean is based on detected concentrations only.
c — Tap water RBCs are from USEPA Region III Risk-Based Concentration Table, January to June 1996.
d — MCL values are from the Drinking Water Regulations and Health Advisories Table (October 1996, USEPA).
NA — Not available

- TPH-DRO was detected in sample 039SGB0101 (120,000 μg/kg) and sample 039SGB0201 (95,000 μg/kg).

Inorganics in Surface Soil

As presented in Tables 7.4.4 and 7.4.5, 11 inorganics were detected in surface soil samples at SWMU 39. None of the 11 inorganic concentrations exceeded both their RC and RBC or SSL.

VOCs in Surface and Subsurface Soil Screening Samples

As presented in Tables 7.4.6 and 7.4.7, nine VOCs were detected in surface and subsurface soil screening samples from seven DPT locations. Of the nine, three exceeded SSLs.

- 1,1,2,2-Tetrachloroethane exceeded its SSL (1 μg/kg) in sample 039SSB0211 (30,000 μg/kg), and in sample 039SGB0313 (150 μg/kg).

- Ethylbenzene exceeded its SSL (5,000 μg/kg) in sample 039SGB0211 (18,000 μg/kg).

- Methylene chloride exceeded its SSL (10 μg/kg) in samples 039SGB0103 (310 μg/kg), 039SGB0211 (77,000 μg/kg), 039SGB0401 (160 μg/kg), 039SGB0403 (150μg/kg), 039SGB0413 (70 μg/kg), 039SGB0501 (450 μg/kg), 039SGB0503 (290 μg/kg), and 039SGB0513 (16 μg/kg).

VOCs in Groundwater

As indicated in Tables 7.4.8 and 7.4.9, five VOCs were detected in loess and fluvial deposits groundwater samples. Four of the five compounds exceeded their tap water RBC or MCL.

- Methylene chloride exceeded both its tap water RBC (4.1 μg/L) and MCL (5 μg/L) in fluvial deposits groundwater sample 039GGB0547 (11 μg/L). Fluvial deposits

groundwater sample 039GGB1248 was collected during the second sampling event adjacent to the 039GGB0547 location to confirm the methylene chloride detection. The results for this sample were all less than detection limits for all compounds on the VOC scan.

- Trichloroethene exceeded its tap water RBC (1.6 μg/L) and equaled its MCL (5 μg/L) in fluvial deposits groundwater sample 039GGB0443 (5 μ/L).

- m-Xylene exceeded its MCL (10 μg/L) in loess groundwater samples 039GGB0214 (1,050 μg/L) and 039GGB0414 (36 μg/L).

- o-Xylene exceeded its MCL (10 μg/L) in loess groundwater sample 039GGB04 (30 μg/L).

One split loess groundwater sample was collected at SWMU 39. Trichloroethene was detected in this sample at a concentration of 5 μg/L.

- Trichloroethene exceeded its MCL (5 μg/L) in fluvial deposits groundwater split sample 039GGB0443 (5 μg/L). Trichloroethene was not detected in the primary sample associated with this split.

7.4.4 Preliminary Risk Evaluation

In accordance with USEPA guidance, a PRE was conducted for SWMU 39 using data from surface soil and groundwater samples collected during the CSI. Surface soil, subsurface soil and groundwater samples were analyzed onsite for VOCs; two surface soil samples were also submitted to an offsite laboratory for FSA. Approximately 25 percent of all samples analyzed onsite for VOCs were split for confirmatory analysis offsite. The PRE was conducted by identifying COPCs from the original set of detected chemicals, calculating the risk ratio for each COPC, and interpreting those results as described in Section 5.

Tables 7.4.2, 7.4.3, 7.4.4, 7.4.5, 7.4.6, 7.4.7, 7.4.8, and 7.4.9 present results for organics detected in surface soil, inorganics detected in surface soil, VOCs detected in surface soil, and VOCs detected in loess and fluvial deposits groundwater, respectively. Subsurface soil data are addressed in Section 7.4.5. Ethylbenzene and m-xylene were identified as COPCs in loess groundwater, while methylene chloride and trichloroethene were identified as COPCs in fluvial deposits groundwater. Ethylbenzene was reported in fluvial deposits groundwater at a concentration less than the residential tap water RBC. No other COPCs were identified. Therefore, loess and fluvial deposits groundwater were the only media evaluated in this PRE. Table 7.4.10 summarizes PRE results for each COPC.

Table 7.4.10
SWMU 39 Preliminary Risk Evaluation

Chemical	Maximum Reported Concentration	Units	Residential RBC		Residential Hazard Quotient	Residential ILCR	Industrial RBC		Industrial Hazard Quotient	Industrial ILCR
Fluvial Deposits Groundwater										
Methylene chloride	11	µg/L	4.1	C	NA	2.68E-06	16.4	C	NA	6.71E-07
Trichloroethene	5	µg/L	1.6	C	NA	3.13E-06	6.4	C	NA	7.81E-07
Summation of Fluvial Deposits Groundwater					NA	5.81E-06			NA	1.45E-06
Loess Groundwater										
Ethylbenzene	260	µg/L	130	N	0.20	NA	520	N	0.050	NA
m-Xylene	1,050	µg/L	140	N	0.75	NA	560	N	0.19	NA
Summation of Loess Groundwater					0.95	NA			0.24	NA
Summation of Groundwater					0.95	5.81E-06			0.24	1.45E-06

Notes:

RBC — Risk-based concentration from USEPA Region III's June 1996 RBC Table; in accordance with USEPA Region IV's Supplemental Guidance to RAGS Bulletin 1 for noncarcinogens, RBCs above were conservatively adjusted to reflect an HQ of 0.1; Residential RBCs were divided by 0.25 for VOCs and were divided by 0.5 for all other compounds to calculate RBCs for nonresidential (industrial) groundwater, in accordance with USEPA Region IV Guidance on Preliminary Risk Evaluations for the Purpose of Reaching a Finding of Suitability to Lease, USEPA Memorandum dated November 22, 1994.

N — Noncarcinogen

C — Carcinogen

NA — Not applicable

ILCR — Incremental lifetime excess cancer risk

Uncertainty

Because methylene chloride is a common laboratory artifact and it was identified in fluvial deposits groundwater at SWMU 39, a collocated confirmatory sample was collected using DPT sampling methods as described in Section 4. Methylene chloride was not detected in the confirmatory sample, indicating methylene chloride could have been a laboratory artifact. However, the sample quantitation limit (SQL) in the confirmatory sample was 50 μg/L, whereas the SQL for the original sample was 10 μg/L.

Although the SQL of the confirmatory sample is higher than the initially reported concentration, a concentration of 11 μg/L would have been reported. If methylene chloride were present slightly below the SQL, the concentration would have been reported as an estimated or "J" qualified value. Estimated concentrations are typically reported to one-tenth of the SQL, so a methylene chloride concentration of 5 μg/L could be reported by the laboratory for the confirmatory sample. For example, a concentration of 11 μg/L would have been reported as an estimated value. Therefore, it is unlikely that methylene chloride is present in fluvial deposits groundwater at the original concentration of 11 μg/L. Consequently, corresponding groundwater risk estimates would be overestimates.

Conclusions and Recommendations

Based on the information gathered during the investigation, the following conclusions and recommendations have been reached based on a PRE performed on data from surface soil and fluvial deposits groundwater:

Residential Land Use — Suitable for Lease

- Carcinogens: The cumulative risk for loess and fluvial deposits groundwater for the residential scenario was estimated to be approximately 6E-06, indicating suitability for

lease of the SWMU 39 area for a residential land use scenario in accordance with USEPA Region IV's November 1994 memorandum.

- Noncarcinogens: The residential HI for loess and fluvial deposits groundwater was estimated at 0.95, indicating suitability for lease of the SWMU 39 area for a residential land use scenario in accordance with USEPA Region IV's November 1994 memorandum.

Industrial Land Use — Suitable for Lease

- Carcinogens: The cumulative risk for loess and fluvial deposits groundwater for was estimated to be approximately 1E-06, indicating suitability for lease of the SWMU 39 area for an industrial land use scenario in accordance with USEPA Region IV's November 1994 memorandum.

- Noncarcinogens: The industrial HI for loess and fluvial deposits groundwater was estimated to be approximately 0.2, indicating suitability for lease for an industrial land use scenario in accordance with USEPA Region IV's November 1994 memorandum.

7.4.5 Fate and Transport Introduction

The approach for Assembly F Fate and Transport is discussed in Section 6. The following discussion applies this approach to SWMU 39. Transport processes for contaminants other than those designated as COPCs will also be discussed if they are in multiple environmental media, or can migrate to other media.

Migration of contaminants by surface water erosion of soil will be reduced for SWMU 39 due to the presence of vegetated areas. The concrete foundation will mitigate potential migration through the soil-to-groundwater pathway and soil-to-sediment pathway because it limits rainwater infiltration and acts as a horizontal barrier to surface water percolation through the soil. These

migration pathways were, however, addressed in a screening level assessment. Also, the soil-to-air migration pathway will be evaluated due to the exceedance of soil-to-air SSLs for some constituents.

SWMU 39 COPCs include:

- Dieldrin, which exceeded its soil-to-groundwater SSL
- ethylbenzene, which exceeded its soil-to-groundwater SSL
- methylene chloride, which exceeded its soil-to-groundwater SSL and its soil-to-air SSL
- 1,1,2,2-tetrachloroethane, which exceeded its soil-to-groundwater SSL.

7.4.5.1 Soil-to-Groundwater Cross-Media Transport

Four contaminants (ethylbenzene, methylene chloride, m-xylene, and o-xylene) were detected in both soil and groundwater at SWMU 39. Of these compounds, only ethylbenzene and methylene chloride exceeded their soil-to-groundwater transfer SSLs. Ethylbenzene was detected at all sampled subsurface intervals (8- to 10-feet, 9- to 11-feet, 11- to 13-feet, and 15- to 17-feet bgs) in DPT locations 039SGB06 and 039SGB07, but did not exceed SSLs. Ethylbenzene did exceed its SSL in the 9- to 11-foot interval of sample 039SGB02. The relatively low frequency of detection of ethylbenzene in soil at concentrations exceeding SSLs indicates that benzene contamination in soil is isolated at SWMU 39. Widespread impact to groundwater from ethylbenzene is not expected based on results of this CSI. Methylene chloride was detected in more soil sample locations than ethylbenzene; however, it was only detected in one groundwater sample location. M-xylene and o-xylene were both detected at only two groundwater sample locations and one soil sampling location. All contaminants detected in groundwater are VOCs, and all were detected in both fluvial deposits groundwater and loess groundwater, with the exception of methylene chloride, which was only detected in fluvial deposits groundwater. As previously discussed, VOCs released to soil have a greater potential to leach to underlying groundwater than

other classes of contaminants, and upon reaching groundwater they will move with groundwater flow as dissolved phase plumes, or as DNAPL by subsurface geologic controls.

Three contaminants pose a potential soil-to-groundwater migration concern as determined by soil concentrations in excess of groundwater protection SSLs. These include one VOC (1,1,2,2 tetrachloroethane), one pesticide (dieldrin), and one inorganic (barium). However, barium did not exceed its background RC, indicating it is naturally occurring. Generally, pesticides and inorganics have a relatively high affinities for soil particles, and low water solubilities, both of which limit their movement to groundwater through advective and dispersive transport mechanisms. Relative to pesticides and inorganics, VOCs do not have high affinities for soil particles (due to a relatively low K_{oc} value) and possess a relatively high solubilities in groundwater. The detection of these contaminants in soil only in limited areas indicates a potential for a somewhat isolated area of soil-to-groundwater leaching.

7.4.5.2 Soil-to-Sediment Cross-Media Transport

No sediment samples were collected at SWMU 39; however surface soil samples were collected in various locations. The contaminants detected in surface soil samples include 10 pesticides (4,4'-DDD, 4,4'-DDE, 4,4'-DDT, dieldrin, endosulfan I, endrin ketone, heptachlor, technical chlordane, alpha-chlordane, and gamma-chlordane), 11 inorganics (arsenic, barium, cadmium, chromium, cobalt, copper, lead, mercury, nickel, vanadium, and zinc), and one VOC (methylene chloride). Only two of the inorganics, lead and zinc, exceeded its background RC at NSA Memphis, indicating that the remaining inorganics are probably naturally occurring in surface soil at SWMU 39.

In the absence of methylene chloride, the remaining classes of contaminants possess properties that cause their affinities for soil particles. If surface soil at SWMU 39 becomes exposed and erodible, pesticides will likely be mobile also. However, since surrounding areas are grass-covered, the

potential for soil particle movement by erosional transport decreases. Also, relative to VOCs, pesticides and inorganics are persistent in the environment; therefore, they are not likely to degrade in soil and will not diffuse into water (surface or groundwater).

7.4.5.3 Soil-to-Air Cross-Media Transport

Contaminants detected in surface soil were screened as potential hazards to air by the soil-to-air cross-media transport mechanism. Of the contaminants detected in surface soil, only methylene chloride was at a level exceeding its respective soil-to-air volatilization screening levels. This screening level was derived to represent the acceptable mean concentration on a 30-acre site. This approach assumes that a homogeneous source exists which can consistently emit methylene chloride at a rate which will result in unacceptable ambient air concentrations. The limited extent of soil impacts at SWMU 39 indicates that the source strength is far less than that assumed in the screening level development model. As a result, the contamination described above in surface soil does not represent a viable threat to ambient air quality via volatilization.

7.4.6 Conclusions and Recommendations

Based on the data gathered during this investigation, the following conclusions and recommendations have been reached.

Conclusions

- SWMU 39 will be developed for commercial use according to the Base Reuse Plan.

- Twelve organic compounds were detected in surface (0 to 1 foot) soil.

  — Dieldrin was detected in one sample at a concentration that exceeds both its residential RBCs and SSL. However, this concentration does not exceed the RC for dieldrin at NSA Memphis.

— Technical chlordane was detected in one sample that exceeds its residential RBC.

- TPH and TPH-DRO were detected in surface soil.

  — A cleanup standard will be established once the permeability of site soil has been determined.

- Eleven inorganics were detected in surface soil, but none exceeded both their RC and RBC or SSL.

- Nine VOCs were detected in surface and subsurface soil screening samples.

  — 1,1,2,2-Tetrachloroethane, ethylbenzene, and methylene chloride exceeded their SSLs.

- Five VOCs were detected in loess and fluvial deposits groundwater samples.

  — m-Xylene exceeded its MCL in two loess groundwater samples.

  — o-Xylene exceeded its MCL in one loess groundwater samples.

  — Methylene chloride exceeded its tap water RBCs and MCL in one fluvial deposits groundwater sample analyzed onsite. An additional sample was collected to confirm the presence of this detection of methylene chloride. Methylene chloride was not detected in the confirmation sample. Therefore, the methylene chloride detected in the original sample may have been introduced from an exogenous source in the onsite lab.

- Trichloroethene exceeded its MCL in one split fluvial deposits groundwater sample. Trichloroethene was not detected in the primary sample associated with the split.

- Based on a PRE performed on data from soil samples collected from the surface interval, the following has been concluded:

  - Carcinogens: Cumulative soil cancer risk estimates for the residential and industrial scenarios were less than the cumulative risk threshold of 1E-4 for PREs, indicating that the site is suitable for lease.

  - Noncarcinogens: Cumulative soil noncancer risk estimates for the residential and industrial scenarios were less than the cumulative HI threshold of 1.0 for PREs, indicating that the site is suitable for lease.

Recommendations

- Based on soil and groundwater data collected during the CSI, a follow-up RFI is required at SWMU 39, including:

  - Collecting permeability data to determine the appropriate cleanup standard for TPH and TPH/DRO.

  - Installing at least four monitoring wells in the fluvial deposits to determine groundwater flow direction and the extent of contamination.

  - Conducting an ecological risk assessment.

8.0 ECOLOGICAL RISK ASSESSMENT

Ecological risk assessments (ERA) assess the actual or potential effects of contaminants to ecological receptors. An ERA considers surface soil contaminant concentrations and distributions, media-specific physicochemical conditions, and exposure pathways which could result in unacceptable levels of exposure to ecological receptors now or in the future. The ERA approach is based on USEPA's *Risk Assessment Guidance for Superfund Volume II — Environmental Evaluation Manual* (1989) and USEPA's *Framework for Ecological Risk Assessment* (USEPA/630/R-92/001), and USEPA's *Ecological Risk Guidance for Superfund: Process for Designing and Conducting Ecological Risk.*

During the follow-up RFIs, ERAs will likely be conducted at SWMUs 20, 22/63, and 39. It is unlikely that an ERA will be necessary for SWMU 30. The rationale for this determination is discussed below.

Problem Formulation

SWMU 30 is an inactive waste-treatment septic tank. A portion of the septic tank is beneath Building S-420, with the remaining portion located on the east and south sides of Building S-420 under grass and sidewalks (Figure 7.3.1). The septic tank operated from 1919 to 1942 and received waste from more than 60 buildings including maintenance areas where aircraft and ground vehicles were serviced. It is reported that the septic tank was partially demolished, pushed in on itself, and covered with soil, but specific documentation is unavailable.

SWMU 30 and the surrounding area is covered by Buildings S-420, grass around the building, concrete sidewalks, and parking lots to the east (Figure 7.3.1). The area is relatively level, low-relief topography and surface drainage flows into storm drains.

Ecosystem at Risk

There is no quality habitat available at SWMU 30. The buildings, sidewalks, parking lots, and grass areas between buildings at this SWMU provide poor habitat for terrestrial species. Based on a very limited foraging area and constant human presence, it is predicted that no upper or lower level terrestrial species use the SWMU 30 area as a part of their home range. The grass areas between the sidewalks and the building could potentially be used by terrestrial receptors such as passerine birds as foraging areas, but their occurrence would most likely be transient or opportunistic. No viable terrestrial community exists in the SWMU 30 area.

Conclusions

At SWMU 30 there is no exposure pathway to be completed based on the lack of ecological receptors which is a result of no quality habitat and constant human presence. Therefore, an ERA is not recommended at SWMU 30.

9.0 CONCLUSIONS AND RECOMMENDATIONS SUMMARY

A follow-up RFI is recommended for SWMUs 20, 22/63, and 39. The following table summarizes the findings of this CSI, and the work recommended for the RFI. Provided is a brief overview of the COPCs, PRE results, contaminant exceedances, and the recommendations and rationale based on these findings. Figures 9.1 through 9.4 provide a graphical summary of the risk for each medium at each SWMU and the summed risk for all media. These figures show where ILCR and HI guidelines have been exceeded.

Table 9.1
Assembly F
CSI Conclusions and Recommendations Summary

SWMU	COPCs[a]	Media Affected[b]	PRE Results Residential	PRE Results Industrial	Screening Criteria Exceeded[c]	RFI Recommendations[d]	Rationale
20	benzene 1,1-dichloroethane 1,1-dichloroethene 1,2-dichloroethane 1,1,2-trichloroethane nickel	Fluvial Groundwater and Surface Soil	Not suitable for lease	Not suitable for lease	1, 2, 5, 6	Install at least four monitoring wells and collect two Shelby tube sample for permeability analysis. Conduct an ERA.	Wells - Determine groundwater flow direction, determine extent of contamination. Permeability - Establish cleanup levels for TPH detected in surface soil. ERA-To assess actual or potential effects to ecological receptors due to contamination.
22/63	arsenic BEQ ethylbenzene methylene chloride m-xylene	Surface Soil and Fluvial Groundwater	Suitable for lease	Suitable for lease	1, 2, 3, 4, 5, 6	Install at least four monitoring wells and collect two Shelby tube sample for permeability analysis. Conduct an ERA.	Wells - Determine groundwater flow direction, determine extent of contamination. Permeability - Establish cleanup levels for TPH detected in surface soil. ERA-To assess actual or potential effects to ecological receptors due to contamination.
30	BEQ	Surface Soil	Suitable for lease	Suitable for lease	3, 4, 5, 6	No further action	benzo(a)pyrene - exceeded residential RBCs, but not Industrial RBCs dieldrin - exceeded SSLs, but no other screening criteria, or the established background concentration. arsenic - exceeded RBCs but not RCs lead - exceeded RBCs, but no other screening criteria
39	methylene chloride ethylebenzene m-xylene trichloroethene	Loess and Fluvial Groundwater	Suitable for lease	Suitable for lease	1, 2, 3, 4, 5, 6	Install at least four monitoring wells and collect two Shelby tube sample for permeability analysis. Conduct an ERA.	Wells - Determine groundwater flow direction, determine extent of contamination. Permeability - Establish cleanup levels for TPH detected in surface soil. ERA-To assess actual or potential effects to ecological receptors due to contamination.

Notes:

a — Contaminant of Potential Concern identified in the PRE
b — Media where the COPC was identified
c — Indicates that a contaminant(s) exceeded a screening criteria, and lists the criteria that was exceeded
d — Recommendation based on screening criteria exceedances
1 — MCL
2 — tap water RBC
3 — residential RBC
4 — industrial RBC
5 — SSL
6 — background RCs

Figure 9.1
Sum Residential ILCR for Assembly F

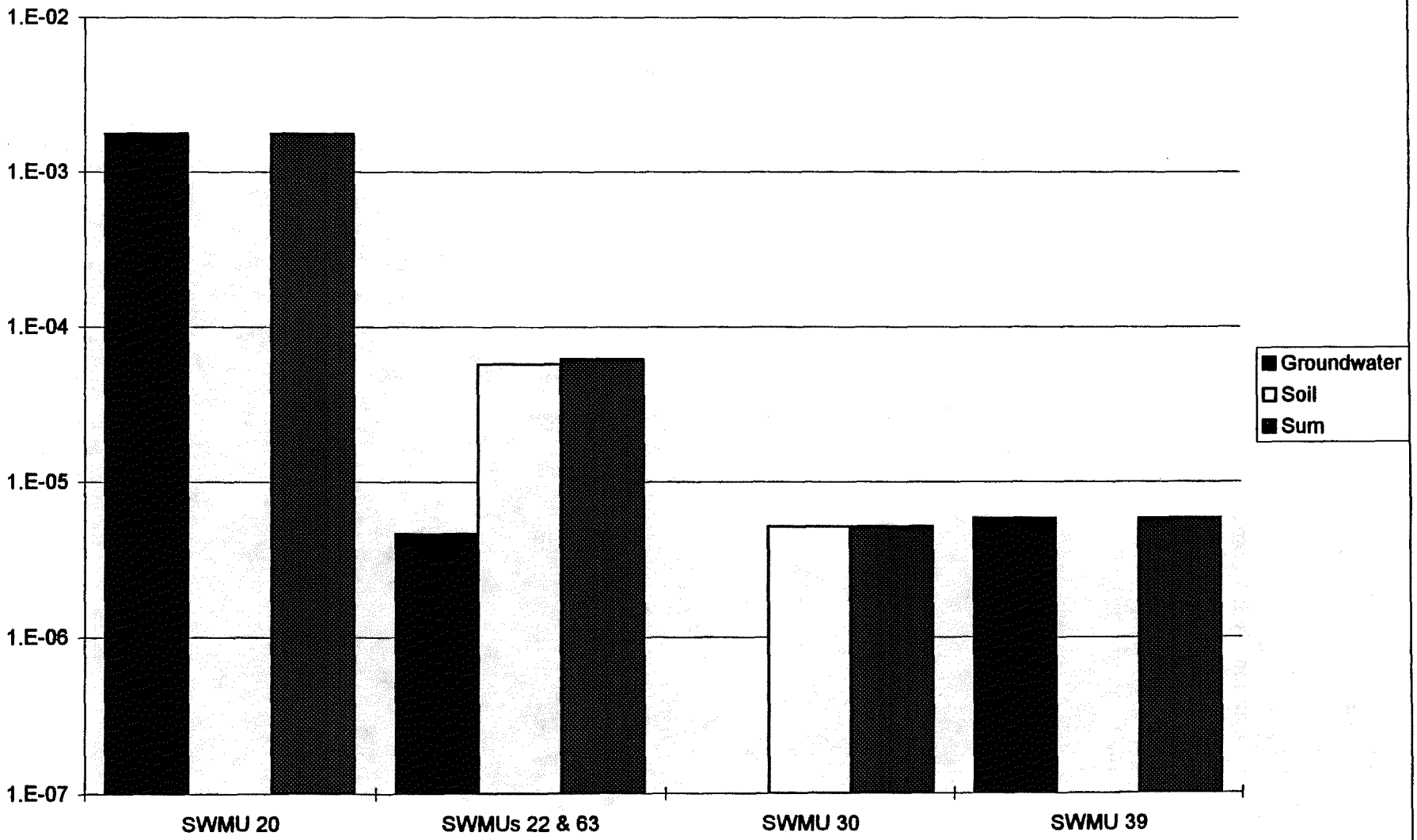


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Figure 9.2
Sum Non-Residential ILCR for Assembly

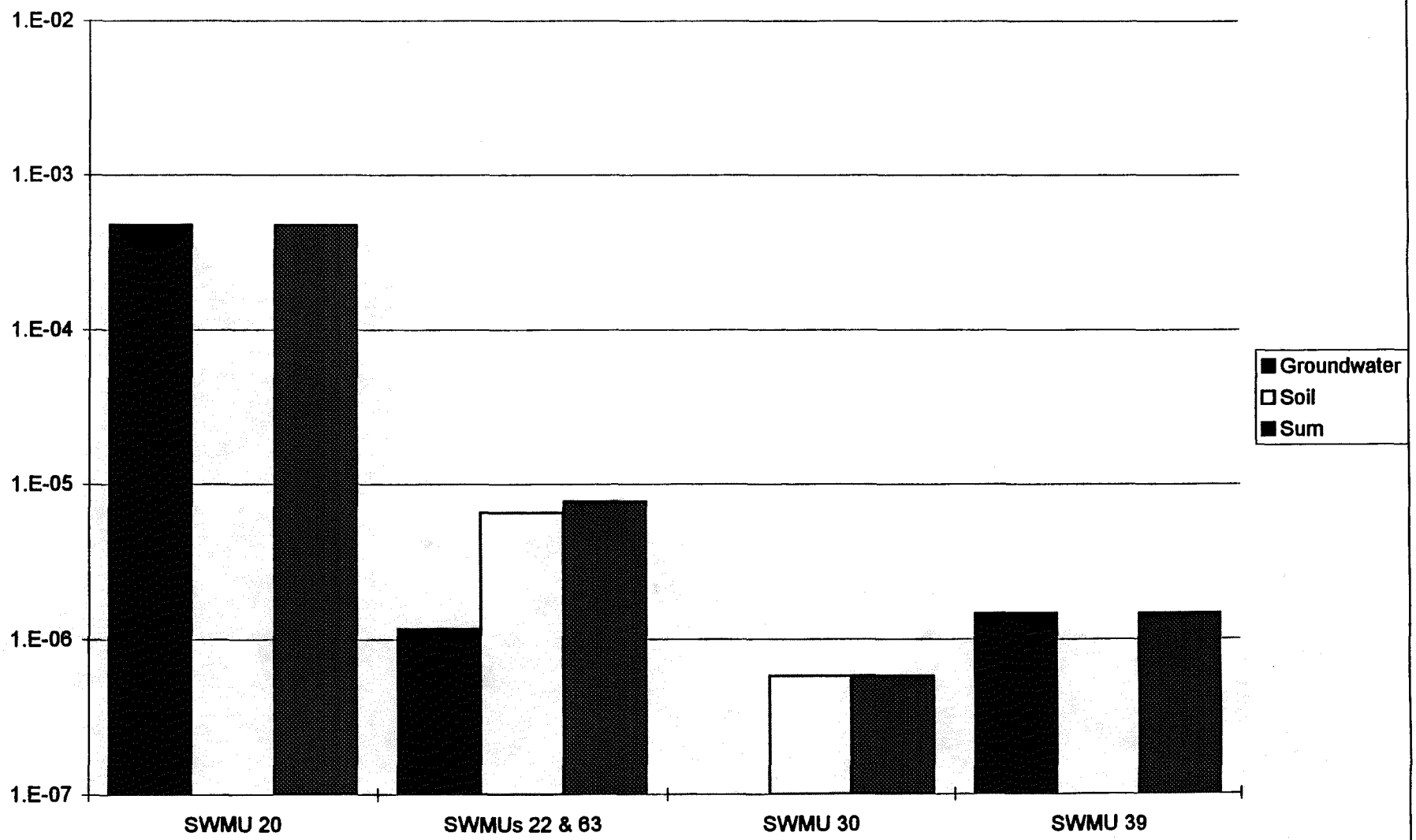

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Figure 9.3
Residential HI for Assembly F

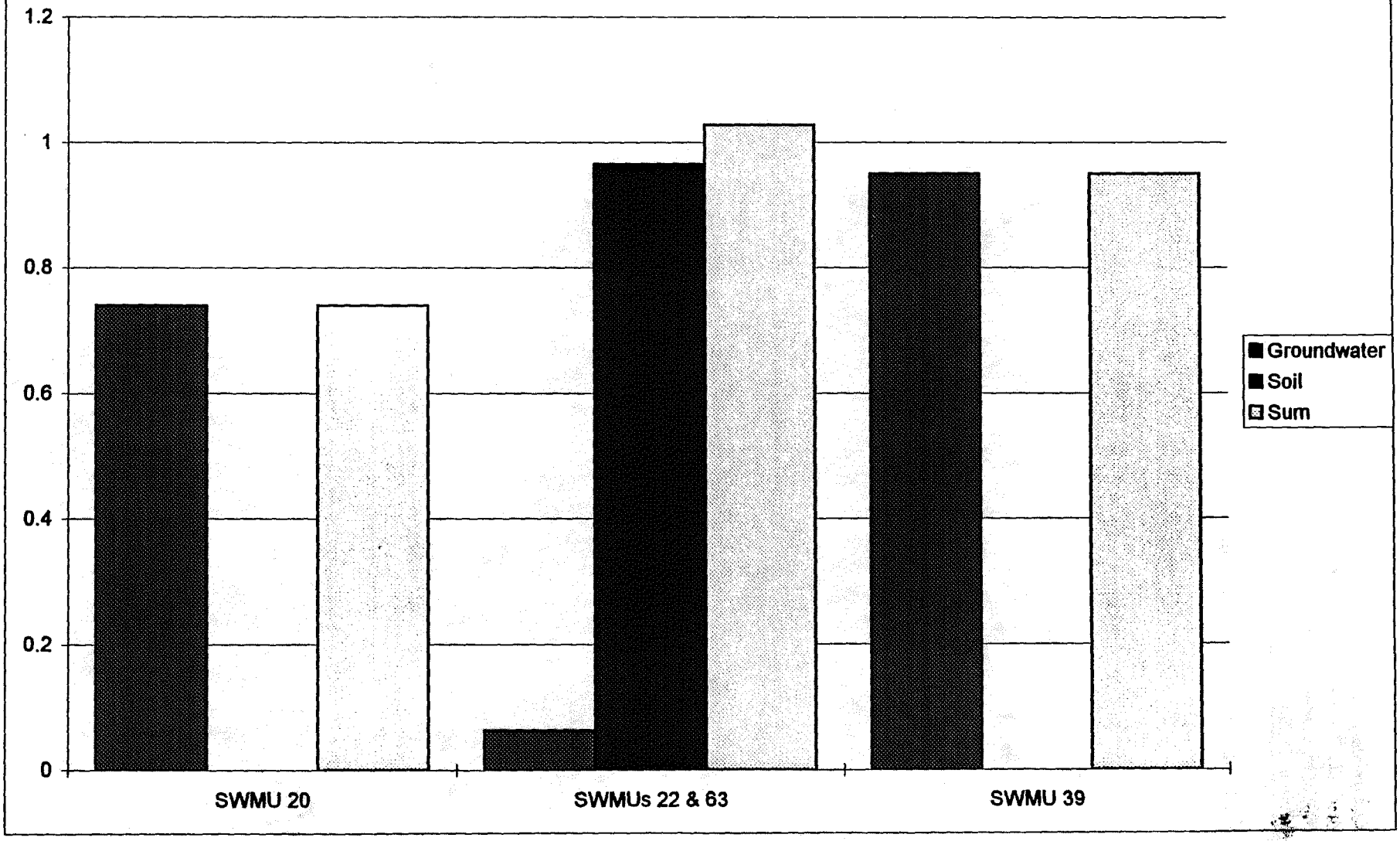

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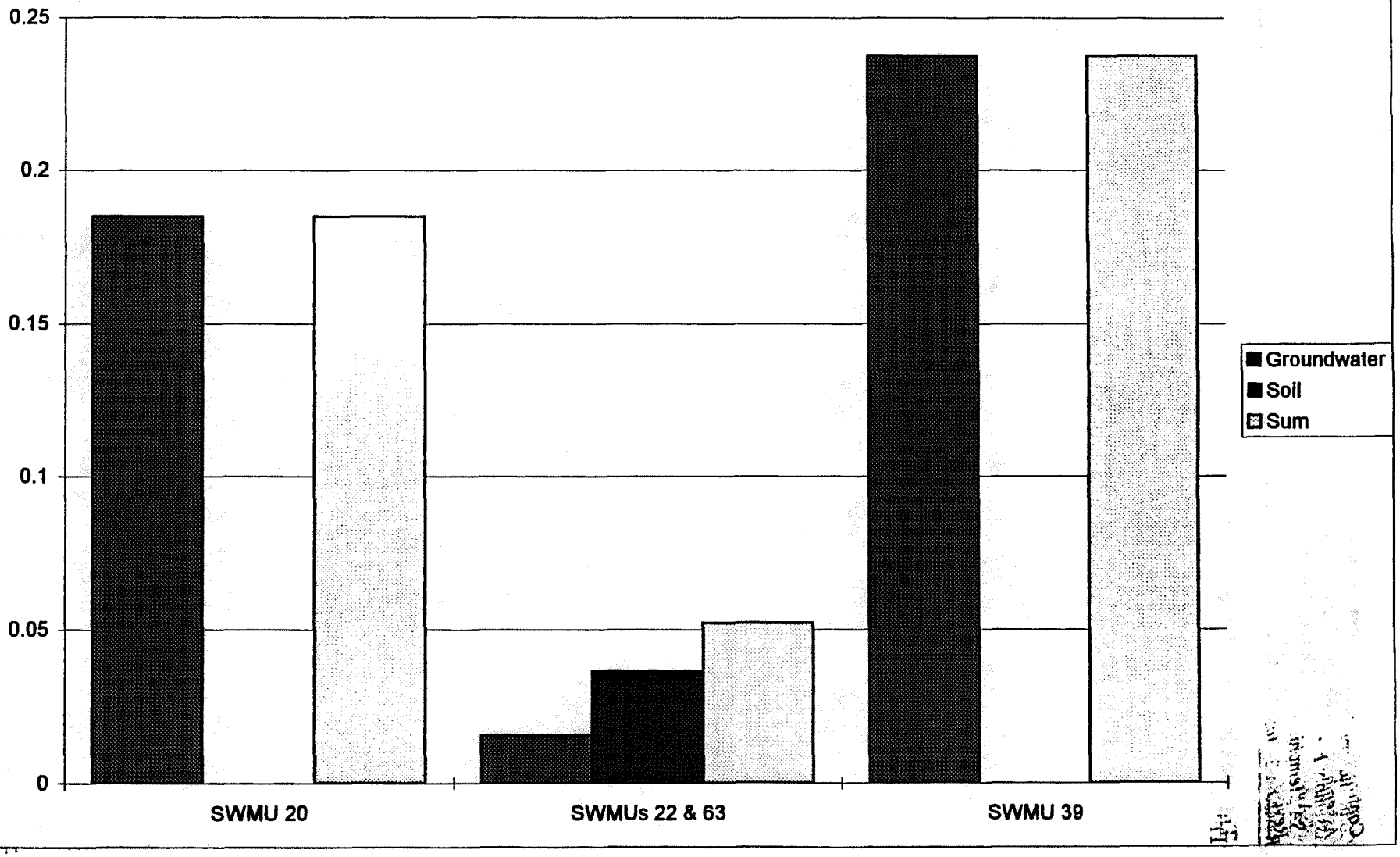
Figure 9.4
Non-Residential HI for Assembly F



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