INSTALLATION RESTORATION PROGRAM

OHIO AIR NATIONAL GUARD
178th FIGHTER GROUP
SPRINGFIELD-BECKLEY MUNICIPAL AIRPORT
SPRINGFIELD, OHIO

SITE INVESTIGATION REPORT

FINAL

July 1995

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Oak Ridge, Tennessee 37831
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Site Investigation Report, Ohio Air National Guard, 178 Fughter Group, Springfield-Beckley Municipal Airport, Springfield, Ohio, Text. This is the first volume of a three volume site investigation report. Five sites (Site 1 - Fire Training Area No. 1, Site 2 - Fire Training Area No. 2, Site 3 - Leach Field, Site 4 - POL Storage Area, and Site 5 - Ramp Drainage Ditch) were investigated under the Installation Restoration Program. Soil and groundwater samples were collected and analyzed. No further action was recommended for any of the five sites under current land use.

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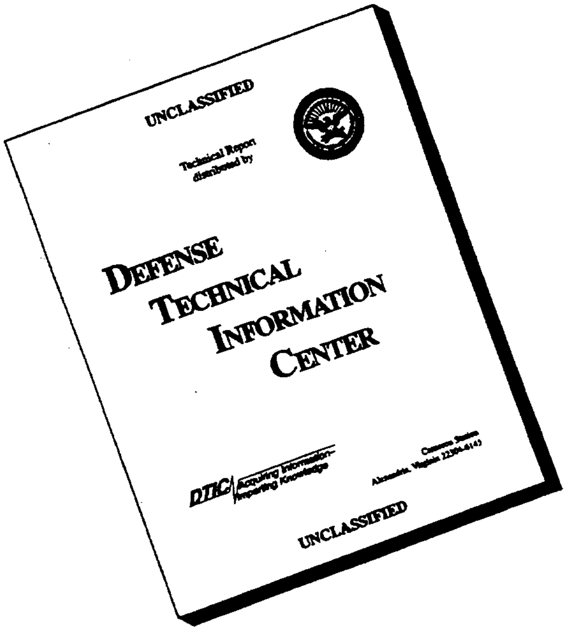

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178th TACTICAL FIGHTER GROUP
SPRINGFIELD-BECKLEY MUNICIPAL AIRPORT, SPRINGFIELD, OHIO

SITE INVESTIGATION REPORT

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EXECUTIVE SUMMARY

This site investigation (SI) report was prepared under the U.S. Department of Defense (DOD) Installation Restoration Program (IRP) at the 178th Fighter Group, Springfield Air National Guard Base (ANGB), Springfield, Ohio, where six sites were identified during the Preliminary Assessment (PA) (HMTC 1988). However, due to site-specific factors, which is addressed in a decision document prepared by Science Applications International Corporation (SAIC), Site 6 - Mess Hall Underground Storage Tank Oil Spill was not included in the SI field effort, bringing the total number of sites included in the SI to five. These five sites are: Site 1 - Fire Training Area No. 1 (FTA-1), Site 2 - Fire Training Area No. 2 (FTA-2), Site 3 - Leach Field (LCH), Site 4 - POL Storage Area, and Site 5 - Ramp Drainage Ditch. The SI was conducted to:

- Determine the chemical nature and magnitude of identified chemical contaminants
- Evaluate the potential for contaminant release and migration
- Compare site-related contaminant concentrations with applicable or relevant and appropriate requirements (ARARs) and conduct a human health risk assessment
- Prepare recommendations for broader investigative activities (RIs) to determine the magnitude and extent of contamination, if necessary
- Evaluate the need for immediate response actions
- Support no further action decisions and the completion of decision documents.

FIELD INVESTIGATION PROGRAM

Field investigation and data analysis activities were conducted at the five sites at Springfield ANGB to meet the objectives of the SI. Data collection activities included aerial photograph review, soil organic vapor (SOV) surveys, onsite gas chromatography (GC) screening, drilling and sampling of soil borings, installing piezometers, installing and sampling groundwater monitoring wells, surface soil and sediment sampling, and aquifer testing. Data analysis activities included geologic and hydrogeologic data evaluation, chemical data analyses, validation and evaluation, and a baseline human health risk assessment on Sites 2, 3, and 5. All aspects of the program from planning through the evaluation and assessment phases were conducted under a stringent quality assurance/quality control (QA/QC) program.

SITE INVESTIGATION FINDINGS

Geology and Hydrogeology—Soils encountered during SI activities were unconsolidated glacial sediments predominantly composed of silts and clays. Bedrock was not encountered during drilling; however, the Niagaran Limestone formation is reportedly at about 40 feet below land surface (BLS). Fine-grained sediments were randomly encountered throughout the Base at or near the top of the surficial aquifer. This layer appears to provide a site of preferential attachment for both organic and inorganic compounds.

Groundwater was encountered in the glacial sediments at each site. Groundwater flow direction was determined to be north-northeast to northeast across the Base with hydraulic conductivities in the aquifer material varying from 10^{-2} to 10^{-8} cm/sec.

Background Investigation—Soil and groundwater samples were collected from locations at sufficient distances and/or upgradient from the SI sites to establish ambient concentration ranges of chemicals at the Base not related to site activities.

Background conditions at Springfield ANGB are characterized by low levels of petroleum-related compounds (i.e., total petroleum hydrocarbons [TPH]; benzene, toluene, ethylbenzene, and xylene [BTEX], and polycyclic aromatic hydrocarbons [PAHs]) and inorganic constituents (i.e., metals). These compounds are attributed to routine airport and Base activities or may be naturally occurring.

Site 1 - Fire Training Area No. 1—FTA-1 was in operation from 1957 to 1963. Its location was verified using an aerial photograph taken in 1964, which clearly shows the burn pit. Using surveyed control points that have not changed since the photograph was taken, the burn pit was located and an SOV survey was conducted at the site. Three soil borings were located within the burn pit based on the aerial photograph and SOV survey results, and one monitoring well was located approximately 50 feet downgradient from the burn pit.

Data collected during the field investigation showed petroleum hydrocarbons and metals present in Site 1 soil at concentrations that are indistinguishable from background levels detected on the Base. Semivolatile organic compounds (SVOCs) were detected in only two samples. None of these contaminants exhibited identifiable distribution patterns or trends within the soil column above the water table. Site 1 has not contributed to degradation of groundwater quality; no site-related contaminants were detected in groundwater 50 feet downgradient from the burn pit. Therefore, Site 1 is not considered to be adversely impacting the environment.

Site 2 - Fire Training Area No. 2—An SOV survey conducted at Site 2 and the surrounding area provided sufficient data to identify the areas of maximum potential contamination. These areas fell within the burn pit area. The burn pit area was located initially based on interviews with Base personnel, evaluation of aerial photographs, and the SOV survey. Two phases of soil, sediment, and groundwater sampling were conducted at Site 2.

Two monitoring wells were installed and sampled at Site 2 to assess downgradient groundwater quality. Groundwater at this site contained metals and trace amounts of diesel fuel. The data indicate that most of the diesel fuel is being adsorbed to the finer grained sediments and only trace quantities have been released to the groundwater. The fuel system for the training area has been changed to propane; therefore, no additional fuel is being added to the surface and natural degradation of the residual fuel can be expected over time. The concentrations of detected metals in the suspended particles are a reflection of the composition of the glacial till sediment.

Site-related contaminants were detected in the upper 9.5 feet of soil within the former burn pit. The contaminants are associated with petroleum products and include TPH, SVOCs (primarily PAHs), and BTEX. Below 9.5 feet BLS, petroleum hydrocarbon concentrations diminish rapidly with depth and only trace concentrations were detected in the groundwater.

Sediment in the drainage swale at Site 2 contained petroleum hydrocarbons and SVOCs. The contamination did not follow an identifiable distribution pattern. The source of sediment contamination was determined to be not site-related because out of 17 SVOCs detected at Site 2, only 4 SVOCs were common to both the drainage swale and the burn pit. In addition, the chief constituent of petroleum hydrocarbons detected in the drainage swale was heavy oil. In contrast, surface soil within the burn pit contained primarily diesel fuel.

The conclusions of the human health risk assessment for Site 2 are that all health risks fall within or below EPA targets under current land use. Under future residential use, health risks are above EPA targets for children and adults due to the presence of chemicals in unfiltered groundwater. All other risks under future land use were below or within EPA targets. The risk assessment also concludes that it is unlikely that future land use will ever be residential (it is zoned for heavy industry and is near an airport), or that groundwater will ever be used for drinking water (due to the low productivity of the aquifer).

Site 3 - Leach Field—The SOV survey conducted at Site 3 - Leach Field and the surrounding area adequately characterized areas of maximum potential contamination. The greatest SOV concentrations were detected within the leach field boundaries. The leach field initially was delineated based on interviews with Base personnel, a review of surveyed construction drawings, and evaluation of aerial photographs taken while the leach field was still clearly visible. Two phases of soil and groundwater sampling were conducted at Site 3.

Interviews with Base personnel and elevation changes at Site 3 noted on construction drawings (ODOT 1988) provide evidence that 2 to 3 feet of native soil fill was placed over the leach field area in 1988. Soil within this fill layer contained PAHs; however, the source could not conclusively be identified. The leach field filter bed was encountered during drilling three of five soil borings. The filter bed was identified as a black, oily sand and gravel layer with pronounced hydrocarbon odor. Petroleum hydrocarbons, small quantities of volatile organic compounds (VOCs), and PAHs were detected in the filter bed. PAH concentrations in the filter bed were less than surface concentrations. Site-related contaminants were not confirmed in soil samples collected approximately 6 feet below the leach field filter bed at the soil-water interface. Based on filtered groundwater analyses, the leach field has not impacted downgradient groundwater.

The conclusions of the human health risk assessment for Site 3 are that all health risks fall within or below EPA targets under current land use. Under future residential use, health risks are above EPA targets for children and adults due to the presence of chemicals in unfiltered groundwater. All other risks under future land use were below or within EPA targets. The risk assessment also concludes that it is unlikely that future land use will ever be residential or that groundwater will ever be used for drinking water.

Site 4 - POL Storage Area—Site 4 was the location of an approximately 1,000-gallon JP-4 jet fuel spill. The location of the spill is well-defined because the boundaries of the POL area where the spill occurred remained essentially unchanged from the time of the spill until the present. An SOV survey was performed beginning directly over the spill site and working away from the site until no VOCs were detected.

Three soil borings were drilled at the site in the area of maximum VOC concentrations. A fourth soil boring was drilled, sampled, and completed as a monitoring well downgradient from the spill area and sampled for groundwater. Soil and water samples were screened using an onsite GC to assist in estimating the vertical extent of VOC contaminants and selecting soil samples to submit for laboratory analyses.

Data collected during the SI indicated that no residual contamination related to the diesel spill was present. Petroleum compounds were detected in one boring at Site 4; however, they do not exhibit the distribution trend expected of bulk hydrocarbon spill residue and appear to be the result of a recent, very localized, small release.

Onsite GC and laboratory analytical results confirmed the presence of chlorinated solvents in soil at the soil-water interface and in groundwater downgradient from the site. Extensive review of the operation and maintenance procedures of the POL yard did not indicate a potential source of the chlorinated solvents. The source and extent of these compounds is unknown; however, they are not believed to be site related.

Site 5 - Ramp Drainage Ditch—The Site 5 - Ramp Drainage Ditch is located along the aircraft parking apron and collects surface runoff from the parking apron, a paved road that runs parallel to the ditch, and an aircraft maintenance hangar ramp. Because an oily sheen was observed floating on water in the ditch, five sediment samples were collected at regularly spaced intervals along the ditch. Analysis of the sediment confirmed the presence of petroleum-related contaminants (i.e., TPH and PAHs) in the upper 0.5 feet BLS. Two soil borings were drilled and sampled to the water table at these locations to determine the vertical extent of petroleum contaminants at the points of maximum potential contamination. To determine ambient concentrations of contaminants, two additional borings were located at areas near the aircraft parking apron, but at sufficient distance from Site 5 to avoid any site-related contaminants. Samples from these borings were included in the background data set.

Although sediment samples show surface contamination from the parking apron runoff, soil samples from the borings indicate that contamination above regulatory criteria is generally confined to surface soil and sediments in the ditch. Petroleum contaminants detected in the site subsurface soil borings are within background criteria.

The conclusions of the human health risk assessment for Site 5 are that all health risks fall within or below EPA targets under current land use. Under future residential use, health risks are above EPA targets for children and adults due to the presence of chemicals in soil. All other risks under future land use were below or within EPA targets. The risk assessment also concludes that it is unlikely that future land use will ever be residential.

SUMMARY OF RECOMMENDATIONS

Site 1 - FTA-1—It is recommended that no further investigation, removal action, or remediation activities be conducted on the soils or groundwater at Site 1. This recommendation is based on the determination that no site-related contamination exists at the site and that the site was accurately located.

Site 2 - FTA-2—Further action is recommended at Site 2 prior to use of the site for other than the current use of fire training. Soil containing contaminants at greater than regulatory criteria within the upper 9.5 feet should be evaluated for remediation. No further action is recommended for sediments located at Site 2. This is based on the assessment that contaminants detected are not site related and that transport of sediment contaminants by surface water is sporadic and does not represent a complete exposure pathway.

Site 3 - Leach Field—No further action is recommended at Site 3 based on current use of the site. Petroleum hydrocarbon concentrations that exceed regulatory criteria are confined to the former leach field filter bed from approximately 6 to 9 feet BLS and have not migrated significantly since operations ceased in 1980. If future uses involve construction and excavation at the site, the former leach field filter bed material should be disposed of in accordance with regulatory guidelines.

Site 4 - POL Area—No site-related actions are recommended for Site 4 because the absence of site-related contamination was confirmed. It is recommended that further action be taken to identify the source and extent of VOCs detected in groundwater and soil upslope from the spill area at Site 4.

Site 5 - Ramp Drainage Ditch—Remediation of surface soils and sediment at Site 5 is not recommended under its current use. Future uses are also likely to be heavy industrial because the area is zoned I-1. If removal is necessary due to rezoning to residential, the vertical extent of contamination should be more precisely identified (between 0.5 and 5 feet BLS) to optimize remediation.

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1. INTRODUCTION

This report documents the site investigation (SI) activities that Science Applications International Corporation (SAIC) performed at the Ohio Air National Guard Base (ANGB), Springfield-Beckley Municipal Airport, in Springfield, Ohio (herein referred to as Springfield ANGB) under the U.S. Department of Defense (DOD) Installation Restoration Program (IRP). Field activities were conducted between April 4, 1992 and May 22, 1993, and were performed in accordance with the approved SI Work Plan (SAIC 1992) and Plan of Action (SAIC 1993). The SI Work Plan addressed activities to be conducted at Springfield ANGB and Blue Ash Air National Guard Station (ANGS), in Cincinnati, Ohio; however, this SI report only addresses the activities conducted at Springfield ANGB. The following subsections present the purpose of the SI program, outline the organization of the report, discuss the sites under investigation, summarize previous IRP activities, and describe the regional environmental setting.

1.1 PURPOSE OF THE INSTALLATION RESTORATION PROGRAM

DOD initiated the IRP to identify, evaluate, and remediate suspected environmental problems associated with past usage, storage, handling, and disposal of hazardous substances at DOD facilities. The principal objective of the IRP is to protect human health, welfare, and the environment. Section 120 of the Superfund Amendments and Reauthorization Act of 1986 (SARA) requires that IRP activities adhere to procedures specified in the National Contingency Plan (NCP) Final Rule [55 FR 8666]. The NCP details a sequence of steps to be followed when investigating and cleaning up suspected hazardous waste sites. This sequence begins with the discovery of a suspected hazardous waste release or threat of release, and ends with a permanent remedy to eliminate or minimize the environmental impact and long-term monitoring of the remediation effort. The five phases that constitute the IRP process and the purpose and activities associated with each phase are presented below and include:

- *Preliminary Assessment*—A preliminary assessment (PA) is conducted to identify and evaluate the type and location of suspected problems associated with past hazardous waste handling procedures, disposal sites, and spill sites. This is accomplished through interviews with past and present Base employees, historical records searches, and visual site inspections. In addition, detailed geologic, hydrologic, meteorologic, land use, and environmental data for the area of study are gathered. A detailed analysis of all information obtained identifies sites of concern. The PA for Springfield ANGB was completed by the Hazardous Materials Technical Center (HMTC) in October 1988.

- ***Site Investigation***—The purpose of an SI is to acquire the necessary data to either confirm or deny the existence of suspected environmental contamination at each identified site of concern and to provide a preliminary evaluation of the potential risks to human health and the environment. The SI includes identifying specific chemical contaminants and their concentrations in environmental media and determining the potential for contaminant migration through site-specific hydrogeologic investigations.
- ***Remedial Investigation***—During a remedial investigation (RI), necessary data are acquired to define the extent of confirmed environmental contamination and to further assess the associated risks to human health and the environment. The RI quantifies the magnitude and extent of contamination at the sites and identifies the specific chemical contaminants present and their concentrations in environmental media. A determination also is made as to the potential for contaminant migration by assessing site-specific hydrogeologic and contaminant characteristics.
- ***Feasibility Study***—A feasibility study (FS) is performed to develop the remedial action alternative that mitigates confirmed environmental contamination at each site and meets the applicable or relevant and appropriate requirements (ARARs). The FS considers risk assessments and cost benefit analyses in providing the necessary data, direction, and documented supportive rationale to acquire regulatory concurrence (Federal, state, and local) with the recommended remedial alternative. During the FS, recommendations are evaluated, developed, and provided for remedial actions at each site where remediation is required.
- ***Remedial Design***—The purpose of remedial design is to provide engineering design drawings and construction specifications required to implement the recommended remedial action selected through the FS process. The implementation of the remediation plan requires appropriate regulatory acceptance.

The IRP requires the identification and evaluation of environmentally deleterious sites on DOD installations and to protect human health, welfare, and the environment from those sites. The Air National Guard Readiness Center (ANGRC), through a U.S. Air Force (USAF) interagency technical support agreement with the U.S. Department of Energy (DOE), uses Martin Marietta Energy Systems, Inc. (Energy Systems) to provide technical assistance for implementing the IRP. SAIC has been retained by Energy Systems under the Hazardous Waste Remedial Actions Program (HAZWRAP) to conduct the IRP SI at Springfield ANGB.

1.2 PURPOSE OF THE SITE INVESTIGATION

This SI was conducted to determine whether environmental contamination is present at Springfield ANGB and to characterize the nature of any identified contamination. The presence of contaminants in the groundwater and soils at the sites was determined and the potential impacts of confirmed contamination to the environment and surrounding populations were evaluated during the SI. The SI Also included characterization of the sources and nature of the contamination, as well as a preliminary evaluation of the movement of confirmed contaminants at the sites and identification of possible receptors of potential contamination. Contaminated sites may require additional field investigative efforts (RIs) to characterize completely the magnitude and extent of any confirmed contamination. The SI at Springfield ANGB was conducted to:

- Confirm the presence or absence of contamination at the IRP sites
- Identify the sources and nature of contamination at the IRP sites
- Provide a preliminary assessment of the extent, magnitude, and movement of identified contamination
- Address applicable or relevant and appropriate requirements (ARARs) and the potential for risk to human health and the environment from confirmed contamination at each site
- Support "no further action" decisions and the completion of decision documents, if appropriate
- Determine if additional investigative efforts are necessary to fully characterize the nature and extent of any detected contamination.

1.3 REPORT ORGANIZATION

This SI report contains the following sections:

- ***Section 1. Introduction***—The remainder of this section describes the history of the Base; the specifics of each individual site; previous studies of the Base; and an overview of the demographics, regional geology and hydrogeology, and background groundwater quality of the area.
- ***Section 2. Field Program***—Section 2 describes the purpose and methods used for determining the hydrogeologic conditions and chemical nature of the sites. Variances between the activities proposed in the SI Work Plan (SAIC 1992a) and the actual field

work performed also are discussed. In addition, the issues of background sampling and disposal of investigation derived wastes are addressed.

- *Section 3. Significance of Results*—Section 3 presents the results of background sampling and a description of the Base geology and hydrogeology, including laboratory analytical data for the environmental samples collected during the SI field effort.
- *Section 4. Chemical Fate and Transport*—Section 4 discusses the probable fate and transport of site-related contaminants introduced into the environment.
- *Section 5. Baseline Human Health Risk Assessment*—Section 5 presents an evaluation of potential risks to human health to support the determination of the need for site remediation. The assessment follows EPA Risk Assessment Guidelines.
- *Section 6. Conclusions and Recommendations*—Section 4 presents a site-by-site list of result summaries and conclusions of the SI findings and recommendations for any future IRP activities.

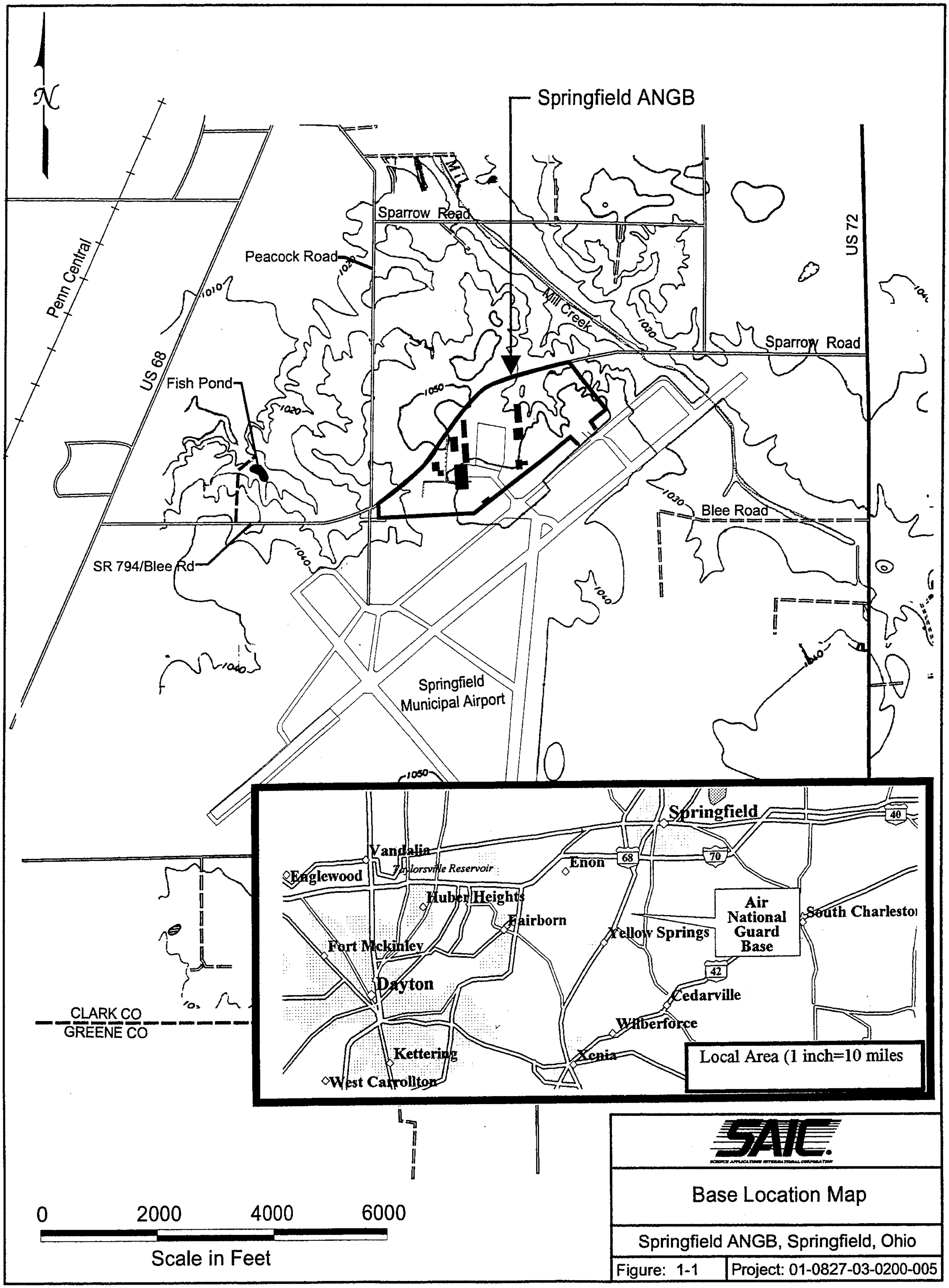
A reference list and a list of acronyms and abbreviations is included in this SI report. In addition, separate appendices detailing monitoring well and soil boring completion, field forms, groundwater probe surveys, standard operating procedures (SOPs), laboratory methods and results, aquifer test methods, and a detailed data quality discussion are provided.

1.4 FACILITY BACKGROUND

Background information pertinent to the Springfield ANGB SI was obtained from the PA completed for the Base by the Dynamac Corporation through HMTC in October 1988; interviews with local and state authorities; site visits; interviews with past and present Base employees; and evaluation of records, aerial photographs, and construction drawings. The following subsections summarize the Base history and facilities, previous IRP activities, and provide site descriptions.

1.4.1 Base Description and History

Springfield ANGB maintains its 178th Tactical Fighter Group at facilities located at the Springfield-Beckley Municipal Airport at township 4, range 8, section 5 in Clark County (Greene Township), Ohio. The Base and airport are located in southeastern Clark County, approximately 5 miles south of the city of Springfield and 30 miles east of Dayton, Ohio, as shown in Figure 1-1. The Base lies directly south of Blee Road (State Route 794) and is situated



Base Location Map

Springfield ANGB, Springfield, Ohio

Figure: 1-1 | Project: 01-0827-03-0200-005

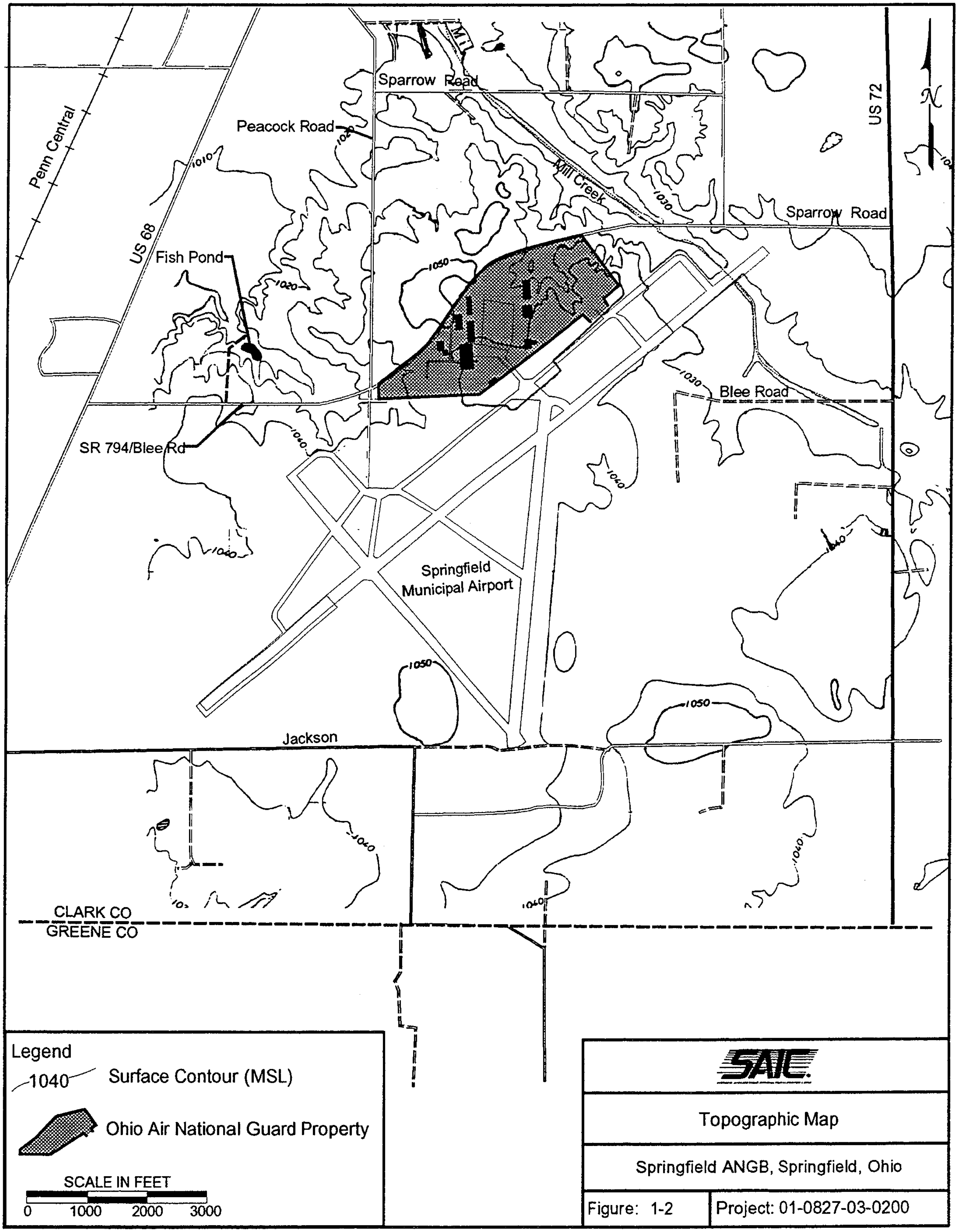
between U.S. Highways 68 and 72. The airport is bordered to the northeast by Mill Creek and is surrounded by agricultural land with sparse population along Peacock and Sparrow Roads. Residential population within a 1-mile radius of the Base is calculated by using the Clifton, Ohio Quadrangle Topographic Map, photo-revised in 1988. All residential properties have been counted and each dwelling unit is assumed to contain 3.8 residents (HMTC 1988). Using this procedure, 247 people were estimated to reside within 1 mile of the Base. The Base population includes administrative, mission support, vehicle and aircraft maintenance, infirmary, firehouse, and engineering support personnel.

Topographically, the Base and Springfield Municipal Airport are situated on a plateau with a slight rise in elevation to the northwest, as shown in Figure 1-2. Elevation in the area ranges between approximately 1,030 and 1,055 feet above mean sea level (msl). Area relief is generally the result of glacial activity that covered bedrock with a veneer of glacial drift. Locally, relief may be distinct due to such glacial landforms as kames, which are irregular, rounded, sometimes dome-like hillocks of stratified drift, and terminal moraines, which are accumulations of glacial till pushed up by the glacier.

1.4.1.1 Ownership and Operational History

Springfield ANGB is located in Clark County, Ohio, south of the city of Springfield. Springfield-Beckley Municipal Airport is bordered by Mill Creek to the northeast. The land around the Base is predominantly agricultural, with homes located along Peacock and Sparrow Roads.

In 1951, the Springfield Ohio Air National Guard was established and the 605th Signal Light Construction Company was organized. The 605th was converted to the 269th Communications Squadron the following year. In 1955, facilities were built to house the 162nd Tactical Fighter Squadron at the Springfield Airport. In the fall of 1955, the 162nd moved its flight operation to Springfield.



SAIC

Topographic Map

Springfield ANGB, Springfield, Ohio

Figure: 1-2 | Project: 01-0827-03-0200

Currently, the Base host, or primary unit, is the 178th Tactical Fighter Group (178 TFG), which flies the A-7D/K aircraft. Tenant units include the 251st Combat Communications Group (251 CCG) and one of its squadrons, the 269th Combat Communications Group (269 CCG).

1.4.1.2 Previous IRP Activities and Regulatory History

The PA for the IRP was conducted at the Base in March 1988 under Contract No. DLA-900-82-C-4426 and included:

- An onsite visit, which included interviews with 19 past and present Base employees, and the acquisition and analysis of pertinent information and records on hazardous material use and hazardous waste generation and disposal at the Base
- The identification of sites on the Base that may potentially be contaminated with hazardous materials/hazardous wastes.

Past Base operations involved the use and disposal of materials and wastes that subsequently were categorized as hazardous. The Base shops that use and dispose of hazardous materials/hazardous wastes include Aircraft Maintenance; Vehicle Maintenance; Facilities Maintenance; Petroleum, Oil, and Lubricants (POL) Management; Photography Processing: Corrosion Control; and Aerospace Ground Equipment (AGE). Major constituents of the hazardous materials/hazardous wastes (HM/HW) generated by these activities include waste oils, paint, solvent, thinner, fuel, methyl ethyl ketone (MEK), battery acid, batteries, ethylene glycol, photographic chemicals, and radiation source tubes.

Interviews with past and present Base personnel and a field survey resulted in the identification of disposal and/or spill sites at the Base that are potentially contaminated. The sites are described in Section 1.4.2.

The integrity of underground POL tanks adjacent to Site 4 - POL Storage Area was tested in 1992. Tightness tests were performed on the underground storage tanks (USTs) and pipeline located at the Base facility fuel farm. Fourteen soil organic vapor (SOV) samples were collected by ANGB personnel on March 24, 1992. The samples were obtained from existing permanent SOV monitoring probes installed in the backfill area of the USTs. Samples were collected and analyzed for the two special tracer compounds (which appear in SOV only if the tanks/pipeline are leaking) and total volatile hydrocarbons by the Tracer Research Corporation in Tucson, Arizona.

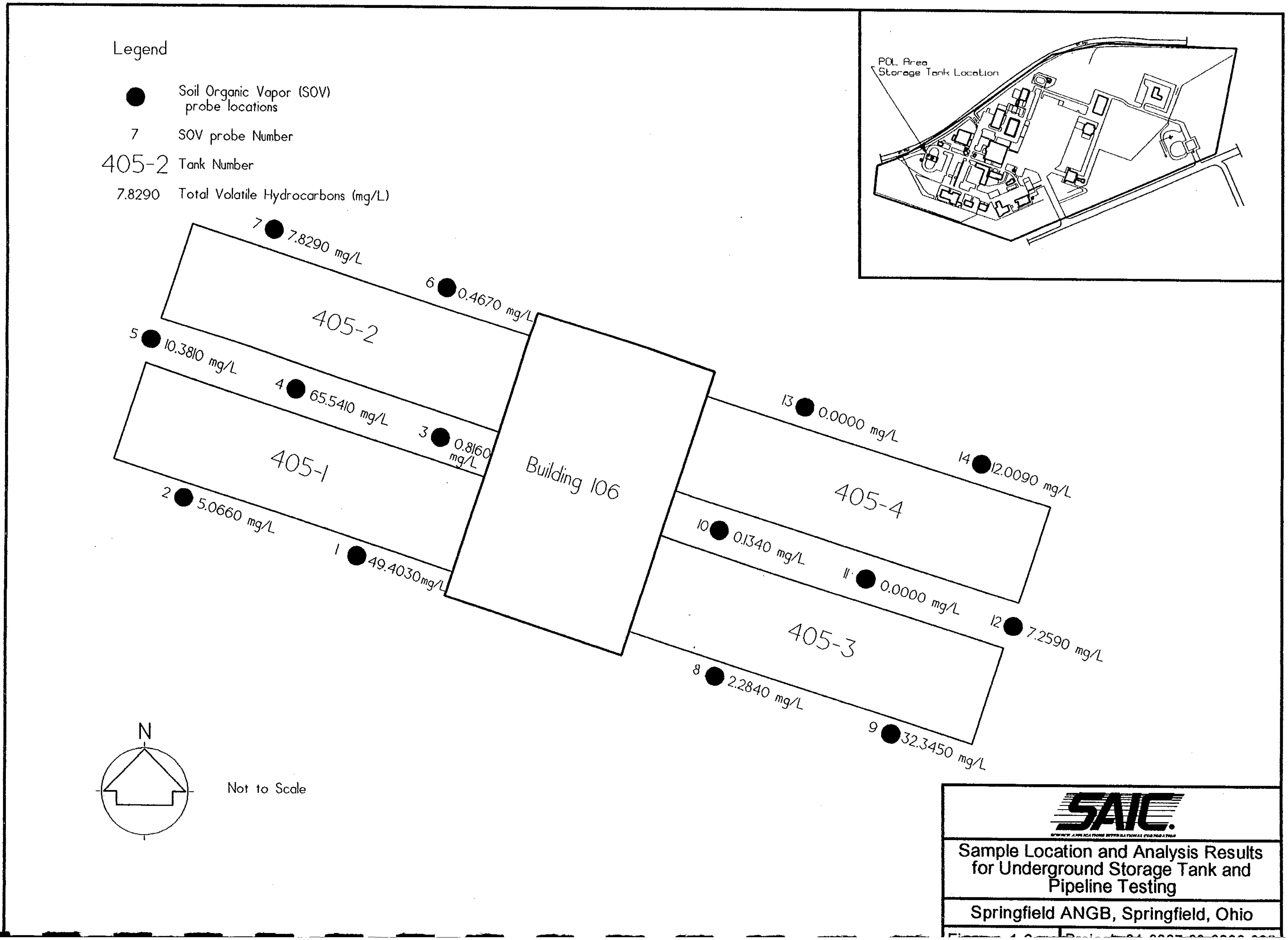
The tests determined that the USTs were not leaking; however, total volatile hydrocarbons were detected in the SOV at probe numbers 1, 4, 5, 9, and 14. The probe locations and concentrations of hydrocarbons (mg/L) detected are presented in Figure 1-3. The source of the hydrocarbon vapors was not determined during the tests but are suspected to result from minor spills and overfills.

1.4.2 Site Descriptions

IRP sites were identified for investigation during this SI. The history of Base activities conducted at each IRP site are described below. These descriptions are based on the findings of the PA (HMTC 1988) and the initial project meeting held in January 1990.

The results of the PA and initial data review activities during the SI indicated that five of the six sites could potentially release contaminants to the environment. Because of shallow (4 to 24 feet below land surface [BLS]) groundwater underlying the Base, the potential for contaminants to migrate from the sites also exists. The six sites at Springfield ANGB identified in the PA were ranked as to the possible hazards they posed using the USAF Hazard Assessment Rating Methodology (HARM) and assigned a Hazard Assessment Score (HAS). The identified sites and the HAS they received, are listed below:

- Site 1 - Fire Training Area No. 1 (FTA-1), (HAS 79)
- Site 2 - Fire Training Area No. 2 (FTA-2), (HAS 79)
- Site 3 - Leach Field (LCH-3), (HAS 63)
- Site 4 - POL Storage Area (POL), (HAS 59)
- Site 5 - Ramp Drainage Ditch (RDD), (HAS 57)
- Site 6 - Mess Hall Underground Storage Tank (MHUST), (HAS 59).



Sample Location and Analysis Results for Underground Storage Tank and Pipeline Testing

Springfield ANGB, Springfield, Ohio

Site 6 was not included in the field portion of this investigation because of the limited quantity (about 4 gallons) and type (fuel oil) of release that occurred. Figure 1-4 shows the locations of the six original sites at Springfield ANGB. These sites are described individually below.

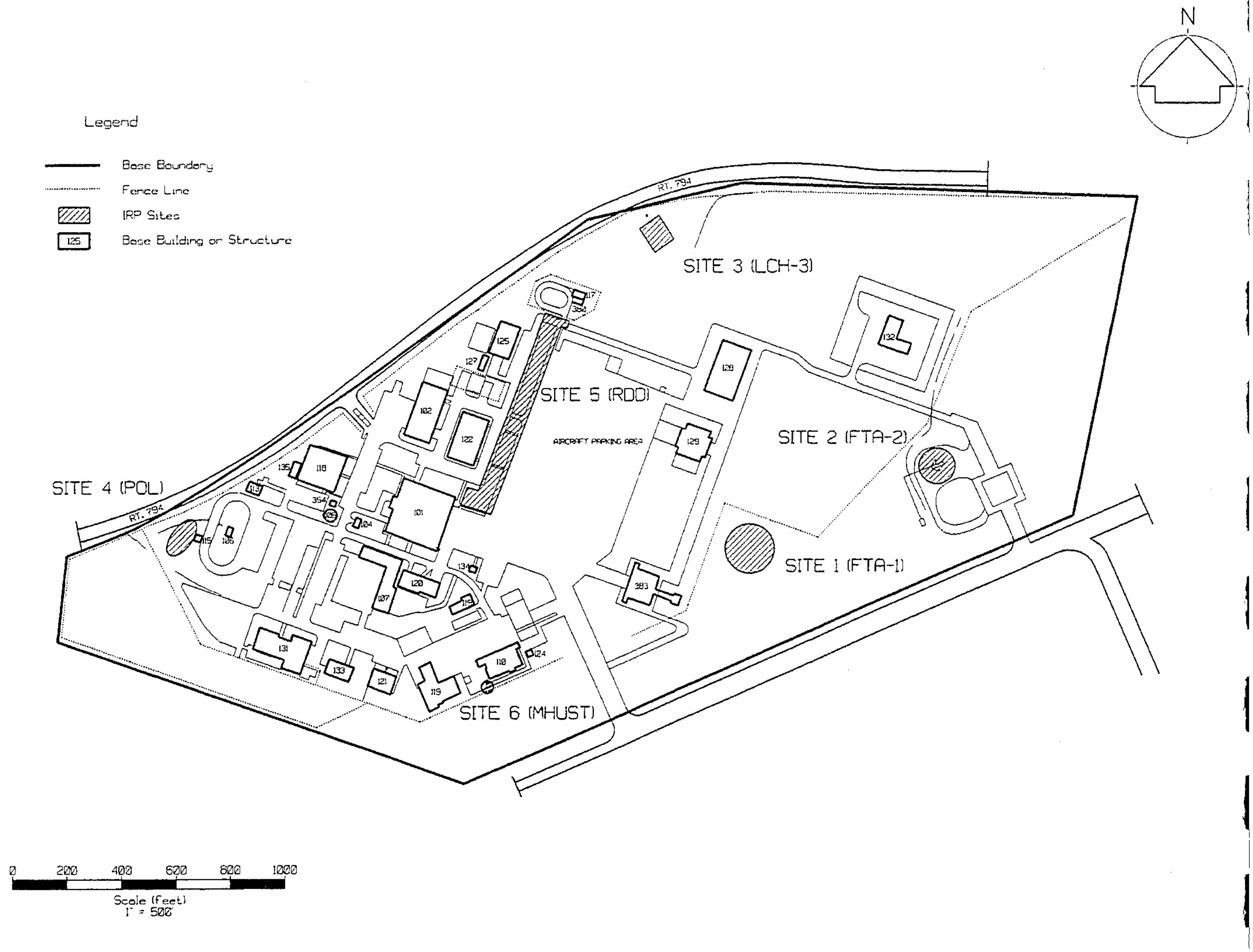
1.4.2.1 Site 1 - Fire Training Area No. 1 (FTA-1)

FTA-1 was located approximately 300 feet southeast of the Avionics Building (No. 128) as shown on Figure 1-4. Fire training exercises reportedly were conducted at this location four times per year from 1957 to 1963. Training procedures included soaking soil at the burn pit with water, floating flammable liquids on top of the water, and igniting the flammable liquids. The flammables were then extinguished by fire-fighting trainees. Details on the burn pit construction are unknown. Approximately 500 gallons of flammable liquids were used per exercise. Assuming that 70 percent (HMTC estimate) of the flammable materials were consumed during the fire training exercises, approximately 3,600 gallons of unconsumed flammable liquid may have evaporated or seeped into the subsurface soils.

1.4.2.2 Site 2 - Fire Training Area No. 2 (FTA-2)

FTA-2, as shown on Figure 1-4, is located approximately 200 feet southeast of the Munitions Maintenance Building (No. 132). The fire training pit was constructed of compacted layers of sand-stone-sand approximately 2 feet deep. Fuel was supplied to the pit by a pipeline that runs from the edge of the pad to the center of the pit. The Base has been the sole operator of FTA-2. The Base Fire Department burned JP-4 and other ignitable materials at this area and was supplied off-specification JP-4 fuel from the Springfield airport, industries in Springfield, and Wright-Patterson Air Force Base (WPAFB).

Fire training exercises reportedly were conducted at this location four times per year from 1967 until 1980. Routine training procedures were to float contaminated fuel or other flammable material on water in the pit, then successively ignite and extinguish the fuel for training. Approximately 1,000 to 1,500 gallons of flammable liquids were used per exercise. Assuming that 70 percent (HMTC estimate) of the flammable materials were consumed during the fire training exercises, approximately 15,600 gallons of flammable liquids may have



SCIENCE APPLICATIONS INTERNATIONAL CORPORATION

Site Location Map

Springfield ANGB, Springfield, Ohio

Figure: 1-4 | Project: 01-0827-03-0200-005

evaporated or seeped into the soils over the 13 years the pit was in operation. Stained soil and stressed vegetation were reported during the site visit. A new propane fueled training pit currently is located on top of the older pit.

1.4.2.3 Site 3 - Leach Field (LCH)

The Leach Field site is located approximately 400 feet northwest of the Avionics Building (No. 128). The location of this site was identified in the PA and is shown in Figure 1-4. From 1950 to 1980, the Base sanitary sewer system incorporated oil/water separators (OWSs) at the following buildings: Aerospace Ground Equipment Shop, Nondestructive Inspection Building, Motor Pool, Munitions, Civil Engineering, POL, and the Fire Station. The OWS effluent from these areas flowed through the sanitary sewer system, which drained into a septic tank and leach field. The hangar and POL Management buildings use acid neutralizers that also drained through this system.

The types of waste disposed of through the Base sewer system include waste oil, solvents, battery acid, photographic chemicals, ethylene glycol, cleaner, degreaser, and fuel. The Base converted to the municipal sewer system in early 1988 and, at this time, the leach field was abandoned in place.

1.4.2.4 Site 4 - POL Storage Area (POL)

In 1972, approximately 60 feet west of the POL facility (Building No. 106), approximately 1,000 gallons of JP-4 fuel were spilled as a result of a refueling valve failure. No cleanup effort was conducted. The location of this site is shown in Figure 1-4.

The fuel drained to a ditch off Base property, flowed along the road (Blee Road), and migrated approximately 3,000 feet to an adjacent fish pond where it killed fish and ducks. Since the incident, the state has excavated the off-Base soils from the drainage ditch alongside Blee Road as part of maintenance regrading; therefore, only the potentially contaminated soil at the POL within the Base boundary was investigated.

1.4.2.5 Site 5 - Ramp Drainage Ditch (RDD)

The ramp drainage ditch runs along the east side of the Hangar, Squadron Operations, and Rocket Storage Buildings (Nos. 101, 122, and 125, respectively). The ditch also handles all storm water runoff from the aircraft parking ramp and the surrounding lawn and automobile parking area. The water consolidates with other storm waters and flows into an outfall to the north of the Base property. During the site visit by HMTC, an oil sheen was observed on standing water within the ditch on the west side of the ramp; however, no stressed vegetation was reported. The location of this site is shown in Figure 1-4.

1.4.2.6 Site 6 - Mess Hall Underground Storage Tank Oil Spill (MHUST)

The underground heating oil storage tank was located at the southeastern corner of the Mess Hall (Building No. 110) and was replaced in 1987. Approximately 4 gallons of fuel were left in the old tank, and upon removal were spilled between the building and the fence line. The tank was removed due to the presence of water; however, no outward leaking was found upon removal. No cleanup efforts were conducted. The location of this site is shown in Figure 1-4.

1.5 ENVIRONMENTAL/REGIONAL SETTING

Descriptions of the environmental setting, population, economy, and meteorology of the region are presented in the following subsections. The environmental setting at Springfield ANGB is summarized to provide a framework for the site-specific investigations at the facility. The information was obtained from the PA, the Final Environment Assessment Report (OANG 1992), and a review of local and state records.

1.5.1 Land Use

Springfield ANGB and the Springfield-Beckley Municipal Airport are located within the Greene Township in Clark County. The county is bordered by Greene, Madison, Champaign, Miami, and Montgomery counties in southeastern Ohio. Clark County is primarily rural in character, with agriculture the predominant land use. The ANG property is situated approximately 5 miles south of the city of Springfield, in the south-central portion of the county.

County land use designations within the airport boundaries include both agricultural and industrial zones. Agricultural zoning on the property generally coincides with the runway and taxiway areas, with four surrounding pockets of industrial zoning. ANGB buildings and the municipal airport terminal area are located in one of the four industrial zones; the three remaining areas are currently undeveloped and used for agricultural purposes. As mentioned previously, agriculture is the predominant land use in the vicinity of the airport and Base property, with small isolated pockets of rural residential and small general businesses. Residential land uses near the Base consist of farmhouses and other single-family residences on large plots; population density in the area is very low. Agricultural activities in the vicinity are focused primarily on the production of row crops and hay.

Five areas having potentially sensitive land uses are located within 5 miles of the Base and airport. These areas include John Bryan State Park, the Clifton Gorge State Nature Preserve, and the Little Miami State and National Scenic River, located about 3 miles to the southeast. In addition, the historic village of Yellow Springs and the adjacent, privately held Glen Helen nature preserve are located about 5 miles to the south.

1.5.2 Population and Local Economy

Springfield ANGB personnel significantly influence the population and economy of Clark, Greene, and Champaign counties. The population for these counties has declined slightly since 1980 and is projected to remain stable or decrease at least until the year 2000. Population figures released by the U.S. Bureau of the Census are slightly higher for Springfield (city), Greene, and Clark counties than was estimated prior to the 1990 Census. Table 1-1 presents population trends for the Springfield area from 1980 to 1990. Land area and population density for the Springfield area are shown in Table 1-2.

Table 1-1. Population Trends for the Springfield, Ohio Area

County	1990 Census[a]	1980 Population[b]	Percent Change
Clark	147,458	150,236	-1.8
Greene	136,731	129,769	5.4
Champaign	36,019	33,649	7.0

Sources: [a] 1990 Census of Population and Housing Summary of Population and Housing Characteristics, Ohio, U.S. Department of Commerce, Bureau of the Census.
[b] Rand McNally Commercial Atlas, 1990.

Table 1-2. Population Density in the Springfield, Ohio Area

County	Land Area (1,000 acres)[a]	1990 Population[b]	Density per Acre
Clark	254.7	147,458	.58
Greene	265.6	136,731	.51
Champaign	274.5	36,019	.13

Sources: [a] Rand McNally Commercial Atlas, 1989.
[b] 1990 Census of Population and Housing Summary of Population and Housing Characteristics, Ohio, U.S. Department of Commerce, Bureau of the Census.

The Clark County civilian labor force, based on place of residence, is approximately 72,700 persons. Information obtained from the Community Improvement Corporation of Springfield-Clark County, Springfield Area Chamber of Commerce listed the following major employers in the area:

- Navistar/International Harvester: 5,500 employees
- SPECO Corporation: 500 employees
- Cooper Industries — Ajax Superior: 450 employees
- Robbins & Myers, Incorporated: 380 employees
- Olan Mills of Ohio: 450 employees
- City Fed Mortgage Company: 450 employees
- Emro Marketing: 475 employees.

According to the ANGB Economic Resource Impact Statement (ERIS), the ANGB ranks among the top 20 Clark County employers. The military work force directly supporting the 178th TFG consists of 94 officers and 869 enlisted personnel.

Inhabitants that reside within 1 mile of the Base do not use the unconsolidated aquifer for potable water. Potable water for these inhabitants is suppliedby the city of Springfield or by private wells that are completed in the bedrock aquifer (Ohio Department of Natural Resources 1995).

1.5.3 Sensitive Environments

This section provides information on sensitive environments at Springfield ANGB, including vegetation, wetlands, wildlife, and threatened and endangered species.

1.5.3.1 Vegetation

Most of the natural vegetation at Springfield ANGB has been removed during construction and grading activities, and the areas of vegetation are limited to lawns and ornamental vegetation. Existing vegetation on the Base consists of mowed turfgrass interspersed with a variety of trees, including dogwood, ash, hickory, elm, oak, white pine, locust, maple, and other ornamental trees. Wheat, hay, corn, and soybeans are grown in the agricultural areas surrounding the Base.

1.5.3.2 Wetlands and Riparian Areas

No wetlands or designated wilderness areas are located within a 1-mile radius of the Base. The nearest wetland is located approximately 1.5 miles southwest of the Base.

1.5.3.3 Wildlife

Common wildlife species found on the Base and in the immediate vicinity include:

- Whitetail deer (Odocoileus virginianus)
- Red fox (Vulpes fulva)

- Gray squirrel (Sciurus niger)
- Muskrat (Ondatra zibethica)
- Opossum (Didelphis marsupialis)
- Eastern chipmunk (Tamius stiatus)
- Deer mouse (Paramiscus leucopus)
- Prairie vole (Microtus leucrogaster)
- Least shrew (Cryltotif parva)
- Short-tailed shrew (Bloria drainacauda)
- Raccoon (Procyon lotor).

1.5.3.4 Threatened and Endangered Species

The Endangered Species Act of 1973 defines a federally listed endangered species as "any species which is in danger of extinction throughout all or a significant portion of its range." A federally listed threatened species is defined as "any species which is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range." A state endangered species is "a species which is in jeopardy of extinction within the State or whose habitat is jeopardized to the extent that the species could be eliminated as a reproducing entity in Ohio." A state threatened species is "a species that is likely to become endangered in the future if its population levels or habitat conditions decline for any reason."

The Indiana bat (Myotis sodalis) is a state and federally listed endangered species known to inhabit Clark County that may occur in the area of Springfield ANGB.

Breeding pairs of the upland sandpiper (Bartramia longicauda), a state threatened species, are known to inhabit the airport area. State threatened species are afforded no legal protection other than their notation on the state threatened species list.

1.5.4 Meteorology

Springfield ANGB is situated in a temperate, humid climate. The average annual temperature in the Springfield area is 52°F, with an average monthly maximum of 76°F in July and an average monthly low of 30°F in January.

The Springfield region has an average annual precipitation of 36.75 inches with rainfall being fairly evenly distributed throughout the growing season, but is heaviest in the spring and summer and lightest in the fall. Most of the creek bottoms are flooded at least once during the spring and summer. Late spring and summer rains often come as downpours, and much of the water runs off before it can infiltrate. Fall, winter, and early spring rains are likely to be slow and steady. The average yearly snowfall is 24 inches; however, snow seldom stays on the ground for more than a few weeks. Crop damage by frost is rare. Fruit crops are occasionally affected by a late spring frost, or corn or soybeans by an unusually early fall frost.

Clark County is not subject to high winds. The average wind velocity is between 8 and 10 miles per hour (mph). Prevailing winds are from the southwest. Hailstorms and tornadoes are rare, and when they do occur, are localized.

1.6 REGIONAL GEOLOGY AND HYDROLOGY

The geology, hydrology, and soils of the region are summarized in the following subsections to support the conclusions of site-specific investigations at the facility.

1.6.1 Regional Geology

The Springfield area is regionally underlain by Quaternary-aged, unconsolidated glacial, glaciofluvial, and lacustrine sediments that overlie Paleozoic carbonate bedrock formations. Studies and information revealed during the drilling efforts indicate that the Springfield ANGB area is blanketed by a veneer of assorted unconsolidated glacial sediments of varying thicknesses. The sediments in the region were deposited during the late Pleistocene Age by large sheets of ice associated with Wisconsin Glaciation. The sediments were either deposited directly by the ice (i.e., till) or by meltwater streams and lakes (i.e., outwash) associated with continental glaciation.

Unconsolidated glacial till deposits composed of mixed clays, silts, sands, and gravels are the principal sediments underlying Springfield ANGB. The glacial till extends to a depth of approximately 30 feet and may be jointed either vertically or horizontally; however, the permeability of the material is low. Little information is available regarding any unconsolidated deposits beneath the glacial till in Clark County (HMTC 1988).

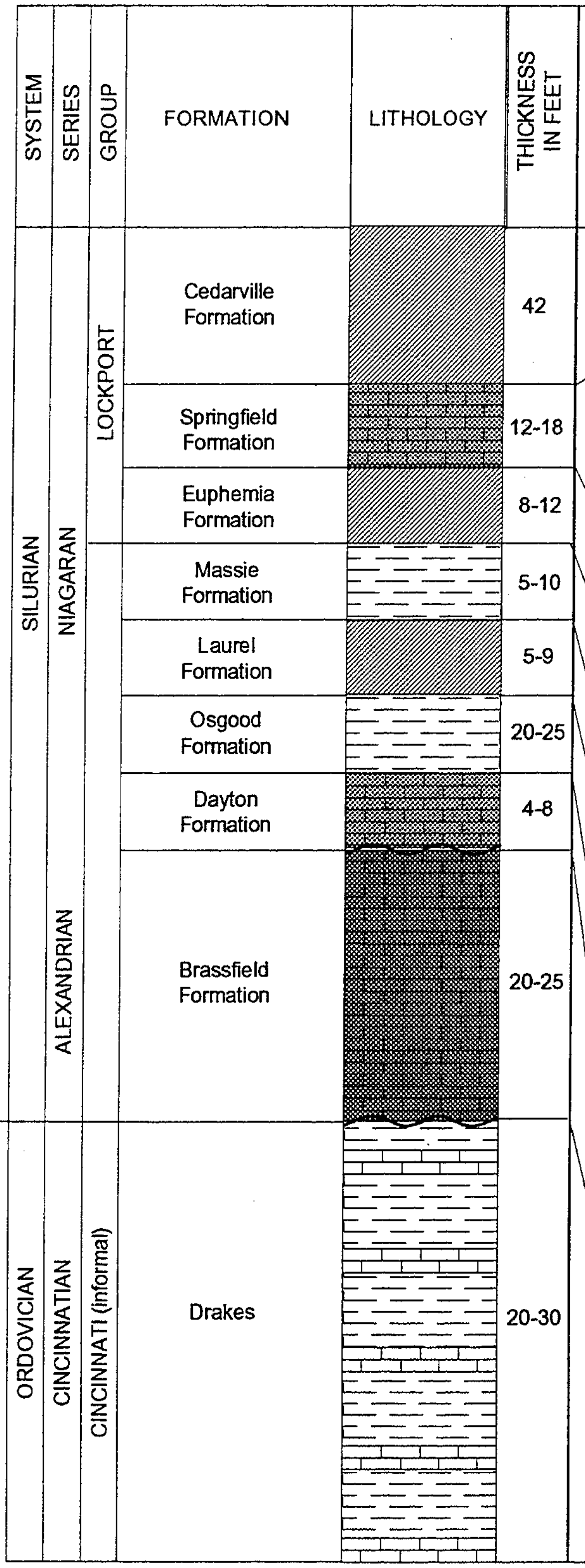
Meltwaters reworked previously deposited materials and redeposited these materials in lakes and streams. A large degree of sorting was achieved through this process, with average grain size in glaciofluvial sediments generally reflecting the energy level in any given portion of the transporting medium. Coarse-grained materials were deposited in fast moving waters (stream channels), while fine-grained materials were deposited in quieter waters (lakes).

The irregular surficial depositional patterns of glacial influence that occur within the Springfield area are the result of fluctuating depositional settings associated with advancing, stagnating, and retreating ice sheets, in addition to modifications due to the present day drainage system.

The bedrock sequence (Figure 1-5) underlying Clark County is composed of the Richmond/Maysfield/Eden Series, the Brassfield Limestone, and the Niagaran Series, which consists of the Dayton Limestone, Osgood Shale, Laural Dolomite, Massie Shale, Euphemia Dolomite, Springfield Limestone, and Cedarville Limestone, all of which have a combined thickness of approximately 100 feet in the area, and were deposited during the Silurian Age.

The Richmond/Maysfield/Eden Series consists of the Blue Limestone, which is interstratified limestones and shales (Eden shales) of Ordovician Age at the bottom of the formation. The characteristics of this series are not prominently displayed because the surface of this layer is heavily covered with glacial drift or alluvial formations. The top portion of this series is marked by nonfossiliferous shales, 20 to 30 feet thick, often red fromiron oxides. This feature marks the end of the Lower Silurian time.

The Brassfield Limestone enters the county in the Mad River Township. The limestone is an uneven bedded rock with a sandy texture in its lower portion and a semi-crystalline, crinoidal limestone in its upper beds; it ranges from 20 to 25 feet thick. The bulk is crystalline



DESCRIPTION

Cedarville Formation - In Clark County the formation which is most extensive in distribution and most valuable for its economic utility is the Cedarville dolomite. The stone is always massively bedded, porous and semi-crystalline in texture, light to bluish gray to drab in color, and rich in fossils

Springfield Formation - The Springfield member is a magnesiam carbonate, containing generally about 50 percent of carbonate of lime and 40 percent of carbonate of magnesia. Prevailing color of the local rocks is a light drab, though several blue courses occur. To the southward section of the county the rock is mainly blue. The thickness of this division is never more than 20 feet, and seldom exceeds 15 feet in this portion of the state

Euphemia Formation - Dolomitic in character with a massive rather than layered structure which occurs locally at a thickness of 8 feet. Fossils found in the Euphemia are few and indifferently preserved

Massie Formation - This shale is of little importance except for paleontological evidence. It is soft clay shale in character, calcareous in composition, light gray in color and rather rich in fossils, common thickness is 5 to 6 feet

Laurel Formation - Dolomitic in character, rich in fossils, dense and crystalline in texture, and dominantly gray in color

Osgood Formation - Soft calcareous clay shales with a few thin to flaky layers of dolomite, mainly in the upper portion. Color range is rather wide and varies with the extent of weathering between bluish gray and light green. In southwestern Ohio the Osgood member varies from 10 to 80 feet in thickness and carries a limited number of faunal fossils, generally in poorly preserved forms

Dayton Formation - Regularly bedded, dense and hard, and contain small quantities of siliceous and argillaceous impurities

Brassifield Formation - An uneven bedded rock, in its lower portions it is of a sandy texture, and is semi-crystalline, crinoidal limestone is found in its upper beds. It passes in color from white, through various shades of yellow and red, to a dark, brownish red, which contains a notable proportion of an oxide of iron

Drakes Formation - Formation is distributed throughout the region but locally varies in thickness. Generally demonstrates typical shale character; however may contain sandy lenses and limy matter, locally blue shales may alternate with red. Composition is classified as siliceous, dolomitic shale rich in potash.

Legend

Sh, sh	☰
Ls, ls	▦
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SAIC

Generalized Stratographic Column
for Clark County

Springfield ANGB, Springfield, Ohio

Figure: 1-5 Project: 01-0827-03-0200-005

in structure, and consequently, resists the weathering action of the air more efficiently than the Blue Limestone layer. The Brassfield Limestone is uniform in its composition, consisting generally of 84 percent carbonate of lime and 10 to 12 percent carbonate of magnesia.

The Niagaran Series is the most important stratigraphic section in Clark County. It covers a wide area and is the thickest geologic unit. The elements of the Niagaran Series found in the county are from bottom to top (oldest to youngest) the Dayton Limestone, the Osgood Shale, the Laurel Dolomite, the Massie Shale, the Euphemia Dolomite, the Springfield Limestone, and the Cedarville Limestone.

The bottom layer of the Niagaran Series is the Dayton Limestone, which is a dense, compact, evenly bedded, white dolomitic limestone ranging in thickness from 4 to 8 feet. The beds are thin and separated by shale partings. The next layer, Osgood Shale, consists of soft, gray calcareous shales with limestone beds ranging in thickness from 20 to 25 feet. The third member of the Niagaran Series is Laurel Dolomite, which is thinly bedded, bluish-gray, and approximately 5 to 9 feet thick. The fourth member is the Massie Shale, which consists of a dense bluish-gray calcareous shale, 5 to 10 feet thick. It may be separated from the Laurel Dolomite by a spring zone. The Springfield Limestone contains a small, nonuniform percentage of silica and alumia. The thickness of this formation ranges from 12 to 18 feet. Cedarville Dolomite is the youngest division and the thickest layer of the Niagaran Series, approximately 42 feet in its vertical section beneath Clark County. This unit is structurally separated into two layers. The lower layer is a massive rock, semi-crystalline in texture and highly fosseliferous. Above this layer are thin, uneven-bedded units that are sandy and porous in texture.

1.6.2 Regional Hydrogeology

According to the U.S. Geological Survey (USGS) (Water Supply Paper 259), the aquifers of Clark County include both the surface deposits of alluvium, till, and morainal deposits, and the rock formations of the Niagaran Limestone, Brassfield Limestone, and Richmond Formation.

The glacial sediment deposits form a heterogeneous system of permeable sands and gravels and impermeable till zones. Although some rural households in Clark County obtain water from streams, the water sources for most residents are the water-bearing layers of the glacial drift, principally sand and gravel deposits in the moraines, outwash valleys, and buried valleys.

The variability of these unconsolidated deposits in terms of areal extent and distribution makes it difficult to predict the precise location and depth for adequately yielding groundwater wells. The depositional pattern in the area results in zoning of deposits according to specific yields. Large variations in well yield occur within a given zone as a consequence of localized variations in depositional patterns. Recharge to the glacial deposits may occur directly from precipitation or by localized infiltration along the bed of a stream.

Throughout the county, the glacial drift is underlain by water-bearing sedimentary bedrock. Water is sometimes obtained from this rock if the glacial deposits are too thin or too dense to supply groundwater for local needs. However, the water from the bedrock has a high content of calcium and magnesium salts; in some places, the content is so high that the water is unsuitable for consumption (HMTC 1988).

The near-surface aquifer accounts for significant quantities of drinking water supplies in the region. This near-surface aquifer is significant to this study because it is shallow and may provide base flow to streams during low flow periods; therefore, any contaminants that exist in the shallow aquifer could migrate into the surface regime.

The bedrock in the area is Silurian limestone and dolomite of the Niagaran Series and Lockport Group. The highly impermeable Osgood Shale of Silurian age underlies this fractured bedrock and forms the Niagara Aquifer. The Niagara Aquifer is a source of groundwater in some areas of Clark County. Groundwater flow characteristics of the Niagara Aquifer are unknown and the orientation of bedrock deposits that make up this aquifer are not such that they may be used as a dependable indicator of flow characteristics. Furthermore, the degree of hydrologic connection between the bedrock and the overlying unconsolidated regolith is unknown.

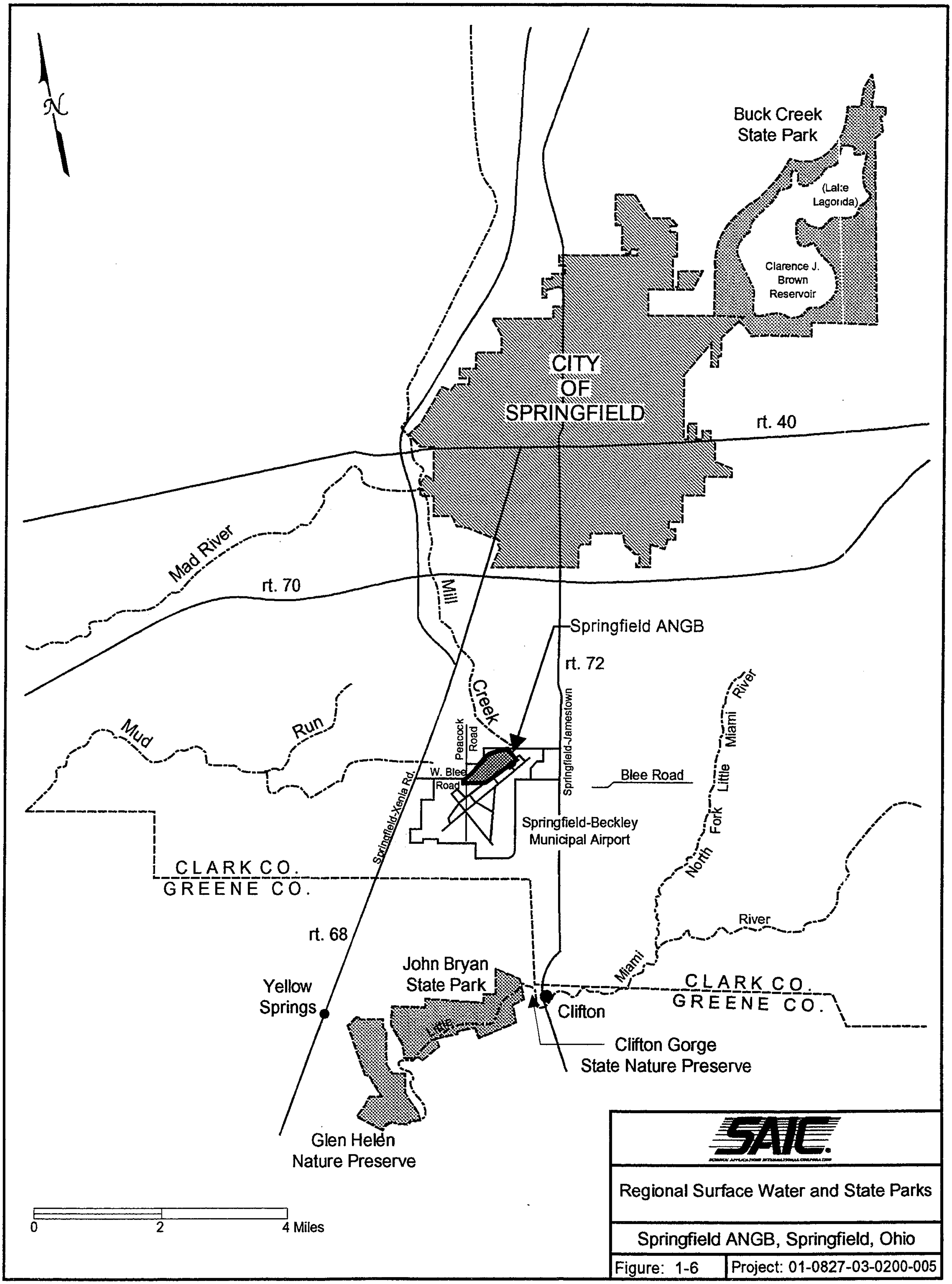
Water for Springfield ANGB was supplied by wells on Base property until early 1988. The Base currently is supplied by the city of Springfield, which obtains its water from ten 100-foot wells on Eagle City Road, located in the northern part of the city.

The yearly low water level for most wells within the Till plains section of the Central Lowlands physiographic province occurs during the winter months. High water levels for the year usually occur from March to June. The yearly water level fluctuations in the groundwater table and confined aquifer wells are usually 3 to 5 feet and are predominantly due to seasonal climatic conditions.

1.6.3 Surface Water Hydrology

The surface waters near the Base consist of the Mill Creek and two unnamed tributaries, as shown in Figure 1-6. Mill Creek borders the northeast side of the airport. One of the tributaries flows directly west of the Base, beginning at the intersection of Blee and Peacock Roads. The second tributary begins south of the runway at the Clark and Greene County boundaries. The airport lies at the border of two drainage basins: the Mill Creek Drainage Basin and the Great Miami River Basin. The divide is located approximately 1 mile east of the Base, forming a east-west divide and then turning west to form a north-south divide at the southern end of the runway.

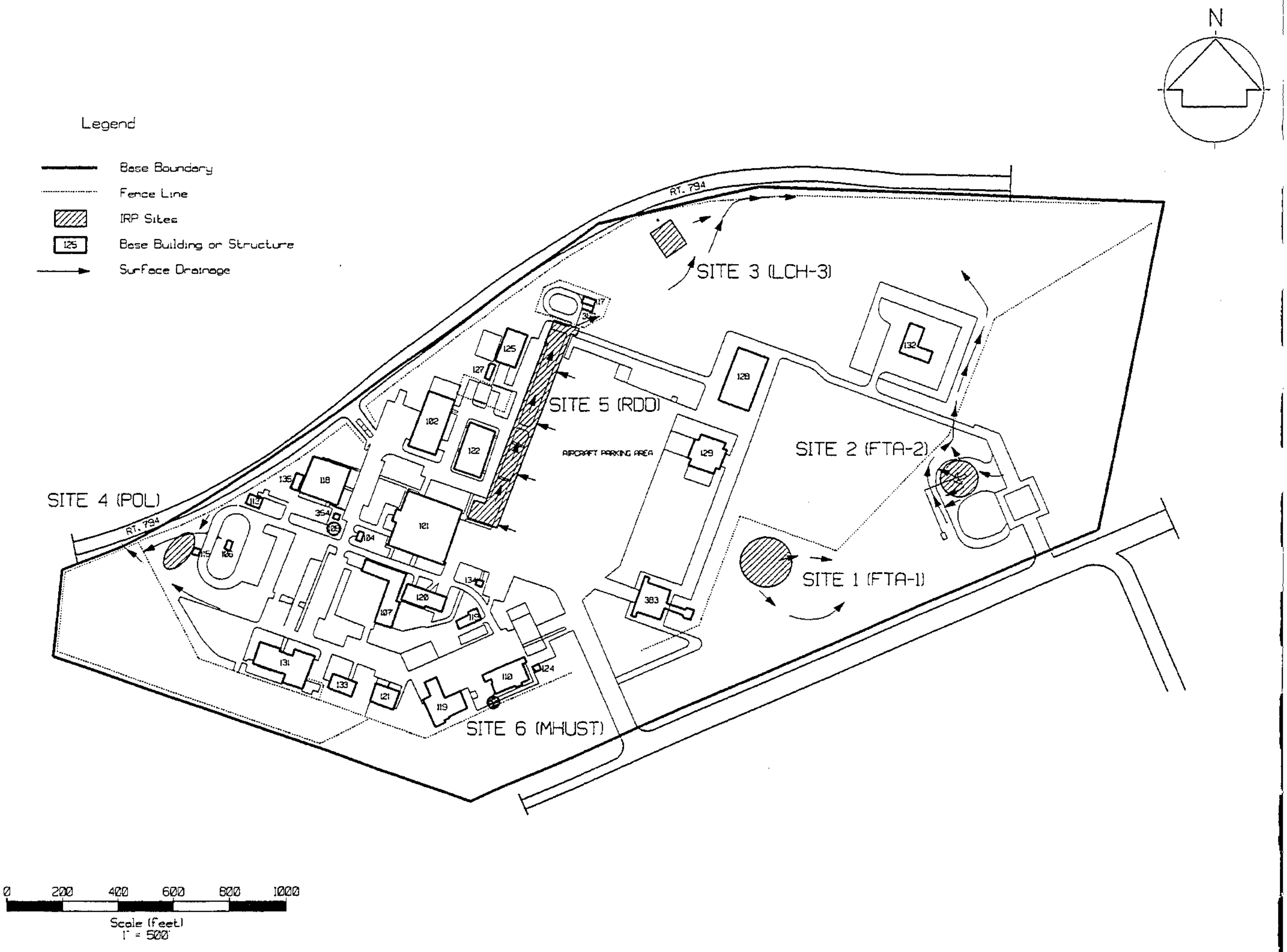
Base drainage flows north into Mill Creek. Mill Creek then flows west for about 3.6 miles into the Mad River. The unnamed northern tributary flows for 1 to 1.5 miles into Mud Run, which flows 10 miles into the Mad River. The unnamed southern tributary flows 1 to 1.5 miles into Yellow Springs Creek, which flows 1 mile into the Little Miami River. Surface water flow was noted during the SI in natural and man-made drainage features and depressions. The surface drainage for the sites as observed during the field portion of the SI is shown in Figure 1-7.



Regional Surface Water and State Parks

Springfield ANGB, Springfield, Ohio

Figure: 1-6 Project: 01-0827-03-0200-005



Base Surface Drainage

Springfield ANGB, Springfield, Ohio

Figure: 1-7 | Project: 01-0827-03-0200-005

1.6.4 Soils

The soils of the Base consist of the Brookstone silt loam; Celina silt loam, undulating phase; Crosby silt loam, nearly level phased; Miami silt loam, undulating phase; and Miami silt loam, eroded undulating phase.

The Brookstone silt loam is dark colored and very poorly drained. It is similar to the Brookstone silty clay loam except for its silt loam surface soil and slightly coarser texture throughout the profile. A typical profile consists of a dense grass mat over a very dark gray-to-black silty clay loam, with a coarse granular structure and high organic matter content. The soil often grades into a mottled olive, dark grayish-brown or dark gray clay loam at about 1 to 2 feet BLS. In addition, it also is associated with a mottled olive-yellow or light gray gritty clay loam, which is usually found between 2 and 4 feet BLS. The permeability of the soil is low and the erosion hazard is slight.

The Celina silt loam, undulating phase, is known locally as a yellow or brown clay. It is moderately well-drained and is found over calcareous glacial till. The top layer of this soil consists of a yellowish-brown to grayish-brown, very friable silt loam. The permeability and erosion hazard are moderate.

The surface layer of the Crosby silt loam, nearly level phased, is grayish-brown and faintly mottled with light brownish-gray, very friable silt loam about 7 inches thick. The subsurface layer is olive-brown, strongly mottled with light, brown-gray. The permeability is low and the erosion hazard is slight.

The Miami silt loam, eroded undulating phase, is a moderately light-colored, well-drained soil that has a yellowish-brown, heavy silt loam surface. This soil is derived from calcareous glacial till. The permeability of this soil is moderate, the erosion hazard is high, and soil boring lithologic descriptions indicate that this was the type of soil found throughout the majority of the Base. Sites 1, 2, and 4 were overlain by the Miami type soils. The Miami silt loam, undulating phase, is a well-drained, light-colored upland soil. It is developed from calcareous glacial till. The permeability and the erosion hazard are moderate.

2. FIELD PROGRAM

This section summarizes the field activities that Science Applications International Corporation (SAIC) performed at Springfield Air National Guard Base (ANGB) as part of the site investigation (SI). The activities planned (SAIC 1992, 1993) and rationale for deviations from these plans are presented in Section 2.1. Field techniques and procedures used during the Springfield SI are provided in Sections 2.2 through 2.6. Activities conducted at each site and the objectives of the activities are outlined in Section 2.7. The results of the field activities are presented in Section 3.

The field investigation activities conducted at Springfield ANGB included reconnaissance soil organic vapor (SOV) surveys, sediment sampling, geotechnical sampling and analysis, onsite gas chromatography (GC) analysis, piezometer installation, soil and groundwater sampling, monitoring well drilling and installation, and topographical surveying. Onsite SOV surveys were conducted by Tracer Research Corporation of Tucson, Arizona. Onsite GC analyses were performed by Plains Environmental Services of Salina, Kansas. Drilling and well installation services were provided by Environmental Exploration, Inc., of Stockbridge, Georgia. Geotechnical analyses were completed by Chattahoochee Geotechnical Consultants of Birmingham, Alabama. Land surveying services were provided by Kramer & Associates of Eaton, Ohio. Analytical services for soil and water chemistry were provided by Weyerhaeuser Laboratories of Seattle, Washington. Prior to initiating the field program, sample and boring locations were staked by Springfield ANGB and SAIC personnel and utilities were cleared by Springfield ANGB and public utility personnel. Field support, including site access and provision for heavy equipment for field operations and/or drum handling, was provided by Springfield ANGB personnel.

2.1 FIELD ACTIVITY SUMMARY

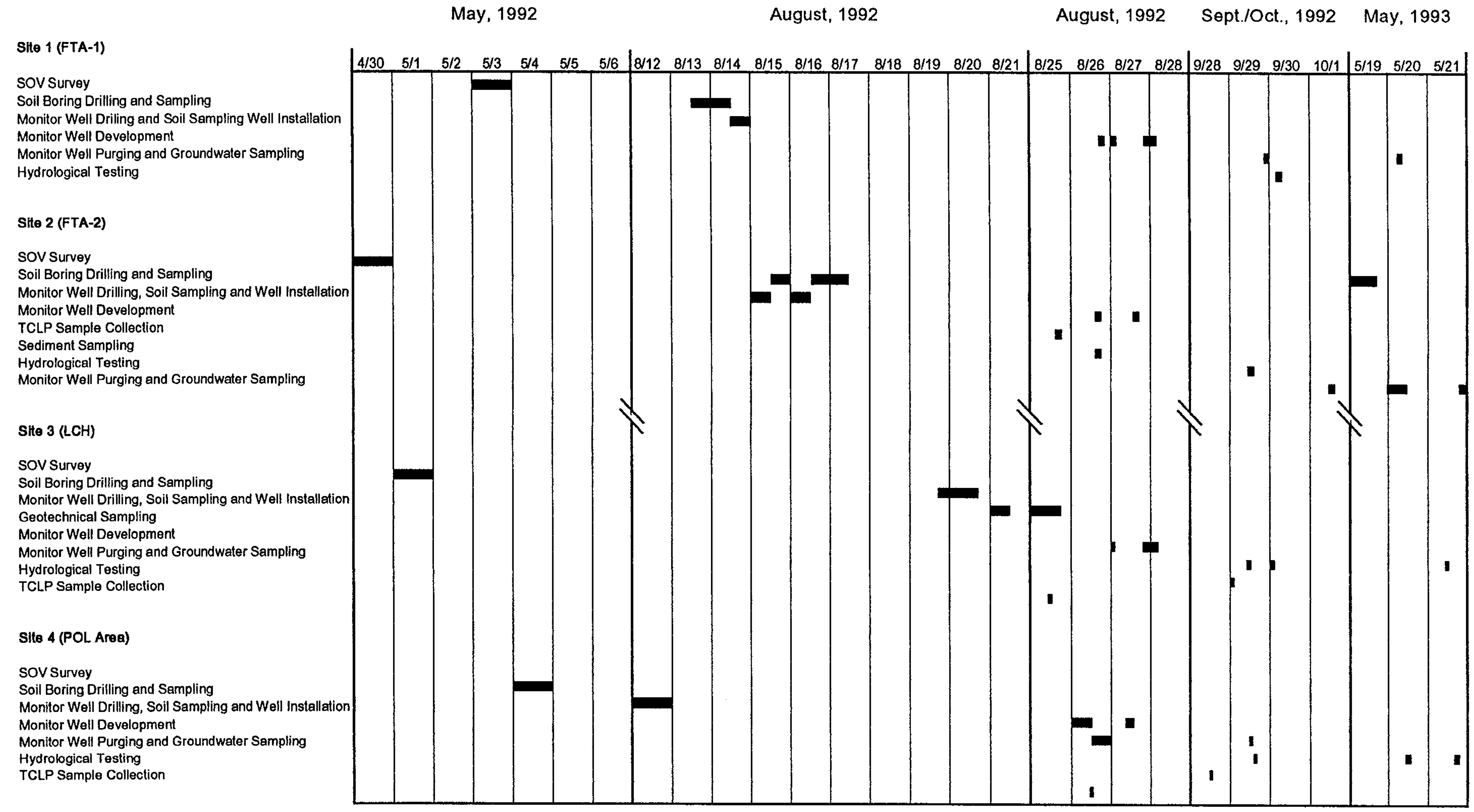
Field activities for the Springfield ANGB SI were conducted between April 1992 and May 1993 to meet the objectives outlined in Section 1.2. Field activities consisted of three phases. The initial effort conducted in May 1992 involved the SOV survey sampling, piezometer drilling and installation, and geotechnical and sediment sampling. The second phase of field activities included soil boring drilling and sampling; monitoring well drilling, installation, development, purging, sampling, and testing; additional piezometer installation; and sediment, toxicity characteristics leaching procedure (TCLP), and geotechnical sampling. The final phase of field activities incorporated soil boring drilling and sampling; monitoring well drilling, installation, development, purging, and sampling; and sediment sampling. The schedule of field activities is provided in Figure 2-1 and the activities completed at each site are compared to the proposed activities in Table 2-1. Figure 2-2 presents piezometer, monitoring well, soil boring, and sediment sample locations.

2.1.1 Deviation from Planned Activities

Prior to the initiation of field activities, meetings were held on December 16 and 17, 1991, at Springfield ANGB to discuss the field activities scheduled for the facility. This meeting was attended by representatives of the Air National Guard Readiness Center (ANGRC), Ohio ANG, the Hazardous Waste Remedial Actions Programs (HAZWRAP), and SAIC. Decisions were made by those in attendance to amend aspects of the proposed work plan to reflect additional requirements that took place since the initiation of the work plan. Changes to the sampling and analysis plan for the sites under investigation included:

- The laboratory analytical method used to determine total petroleum hydrocarbons (TPH) for soil and groundwater samples was changed from Methods SW 3550/E418.1 for soil samples and E418.1 for groundwater samples to California Method 8015 for soil and groundwater samples.
- If no volatile organic compound (VOC) contamination was detected in the soils by laboratory analysis and no contamination was identified by TCLP analysis, soil cuttings from monitoring wells, soil borings, and piezometers could be disposed of by spreading them onsite in an area determined by the Base. This allows for more economical disposal of the investigation-derived wastes (IDW).

Although activities conducted under the SI were extensively planned and agreed to by personnel from HAZWRAP and ANGRC, initial plans were modified when data gaps were identified. Table 2-1 compares the proposed SI activities with the activities that were actually conducted. These deviations served to maintain the SI data quality objectives (DQOs) and are



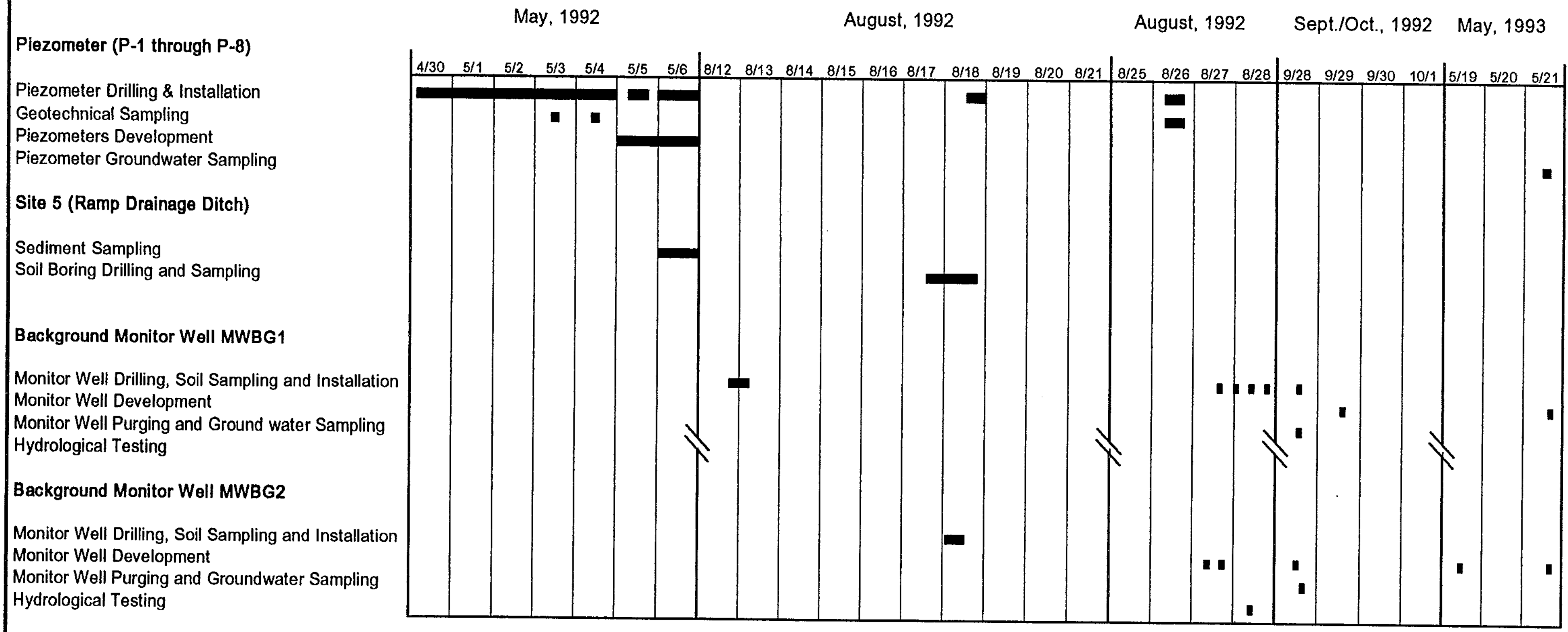
\\ - Break in field investigation activities

SAIC

Chronological Summary of Site Investigation Field Activities

Springfield ANGB, Springfield, Ohio

Figure: 2-1 Project: 01-0827-03-0200-005



// - Break in field investigation activities

Chronological Summary of Site Investigation Field Activities (Continued)

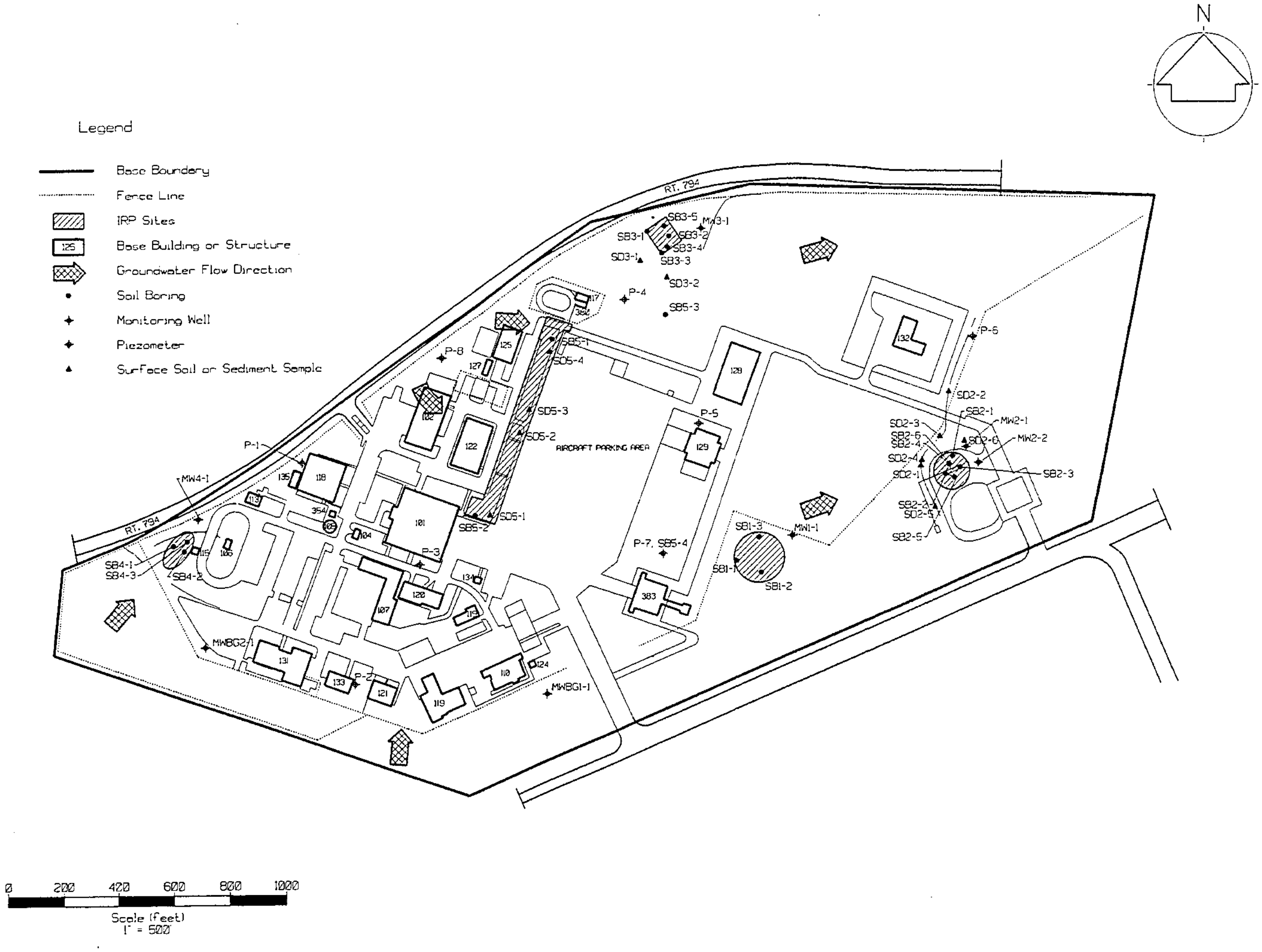
Springfield ANGB, Springfield, Ohio

Table 2-1. Summary of Proposed and Implemented Site Investigation Field Activities for 178th Tactical Fighter Group, Springfield ANGB, Springfield, Ohio

Site	Proposed Site Investigation Activities	Implemented Site Investigation Activities
Site 1 - Fire Training Area (FTA-1)	• 20 soil gas survey samples • 3 soil borings • 11 soil samples • 1 monitoring well • 1 hydrological test • 1 groundwater sample	• 20 soil gas survey samples • 3 soil borings • 10 soil samples, includes 1 replicate sample • 1 monitoring well • 1 hydrological test • 2 groundwater samples
Site 2 -Fire Training Area (FTA-2)	• 20 soil gas survey samples • 4 soil borings • 14 soil samples • 1 monitoring well • 2 surface soil/sediment samples • 1 groundwater sample • 1 hydrological test	• 20 soil gas survey samples • 6 soil borings • 16 soil samples, includes 2 replicate samples • 2 monitoring wells • 7 sediment samples, includes 1 replicate sample • 3 groundwater samples • 1 hydrological test
Site 3 - Leach Field and Outfall (LCH-3)	• 30 soil gas survey samples • 5 soil borings • 15 soil samples • 2 monitoring wells • 1 hydrological test • 2 groundwater samples	• 24 soil gas survey samples • 5 soil borings • 15 soil samples, includes 1 replicate sample • 1 monitoring well • 1 geotechnical analysis (shelby tube) • 1 hydrological test • 3 groundwater samples, includes 1 replicate sample

Table 2-1. Summary of Proposed and Performed Site Investigation Field Activities, for 178th Tactical Fighter Group, Springfield ANGB, Springfield, Ohio (continued)

Site	Proposed Site Investigation Activities	Implemented Site Investigation Activities
Site 4 - POL Site (POL)	• 20 soil gas survey samples • 3 soil borings • 9 soil samples • 1 monitoring well • 1 hydrological test • 1 groundwater sample	• 22 soil gas survey samples • 3 soil borings • 11 soil samples, includes 1 replicate sample • 1 monitoring well • 1 hydrological test • 2 groundwater samples
Site 5 - Ramp Drainage Ditch (RDD)	• 5 sediment samples • 3 surface water samples (if ditch contained water) • 5 soil samples	• 6 sediment samples, includes 1 replicate sample • 4 soil borings • 9 soil samples, includes 1 replicate sample
Nonsite-Specific Activities Basewide and Background	• 2 monitoring wells • 2 soil borings • 4 soil samples • 2 groundwater samples • 2 hydrological tests • 6 piezometers	• 2 monitoring wells • 4 soil borings (2 are ambient borings also included in Site 5 activities) • 5 soil samples, includes 1 replicate sample • 2 hydrologic tests • 7 groundwater samples • 8 piezometers



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Sample Location Map

Springfield ANGB, Springfield, Ohio

Figure: 2-2

Project: 01-0827-03-0200-005

discussed in the following subsections. In all cases, the deviations were discussed with and approved by HAZWRAP and ANGRC project personnel.

2.1.1.1 Piezometers

Initially, six piezometers were proposed for the SI at Springfield ANGB; however, due to the complexity of the shallow aquifer underlying the Base and the associated groundwater flow direction, a total of eight piezometers were required to adequately characterize the groundwater flow direction. This allowed for the accurate placement of site-specific monitoring wells downgradient from the sites.

2.1.1.2 Soil Borings

During the SI at Springfield ANGB, adjustments to the proposed number of soil borings were made at Site 2 - Fire Training Area No. 2 (FTA-2) and Site 5 - Ramp Drainage Ditch (RDD). These changes were the result of site-specific requirements and field conditions associated with the sites.

At Site 2 - FTA-2, the SOV survey identified the specific area of contamination associated with the fire training activities. Three soil borings were drilled during the initial phase of the field investigation (one less than the four proposed); however, after identification of data gaps (e.g., vertical extent of contamination), three additional borings were drilled to further characterize the extent of contamination.

Following identification of surface sediment contamination at Site 5 - RDD during initial field activities, two soil borings were added to determine the vertical extent of contaminants detected in sediment. Two other soil borings were added to assess ambient soil contaminants associated with routine Base operations in the vicinity of Site 5.

2.1.1.3 Monitoring Wells

At Site 3 - Leach Field (LCH), two monitoring wells were initially proposed to determine the presence of contamination associated with the leach field. However, because the location of the leach field and direction of groundwater flow were certain, only one well was required to monitor downgradient conditions.

2.2 GEOLOGIC AND HYDROGEOLOGIC INVESTIGATION PROCEDURES

At the beginning of the SI, limited information and data were available concerning the geologic units underlying the Base and the hydraulic characteristics of these units. The SI activities were planned so that a detailed description of the Base and site-specific geologic and hydrogeologic information would be obtained. The activities that were conducted included:

- Collecting soil samples from soil borings, which provided geologic descriptions of the Base lithology
- Installing piezometers and monitoring wells, which provided static water level measurements to determine groundwater flow direction and enabled the testing of aquifer characteristics
- Conducting geotechnical sampling and analysis of the aquifer and soil column material to enable accurate selection of sand pack material and well screen sizes.

The techniques and procedures used during the SI are described below. The results and interpretations are provided in Section 3.

2.2.1 Piezometer Installation and Static Groundwater Measurements

Six piezometers were installed between April 30 and May 4, 1992, and two additional piezometers were installed in late August 1992 at the locations shown in Figure 2-2. Piezometer construction consisted of a 10- or 15-foot long, 2-inch inside diameter (I.D.), polyvinyl chloride (PVC) screen coupled to a 2-inch I.D., Schedule 40 PVC riser pipe.

At the request of Springfield ANGB, all piezometers were installed with flush mounts. For flush mount completion, the riser was cut off to the appropriate depth before installing the piezometer in the borehole, and a protective casing and vault with a manhole type cover was set around the riser pipe in a sloped concrete pad (2 by 2 feet). All concrete pads at the Base extended below the frost line and stamped steel identification tags were embedded in the pad of each piezometer. All piezometers were secured with locking, keyed-alike caps. Details of the flush mount piezometer construction are provided in Figure 2-3.

Once the concrete pads had hardened, the piezometers were developed by pumping or bailing until the produced water was of acceptable clarity and specific conductance. As-built diagrams of the piezometers are contained in Appendix A, and surveyed locations and elevations are presented in Appendix E.

Water levels were measured several times during the field investigation. The water level measurements were used to determine groundwater flow direction and to help calculate groundwater flow rate. Water levels were measured with an electric water level indicator, which emits an audible tone when the water surface is contacted. Measurements were made at a surveyed notch on top of the piezometer or monitoring well casing and were reported to the nearest 0.1 foot. Water levels were referenced to the mean sea level (msl) elevation.

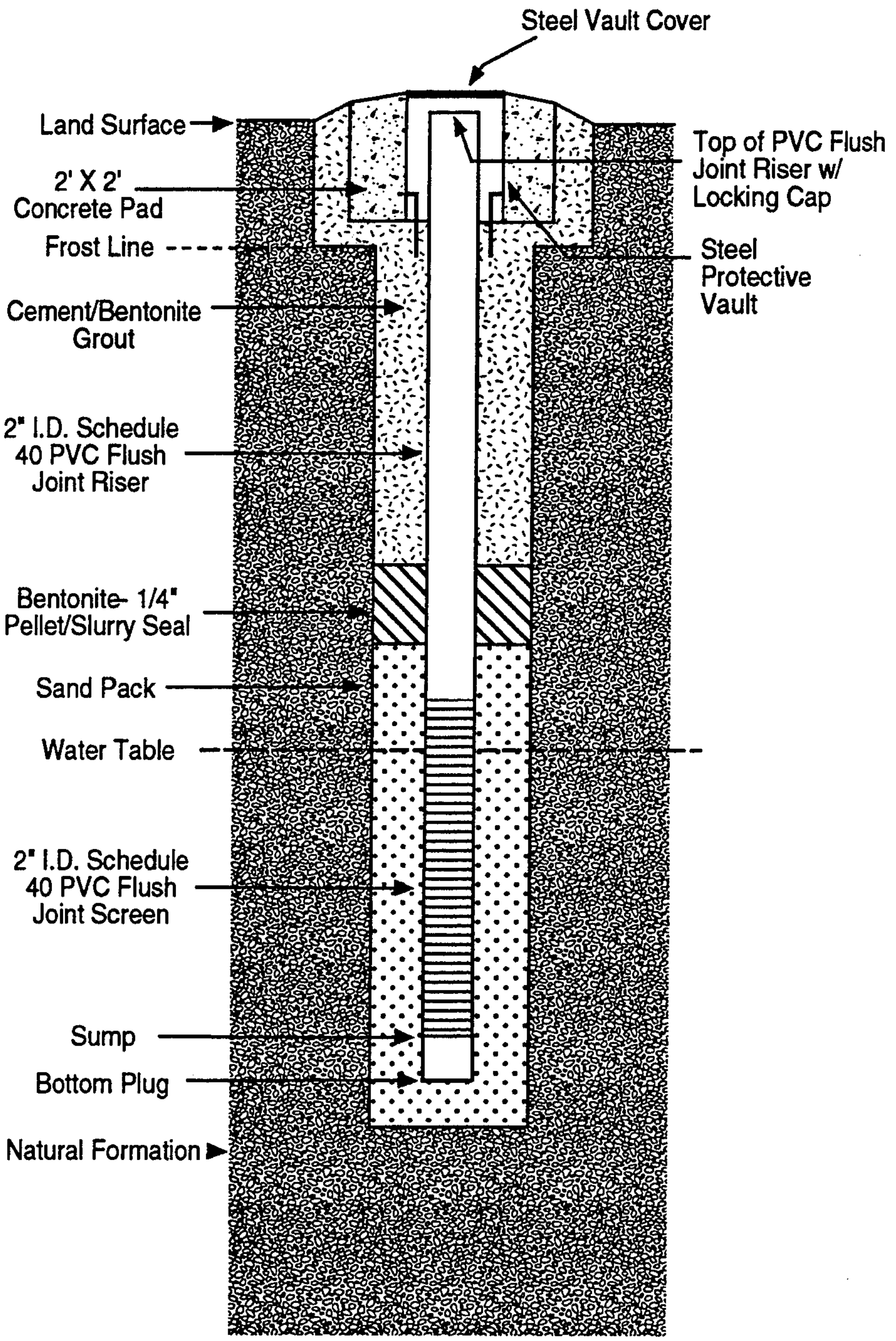
2.2.2 Lithologic Sampling

In addition to soil sampling for chemical analysis, soil samples were collected from each boring for lithologic descriptions. At least three borings were completed at each site and samples were collected continuously from the land surface to the top of the saturated interval. In cases where soil borings were converted to piezometers and monitoring wells, lithologic samples were collected at the discretion of the rig geologist. These data were used to develop geologic logs for the detailed description of the soil column. The soil boring logs are presented in Appendix A.

2.2.3 Geotechnical Sampling and Analysis

Six soil samples were collected using Shelby tubes during the field activities to obtain analytical data on the physical characteristics of the surficial aquifer material and the suspected confining layer overlying the aquifer, and to confirm the field geologic descriptions. Geotechnical analyses, including grain size, permeability, consolidation, Atterberg limits, and moisture content, were conducted on samples from soil borings P-2, P-3, P-4, P-8, and MW3-1 to determine the appropriate sand pack and screen slot size. Geotechnical test results are

Flush Mount Completion



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Piezometer Detail

Springfield ANGB
Springfield, Ohio

Figure: 2-3	Project: 1-827-03-200-005

presented in Appendix J. These data also were used to confirm the geologic descriptions of the material encountered during the drilling of the remaining soil borings and monitoring wells.

2.2.4 Hydrogeologic Testing

Aquifer permeability tests were conducted on the six monitoring wells installed at Springfield ANGB. These permeability tests involved the removal (rising head test) of a volume of water at a well and the subsequent recording of the water level response in the well as it recovered to equilibrium. The permeability tests were conducted to determine the hydraulic conductivity of the natural formations and materials surrounding each well following standard operating procedure (SOP) FP 7-1. A detailed report discussing the methodology, theories, and results associated with the tests is presented in Appendix B.

Water levels measured in piezometers and monitoring wells were used to determine the water table gradient. This information, in addition to an estimated aquifer hydraulic conductivity, was used to estimate the direction and velocity of potential contaminant migration in the groundwater.

2.3 FIELD SCREENING PROCEDURES

Before any site activities were undertaken, an initial site survey was conducted. Each site was visually inspected to identify surficial features that could add further insight concerning the history and conditions of the site. In addition, aerial photographs and engineering drawings that included the sites were reviewed to confirm site locations. The site surveys were conducted to provide information on contamination release, areal delineation of the site, or cultural features that might interfere with the planned investigations. Field screening activities used to evaluate the presence of potential contamination included SOV surveys, HNu monitoring, and onsite GC analysis. These activities are discussed in the following subsections.

2.3.1 Soil Organic Vapor Survey

SOV surveys were conducted at four sites between April 30 and May 5, 1992: Site 1 - Fire Training Area No. 1 (FTA-1), Site 2 - Fire Training Area No. 2 (FTA-2), Site 3 - Leach

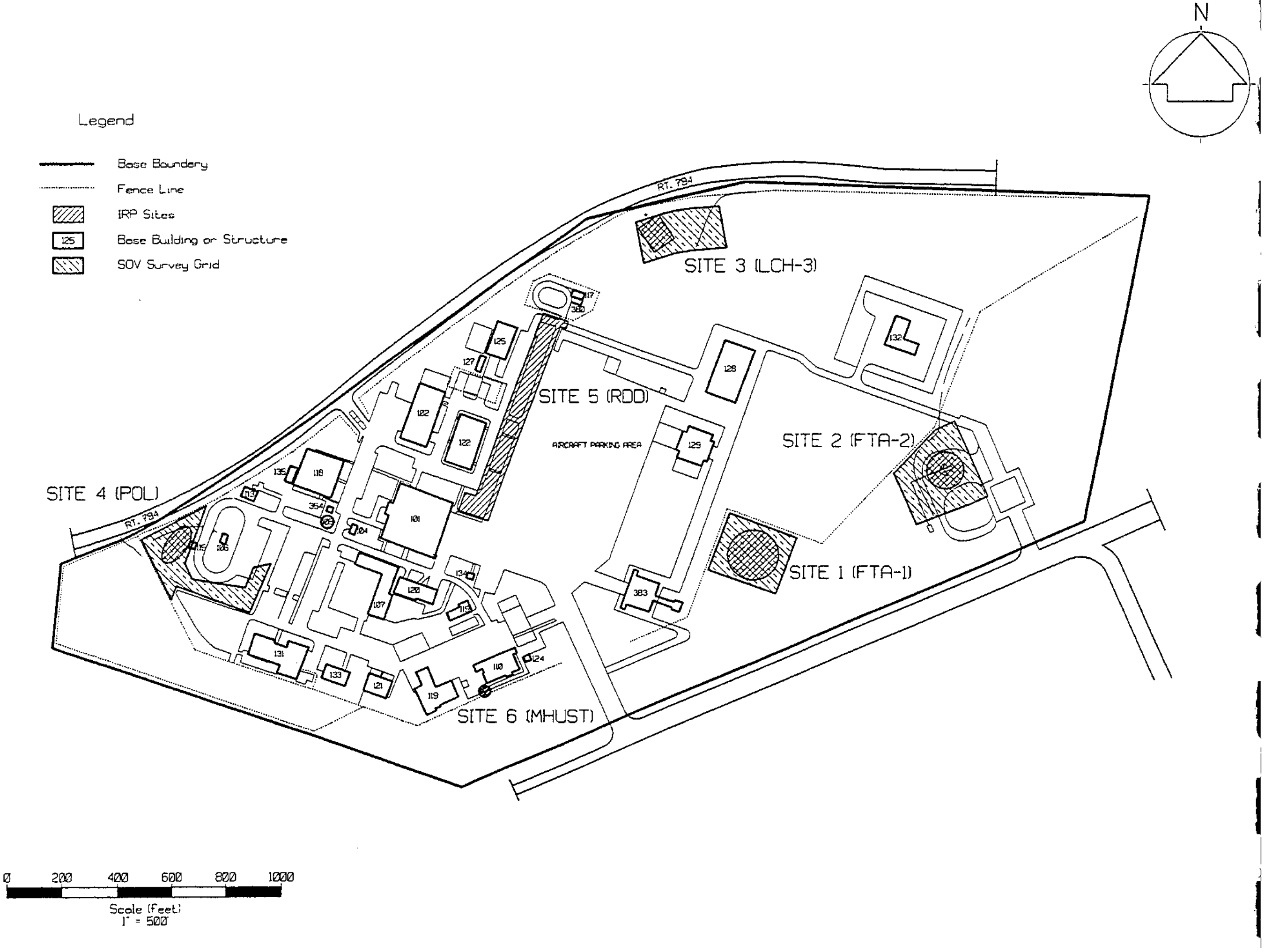
Field (LCH), and Site 4 - POL Storage Area (POL). This semi-intrusive technique was used to determine the presence of VOCs in the soil atmosphere, which is a function of the concentration of VOCs in groundwater or subsoil. The SOV survey data helped to determine the severity, migration direction, and extent of volatile organic contamination. Isoconcentration plots for each identified compound were generated and used to finalize the locations of soil borings, piezometers, and monitoring wells.

The SOV survey was conducted by inserting metal probes into the ground at selected locations, withdrawing a volume of soil gas, and analyzing the samples for VOCs. The measurement locations were points of a grid system that were established before the actual survey. When the data obtained from within the initially identified survey area indicated that the extent of detectable volatile contaminants had not yet been reached, the survey area was expanded and samples were collected until volatile contaminants were no longer detected. The locations of the SOV surveys are shown in Figure 2-4.

The results of the SOV survey are discussed in Section 3, and raw data levels are provided in Appendix C. SAIC field personnel followed SOP FP 6-1 to perform the SOV surveys. The Tracer Research Corporation report that summarizes the data and results of the SOV surveys is presented in Appendix C.

2.3.2 HNu Field Screening

During borehole drilling and sampling, a representative portion of material from each split spoon sample was placed in a lithologic sample jar for head space analysis of VOCs. The analysis was conducted by placing the soil sample in the jar, securing it with a lid, and then allowing the soil and atmosphere to equilibrate and volatiles to dissipate from the sample. To the extent possible, the time before the sample was measured was standardized. After the sample was allowed to equilibrate, the HNu probe was inserted into the jar to measure the level of volatile organics in the head space of the jar. The results were recorded in the site geologist's logbook and on the boring log.



Soil Organic Vapor (SOV) Survey Locations

Springfield ANGB, Springfield, Ohio

Figure: 2-4	Project: 01-0827-03-0200-005

2.3.3 Onsite Gas Chromatography

Laboratory-grade GC equipment was used onsite during the drilling program to screen soil and groundwater samples, decontamination water, and drill cuttings. Heated headspace analyses were performed for both water and soil samples. This analysis consisted of placing approximately 20 mL of water or 2 grams of soil in a 40-mL vial. Each vial was then capped tightly and heated at 60°C for 30 minutes. This technique drives the volatile components from the sample into the headspace of the vial. A sample of the headspace was then directly injected into the GC for analysis.

The onsite GC was used to select which samples should be sent for detailed laboratory analysis. The inherent shortcomings of onsite GC analysis (i.e., shorter sample run time, lack of second column confirmation, and no temperature programming) are such that the results can only be interpreted as qualitative. At a minimum, two soil samples were collected from each boring: one from the upper 2 feet and a second sample from just above the water table. However, in most instances, GC analyses were conducted on each sample obtained during the continuous soil sampling associated with the soil borings. Optional samples also were collected from between the surface and the water table if visible contamination was detected, the sample had a strong odor, or the HNu detected VOCs or the onsite GC indicated potential contamination.

In addition, the GC was used onsite to screen samples of cuttings generated during piezometer and monitoring well installation. This screening was used to determine the proper disposition of the drill cuttings and identify any contamination that could require immediate attention. Based on the compounds that reportedly were used at the sites, chemical standards were available to quantify the concentration of the following compounds in the water and soil samples: benzene, toluene, xylene, ethylbenzene, 1,1,1-trichloroethane, trichloroethene, tetrachloroethene, and carbon tetrachloride. Onsite GC sample results are presented in Appendix D.

2.4 FIELD DATA COLLECTION PROCEDURES

The procedures used to make a quantitative determination of the presence of contamination and a qualitative determination of the extent of contamination at each site being investigated are discussed below. These determinations required careful sampling of subsurface media and offsite laboratory analyses for the chemical parameters that were suspected to occur in the soil and groundwater at a site. The SI activities included borehole drilling and sampling, groundwater sampling of monitoring wells, and surface sediment sampling. The objective of the investigation was to determine if contamination is present in the soils and surficial aquifer at the sites. The techniques and procedures are described in this section; the results and interpretations are provided in Section 3. The detailed procedures followed for each field activity are contained in the SOPs presented in Appendix I.

2.4.1 Soil Borings

Soil borings were drilled at all of the sites studied under this SI. The soil boring program was conducted to obtain subsurface soil samples for geologic descriptions and chemical analysis. The specific details of each soil boring are listed in Table 2-2. All soil sampling procedures were in accordance with SOP FP 6-3. These methods and procedures also were in accordance with the appropriate HAZWRAP guidance and consistent with the SI Work Plan (SAIC 1992).

The soil borings were located based on the history of the site and the results of the SOV surveys. Boring locations are shown in Figure 2-2. Samples analyzed from the borings provided data that helped determine the presence of contamination and identified the compounds of concern.

The boreholes for soil sampling and monitoring well and piezometer installation were drilled using a nominal 4.25-inch I.D., continuous flight, hollow-stem auger. Hollow-stem augering combines rotational and downhole pressure to advance the auger flights. Samples were collected by driving or pushing sampling devices inside the auger flights. SAIC collected subsurface soil samples during soil boring activities at all five sites investigated during the SI activities.

Table 2-2. Soil Boring Specifications,
178th Tactical Fighter Group, Springfield ANGB, Springfield, Ohio

Site/Location	Soil Boring (I.D.)	Date of Soil Boring Completion	Soil Boring Diameter (inches)	Groundwater Encountered during Drilling (a)	Static Groundwater Level (BLS)	Total Depth Drilled Completion Depth (BLS)
Site 1 - Fire Training Area (FTA-1)	SB1-1	8/13/92	8.0	20.0	---	21.0
	SB1-2	8/13/92	8.0	15.0	---	16.0
	SB1-3	8/14/93	8.0	21.0	---	22.5
Site 2 - Fire Training Area (FTA-2)	SB2-1	8/15/92	8.0	29.0	---	32.0
	SB2-2	8/16/92	8.0	34.0	---	35.0
	SB2-3	8/17/92	8.0	32.0	---	33.5
	SB2-4	5/19/93	8.0	N/A	N/A	23.5
	SB2-5	5/19/93	8.0	N/A	N/A	27.0
	SB2-6	5/20/93	8.0	N/A	N/A	17.5
Site 3 - Leach Field and Outfall	SB3-1	8/20/92	8.0	15.0	---	16.0
	SB3-2	8/20/92	8.0	13.0	---	14.0
	SB3-3	8/20/92	8.0	15.0	---	16.5
	SB3-4	5/19/93	8.0	N/A	N/A	14.0
	SB3-5	5/19/93	8.0	N/A	N/A	16.0
Site 4 - POL Area	SB4-1	8/12/92	8.0	3.0	3.04	10.0
	SB4-2	8/12/92	8.0	3.0	2.85	8.5
	SB4-3	8/12/92	8.0	4.0	3.72	8.5
Site 5 - Ramp Drainage Ditch	SB5-1	8/17/92	8.0	26.0	---	2.7
	SB5-2	8/18/92	8.0	32.0	---	32.5
	SB5-3	8/18/92	8.0	27.0	24.0	28.5
	SB5-4	8/18/92	8.0	29.0	---	34.0
Background	Wells were installed in background soil borings MWBG1-1 and MWBG2-1; these specifications are shown in Table 2-3.					

(a) Measurement to the nearest foot below land surface

--- Not Recorded

BLS Below land surface

NA Not Applicable

Soil samples were collected from the land surface, through the unsaturated interval, to the water table from all soil borings that were completed as piezometers or monitoring wells. In some instances, sample frequency was increased because the geologist deemed it necessary to develop a complete geologic log. Samples also were obtained from the initial split spoon sample and from the interface of the saturated and unsaturated interval.

Soil borings that were not completed as piezometers or monitoring wells were abandoned in compliance with the State of Ohio regulations and SOP FP 5-7. Each soil boring or monitoring well that was abandoned was filled with a cement/bentonite grout mixture and allowed to dry overnight. After the grout had dried, surface settlement was filled with additional grout and the boring was inspected to ensure acceptable abandonment. The detailed borehole abandonment procedures followed during this SI are presented in SOP FP 5-7 (Appendix I).

2.4.2 Monitoring Well Drilling and Installation

Seven monitoring wells were drilled and installed during this SI to assess groundwater quality upgradient and downgradient from the SI sites. The monitoring well drilling and installation activities are summarized in Table 2-3. Monitoring well locations are shown in Figure 2-2.

The casing, screen, and end cap materials consisted of Schedule 40 PVC. Specific placement of the screens and sandpack were determined in the field based on information obtained during drilling. Screen slot and sand pack size were selected based on sieve analysis of formation samples collected during the drilling and installation of the piezometers and monitoring wells. The depth of the screened interval was positioned to intersect the water table to allow any floating contaminants to enter the piezometers and monitoring wells.

The monitoring well borings were drilled with a truck-mounted rotary rig (Mobile B-57) equipped for hollow-stem augering. The boreholes for monitoring well installation were advanced at least 7 feet below the water table. After the proper completion depth was reached, the monitoring well was assembled and installed in the boring through the hollow stem of the augers. If the formation was sufficiently competent to stay open, the augers were withdrawn

Table 2-3. Monitoring Well and Piezometer Specification, 178th Tactical Fighter Group, Springfield, ANGB, Springfield, Ohio

Site Number/ Site Name	Well Number	Total Depth Drilled (BLS)	Borehole Diameter (indices)	Completion Depth (BLS)	Top of Casing Elevation (MSL)	Surface Pad Elevation (MSL)	Top of Sand Pack Elevation (MSL)	Top of Screen Elevation (MSL)	Bottom of Screen Elevation (MSL)	Water Levels (MSL)
Background	MWBG1-1	20.0	8	20.0	1051.47	1051.97		1043.47	1033.47	1042.14
	MWBG2-1	19.5	8	19.5	1046.36	1046.86	1043.1	1042.46	1027.46	1041.28
Site 1/FTA-1	MW1-1	20.0	8	20.0	1049.66	1050.16	1040.2	1037.96	1027.96	1034.99
Site 2/FTA-2	MW2-1	29.2	8	29.24	1045.01	1045.60	1028.6	1026.29	1016.29	1019.51
MW2-2		29.5	8	29.5	1046.50	1047.00	1029.3	1027.00	1017.00	1022.90[a]
Site 3/ Leach Field	MW3-1	16.0	8	16.0	1037.92	1038.42	1035.1	1033.22	1023.22	1030.92
Site 4/ POL Area	MW4-1	14.5	8	14.52	1040.68	1041.18	1037.9	1036.69	1026.67	1038.10
Background	P-1	32.0	8	32.0	1046.90	1046.30	1036.3	1034.70	1024.70	1036.99
	P-2	18.0	8	18.0	1051.20	1051.43	1044.4	1043.50	1033.50	1049.78
	P-3	37.0	8	37.0	1048.98	1049.28	1027.3	1023.78	1013.78	1031.98
	P-4	18.5	8	18.5	1040.20	1040.38	1036.4	1034.30	1024.30	1035.8
	P-5	25.0	8	25.0	1047.07	1047.27	1042.3	1035.07	1025.07	1039.24
	P-6	18.0	8	18.0	1041.13	1041.55	1025.6	1021.13	1011.13	1019.13
	P-7	32.5	8	32.5	1050.69	1050.89	1039.9	1036.19	1026.19	1036.57
	P-8	29.0	8	29.0	1044.88	1045.00	1037.0	1037.48	1022.48	1040.46

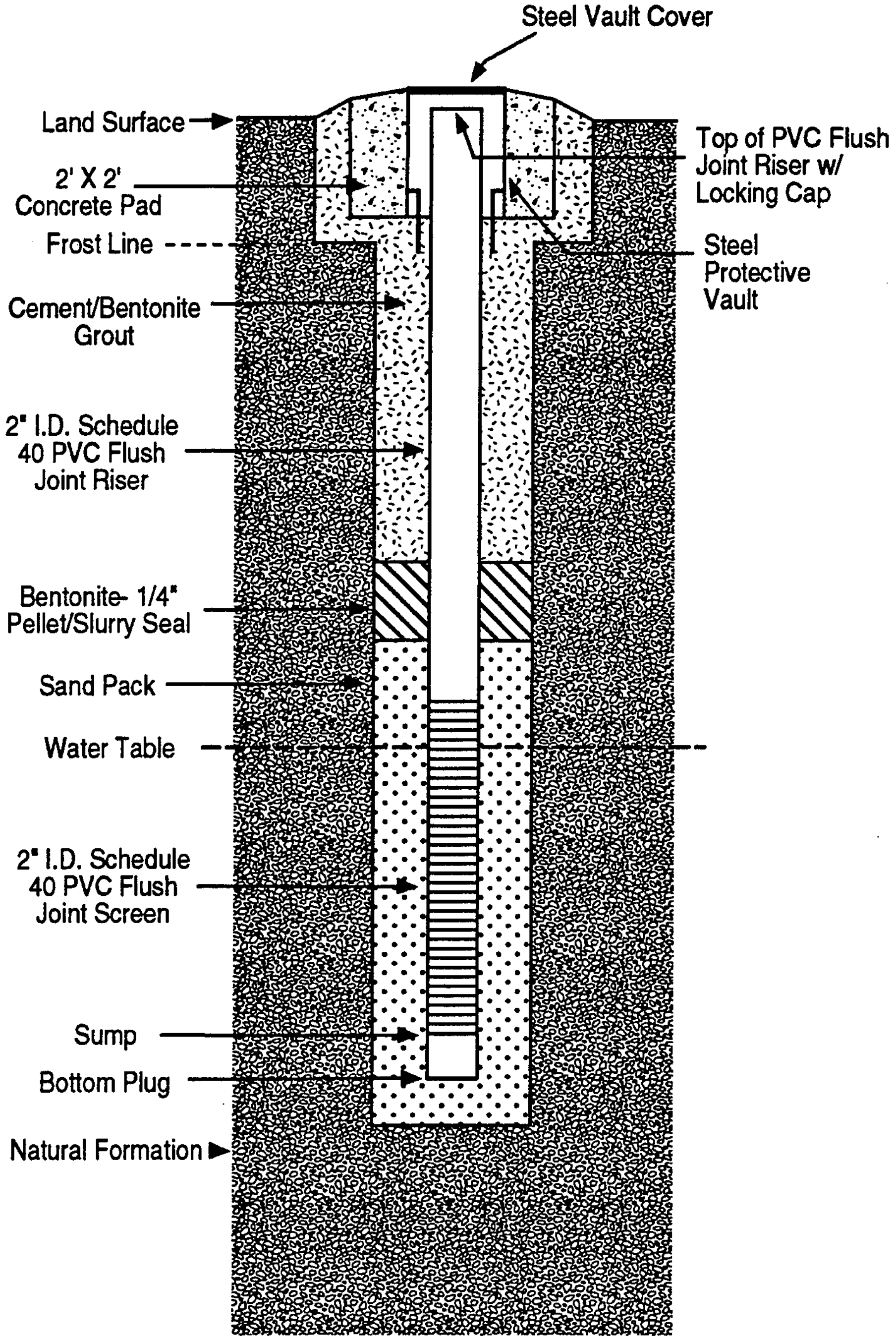
[a] Water level measurement taken May 21, 1993.

and the well was installed in the open borehole. The sand pack was installed with the augers in place by pouring the sand between the annulus of the well casing and the augers, while the augers were slowly withdrawn from the boring. This procedure allowed the sand to remain partially within the lead auger and enabled installing a uniform sand pack. When the augers were removed from the boreholes before well installation, the sand pack was installed using a tremie pipe. The tremie pipe was placed near the bottom of the borehole and sand and water were poured simultaneously into the tremie pipe. The pipe was incrementally removed as the sand pack was installed. In both cases, the sand pack was placed in the borehole to extend from the bottom of the borehole to 2 feet above the screen. Measurements (soundings) were made and recorded during emplacement of the sand pack to ensure the proper installation. The quantity of water used to tremie the sand was recorded so the proper volume of water could be removed during well development.

After installation of the sand pack at each monitoring well, a 2-foot thick seal of bentonite pellets was placed on top of the sand to prevent grout flow into the screened interval. Because of the shallow water table at some locations, it was necessary to reduce the thickness of the bentonite pellet seal to less than 2 feet. Once the bentonite seal was in place, pellets were allowed to hydrate for at least 30 minutes before a cement/bentonite grout was tremied in above the seal. The grout was mixed at one 94-pound bag of Type II cement and 5 pounds of bentonite per 8 gallons of water. The grout extended from the top of the pellet seal to land surface. An 8-inch I.D. protective casing was placed in the cement/bentonite grout and allowed to set over a 24-hour period. After this period, grout was added to compensate for settling.

Surface completion consisted of installing a square reinforced concrete pad around each well surface and aligning the steel protective vault and manhole cover flush with the land surface. All concrete pads were sloped to drain away from the well. The surface completion of the monitoring wells included locking caps to prevent unauthorized entry fitted with keyed-alike locks. Figure 2-5 illustrates the typical construction of the monitoring wells. A well construction diagram for each well is included in Appendix A.

Flush Mount Completion



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Monitoring Well Detail

Springfield ANGB, Springfield, Ohio

Figure: 2-5	Project: 1-827-03-200-005

All activities were documented in the site geologist's logbook and on the boring or well completion forms. These documents are part of the permanent project file.

2.4.3 Specific Media Sampling

To determine lithology and the type and concentration of contaminants at the sites, soil and groundwater samples were collected and analyzed for a variety of compounds. Soil samples were collected from boreholes during drilling and groundwater samples were collected from monitoring wells. The collection, packaging, and shipment of samples were conducted in accordance with the SOPs referenced in the SI Work Plan and Quality Assurance Project Plan (QAPP) (SAIC 1992). The sampling methods for each of the media sampled are described in the following subsections.

2.4.3.1 Soil Sampling

Subsurface soil sampling refers to samples collected during soil boring and well drilling. Two and one-half and 3-inch outside diameter (O.D.) split spoons equipped with 3- and 6-inch brass and 3-inch stainless steel sleeves were used to collect samples necessary for chemical analysis. A standard 2-inch split spoon sampler was used to collect samples for lithologic descriptions. Sampling was conducted continuously throughout the unsaturated interval of each soil boring not converted to a monitoring well or piezometer.

The California ring samplers were lined with metal sleeves. As the sampler was driven into the ground, the sample material filled the sleeves. Both brass and stainless steel rings were used in the ring samplers to allow sampling for both organic and inorganic analyses. Samples collected in brass sleeves were used for the organic analytical fraction, and samples collected in stainless steel sleeves were used for metals analysis. After the sampler was opened, the rings were separated using a stainless steel knife and a separate sample was obtained for onsite analysis, labeled, and presented to the GC analyst. All sleeved samples were immediately sealed, labeled, and cooled to 4°C. After all soil samples from a given borehole had been obtained and the onsite GC analysis for each sample had been completed, the rig geologist and site manager determined which samples would be submitted for laboratory analysis based on the following: at a minimum, two soil samples were collected from each boring; one from the upper 2 feet of the lithologic section and a second from the soil-water interface. An optional third sample was selected based on the following criteria:

- If high concentrations of volatile contaminants were detected from the onsite analysis, the sample with the highest values were sent to the laboratory for analysis
- If obvious discoloration or other visible signs of contamination were evident, a sample from that interval also was sent to the laboratory for analysis
- If no visible signs of contamination were evident, a sample from the depth that corresponds to the subsoil zone that has the highest expected level of contamination was selected for laboratory analysis based on the type of release and the site history.

Because of decontamination requirements between samples, the rig was equipped with four complete split spoon samplers (two 2.5 inch and two 3 inch). In addition, the rig was equipped with a sufficient number of standard split spoons and Shelby tubes to collect any necessary samples for lithologic descriptions or geotechnical analysis. Standard Penetration Tests (SPTs) were conducted in accordance with American Society for Testing and Materials (ASTM) procedure D-1586 and undisturbed sampling (Shelby tube) in accordance with ASTM procedure D-1587. California-type ring-lined barrel sampling was conducted in accordance with ASTM procedure D-3550. Procedures for logging and describing soil samples are presented in SOP FP 7-3 (Appendix I).

Samples for detailed laboratory analysis were collected from 20 boreholes: 3 soil borings each at Sites 1, 2, 3, and 4; 4 soil borings at Site 5; and 4 borings that were converted to monitoring wells (i.e., MWBG-1, MWBG-2, MW3-1, and MW4-1). The borings were drilled to depths ranging between 14.5 and 37 feet below land surface (BLS). Drill cuttings and sampling waste were containerized and handled as discussed in Section 2.5.

2.4.3.2 Groundwater Sampling

Procedures for purging and sampling monitoring wells are described in detail in SOPs FP 5-5, FP 5-6, and FP 6-5, and summarized in the following subsections.

2.4.3.3 Purging

Before purging and sample collection, static water level measurements were taken in each well using an electric water level indicator. Depths to groundwater were used to calculate the volume of standing water in each well and to determine the volume of water to be purged from each well.

Before samples were collected from the monitoring wells, three to five casing volumes of water were purged from each well using a submersible pump, hand pump, or bailer. Wells and piezometers with very slow recharge rates were purged completely dry three times. Field measurements for temperature, pH, and specific conductivity were monitored during purging to ensure that these parameters had stabilized. Well purging ensured that a representative sample of the aquifer water (i.e., not stagnant well water) was collected.

Before well purging operations began, between wells, and after purging was completed, the pump and/or hose were washed with a laboratory-grade detergent (i.e., Liquinox®/Alconox®) and rinsed with potable water. A sample of the potable water sources used was screened for VOCs with an onsite GC.

2.4.3.4 Groundwater Sample Collection

Groundwater samples were collected from each monitoring well within 3 hours of purging. All samples were retrieved using a point-source, bottom-filling, Teflon® bailer and dispensed directly into an appropriate labeled and preserved sample bottle. The samples collected for metals analysis were not filtered onsite and laboratory analyses were for total concentrations. Samples were shipped directly to the laboratory for analysis. The QAPP identifies specific equipment types and details quality assurance/quality control (QA/QC) for sample collection.

2.4.3.5 Sediment Sampling

Surface soil and sediment sampling was conducted to provide data on the presence or absence of contamination in the surface soil. Surface sediment samples were collected at Site 2 -

Fire Training Area No. 2 (FTA-2) and Site 5 - Ramp Drainage Ditch (RDD) because records from the preliminary assessment (PA) indicated the potential for surface contamination at these locations. Surface sediment samples were collected from drainage water and ditches at Sites 2 and 5. These drainage structures displayed the potential to channel surface contamination to the surface water regime.

Surface soil and sediment samples were collected using stainless steel sampling equipment, following the procedures presented in SOP FP 6-2. Sediment sample locations are shown in Figure 2-2. The SI Work Plan (SAIC 1992a) indicated that surface water samples would be collected; however, no surface water was present during the sampling events.

2.4.4 Equipment Decontamination

Before, between, and after sampling activities at a site had been completed, all sampling equipment (e.g., split spoon samplers, California-type ring samplers, and bailers) was decontaminated according to the procedures presented in SOP FP 3-1. Field blanks were collected and submitted to the laboratory to provide baseline data on the water used to decontaminate equipment (i.e., ASTM Type II, high pressure liquid chromatography [HPLC], and deionized water). In addition, water samples from the water tank used in monitoring well and piezometer drilling or installation were collected for analysis.

Well purging equipment was decontaminated by washing with laboratory-grade detergent and rinsing with potable and ASTM Type II, HPLC, or deionized water. The decontaminated equipment was wrapped in aluminum foil, shiny side out, for transport to the site to prevent accidental contamination.

Between drilling locations, drilling equipment was cleaned at the decontamination area with a steam cleaner, laboratory-grade detergent (i.e., Liquinox®/Alconox®), and a potable water rinse. A decontamination pad was established at Site 2 - FTA-2 due to the close proximity of a fire hydrant, which was used as a potable water source. The decontamination pad was cleaned after each use and all decontamination-generated wastes were collected and stored pending disposal in accordance with approved procedures.

2.4.5 Surveying

Sample locations, including boreholes, wells, piezometers, and sediment sample points were surveyed during the SI. Surveys were subcontracted to Kramer & Associates, who are licensed in the State of Ohio. The surveys determined the horizontal and vertical location of the sample points and was referenced to msl. A foot-based coordinated system using ANGB control points was used to survey horizontal locations. The surveys were completed to a vertical accuracy of 0.01 foot and a horizontal accuracy of 0.1 foot. The horizontal coordinates and elevation data of the sample points are summarized in Appendix E.

To verify the location of Site 1 - FTA-1, surveyors located control points (such as buildings and railroad tracks) that have been undisturbed and unchanged throughout the period from when FTA-1 was in use (1957 to 1963) to the present. Using scaled aerial photographs showing Site 1 and the control points, SI sample points were located at the site of the former fire training area.

2.5 DISPOSAL OF INVESTIGATION-DERIVED WASTES

All wastes generated during the field work portion of the SI were accumulated in specific interim storage facilities, analyzed for hazardous characteristics when necessary, and disposed of in an approved manner. Materials, generated as a result of the SI program including drill cuttings, development and purge water, and decontamination water, are discussed below.

2.5.1 Drill Cuttings

Cuttings generated from drilling the soil borings, piezometers, and monitoring wells were screened with a photoionization detector (PID) and the onsite GC to determine the presence of VOCs. Drill cuttings and soil samples also were visually inspected by the rig geologist for evidence of contamination.

All soils were containerized in 55-gallon steel drums and retained at the site until the results of the onsite chemical analysis for any soil samples taken from the borehole were received. When these soil sampling results indicated that the cuttings might be contaminated, a composite sample was taken and analyzed for hazardous characteristics (TCLP analysis). Sampling the cuttings in each drum consisted of hand augering at three to four random locations continuously to the bottom of the drum. The samples from each site were then composited separately in 5-gallon buckets. A representative sample of this composite was placed in an appropriate container and sent to the laboratory for analysis.

If VOCs were not detected in the soil, the cuttings were spread onsite. Soils that exhibited VOC concentrations greater than nondetected (ND) were containerized to await laboratory analysis. TCLP results determined that the containerized soils from the SI are nonhazardous, and therefore, will be disposed of by the Defense Reutilization Management Office (DRMO). Otherwise, the Base will be responsible for the appropriate disposal of the IDW. Figures 2-6, 2-7, and 2-8 illustrate the procedures for handling and disposing of the IDW from the soil borings, piezometers, and monitoring wells, respectively. Table 2-4 presents TCLP results for the SI soil samples.

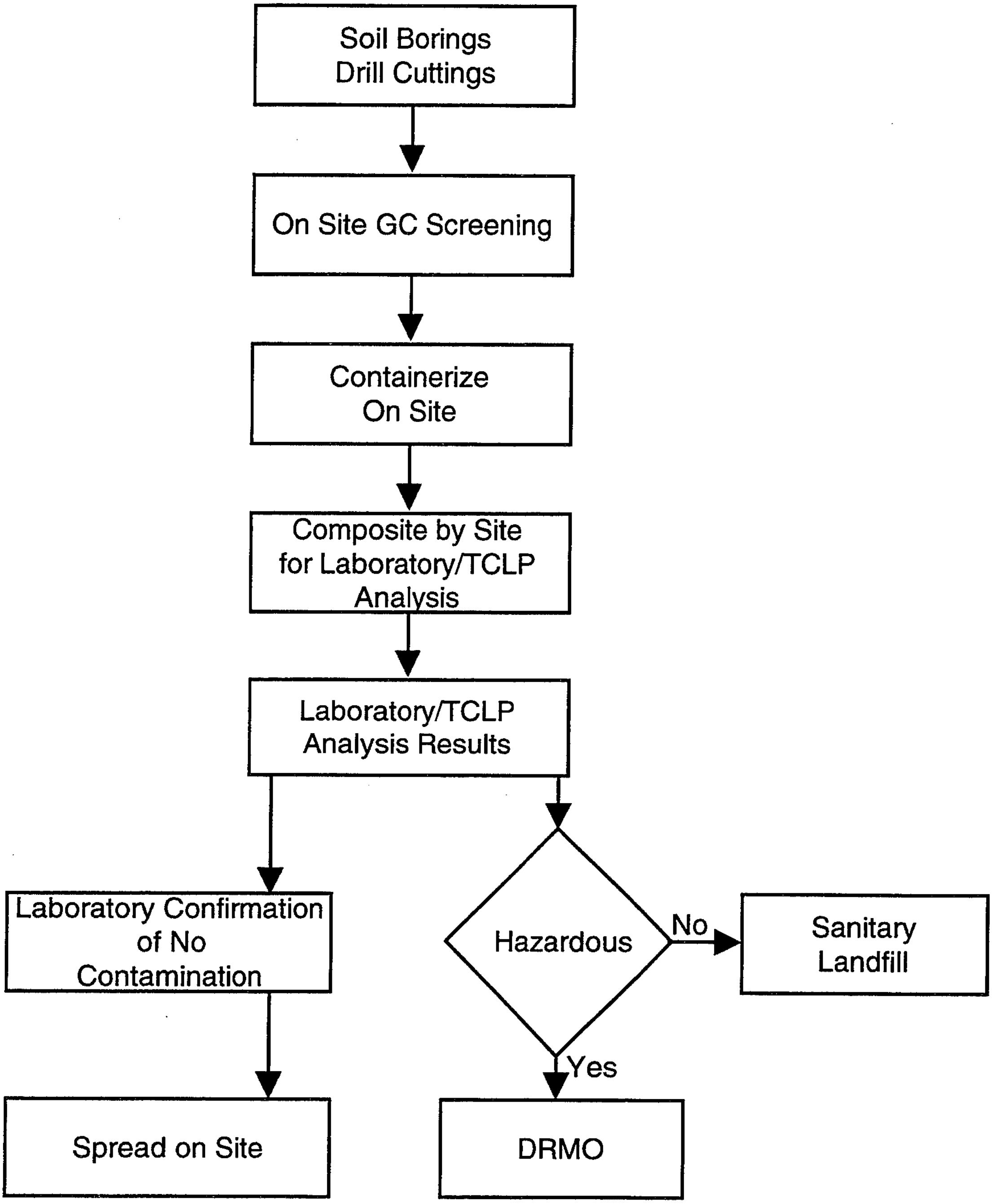
2.5.2 Development and Purge Water

The liquid wastes generated during the SI field activities were managed in compliance with the procedures detailed in Section 1.3.2 of the SI Work Plan (SAIC 1992a). These procedures are summarized below.

All development and purge waters were collected and stored in 55-gallon drums until onsite screening or laboratory results were reviewed for the presence of VOCs. Because neither onsite screening nor laboratory analyses showed the presence of VOC contamination, the water was disposed of in the Base sanitary sewer system.

2.5.3 Decontamination Wastes

All disposable clothing and other materials from decontamination activities were stored in 55-gallon drums, checked with an HNu, and visually inspected. Through screening with an HNu, all protective clothing was determined to be uncontaminated and was disposed of through the Base trash collection system.



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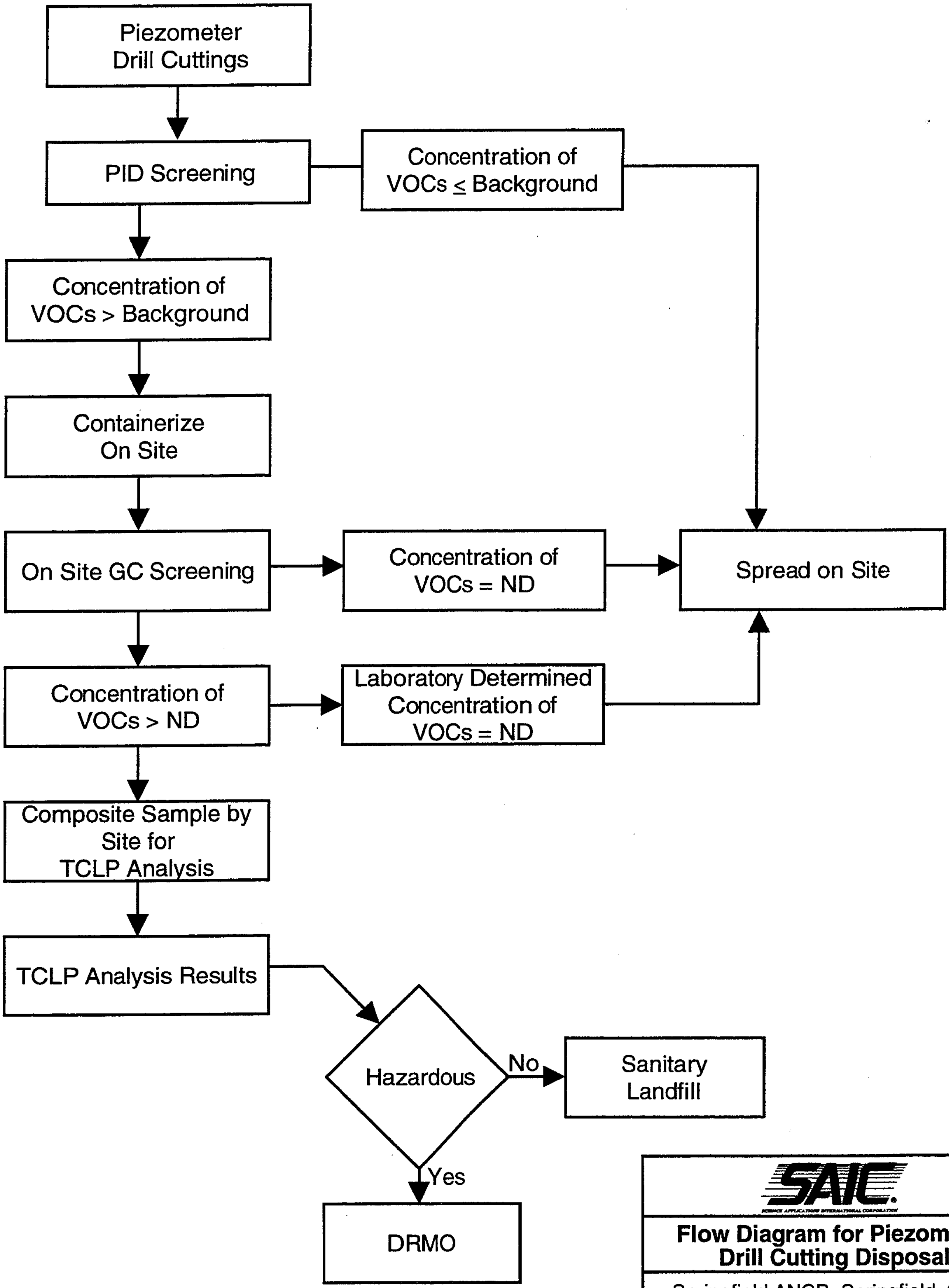
Flow Diagram for Soil Boring Drill Cutting Disposal

Springfield ANGB, Springfield, Ohio

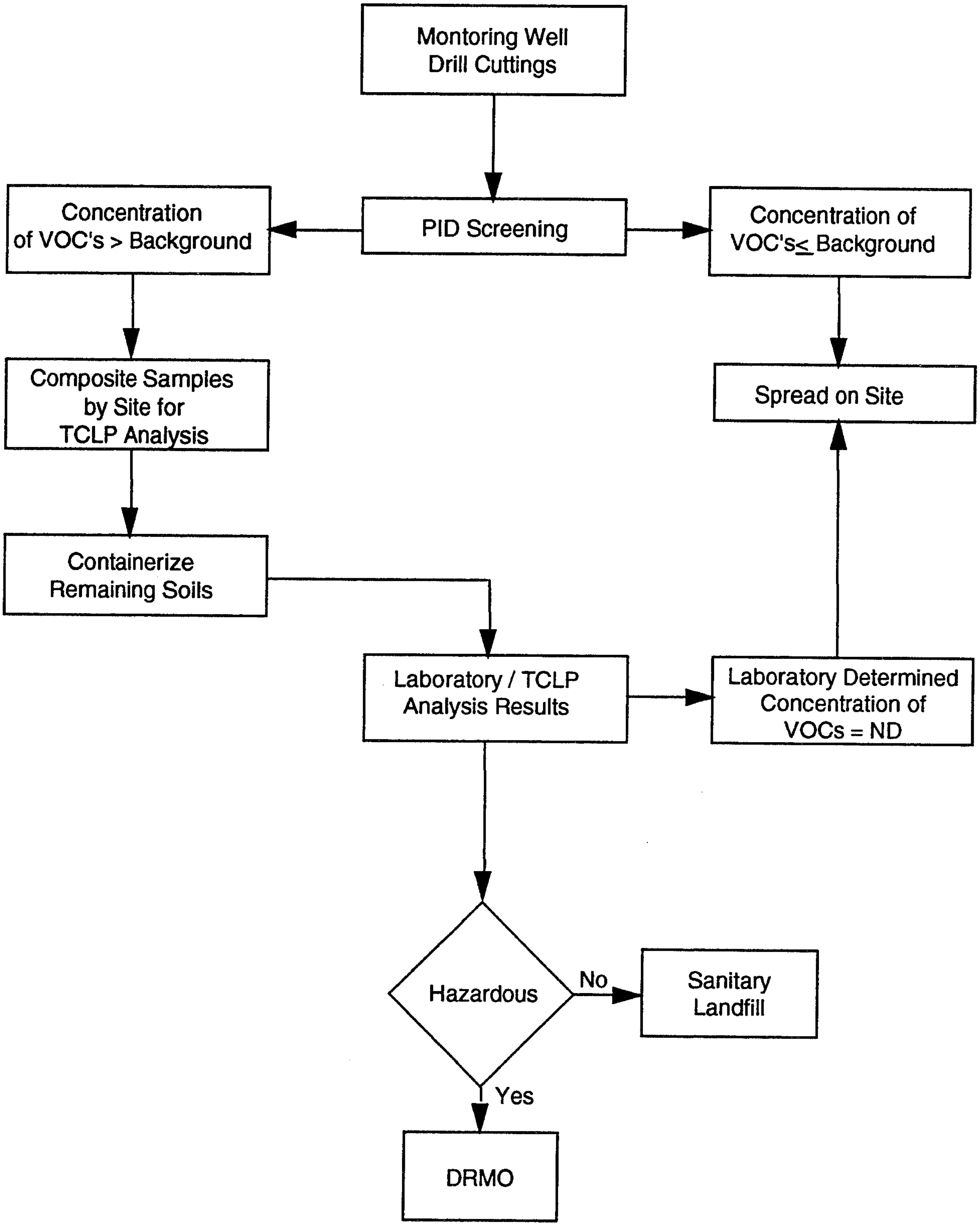
Figure: 2-6 | Project: 01-0827-03-0200-005



Flow Diagram for Piezometer Drill Cutting Disposal

Springfield ANGB, Springfield, Ohio

Figure: 2-7 Project: 01-0827-03-0200-005



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Flow Diagram for Monitoring Well Drill Cutting Disposal

Springfield ANGB, Springfield, Ohio

Figure: 2-8	Project: 01-0827-03-0200-05

Table 2-4. Toxicity Characteristic Leaching Procedure Results for Soil Cuttings 178th Tactical Fighter Group, Springfield ANGB, Springfield, Ohio

SAIC ID Number Collection Date Parameter	Units	Regulatory Level	TCLP-2 8-25-92	TCLP-3 8-25-92	TCLP-4 8-27-92
TCLP METALS					
Arsenic	mg/L	5.0	<0.1	<0.1	<0.1
Barium	mg/L	100.0	0.6	<0.5	0.9
Cadmium	mg/L	1.0	<0.01	<0.01	<0.01
Chromium	mg/L	5.0	<0.01	<0.01	<0.01
Lead	mg/L	5.0	<0.05	<0.05	<0.05
Mercury	mg/L	0.2	<0.0001	<0.0001	<0.0001
Selenium	mg/L	1.0	<0.2	<0.2	<0.2
Silver	mg/L	5.0	0.01	<0.01	<0.01
VOLATILE ORGANICS					
Benzene	mg/L	0.5	<0.003	<0.003	<0.003
Carbon Tetrachloride	mg/L	0.5	<0.006	<0.006	<0.006
Chlorobenzene	mg/L	100.0	<0.004	<0.004	<0.004
Chloroform	mg/L	6.0	<0.005	<0.005	<0.005
1,4-Dichlorobenzene	mg/L	7.5	<0.100	<0.100	<0.100
1,2-Dichloroethane	mg/L	0.5	<0.100	<0.100	<0.100
1,1-Dichloroethylene	mg/L	0.7	<0.010	<0.010	<0.010
Methyl ethyl ketone	mg/L	200.0	<0.030	<0.030	<0.030
Tetrachloroethylene	mg/L	0.7	<0.006	<0.006	<0.006
Trichloroethylene	mg/L	0.5	<0.006	<0.006	<0.006
Vinyl chloride	mg/L	0.2	<0.008	<0.008	<0.008
SEMIVOLATILE ORGANICS					
o-Cresol (a)	mg/L	200.0	<0.100	<0.100	<0.100
m-Cresol (a)	mg/L	200.0	<0.100	<0.100	<0.100
p-Cresol (a)	mg/L	200.0	<0.100	<0.100	<0.100
Hexachloroethane	mg/L	3.0	<0.100	<0.100	<0.100
Nitrobenzene	mg/L	2.0	<0.100	<0.100	<0.100
Hexachlorobutadiene	mg/L	0.5	<0.100	<0.100	<0.100
2,4,6-Trichlorophenol	mg/L	2.0	<0.100	<0.100	<0.100
2,4,5-Trichlorophenol	mg/L	400.0	<0.250	<0.250	<0.250
2,4-Dinitrotoluene	mg/L	0.13	<0.100	<0.100	<0.100
Hexachlorobenzene	mg/L	0.13	<0.100	<0.100	<0.100
Pentachlorophenol	mg/L	100.0	<0.250	<0.250	<0.250
Pyridine	mg/L	5.0	<0.100	<0.100	<0.100
PESTICIDES					
alpha-Chlordane	mg/L	0.03	<0.0001	<0.0001	<0.0001
gamma-Chlordane	mg/L	0.03	<0.0001	<0.0001	<0.0001
Endrin	mg/L	0.02	<0.0001	<0.0001	<0.0001
Heptachlor	mg/L	0.008	<0.0001	<0.0001	<0.0001
Heptachlor Epoxide	mg/L	0.008	<0.0001	<0.0001	<0.0001
Lindane	mg/L	0.4	<0.0001	<0.0001	<0.0001
Methoxychlor	mg/L	10.0	<0.0005	<0.0005	<0.0005
Toxaphene	mg/L	0.5	<0.005	<0.005	<0.005
HERBICIDES					
2,4-D	mg/L	10.0	<0.010	<0.010	<0.010
2,4,5-TP (Silvex)	mg/L	1.0	<0.002	<0.002	<0.002

(a) 2-, 3-, 4-methylphenol are reported as Cresol isomers ,o-, m-, and p-cresol, respectively.

All liquid decontamination wastes were collected and stored in the tanks dedicated to this purpose. Disposal was accomplished following the procedures described for the development and purge water.

2.6 SITE INVESTIGATION ANALYTICAL AND FIELD METHODS

This section outlines the methods and rationale used to investigate potential contamination at Sites 1, 2, 3, 4, and 5. The specific procedures described previously in this section were followed for the field investigation activities.

2.6.1 Analytical Methods

Soil borings were drilled at each of the sites being studied under the SI. Each borehole that was not completed as a piezometer or monitoring well was sampled continuously from the land surface to the water table, providing a record of the subsurface lithology. At least two soil samples from each borehole were selected according to the procedure specified in Section 2.4.4.1 and submitted to the analytical laboratory for chemical analysis. The same analyses were conducted on sediment samples, which were collected from Sites 2, 3, and 5. Analytical parameters for soil, sediment, and their related field QC blank samples included:

- VOCs (SW Method 8240 [soils], CLP SOW 3/90 [field QC blanks])
- Semivolatile organic compounds (SVOCs) (SW Method 8270 [soils], CLP SOW 3/90 [field QC blanks])
- Priority pollutant metals:

  ICP Metals: Be, Cd, Cr, Cu, Ni, Ag, and Zn (SW Method 6010)

  AA Metals: Sb (SW 7041), As (7060), Pb (7421), Hg (7471), Se (7740), and Tl (7841)
- TPH (SW Method 8015 modified).

SAIC collected groundwater samples from all seven monitoring wells and two piezometers installed during the SI. The samples were submitted to offsite laboratories for chemical analysis for the following parameters:

- VOCs (EPA 524.2 [samples collected in 1992], SW Method 8240 LDL [samples collected in 1993])
- SVOCs (SW Method 8270)
- Priority pollutant metals:

  ICP Metals: Be, Cd, Cr, Cu, Ni, Ag, and Zn (SW Method 6010)

  AA Metals: Sb (SW 7041), As (7060), Pb (7420), Hg (7470), Se (7740), and Tl (7841)
- TPH (SW Method 8015 modified).

These methods were modified to include the CLP-type QC limits.

2.6.2 Site Investigation Field Methods

Table 2-5 presents a summary of site sampling activities including the requested analysis for each sample.

Nonsite-specific Activities

- Eight piezometers were installed during the SI: six between April 30 and May 4, 1992 and two in late August 1992. Water level measurements were obtained from the piezometers to determine hydraulic gradients and flow directions. These data were used to finalize the monitoring well placement downgradient from their respective sites.
- Four soil borings (i.e., MWBG-1, MWGB-2, SB5-3, and SB5-4) were drilled and sampled to provide data on ambient concentrations of compounds of concern in soil. Although focused primarily on naturally occurring constituents, these samples also provided information on the anthropogenic contamination originating from Base activities.
- Two of the borings were completed as monitoring wells (i.e., MWBG-1 and MWBG-2) and provided upgradient groundwater quality data.
- Ambient concentrations were compared to site-specific sample results to determine if evidence of site-related contamination exists.

Table 2-5. Summary of Site Sampling Activities, 178th Tactical Fighter Group, Springfield ANGB, Springfield, Ohio

Site	Sampling Location I.D.	Sample Matrix	Sample Numbers	Collection Date	Analysis Requested
Site 1 - Fire Training Area	Soil Boring SB1-1	Soil	SB1-1-1 SB1-1-3 SB1-1-6	8/13/92	TPH, Priority Pollutant Metals, VOC, SVOC
	Soil Boring SB1-2	Soil	SB1-2-1 SB1-2-3 SB1-2-8	8/13/92	TPH, Priority Pollutant Metals, VOC, SVOC
	Soil Boring SB1-3	Soil	SB1-3-1 SB1-3-3 SB1-3-11 SB1-3-11R	8/14/92	TPH, Priority Pollutant Metals, VOC, SVOC
	Monitoring Well MW1-1	Water	MW1-1-1 MW1-1-2	9/30/92 5/21/93	TPH, Priority Pollutant Metals, VOC, SVOC TPH, Priority Pollutant Metals, VOC, SVOC
Site 2 - Fire Training Area	Soil Boring SB2-1	Soil	SB2-1-1 SB2-1-4 SB2-1-14	8/15/92	TPH, Priority Pollutant Metals, VOC, SVOC
	Soil Boring SB2-2	Soil	SB2-2-1 SB2-2-1R SB2-2-2 SB2-2-17	8/16/92	TPH, Priority Pollutant Metals, VOC, SVOC
	Soil Boring SB2-3	Soil	SB2-3-1 SB2-3-4 SB2-3-16	8/17/92	TPH, Priority Pollutant Metals, VOC, SVOC
	Soil Boring SB2-4	Soil	SB2-4-1 SB2-4-2	5/19/93	TPH, Priority Pollutant Metals, VOC, SVOC
	Soil Boring SB2-5	Soil	SB2-5-1 SB2-5-2	5/19/93	TPH, Priority Pollutant Metals, VOC, SVOC
	Soil Boring SB2-6	Soil	SB2-6-1 SB2-6-1R	5/20/93	TPH, Priority Pollutant Metals, VOC, SVOC
	Sediment Sample SD2-1	Sediment	SD2-1 SD2-1R	8/26/92	TPH, Priority Pollutant Metals, VOC, SVOC

Priority Pollutant Metals: Sb, As, Be, Cd, Cr, Cu, Pb, Ni, Hg, Se, Ag, Ti, Zn

SB - Soil Boring
MW - Monitor Well
SD - Sediment

Table 2-5. Summary of Site Sampling Activities, 178th Tactical Fighter Group, Springfield ANGB, Springfield, Ohio (continued)

Site	Sampling Location I.D.	Sample Matrix	Sample Numbers	Collection Date	Analysis Requested
Site 2 - Fire Training Area (continued)	Sediment Sample SD2-2	Sediment	SD2-2	8/26/92	TPH, Priority Pollutant Metals, VOC, SVOC
	Sediment Sample SD2-3	Sediment	SD2-3	5/21/93	TPH, Priority Pollutant Metals, VOC, SVOC
	Sediment Sample SD2-4	Sediment	SD2-4	5/21/93	TPH, Priority Pollutant Metals, VOC, SVOC
	Sediment Sample SD2-5	Sediment	SD2-5	5/21/93	TPH, Priority Pollutant Metals, VOC, SVOC
	Sediment Sample SD2-6	Sediment	SD2-6	5/21/93	TPH, Priority Pollutant Metals, VOC, SVOC
	Monitoring Well MW2-1	Water	MW2-1-1 MW2-1-2	10/01/92 5/21/93	TPH, Priority Pollutant Metals, VOC, SVOC TPH, Priority Pollutant Metals, VOC, SVOC
	Monitoring Well MW2-2	Water	MW-2-2-1	5/21/93	TPH, Priority Pollutant Metals, VOC, SVOC
Site 3 - Leach Field and Outfall	Soil Boring SB3-1	Soil	SB3-1-1 SB3-1-8	8/19/92 8/20/92	TPH, Priority Pollutant Metals, VOC, SVOC
	Soil Boring SB3-2	Soil	SB3-2-1 SB3-2-4 SB3-2-7	8/20/92	TPH, Priority Pollutant Metals, VOC, SVOC
	Soil Boring SB3-3	Soil	SB3-3-1 SB3-3-8	8/20/92	TPH, Priority Pollutant Metals, VOC, SVOC
	Soil Boring SB3-4	Soil	SB3-4-1 SB3-4-2	5/19/93	TPH, Priority Pollutant Metals, VOC, SVOC
	Soil Boring SB3-5	Soil	SB3-5-1 SB3-5-2	5/19/93	TPH, Priority Pollutant Metals, VOC, SVOC

Priority Pollutant Metals: Sb, As, Be, Cd, Cr, Cu, Pb, Ni, Hg, Se, Ag, Ti, Zn

SB - Soil Boring
MW - Monitor Well
SD - Sediment

Table 2-5. Summary of Site Sampling Activities, 178th Tactical Fighter Group, Springfield ANGB, Springfield, Ohio (continued)

Site	Sampling Location I.D.	Sample Matrix	Sample Numbers	Collection Date	Analysis Requested
Site 3 - Leach Field and Outfall (continued)	Sediment Sample SD3-1	Sediment	SD3-1	5/21/93	TPH, Priority Pollutant Metals, VOC, SVOC
	Sediment Sample SD3-2	Sediment Sediment	SD3-2 SD3-2R	5/21/93	TPH, Priority Pollutant Metals, VOC, SVOC
	Monitoring Well MW3-1	Soil	MW3-1-1 MW3-1-1R MW3-1-8 MW3-1-1a	8/26/92 8/26/92 8/21/92 8/21/92	TPH, Priority Pollutant Metals, VOC, SVOC
	Monitoring Well MW3-1	Water	MW3-1-1 MW3-1-1R	9/30/92 9/30/92	TPH, Priority Pollutant Metals, VOC, SVOC
			MW3-1-2	5/21/93	TPH, Priority Pollutant Metals, VOC, SVOC
Site 4 - POL Area	Soil Boring SB4-1	Soil	SB4-1-1 SB4-1-2	8/12/92	TPH, Pb, Priority Pollutant Metals, VOC
	Soil Boring SB4-2	Soil	SB4-2-1 SB4-2-2	8/12/92	TPH, Pb, Priority Pollutant Metals, VOC
	Soil Boring SB4-3	Soil	SB4-3-1 SB4-3-1R SB4-3-2 SB4-3-3	8/12/92	TPH, Pb, Priority Pollutant Metals, VOC
	Monitoring Well MW4-1	Soil	MW4-1-1S MW4-1-4S MW4-1-5S	8/26/92	TPH, Pb, Priority Pollutant Metals, VOC
	Monitoring Well MW4-1	Water	MW4-1-1	9/29/92	TPH, Pb, Priority Pollutant Metals, VOC, SVOC
			MW4-1-2	5/21/93	TPH, Pb, Priority Pollutant Metals, VOC, SVOC

Priority Pollutant Metals: Sb, As, Be, Cd, Cr, Cu, Pb, Ni, Hg, Se, Ag, Ti, Zn

SB - Soil Boring
MW - Monitor Well
SD - Sediment

Table 2-5. Summary of Site Sampling Activities, 178th Tactical Fighter Group, Springfield ANGB, Springfield, Ohio (continued)

Site	Sampling Location I.D.	Sample Matrix	Sample Numbers	Collection Date	Analysis Requested
Site 5 - Ramp Drainage Ditch	Soil Boring SB5-1	Soil	SB5-1-1 SB5-1-7	8/17/92	TPH, Priority Pollutant Metals, VOC, SVOC
	Soil Boring SB5-2	Soil	SB5-2-1 SB5-2-2	8/18/92	TPH, Priority Pollutant Metals, VOC, SVOC
	Soil Boring SB5-3	Soil	SB5-3-1 SB5-3-2	8/18/92	TPH, Priority Pollutant Metals, VOC, SVOC
	Soil Boring SB5-4	Soil	SB5-4-1 SB5-4-1R SB5-4-2	8/18/92	TPH, Priority Pollutant Metals, VOC, SVOC
	Sediment Sample	Sediment	SD5-1 SD5-2 SD5-3 SD5-3R SD5-4 SD5-5	5/06/92	TPH, Priority Pollutant Metals, VOC, SVOC
Background	Monitoring Well MWBG1	Soil	MWBG1-1 MWBG1-2	8/12/92 8/12/92	TPH, Priority Pollutant Metals, VOC, SVOC VOC and SVOC only
	Monitoring Well MWBG1	Water	MWBG-1-1 MWBG-1-2	9/30/92 5/21/93	TPH, Priority Pollutant Metals, VOC, SVOC TPH, Priority Pollutant Metals, VOC, SVOC
	Monitoring Well MWBG2	Soil	MWBG-2-1 MWBG-2-3 MWBG-2-3R	8/19/92	TPH, Priority Pollutant Metals, VOC, SVOC
	Monitoring Well MWBG2	Water	MWBG-2-1 MWBG-2-2	9/29/92 5/21/93	TPH, Priority Pollutant Metals, VOC, SVOC TPH, Priority Pollutant Metals, VOC, SVOC

Priority Pollutant Metals: Sb, As, Be, Cd, Cr, Cu, Pb, Ni, Hg, Se, Ag, Ti, Zn

SB - Soil Boring
MW - Monitor Well
SD - Sediment

Table 2-5. Summary of Site Sampling Activities, 178th Tactical Fighter Group, Springfield ANGB, Springfield, Ohio (continued)

Site	Sampling Location I.D.	Sample Matrix	Sample Numbers	Collection Date	Analysis Requested
Background (continued)	Piezometer P-4	Water	P-4-1	5/21/93	TPH, VOC, SVOC, Priority Pollutant Metals (Dissolved and Total)
			P-4-1R	5/21/93	TPH, VOC, SVOC, Priority Pollutant Metals (Dissolved and Total)
	Piezometer P-5	Water	P-5-1	5/21/93	TPH, VOC, SVOC, Priority Pollutant Metals (Dissolved or Total)

Priority Pollutant Metals: Sb, As, Be, Cd, Cr, Cu, Pb, Ni, Hg, Se, Ag, Ti, Zn

SB - Soil Boring
MW - Monitor Well
SD - Sediment

Site 1 - Fire Training Area No. 1 (FTA-1)

- The boundaries of the former FTA were located through the use of aerial photographs and interviews with Base personnel and met the objective of identifying the location of maximum FTA use and potential for contamination.
- An SOV survey was conducted, which encompassed the former FTA location and the surrounding area. The results of the survey showed that areas of maximum potential contamination were within the FTA boundaries. Because of the correlation of maximum SOV concentrations with the FTA, the SOV survey met its objective of identifying maximum potential site-related contamination.
- Three soil borings were drilled from the land surface to the water table within the former FTA boundaries located based on the SOV survey results. These borings were sampled continuously at 2-foot intervals and screened with an onsite GC for VOCs, which provided qualitative information on vertical distribution of contaminants. This information was used to select soil samples for offsite laboratory analysis, which identified chemicals of potential concern in soil at the site.
- One monitoring well was installed approximately 50 feet downgradient from Site 1 and analyses of groundwater samples collected from this well were used to evaluate whether contaminants from the FTA have migrated to groundwater.

Site 2 - Fire Training Area No. 2 (FTA 2)

- The location of Site 2 was identified by Base personnel and confirmed using aerial photographs. This activity identified the location of FTA activities and, therefore, the location of maximum impact of FTA contaminants.
- An SOV survey was conducted that encompassed Site 2 and the surrounding area. Results showed maximum potential contamination within the area identified as the former FTA.
- Three soil borings were drilled within the former FTA. These borings were located at points of maximum potential contamination based on the SOV survey results. An onsite GC was used to screen the borings continuously to provide qualitative information regarding vertical distribution of volatile compounds.
- One monitoring well was installed in what was initially believed to be the downgradient direction from Site 2.
- Sediment samples were collected from a drainage ditch that drains the FTA. Evaluation of sediment analytical data provided information on the presence of contaminants.
- Data gaps were identified following the soil, sediment, and groundwater sampling described above. These data gaps included the vertical extent of petroleum-related contamination, the presence of site-related contaminants in groundwater, and the source of sediment contaminants.

- An additional well was installed downgradient from the site. Water level measurements following installation of the first well required adjusting original calculations of groundwater flow direction toward the east.
- Three additional soil borings, which identified the vertical extent of soil contamination, were drilled within the former FTA.
- Both Site 2 wells were sampled and data from the analyses were used to evaluate potential migration of FTA contaminants.
- Three additional sediment samples were collected and used to evaluate potential sources of sediment contamination.

Site 3 - Leach Field (LCH)

- The location of the former leach field was identified by Base personnel and confirmed through the use of construction drawings and aerial photographs.
- An SOV survey was conducted, which encompassed the leach field and surrounding area. Maximum SOV concentrations detected were within the area identified as the former leach field.
- Three soil borings were drilled and sampled at the locations of maximum SOV readings. Onsite GC screening provided preliminary qualitative information on the vertical distribution of volatile contaminants. Soil analytical results identified the presence of contaminants potentially resulting from leach field operations.
- One monitoring well was installed and sampled approximately 50 feet downgradient from Site 3. Groundwater analytical results were used to evaluate potential migration of FTA contaminants.
- Data gaps were identified following evaluation of sample results from activities described above. These included: vertical extent of leach field contaminants in soil, the presence of dissolved metals concentrations in groundwater, and upgradient surface soil characteristics.
- Two additional soil borings were drilled and sampled at locations based on maximum SOV measurements to evaluate the vertical extent of identified contaminants.
- Two surface soil samples were collected upslope and upgradient from Site 3 and were evaluated to identify the source of contaminants detected in surface soil samples collected at the site.
- One additional groundwater sample was collected, which confirmed earlier results and provided data regarding the presence of dissolved metals.

Site 4 - POL Storage Area (POL)

- The spill area was identified in the PA and during site visits by Base personnel.
- An SOV survey was conducted throughout the POL yard where the spill occurred to obtain evidence of spill-related VOCs in soil vapor.
- The SOV survey detected one isolated point of potential hydrocarbon contamination. Although this detection did not appear to be spill-related, one soil boring was located at the point, and two borings were located in the downslope direction, which confirmed the absence of residual spill-related contaminants in soil.
- One monitoring well was installed and sampled downgradient from the spill area and provided data regarding the presence of contaminants in groundwater.
- Data gaps were identified, including the source and extent of TCE contamination detected in groundwater and in soil collected from the monitoring well boring.
- A second round of groundwater sampling was conducted, which confirmed the initial sampling results.

Site 5 - Ramp Drainage Ditch (RDD)

- Five points were staked at regularly spaced intervals along the drainage ditch comprising Site 5. Surface sediment samples were collected at these points and analyzed. Laboratory analyses confirmed the presence of contaminants in Site 5 sediments.
- Because contaminants were detected in the Site 5 surface sediments, two soil borings were drilled at the points of maximum surface contamination, which determined the vertical extent of detected contaminants. Onsite GC screening was used, which provided a qualitative indication of the vertical distribution of VOCs.
- Due to the presence of paved surfaces surrounding the ditch, the horizontal extent of Site 5 is bounded by the physical extent of the drainage ditch.

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3. SIGNIFICANCE OF RESULTS

This section presents the results of the site investigation (SI) conducted at five sites at Springfield Air National Guard Base (ANGB), Springfield, Ohio. The general geologic and hydrogeologic characteristics of the Base are discussed in Section 3.1. Section 3.2 summarizes the quality assurance/quality control (QA/QC) results for the SI program. Section 3.3 presents the background/ambient sampling results. Section 3.4 provides regulatory criteria used for comparison to analytical results. Sections 3.5 through 3.9 present site-specific information on the analytical results of samples collected and the significance of these results.

3.1 BASE GEOLOGY AND HYDROGEOLOGY

The following two sections describe the geology and hydrogeology common to the five sites studied at Springfield ANGB. Details of lithology encountered at each site are presented in the site-specific discussions in Sections 3.5 through 3.9.

3.1.1 Base Geology

All boreholes drilled during the SI were completed within 37 feet of the land surface in unconsolidated glacial sediments. Underlying these sediments, bedrock is reportedly at approximately 40 feet below land surface (BLS) (ODNR 1988); however, bedrock was not encountered during the SI drilling program. Bedrock underlying the sites is limestone of the Niagaran Formation. Soils within the upper 3 to 4 feet at Sites 1, 2, and 4 are composed of yellowish-brown silt loam or silty clay loam with limestone pebbles derived from calcareous glacial till and are classified as Miami Silt Loam. The soil horizons at Sites 3 and 5 in the upper 3 to 5 feet are composed of fill, which ranges from brown to yellowish-brown and ranges from sandy loam to silty, clay loam. Permeability in the upper soil horizons ranges from 4.5 x 10^{-4} to 1.4 x 10^{-3} cm/sec (HTMC 1988).

The unconsolidated glacial sediments encountered from below the soil horizon to 37 feet BLS are generally composed of calcareous glacial till with some outwash and lake deposits. Permeabilities in this unstratified glacial drift vary over a wide range (10^{-3} to 10^{-8} cm/sec) due to the combination of silt, clay, sand, and gravel lenses. Figure 3-1 shows a generalized geologic cross section of the glacial lithology encountered at the Base.

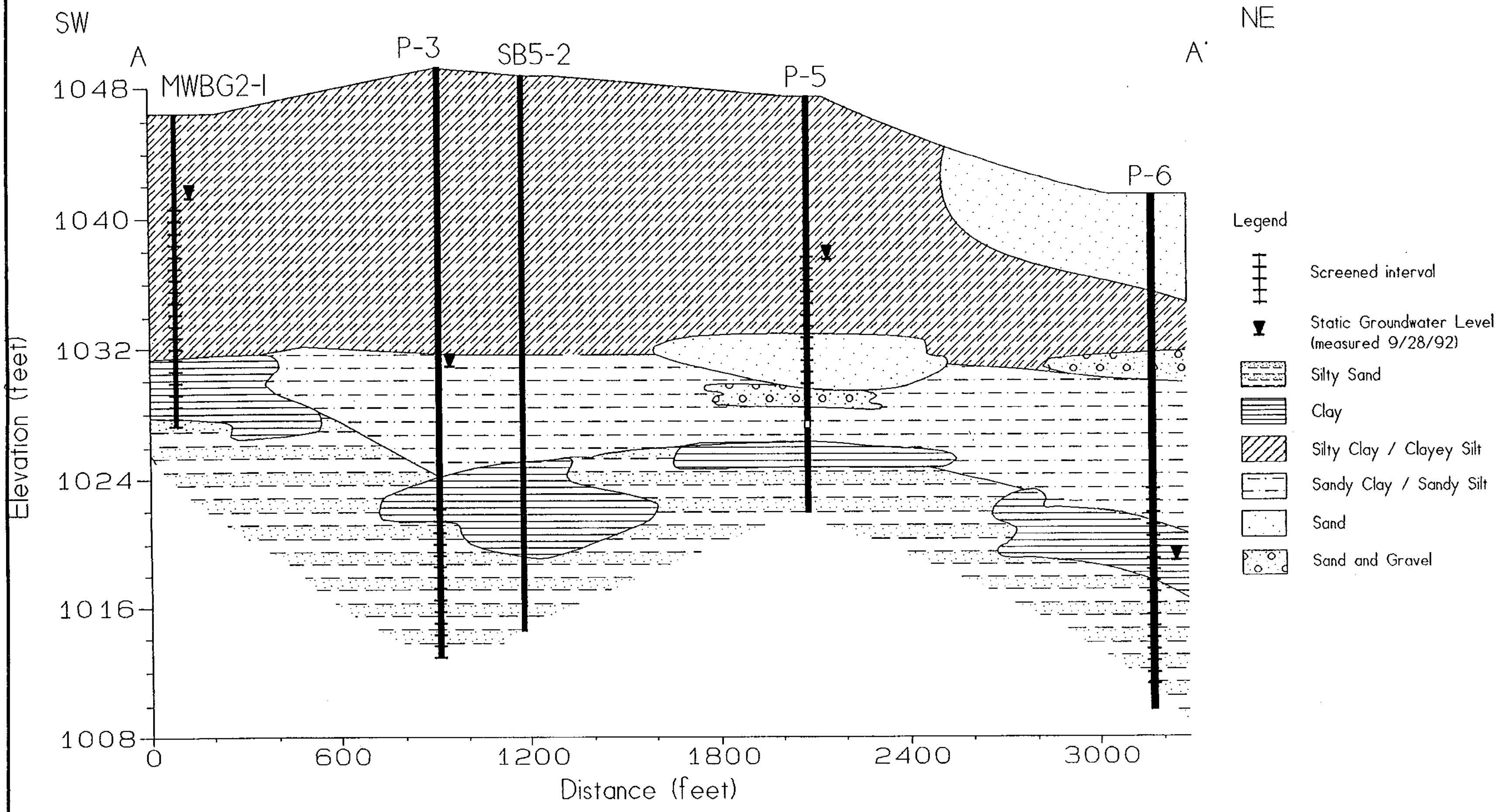
A layer of dark gray lacustrine deposits of silts, clays, and fine sands was encountered, with permeabilities determined by geotechnical testing to be as low as 7×10^{-8} ft/min. The deposits ranged from 1 to 14 feet thick and were randomly encountered between 10 and 31 feet BLS.

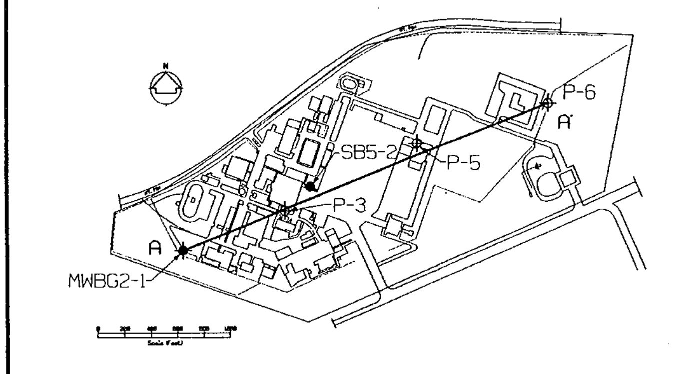
The overburden material was usually saturated just below the lacustrine deposits described above. The thickness of the aquifer material varied from less than 1 foot to about 4 feet and was encountered between 11 and 37 feet BLS. The saturated material was generally composed of sand and gravel, but some saturated intervals consisted primarily of clay or silt. Permeabilities were determined for aquifer material at each site by geotechnical testing and aquifer testing. Aquifer characteristics are discussed in Section 3.1.2.

3.1.2 Base Hydrogeology

The hydrogeologic characterization of Springfield ANGB is based on lithology encountered during drilling, geotechnical testing, static water level measurement of wells and piezometers, and aquifer tests. Data were collected from six groundwater monitoring wells and eight piezometers located across the Base. The locations of the monitoring wells and piezometers are shown in Figure 3-2.

Two distinct hydrologic systems are present in the vicinity of the Base: a near-surface, or shallow, aquifer that is affected by surficial hydrologic conditions, and a deeper bedrock aquifer that acts independently of surface conditions. The near-surface system can be divided into two categories: a system consisting predominantly of fine sediments (silt and clay) originating from recent alluvial processes and another system consisting of coarser sediments (sand and gravel) originating from retreating glacial processes. In a regional sense, the two shallow groundwater systems are hydraulically connected and discussed as a single unit.





Plan View

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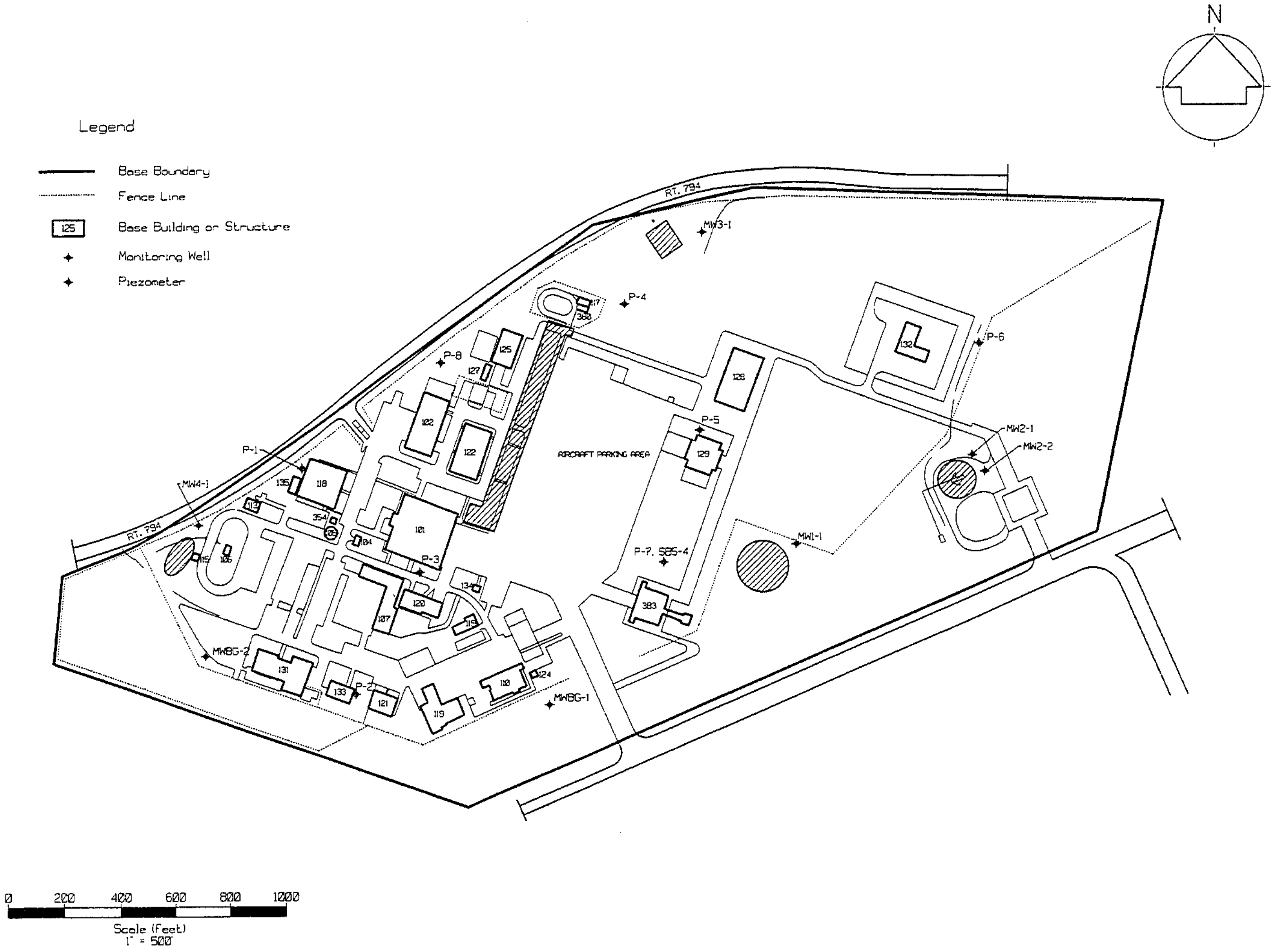
Generalized Glacial Lithology, Cross Section A-A'

Springfield ANGB, Springfield, Ohio

Figure: 3-1

Project: 01-0827-03-0200-005



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Piezometer and Monitoring Well Location Map

Springfield ANGB, Springfield, Ohio

Figure: 3-2	Project: 01-0827-03-0200-005

The shallowest aquifers at the Base, and in the surrounding region, are unconfined and exist in the regolith, above the uppermost layer of bedrock. The uppermost layer of bedrock ranges from 4 feet to more than 100 feet deep. The surface of the shallow aquifer, the groundwater table, ranges in depth from approximately 3 to 35 feet. It is presumed that the potentiometric surface of the shallow aquifer roughly follows the topography and that the topography exhibits local control over near-surface groundwater movement. In general, groundwater flow in upland, unconsolidated hydrogeologic systems is downslope; in lowland or stream-valley hydrogeologic systems, groundwater is presumed to be down-valley. While surface water and groundwater on the Base flow north and northwest, toward the nearby Mill Creek, regional surface water and shallow groundwater are drained by the Miami River, and therefore, generally flow south and ultimately into the Ohio River.

During the SI, groundwater was encountered in glacial drift material. Groundwater levels generally rose several feet higher than the depth initially encountered during drilling, indicating a very slow recharge rate from the fine grained aquifer material. Several rounds of groundwater measurements were completed from May to December 1992 and in May 1993. Water levels were collected from each monitoring well and piezometer, compared to mean sea level (msl), and used to calculate groundwater flow directions and rates. These data show that the groundwater elevation varies as a result of the seasonal climatic changes in the rate of precipitation, evaporation, and transpiration. The water elevations at various dates are summarized in Table 3-1. As shown in Figures 3-3 and 3-4, the groundwater flow direction across the Base is generally toward the northeast throughout seasonal climatic changes. However, two distinct groundwater regions are located on Springfield ANGB, separated by a slightly uplifted groundwater lobe extending through the central area of the Base. This lobe roughly divides Site 4 in the southwestern area of the Base from Sites 1, 2, and 3 in the northeastern area of the Base. The two groundwater zones have somewhat different characteristics. In the southwestern zone, the groundwater is generally flowing toward the north-northeast; in the northeastern zone, the groundwater is generally flowing toward the east-northeast.

Table 3-1. Summary of Water Elevations, 178th Tactical Fighter Group, Springfield ANGB, Springfield, Ohio

Well	TOC Elevation (MSL)	Date	Water Level (BTOC)	Water Level (MSL)
MW1-1	1049.66	8/25/92	15.55	1034.11
		9/28/92	13.91	1035.75
		12/16/92	14.67	1034.99
MW2-1	1045.01	8/18/92	19.61	1025.40
		9/28/92	24.34	1020.67
		12/17/92	25.50	1019.51
MW3-1	1037.92	8/25/92	14.44	1023.48
		9/28/92	8.34	1029.58
		12/16/92	7.00	1030.92
MW4-1	1040.68	9/28/92	2.33	1038.35
		12/16/92	2.58	1038.10
MWBG1	1051.47	8/18/92	7.87	1043.60
		8/25/92	8.69	1042.78
		9/28/92	12.05	1039.42
		12/16/92	9.33	1042.14
MWBG2	1046.36	8/25/92	14.21	1042.15
		9/28/92	5.09	1041.27
		12/16/92	5.08	1041.28
P-1	1046.90	5/05/92	7.20	1039.70
		8/10/92	4.12	1032.78
		8/11/92	10.01	1036.89
		8/18/92	10.30	1036.60
		8/25/92	11.37	1035.53
		9/28/92	11.76	1035.14
		12/16/92	9.91	1036.99

Table 3-1. Summary of Water Elevations, 178th Tactical Fighter Group, Springfield ANGB, Springfield, Ohio (continued)

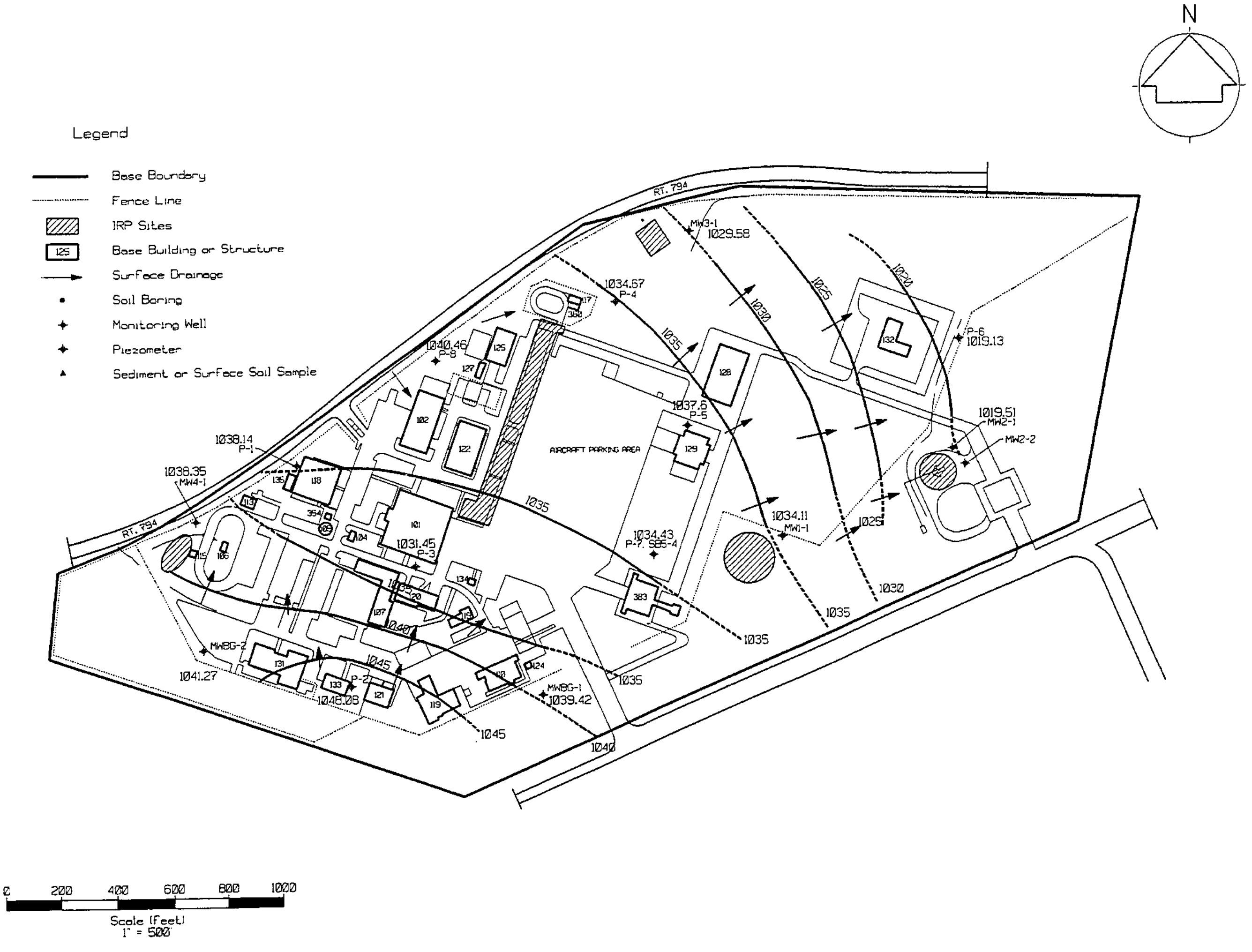
Well	TOC Elevation (MSL)	Date	Water Level (BTOC)	Water Level (MSL)
P-2	1051.20	5/05/92	6.00	1045.20
		8/10/92	2.35	1048.85
		8/11/92	2.18	1049.02
		8/18/92	2.50	1048.70
		8/25/92	3.14	1048.06
		9/28/92	3.12	1048.08
		12/16/92	1.42	1049.78
P-3	1048.98	5/05/92	14.20	1034.78
		8/10/92	15.72	1033.26
		8/11/92	15.75	1033.23
		8/18/92	17.08	1031.90
		8/25/92	16.90	1032.08
		9/28/92	17.54	1031.45
		12/16/92	17.00	1031.98
P-4	1040.20	5/05/92	5.30	1034.90
		8/10/92	4.15	1036.05
		8/11/92	4.13	1036.07
		8/18/92	4.30	1035.90
		8/25/92	4.60	1035.60
		9/28/92	4.53	1035.67
		12/16/92	4.33	1035.87
P-5	1047.07	5/05/92	10.00	1037.07
		8/10/92	7.05	1040.02
		8/11/92	6.79	1040.28
		8/18/92	7.47	1039.60
		8/25/92	8.24	1038.83
		9/28/92	9.46	1037.61
		12/16/92	7.83	1039.24

Table 3-1. Summary of Water Elevations, 178th Tactical Fighter Group, Springfield ANGB, Springfield, Ohio (continued)

Well	TOC Elevation (MSL)	Date	Water Level (BTOC)	Water Level (MSL)
P-6	1041.13	5/05/92	22.40	1018.73
		8/10/92	21.42	1019.71
		8/11/92	21.44	1019.69
		8/18/92	21.13	1020.00
		8/25/92	21.92	1019.21
		9/28/92	22.47	1018.66
		12/16/92	22.00	1019.13
P-7 (SB5-4)	1050.69	8/25/92	14.49	1036.20
		9/28/92	16.26	1034.43
		12/16/92	14.12	1036.57
P-8	1044.88	9/28/92	4.93	1039.95
		12/16/92	4.42	1040.46

Notes:

MSL - feet above mean sea level
TOC - top of casing
BTOC - below top of casing



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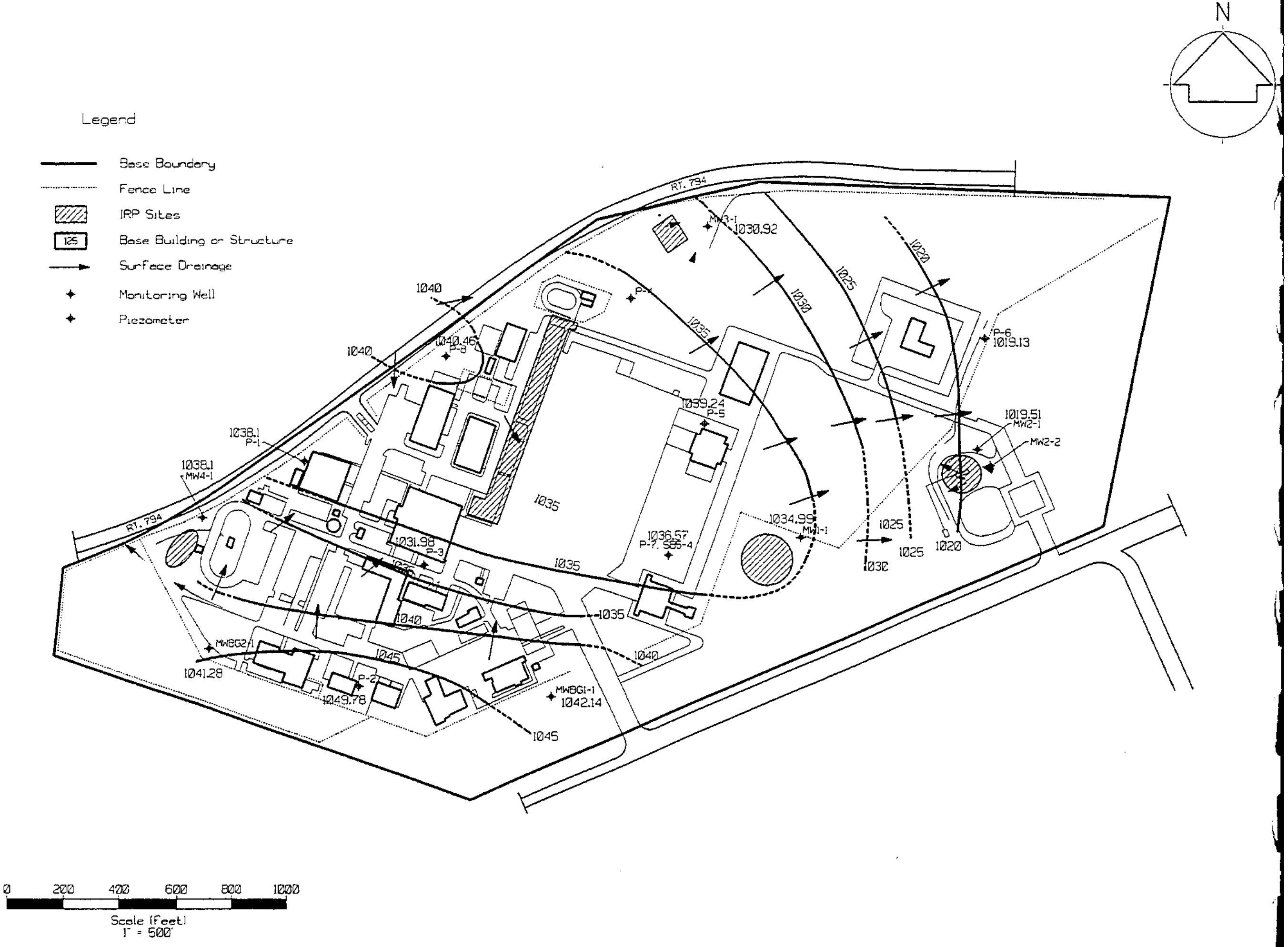
Groundwater Contour Elevations Based on 9/28/92 Measurments

Springfield ANGB, Springfield, Ohio

Figure: 3-3	Project: 01-0827-03-0200-005



Groundwater Contour Elevations Based on 12/16/92 - 12/17/92 Measurements

Springfield ANGB, Springfield, Ohio

Figure: 3-4 | Project: 01-0827-03-0200-005

Determination of groundwater flow direction in the central portion of the Base where the lobe appears was not required to determine flow direction at the SI sites. The lobe is possibly the result of an uplifted bedrock feature on which the uppermost aquifer rests. An uplifted area of bedrock could support the groundwater table, creating an elevated aquifer zone. It also is possible that construction of the aircraft parking apron, which covers much of the central portion of the Base, required extensive soil excavation and introduction of gravel fill over much of the groundwater lobe. This type of construction may allow relatively rapid recharge over the central area and consequently the elevated groundwater lobe.

Hydraulic gradient is a factor in determining groundwater flow rate; therefore, as the hydraulic gradient varies with the different areas and changing climatic seasons, the resulting flow rate also will vary. Four values for hydraulic gradient and flow rate were calculated. The different values are intended to describe hydrogeological conditions in the southwestern and northeastern areas for two different water level measurement rounds. These measurement rounds occurred at the end of two distinctly different climatic seasons. Hydraulic gradients and flow rates are presented in Table 3-2.

Rising or falling head permeability (slug) tests were performed on the six monitoring wells installed during the SI following the procedures discussed in Section 2.2.4. The test results were analyzed using the Bouwer and Rice slug test method (Bouwer and Rice 1976; Bouwer 1989a; Bouwer 1989b), as outlined in Appendix B. The results of the Bouwer and Rice slug test analyses are presented in Table 3-3.

A Hermit 50 psi pressure transducer was used to measure water levels as they changed during the slug test. The accuracy of the pressure transducer was checked prior to each slug test. The recorded difference between pressure transducer readings for a measured distance never exceeded ±2%, which is considered acceptable for a Hermit 50 psi pressure transducer.

All monitoring wells were designed to intercept the water table, and pre-test equilibrium water levels in all wells, except MW4-1, were recorded below the top of the screen. Rising head slug tests, "slug out" tests, were conducted or attempted at all locations; however, at three

Table 3-2. Hydraulic Gradient and Groundwater Flow Rate of the Shallow Aquifer, 178th Tactical Fighter Group, Springfield ANGB, Springfield, Ohio

Area	Date	Hydraulic Gradient	Groundwater Flow Rate (ft/yr)
Southwest (Site 4)	9/28/92	.026	8.3
Southwest (Site 4)	12/16/92	.025	8.0
Northeast (Sites 1, 2, 3)	9/28/92	.017	6.6
Northeast (Sites 1, 2, 3)	12/16/92	.019	7.3

Table 3-3. Bouwer and Rice Slug Test Results, 178th Tactical Fighter Group, Springfield ANGB, Springfield, Ohio

Well Identification	Test Type	Estimated Hydraulic Conductivity (ft/min)
MWBG1-1	Slug Out	4.129×10^{-2}
MWBG2-1	Slug Out	2.822×10^{-4}
MW1-1	Slug In[a]	5.459×10^{-5}
MW2-1	Slug In[a]	6.866×10^{-4}
	Slug Out	water level below pressure transducer
MW3-1	Slug In[a]	2.101×10^{-5}
MW4-1	Slug In	1.620×10^{-4}
	Slug Out	2.828×10^{-4}

[a] Actual formation hydraulic conductivity is less than or equal to estimated slug test hydraulic conductivity.

locations (as noted in Table 3-3), the induced water level change for the "slug out" tests went below the pressure transducer and data were unable to be recorded. Therefore, at these locations, falling head, or "slug in," tests were conducted. However, the subsequent flow of water into the aquifer due to the falling water level for these tests not only took place through the screen below the original water table, but also through the vadose zone above the original water table during the initial portion of the test. This effect may lead to overestimation of hydraulic conductivity; however, this overestimation was minimized by focusing upon the later portion of the data when this effect is reduced.

The Bouwer and Rice method (Bouwer and Rice 1976) and (Bouwer 1989) determines the hydraulic conductivity of an unconfined aquifer from a slug test and accommodates a variety of well geometries, including partial penetration and screened or open wells.

The assumptions that the Bouwer and Rice slug test model are based upon are listed below (summarized in Kruseman and de Ridder 1990):

- The aquifer is unconfined and has apparently infinite extent
- The aquifer is homogeneous, isotropic, and of uniform thickness over the area influenced by the slug test
- Prior to the test, the water table is (nearly) horizontal over the area that will be influenced by the test
- The head of the well is lowered instantaneously at $t_0=0$; the drawdown in the water table around the well is negligible; there is no flow above the water table
- The inertia of the water column in the well and the linear and non-linear well losses are negligible
- The well either partially or fully penetrates the saturated thickness of the aquifer
- The well diameter is finite; hence, storage in the well cannot be neglected
- The flow to the well is in a steady state.

The calculated hydraulic conductivities for monitoring wells MWBG2-1, MW1-1, MW2-1, MW3-1, and MW4-1 are consistent with values common to silt, and the calculated hydraulic conductivity for monitoring well MWBG1-1 is similar to values common for a clean sand (Freeze and Cherry 1979). The sand unit in monitoring well MWBG1-1 comprises approximately 50 percent of the saturated sequence and the resulting calculated hydraulic conductivity is greatly influenced by this permeable sand. However, the sand units in MWBG2-1 and MW1-1 apparently do not contribute to the calculated hydraulic conductivities for these wells.

The pre-slug test water levels for all monitoring wells, except MW4-1, were recorded to fall within the screened portion of the wells. Therefore, adjustments to the casing radii (r_c) and screen lengths (L) were made (as outlined by Bouwer 1989a, 1989b) to account for the effects of the sand pack and original borehole diameter on water level changes in the screened portion of the wells.

Geotechnical testing of soil samples for permeability was conducted on aquifer material and the gray silty clay layer identified at some boreholes just above the saturated interval. Geotechnical permeability testing is performed in a laboratory on a presumed undisturbed sample of approximately 100 to 200 cubic inches of soil. Although the assumption is that the sample is representative of the aquifer, the test is on a scale several times smaller than the in situ aquifer testing described above. Results of geotechnical permeability testing of aquifer material ranged from 10^{-4} to 10^{-8} cm/sec. Tests of the gray silty clay layer above the aquifer ranged from 1.4×10^{-8} to 7.0×10^{-8} cm/sec. The range in permeabilities is attributed to the interfingered layers of low and high permeability zones in generally unconfined or "water table" conditions.

3.2 DATA QUALITY ASSESSMENT

A standardized QA/QC program was followed during the SI conducted at Springfield ANGB to ensure that analytical results and the decisions based on these results were representative of the environmental condition at the Base. The objectives of the SI were to confirm the presence of contamination, and collect and analyze sufficient numbers of samples to support recommendations for further investigation or the development of decision documents that recommend no further action. The SI was conducted using the Hazardous Waste Remedial Actions Program (HAZWRAP) Level C (i.e., U.S. Environmental Protection Agency [EPA] Level III) for soil and groundwater samples; QC requirements described in *Requirements for*

Quality Control of Analytical Data (DOE/HWP-65/R1, July 1990); and the guidelines and specifications described in the Quality Assurance Project Plans (QAPPs) submitted as part of the project work plans prepared by Science Applications International Corporation (SAIC). The number of soil and sediment samples and groundwater samples collected during the Springfield ANGB SI, in addition to the number of field QC samples collected and selected laboratory QC (i.e., matrix spikes and duplicates) samples analyzed, are summarized in Appendix G. The data validation worksheets are referenced within the subsection describing the applicable analysis. The QC checks and results are summarized below.

3.2.1 Data Quality Objectives

The following sections summarize the data quality objectives (DQOs) for precision, accuracy, representativeness, comparability, and completeness (PARCC) obtained during the Springfield ANGB SI.

3.2.1.1 Precision

Precision was defined as the reproducibility, or degree of agreement, among the replicate measurements of the same quantity. The closer the numerical values of the measurement are to each other, the more precise the measurement is. Analytical precision was expressed as the percentage of the difference between the results of duplicate samples for a given compound or element. Relative percent difference (RPD) was calculated using the equation given in Appendix G.

Precision was determined using matrix spike/matrix spike duplicate (MS/MSD) and duplicate sample analyses conducted on samples collected for volatile organic compound (VOC), semivolatile organic compound (SVOC), gasoline range, diesel fuels and heavy oils, and priority pollutant metals during the Springfield ANGB SI. The laboratory selected 1 sample in 20 and split the sample into 2 additional aliquots. MS/MSD samples were prepared by routinely analyzing the first aliquot for the parameters of interest, while the remaining two aliquots were spiked with known quantities of the parameters of interest before analysis. The RPD between the spiked results was calculated and used as an indication of the analytical precision for the VOC, SVOC, gasoline range, diesel fuel range, and heavy oil range analyses performed.

Duplicate samples (i.e., priority pollutant metals analyses) were prepared by subdividing 1 sample of every 20 samples received and analyzing both samples of the duplicate pair. The RPD between the two detected concentrations was calculated and used as an indication of the analytical precision for the analyses performed.

All RPD values calculated from the VOC MS/MSD were within the EPA Contract Laboratory Program (CLP) advisory control limits for analytical precision. Ten RPD values (of 77 total values) calculated from the SVOC MS/MSD analyses were outside the EPA CLP advisory control limits for analytical precision. Since each analysis was evaluated according to the required QC criteria described in Appendix G (Section G.3) and all of the criteria were met for the environmental samples analyzed, these RPD values are considered to be a more representative reflection of the variability characteristic of the environmental condition at Springfield ANGB, and as a result, the analytical DQO for VOC and SVOC precision is considered to have been met. RPD values were calculated from gasoline range and diesel fuel range MS/MSD analyses. Strict CLP validation guidelines were applied to priority pollutant metals duplicate sample results, even though no practical methods are defined by EPA to determine or relate the duplicate results in one environmental duplicate sample to those that might be calculated in another unrelated environmental sample. As a result, data validation qualifiers were applied to elements detected in soil and water samples associated with those samples analyzed in duplicate. These results are considered to have little impact on the environmental data quality and considered more likely to be the result of the regional matrix variability, since all other required analytical QC criteria were met. Therefore, the analytical precision DQO for priority pollutant analyses is considered to have been met. The analytical QC criteria used to evaluate analytical precision and all MS/MSD results are discussed in Appendix G (Section G.3).

Sample collection reproducibility and media variability were measured in the laboratory by the analysis of field replicates. Field replicates were collected using the same techniques as those used to collect the environmental samples. One sample in 10 similar matrices was collected, and sample collection reproducibility and media variability were evaluated based on the RPD values between two duplicate samples. No corrective action was taken based on the RPD values.

All soil samples to be analyzed by the Weyerhauser Laboratory, located in Tacoma, Washington, were collected using brass (i.e., for VOC, SVOC, and diesel fuel and heavy oil analyses) and stainless steel (i.e., for priority pollutant metals) liners. Each split spoon was filled with sufficient liners such that the replicate samples could be collected at any sample collection interval. After the split spoon sampler was retrieved from the borehole, these liners were capped and labeled and each sample was then shipped to the laboratory in the liner. Therefore, the replicate concentrations measured by the laboratory reflect the natural matrix variability inherent in the subsurface soils at Springfield ANGB and were not used to assess sample collection precision. Field RPD values were calculated only for compounds detected in concentrations greater than the contract required quantitation limits (CRQLs) in both replicate pair samples, for compounds detected in one sample and not the other, and only for those compounds and elements not considered to be common laboratory contaminants (e.g., methylene chloride). All VOC RPDs met the acceptance criteria except for xylenes (total) (200 percent) in MWBG-2-3 and MWBG-2-3R. All SVOC replicate RPD values met the acceptance criteria, except for phenanthrene (103.8 percent), fluoranthene (84.9 percent), pyrene (70.3 percent), chrysene (57.7 percent), benzo(b)fluoranthene (69.1 percent), indeno(1,2,3-c,d)pyrene (56.3 percent), and benzo(g,h,i)perylene (56.1 percent) in SD5-3 and SD5-3R, and fluoranthene (100 percent) and pyrene (91.5 percent) in SD2-1 and SD2-1R. Field RPD values were calculated for all priority pollutant metals detected in both replicate pair samples All priority pollutant metals replicate RPD values met the evaluation criteria, except for chromium (76 percent) and lead (94 percent) in SD5-3 and SD5-3R, and chromium (144.8 percent), copper (81.2 percent), silver (54.5 percent), and zinc (145.8 percent) in SD2-1 and SD2-1R. The RPD criteria were not met for lead (56 percent) and zinc (66 percent) in MW3-1-1 and MW3-1-1R. The CRDL criteria were not met for arsenic, beryllium, copper, and nickel in groundwater samples MW3-1-1 and MW3-1-1R. All gasoline range, diesel fuel range, and heavy oil range RPD values did not meet the acceptance criteria for diesel fuel range and heavy oil in SD5-5 and SD5-5R, SB4-3-1 and SB4-3-1R, MWBG-2-3 and MWBG-2-3 R, SB1-3-11 and SB1-3-11R, SD2-1 and SD2-1R. The diesel fuel range RPD value did not meet the required evaluation criteria in SB2-2-1 and SB2-2-1R. Average diesel fuel range and heavy oil RPD values from range from 66.7 percent to 200 percent.

A conclusion of the Springfield ANGB SI is that field duplicates play a minor role in judging the media component variability. For solid matrices such as soil and sediments, the lack of precision due to the media overwhelms the other components of precision (sampling activities, laboratory methods, etc.). Based on these RPD results and the acceptable QC results, the sample collection DQO criteria for reproducibility is considered to have been met, except where noted. A comprehensive discussion of all replicate sample results is presented in Appendix G (Section G.2.4).

3.2.1.2 Accuracy

Accuracy is defined as the degree of difference between measured or calculated values and the true value. The closer the numerical value of the measurement approaches the true value, or actual concentration, the more accurate the measurement is. Analytical accuracy is expressed as the percent recovery of a compound or element that has been added to the environmental sample at a known concentration before analysis. The percent recovery values were calculated using the equation given in Appendix G.

Laboratory accuracy was qualitatively assessed by evaluating the following laboratory QC information: surrogate recovery (GC/MS only), laboratory control sample (LCS), and field samples spiked with target compounds.

Twenty-four (of 154 values) and 36 (of 138 values) matrix spike and matrix spike duplicates percent recovery values were outside the applicable EPA CLP SOW and CLP functional guideline control limits. The limits are contained in Appendix G (Tables G-17 and G-18, pages G-122 and G-123). All supporting SVOC and priority pollutant metals QC information cited above also was qualitatively evaluated with respect to the analytical accuracy DQO. Selected data validation qualifiers were applied to the SVOC environmental sample results due to poor surrogate recoveries. Of the qualified SVOC data points, these values have the greatest adverse impact on the environmental data quality, since these results prevent an evaluation of any aged petroleum fuel hydrocarbons that may have been detected in the samples.

Data validation qualifiers were applied to 25 antimony, 4 arsenic, and 26 selenium concentrations to indicate that these values were rejected due to unacceptable (i.e., less than 30 percent) matrix spike recoveries. In addition, data validation qualifiers were applied to numerous other priority pollutant metals concentrations to indicate that the matrix spike recoveries were outside the applicable control limits. Despite these values, no systematic laboratory error was detected, since all LCS criteria for soil and water samples were met. As a result, all associated soil and groundwater data were qualified for data validation purposes, as required by EPA validation guidelines; however, the results are considered to have little impact on the overall environmental data quality.

The data validation qualifier "U[MB]" was applied to the VOC (i.e., 2-butanone) detected in 1 soil sample and the SVOC (i.e., bis[2-ethylhexyl]phthalate) detected in 19 soil samples to indicate that the concentrations reported in these samples did not exceed 10 times that detected in the associated laboratory method blanks. Therefore, 2-butanone and bis(2-ethylhexyl)phthalate will not be considered detected compounds for risk assessment purposes due to associated laboratory method blank contamination. The data validation qualifier "U[MB]" was applied to various elements (i.e., antimony, arsenic, cadmium, copper, lead, nickel, silver, selenium, thallium, and zinc) detected in the environmental samples in concentrations less than five times that detected in the associated laboratory method blank. Despite the data validation qualifiers, these laboratory method blank results are not considered to have adversely impacted the sample data quality. Based on the evaluation of the MS/MSD and laboratory method blank results and the associated laboratory QC results summarized in Appendix G (Section G.3), the overall accuracy is acceptable, and as such, the analytical DQO for accuracy was met, except where noted.

Sampling accuracy was maximized by adherence to the strict QA program presented in the SI QAPP. All procedures (i.e., soil boring and monitoring well installation, soil and groundwater sample collection, equipment decontamination, and health monitoring equipment calibration and operation) used during the Springfield ANGB SI were documented as standard operating procedures (SOPs). Field QC blanks (i.e., trip blanks, field blanks, and equipment blanks) were prepared to ensure that all samples represent the particular site from which they were collected, assess any cross-contamination that may have occurred, and qualify the analytical data accordingly.

Data validation qualifiers were applied to the VOCs (i.e., methylene chloride, acetone, and chloroform) detected in nine selected environmental samples (i.e., one groundwater and eight soil) and to the SVOC (i.e., bis [2-ethylhexyl] phthalate) detected in four groundwater samples, to indicate that these compounds were considered not detected due to associated field QC blank contamination. These samples were validated using the highest concentration of the applicable interferent detected in the associated field QC blank. Data validation qualifiers also were applied to copper, lead, and zinc detected in groundwater samples to indicate that these concentrations are considered estimated, since the concentrations detected in groundwater samples did not exceed five times that detected in the associated field QC blank. Despite the data validation qualifiers, these field QC results are not considered to have adversely impacted the groundwater sample data quality, since metals are relatively nonvolatile and the possibility of cross-contamination between field QC blanks and groundwater samples is considered remote. In addition, it is unlikely that the water used to prepare the field QC blanks was the source of copper, lead, and zinc detected in the associated groundwater samples, since the bailer was effectively rinsed numerous times with the sample media during the well preparation activities. Based on an evaluation of the compounds and elements detected in the field QC blanks, the overall field accuracy is acceptable, except where noted. As a result, the field DQO for accuracy is considered to have been met. A comprehensive discussion of the field QC results is presented in Appendix G (Section G.2).

3.2.1.3 Representativeness

Representativeness was defined as the degree to which the data accurately and precisely represent a characteristic of a population, parameter variations at a sampling location, a process condition, or an environmental condition. Sample representativeness was ensured during the SI by collecting sufficient samples of a population medium, properly distributed with respect to location and time. Representativeness was assessed by reviewing the drilling techniques and equipment; well installation procedures and materials; and sample collection methods, equipment, and sample containers used during the Springfield ANGB SI, in addition to evaluating the RPD values calculated from the duplicate samples and the concentrations of interferents detected in the field and laboratory QC samples. The reproducibility of a representative set of samples reflects the degree of heterogeneity of the sampled medium, as well as the effectiveness of the sample collection technique.

Seven monitoring wells and eight piezometers were installed using hollow-stem auger drilling techniques. This method is commonly used to install monitoring wells to depths less than 100 feet. All samples were collected using the split spoon driven in front of the auger. As originally specified in the SI Work Plan (SAIC 1992a), California ring samplers (i.e., brass or stainless steel liners inserted into a split spoon sampler) were used to collect all soil samples. All data are considered to be representative.

Based on the evaluation of the factors described above and summarized in Appendix G (Section G.3), the samples collected during the SI are considered to be representative of the environmental conditions at Springfield ANGB.

3.2.1.4 Comparability

Comparability is a qualitative parameter expressing the confidence with which one data set can be compared to another and is limited to the other PARCC parameters, because only when precision and accuracy are known can one data set be compared to another. To optimize comparability, only the specific methods and protocols that were specified in the SI QAPP, as required by DOE/HWP-65/R1, were used to collect and analyze samples during the Springfield ANGB SI. By using consistent sampling and analysis procedures, all data sets were comparable within the sites at Springfield ANGB, between sites at the installation, or among U.S. Air Force (USAF) facilities nationwide, to ensure that remedial action decisions and priorities were based on a consistent data base. Comparability also was ensured by the analysis of EPA reference materials, establishing that the analytical procedures used were generating valid data.

All samples collected for VOC, SVOC, and priority pollutant metals analyses were analyzed using EPA methods. Samples collected for gasoline range, diesel fuel range, and heavy oil range analyses were analyzed using Total Petroleum Hydrocarbon Modified 8015 (WTPH-D) Method. Based on the precision and accuracy assessment presented above, the data collected during the SI are considered to be comparable with the data collected during previous investigations.

3.2.1.5 Completeness

Completeness is a measure of the amount of usable data resulting from a measurement system. Springfield ANGB data are considered valid within the constraints identified by data qualifiers.

Furthermore, project completeness was defined as the percentage of data used to prepare a preliminary risk evaluation and upon which recommendations for site remediation are based. For analytical data to be considered to be usable for preliminary risk evaluation and remediation recommendations, each data point must be satisfactorily validated. Rejected (e.g., due to matrix spike recoveries) concentrations reported for all analyses were not used in the risk estimates or for remediation recommendations due to the increased potential of using the concentration of compounds and elements (i.e., false negatives) that may have an adverse impact on human health. As a result, 54 priority pollutant metals (3.1 percent of the total priority pollutant metals data) data points were recommended to not be included in a preliminary risk evaluation. Certain undetected results for antimony, arsenic, and selenium were rejected due to spike recoveries being less than 30 percent. Based on the evaluation of the field and laboratory QC results presented in Appendix G (Sections G.2 and G.3), 100 percent of the sample data collected for VOC, SVOC, gasoline range, diesel fuel range, and heavy oil range analyses, and 96.9 percent of the sample data collected for priority pollutant metals analyses during the SI were used as the basis for all recommendations presented in this report. A complete list of these data points is presented in Appendix G.

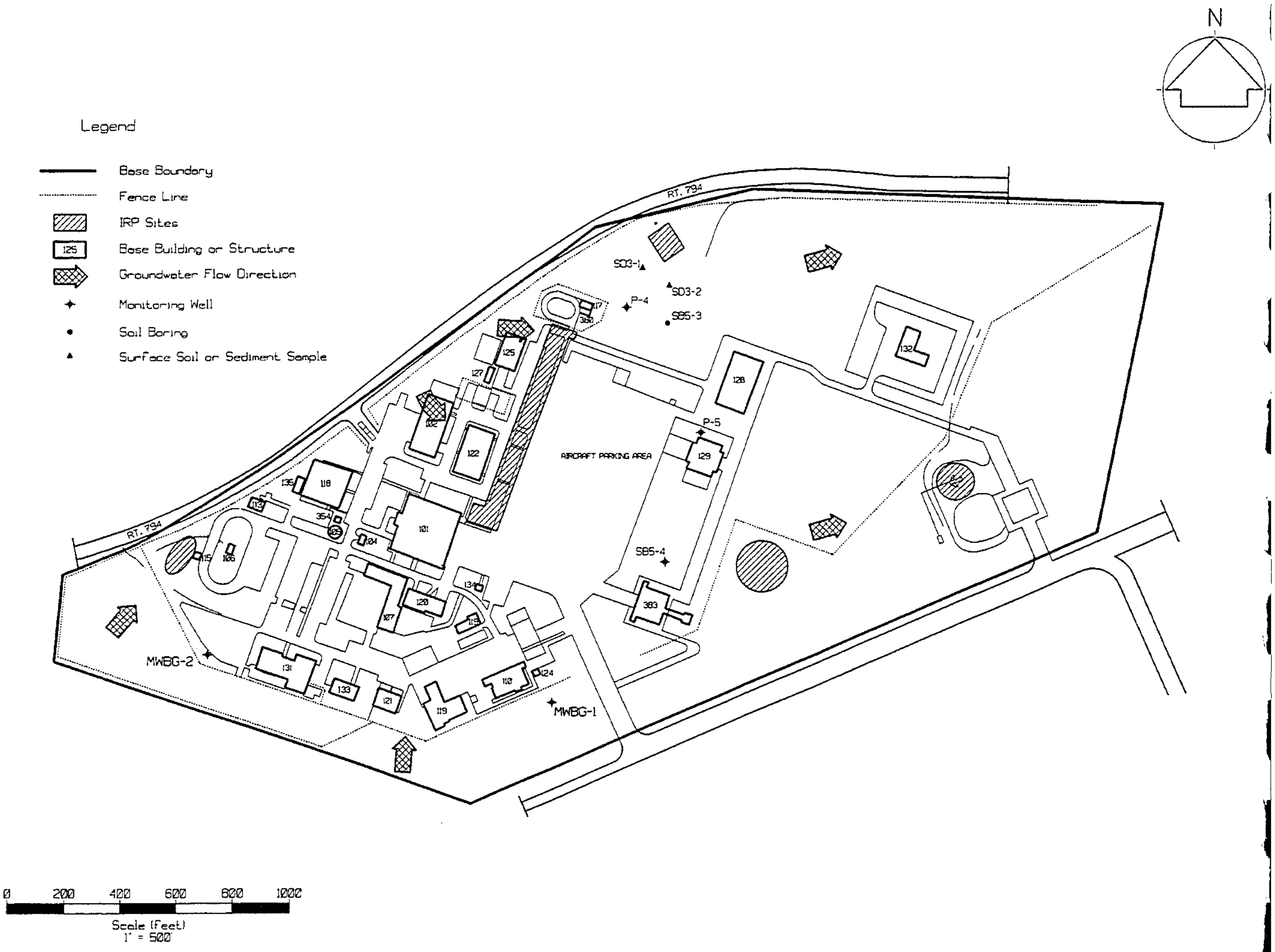
3.3 BACKGROUND SAMPLING

Soil and groundwater samples were collected from locations at sufficient distances and/or upgradient from the SI sites to establish ambient concentration ranges of chemicals at the Base not related to site activities. These locations are shown in Figure 3-5. Tables presenting background sampling information (Tables 3-4 through 3-7) are presented at the end of Section 3.3. After the piezometers were installed and groundwater flow direction was assessed, two background soil borings (i.e., MWBG-1 and MWBG-2) were located upgradient and upslope of the SI sites. These two borings were completed as monitoring wells. Two soil samples were collected from each boring (one at the surface and one at the soil-water interface), and two rounds of groundwater samples were collected from each of the two monitoring wells.

Analytical results were evaluated during the course of the field investigation and indicated the need for additional background data. Borings SB5-3 and SB5-4 were drilled at the north and east sides of the aircraft parking apron, respectively. These borings were sampled at the surface and soil-water interface. Data from these borings were used to assess the impact of routine Base operations on soils surrounding the aircraft parking area and to determine if contaminants detected at Site 5 were site related. Because the locations of SB5-3 and SB5-4 preclude impact by the SI sites, soil analytical data from these borings are included in the background data set.

Surface soil samples (i.e., SD3-1, SD3-2, and SD3-2R) were collected and analyzed upgradient and upslope of Site 3 for comparison to contaminants detected in surface soil at Site 3, as discussed in Section 3.7. Because these samples are located outside of the influence of the SI sites, analytical results from SD3-1, SD3-2, and SD3-2R are included in the background data set.

Groundwater samples collected from piezometers P-4 and P-5 were used to evaluate groundwater quality upgradient of Sites 3 and 2, respectively. The piezometers were installed following the same procedures used to install monitoring wells during the SI; therefore, DQOs were not adversely affected. Piezometers were installed in locations considered to be unaffected by site activities; therefore, groundwater analytical data from P-4 and P-5 are included in the background data set.



SAIC
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Background/Ambient Sample Location Map

Springfield ANGB, Springfield, Ohio

Figure: 3-5 | Project: 01-0827-03-0200-005

Onsite GC screening was conducted for VOCs throughout the soil column and groundwater for the soil borings drilled in background sites. However, chemicals were not detected in the samples.

The samples collected to represent background conditions at Springfield ANGB showed low levels of petroleum-related compounds (i.e., total petroleum hydrocarbons [TPH]; benzene, toluene, ethylbenzene, and xylene [BTEX]; and polycyclic aromatic hydrocarbons [PAHs]) and inorganic constituents (i.e., metals). Some of these chemicals occur naturally in background (e.g., many metals), while others are anthropogenic (the result of routine airport and Base activities). Following OEPA guidance *How Clean is Clean?* (OEPA 1991), a statistical analysis was performed to determine whether contaminant concentrations in site samples exceeded levels detected in the background soils. The results of the analysis are used to determine if contamination is site-related. A statistical approach for determining evidence of site-related contamination is to define background upper tolerance limits (Tu) for each contaminant of potential concern and to compare the Tu to chemical concentrations found at the site. Levels exceeding the Tu are expected to be site related.

Probability plots were prepared for analytes detected in background samples. The results of these statistical tests, which are reported in Appendix M, did not confirm that the data were normally distributed. After lognormally transforming the background data, the tests were repeated. The results did not confirm that the background data are characteristic of a lognormal distribution. OEPA's guidance (OEPA 1991) does not indicate the requirements for data that are neither normally distributed nor normally distributed after a transformation (e.g., lognormal). Washington State Department of Ecology (Washington State 1992) provides a statistical method, taken from Conover (1980), that may be used in such cases. This nonparametric method is useful for small (i.e., $\leq$ 20 samples) data sets. For the data set for Springfield ANGB, the nonparametric method recommended by Washington State Department of Ecology was used to compare background results with results from the sites. Background levels are defined as chemical concentrations present at an investigation area that would be expected in the absence of site-related disposal activities.

A statistical approach for determining evidence of site-related contamination was used to define an upper confidence limit (UCL_{90}) and a lower confidence limit (LCL_{90}) around the 90th percentile of the background sample data for each contaminant of potential concern, and to use the UCL_{90} as a point of comparison for chemical concentrations detected at the site.

The background results were ordered from the smallest to largest, and a rank was assigned to each sample value. The LCL_{90} and the UCL_{90} were determined for these values. Because of the number of background samples and the confidence around the upper percentile, the UCL_{90} represents the highest ranking sample (the highest measured concentration).

The tolerance interval comparison conducted for Springfield ANGB determines the number of site samples (i.e., soil, sediment, and groundwater) that exceed the background upper tolerance limit. A proportion is presented for each analyte in each medium with the number of samples exceeding the background tolerance interval over the total number of samples for a given analyte. If site sample concentrations exceed the background upper tolerance limit for a contaminant, that chemical may be concluded to be statistically different from background (i.e., site related). Site samples below the background upper tolerance limit are indistinguishable from background and are not site-related contaminants. The background tolerance limits are presented in Tables 3-4 and 3-5 for soil and groundwater, respectively. The comparisons are presented in Sections 3.4 through 3.9.

3.3.1 Chemicals Detected in Soil

Laboratory analytical results for soil are summarized in Table 3-6. A detailed discussion of the TICs detected in soil samples is presented in Appendix G, Section G.4. TPHs were detected as diesel fuel and/or heavy oil in the four soil borings ranging from 2 to 136 mg/kg. The highest soil boring TPH concentrations were detected in the samples from the soil-water interface. Surface soil TPH analyses distinguished between gasoline, diesel fuel, and heavy oil. Gasoline was not detected in surface soil, diesel fuel was detected in the three samples from 23 to 37 mg/kg, and heavy oil was detected from 99 to 160 mg/kg.

VOCs were detected in soil from borings MWBG-2 and SB5-4. BTEX were detected in soil sample MWBG2-3 (17.5 to 19.5 feet BLS) at estimated concentrations of 3, 14, 10, and 72 μg/kg, respectively. Toluene, ethylbenzene, and xylene were detected in soil boring sample SB5-4-1 (0.5 to 2.5 feet BLS) at estimated concentrations of 10, 7, and 8 μg/kg, respectively. In addition, acetone was detected in sample SB5-4-2 (28.5 to 30.5 feet BLS). VOCs were not detected in surface soil samples SD3-1, SD3-2, and SD3-2R.

The only VOC TICs detected were in soil sample MWBG2-3. Two VOC TICs, which were identified as an alkyl benzene, were placed in the petroleum or petroleum degradation products category. Two VOC TICs, which may have been introduced through contamination either during field sampling laboratory preparation and analysis, were placed in the other category.

SVOCs were detected in borings MWBG-1, MWBG-2, and SB5-4. Fluoranthene, pyrene, and benzo(b)fluoranthene were detected in MWBG2-1 (0.5 to 2.0 feet BLS) and bis(2-ethylhexyl)phthalate was detected in samples MWBG1-2 and SB5-4-1 at estimated concentrations of 36 and 35 μg/kg, respectively. SVOCs detected in SD3-1, SD3-2, and SD3-2R include 13 PAH compounds and carbazole ranging from 2 to 550 μg/kg.

SVOC TICs detected in the background samples include straight-chain alkanes or branched alkanes series, and several other compounds that have been detected infrequently. 9-Hexadecanoic acid and hexadecanoic acid concentrations from the August 1992 and May 1993 sampling appear to show a consistent distribution in the area. These SVOC TICs were identified in MWBG1-1, MWBG1-2, SD3-1, SD3-2, SD3-2R, SB5-3-1, and SB5-4-1. Hexadecanoic acid and 9-hexadecanoic acid occur naturally in soil, but also can be found in petroleum or petroleum degradation products. 9-Hexadecanoic acid and hexadecanoic acid are treated as representative of background conditions at Springfield ANGB. Therefore, they were placed in the naturally occurring organic compounds category if detected at levels below those of the background samples. Hexanedioic acid, mono(2-ethylhexyl)ester detected in SD3-2R was placed in another category. 4-Hydroxy-4-methyl-2-pentanone was detected in all background samples. This compound is an aldol reaction product of acetone used in the analytical procedure and in the cleaning of laboratory equipment, and therefore, is considered a laboratory artifact. 4-Hydroxy-4-methyl-2-pentanone was considered nondetected in SD3-1 because the detected concentration was lower than that detected in the associated method blank. The majority of the SVOC TICs were identified as straight-chain alkanes or branched alkanes. 1-Chloro-3-isocyana and 1,4-hexadiene-3,3,5-trimethyl were placed in the petroleum or petroleum degradation product category. Iron-tricarbonyl [N-(phenyl]) identified in MWBG-2-3 was classified as a petroleum degradation product. The source of contamination with this compound may be automobile exhaust. Ci70 D12-Chrysene was identified in MWBG1-1 and was placed in the PAH category. Two amide compounds were classified in the other category as the source of this contamination does not appear to be petroleum-related materials. The remainder of the TICs were identified as unknown and are possibly naturally occurring in soil or are of anthropogenic origin. However, little can be interpreted from these detections of unknown compounds. Further study may resolve the identification of these unknown compounds.

The majority of the TIC compounds listed in Table 3-6 are unknown or various types of unknown organic chemical classes (i.e., "unknown hydrocarbon"). As such, these compounds were not specifically interpreted.

Inorganic constituents, including 11 metals and arsenic, were detected in background soils. These chemicals are considered naturally occurring or the result of routine Base operations and are used to determine background criteria.

3.3.2 Chemicals Detected in Groundwater

As shown in Table 3-7, no TPH, VOCs, or SVOCs were detected in monitoring wells MWBG-1 and MWBG-2 or piezometer P-5. Two VOCs were detected in piezometer P-4: 1,2-dichloroethene at 0.6 μg/L and trichloroethene at 0.7 μg/L. This single occurrence of VOCs in background groundwater was not sufficient to include the values in the background comparisons. No TPH or SVOCs were detected in piezometer P-4. No VOC TICs were detected. Detection of SVOC TICs in the area appears to be sporadic for SVOC nontarget compounds. Two SVOC TICs were identified as methylated ketone and amide. These were placed in the other category. Hexanoic acid-6-amino detected in MWBG-2-2, P4-1, P4-1R, and P5-1 were categorized as naturally occurring organic compounds.

The metals arsenic and chromium were detected in MWBG-1. Metals detected in unfiltered groundwater from P-4 and P-5 include antimony, arsenic, lead, mercury, beryllium, chromium, copper, nickel, silver, and zinc. The majority of these concentrations are considered to be bound to suspended solids because only antimony and lead were detected in filtered groundwater at P-4, and only antimony and zinc were detected in the filtered sample from P-5.

3.3.3 Summary

Background analytical results represent conditions on the Base not associated with site activities. Chemicals detected may be naturally occurring or anthropogenic. Anthropogenic chemicals represent those generated by routine Base operations and also are included in the determination of site-related contamination. Organic compounds detected in background were generally petroleum-related and include TPH, aromatic hydrocarbons, and PAHs. Analytical results are compared with background criteria site by site in Sections 3.5 through 3.9.

3.4 APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (ARARs)

Drinking water ARARs, shown in Table 3-8, are compared to the site-related chemicals detected in unfiltered and filtered groundwater in Sections 3.5 through 3.9.

Petroleum hydrocarbons in soil are compared to action levels determined by the Ohio Division of State Fire Marshall, Bureau of Underground Storage Tank (UST) Regulations (ODOC 1992). The action levels promulgated under this guidance are appropriate for UST sites and are not directly applicable to the Springfield ANGB SI. However, because of the similarity of contaminants and the lack of other guidance for soil contaminants, the most conservative Division of State Fire Marshall TPH action levels are used as a point of comparison. The most conservative action level for UST sites for TPH as gasoline and "other than gasoline" (i.e., diesel fuel or heavy oil) are 105 and 380 mg/kg in soil, respectively. TPH concentrations are also compared to the action level of 105 mg/kg set by OEPA's Division of Solid and Infectious Waste Management (DSIWM).

Table 3-4. Statisitcal Evaluation: Tolerance Intervals for Metals and Organic Compounds Background Soil Samples 178th Tactical Fighter Group, Springfield ANGB, Springfield, Ohio

Parameter	Units	Proportion of Results Greater than Detection Limit	Minimum Detected Result	Maximum Detected Result	Mean Detected Result	Standard Deviation	Upper Tolerance Limit
Diesel Fuel	mg/kg	4 / 6	3	37	12.08	14.87	37
Heavy Oil	mg/kg	6 / 6	2	160	51.58	66.5	160
INORGANICS							
Antimony	mg/kg	3 / 5	0.0975	0.21	0.1175	0.0544	0.21
Arsenic	mg/kg	6 / 6	6.1	11.3	8.433	2.038	11.3
Beryllium	mg/kg	6 / 6	0.27	0.55	0.4125	0.1368	0.55
Cadmium	mg/kg	2 / 6	0.3	1.5	0.3942	0.5509	1.5
Chromium (III)	mg/kg	6 / 6	6.4	121	29.93	44.84	121
Copper	mg/kg	6 / 6	11.7	48.7	20.64	14	48.7
Lead	mg/kg	6 / 6	8.2	126	32.67	45.93	126
Mercury	mg/kg	1 / 6	0.5	0.5	0.1171	0.188	0.5
Nickel	mg/kg	6 / 6	13	61.5	22.85	19.12	61.5
Selenium	mg/kg	1 / 6	0.25	0.25	0.1117	0.0865	0.25
Silver	mg/kg	4 / 6	0.635	5.3	1.737	1.812	5.3
Thallium	mg/kg	4 / 6	0.1675	0.4	0.2413	0.126	0.4
Zinc	mg/kg	6 / 6	39.1	343	100.3	119.5	343
ORGANICS							
Acenaphthylene	mg/kg	2 / 6	0.002	0.1095	0.1095	0.0732	0.1095
Anthracene	mg/kg	1 / 6	0.116	0.116	0.116	0.0301	0.116
Benzo(a)anthracene	mg/kg	2 / 6	0.011	0.205	0.1556	0.0725	0.205
Benzo(a)pyrene	mg/kg	2 / 6	0.012	0.22	0.1583	0.0744	0.22
Benzo(b)fluoranthene	mg/kg	3 / 6	0.025	0.37	0.1599	0.123	0.37
Benzo(g,h,i)perylene	mg/kg	2 / 6	0.013	0.195	0.1543	0.0704	0.195
Benzo(k)fluoranthene	mg/kg	2 / 6	0.009	0.125	0.125	0.0696	0.125
Carbazole	mg/kg	1 / 6	0.112	0.112	0.112	0.0316	0.112
Chrysene	mg/kg	2 / 6	0.013	0.245	0.1626	0.0787	0.245
Ethylbenzene	mg/kg	1 / 6	0.0063	0.0063	0.0058	0.0003	0.0063
Fluoranthene	mg/kg	3 / 6	0.018	0.44	0.1763	0.144	0.44
Indeno(1,2,3-cd)pyrene	mg/kg	2 / 6	0.016	0.225	0.1598	0.0736	0.225
Phenanthrene	mg/kg	2 / 6	0.006	0.265	0.1648	0.0858	0.265
Pyrene	mg/kg	3 / 6	0.018	0.44	0.1751	0.1449	0.44
Toluene	mg/kg	1 / 6	0.012	0.012	0.0068	0.0026	0.012
Xylenes	mg/kg	1 / 6	0.0068	0.0068	0.0059	0.0005	0.0068

Samples MWBG-1-1s, MWBG-2-1s, SB5-3-1, SB5-4-1, SD3-1, and SD3-2 were used to estimate the 95 percent confidence limit of the 90th percentile of background data

Table 3-5. Statisitcal Evaluation: Tolerance Intervals for Metals and Organic Compounds Background Groundwater Samples 178th Tactical Fighter Group, Springfield ANGB, Springfield, Ohio

Parameter	Units	Proportion of Results Greater than Detection Limit	Minimum Detected Result	Maximum Detected Result	Mean Detected Result	Standard Deviation	Upper Tolerance Limit
INORGANICS							
Antimony	mg/L	5 / 5	0.0009	0.0015	0.0012	0.0003	0.0015
Arsenic	mg/L	5 / 5	0.0028	0.0162	0.0068	0.0054	0.0162
Beryllium	mg/L	5 / 6	0.0005	0.0042	0.0015	0.0016	0.0042
Chromium (III)	mg/L	6 / 6	0.0091	0.15	0.0505	0.0546	0.15
Copper	mg/L	4 / 6	0.0245	0.21	0.0676	0.0788	0.21
Lead	mg/L	4 / 6	0.0098	0.104	0.0324	0.0399	0.104
Nickel	mg/L	5 / 6	0.0217	0.247	0.0777	0.0945	0.247
Silver	mg/L	2 / 6	0.0031	0.0033	0.0022	0.0008	0.0033
Zinc	mg/L	4 / 6	0.0971	0.763	0.2689	0.2994	0.763
Antimony (dissolved)	mg/L	4 / 4	0.0009	0.002	0.0014	0.0004	0.002
Lead (dissolved)	mg/L	1 / 4	0.0067	0.0067	0.0019	0.0032	0.0067
ORGANICS							
1,2-Dichloroethylene	mg/L	1 / 6	0.0006	0.0006	0.0003	0.0001	0.0006
Trichloroethylene	mg/L	1 / 6	0.0007	0.0007	0.0003	0.0002	0.0007

Samples MWBG-1-1, MWBG-1-2, MWBG-2-1, MWBG-2-2, P-4-1, and P-5-1 were used to estimate the 95 percent confidence limit of the 90th percentile of background data

Table 3-6. Data Summary Table: Soil – Background Site, 178th Tactical Fighter Group, Springfield ANGB, Springfield, Ohio

Parameter	Units		MWBG1-1			MWBG1-2			MWBG-2-1	
SAIC ID Number			MWBG1-1			MWBG1-2			MWBG-2-1	
Laboratory ID Number			94527			94526			94912	
Collection Date			8-12-92			8-12-92			8-19-92	
Collection Depth (ft)			1.3-2.0			8.0-10.0			0.5-2.0	
Associated Field QC Sample			TB-1 on 8-12-92 ER1-1 FB1-1 SD5-FB			TB-1 on 8-12-92 ER1-1 FB1-1 SD5-FB			TB-6 EB3-1 FB3-1 SD5-FB	
TOTAL PETROLEUM HYDROCARBONS (SW 8015M)										
Diesel Fuel	mg/kg		7			NA			<2	
Heavy Oil	mg/kg		14			NA			2	
PRIORITY POLLUTANT METALS										
AA METALS										
Antimony (SW 3050/7041)	mg/kg		0.15 UJ(N)			R(N)			R(N)	
Arsenic (SW 3050/7060)	mg/kg		7			6.8			6.1 J(N)	
Lead (SW 3050/7421)	mg/kg		8.2			87 J(*)			15.3	
Selenium (SW 3050/7740)	mg/kg		0.06 UJ(N,W)			R(N)			0.13 UJ(N,W)	
Thallium (SW 3050/7841)	mg/kg		0.3 UJ(N,W)			0.16 J(N,W)			0.17 U(MB)	
ICP METALS (SW 3050/6010)										
Beryllium	mg/kg		0.27 B			0.32 B			0.53 B	
Cadmium	mg/kg		0.3 B			0.39 U			0.2 U	
Chromium	mg/kg		6.4			8.4			13.5	
Copper	mg/kg		12.4			16.9 U(EB)			11.7	
Nickel	mg/kg		13.1			11.6			13	
Silver	mg/kg		1.6 U(MB)			0.32 U			0.97 U(MB)	
Zinc	mg/kg		43.9 J(E)			38.8 J(E)			39.1 J(E)	
VOLATILE ORGANICS (SW 8240 [A])										
Acetone	µg/kg		11 U			11 U			12 U	
Benzene	µg/kg		11 U			11 U			12 U	
Toluene	µg/kg		11 U			11 U			12 U	
Ethylbenzene	µg/kg		11 U			11 U			12 U	
Xylene (total)	µg/kg		11 U			11 U			12 U	
TICs	µg/kg		0 (0)			0 (0)			0 (0)	
TIC Total	µg/kg		0 (0)			0 (0)			0 (0)	
SEMIVOLATILE ORGANICS (SW 8270 [B])										
Fluoranthene	µg/kg		330 U			330 U			82 J	
Pyrene	µg/kg		330 U			330 U			75 J	
bis(2-Ethylhexyl)phthalate	µg/kg		330 U			36 J			400 U	
Benzo(b)fluoranthene	µg/kg		330 U			330 U			47 J	
TICs	µg/kg	4-Hydroxy-4-Methyl-2-Pentanone[a]	19000 B,J,N,A	(RT 4.83)	4-Hydroxy-4-Methyl-2-Pentanone[a]	17000 B,J,N,A	(RT 4.82)	4-Hydroxy-4-Methyl-2-Pentanone[a]	14000 B,J,N,A	(RT 5.40)
		9-Hexadecenoic Acid[f]	240 J,N	(RT 23.72)	Unknown[d]	71 J	(RT 23.02)	Unknown[d]	270 J	(RT 32.91)
		Hexadecanoic Acid[f]	160 J,N	(RT 23.87)	9-Hexadecenoic Acid[f]	83 J,N	(RT 23.69)	Unknown[d]	270 J	(RT 33.94)
		Nonanamide[c]	95 J,N	(RT 23.97)	Hexadecanoic Acid[f]	110 J,N	(RT 23.85)	Unknown[d]	160 J	(RT 34.06)
		Unknown[d]	68 J	(RT 24.32)	Unknown[d]	82 J	(RT 24.32)	Pentatriacontane[b]	350 J,N	(RT 34.99)
		Unknown[d]	56 J	(RT 25.57)	Unknown[d]	71 J	(RT 25.57)	Unknown[d]	390 J	(RT 37.26)
		Unknown[d]	91 J	(RT 26.04)	Unknown[d]	160 J	(RT 26.24)	Unknown[d]	360 J	(RT 38.92)
		Unknown[d]	290 J	(RT 26.26)	Dodecanamide[c]	140 J,N	(RT 26.49)			
		Dodecaramide[c]	280 J,N	(RT 26.51)	Unknown[d]	120 J	(RT 26.76)			
		Unknown[d]	74 J	(RT 26.76)	Unknown[d]	170 J	(RT 27.91)			
		Unknown[d]	110 J	(RT 27.41)	Unknown[d]	170 J	(RT 28.51)			
		Unknown[d]	100 J	(RT 27.91)	Unknown[d]	2900 J	(RT 28.61)			
		Unknown[d]	350 J	(RT 28.51)	Unknown[d]	55 J	(RT 28.86)			
		Unknown[d]	5300 J	(RT 28.64)	Unknown[d]	140 J	(RT 29.02)			
		Unknown[d]	74 J	(RT 28.86)	Unknown[d]	180 J	(RT 30.09)			
		Unknown[d]	77 J	(RT 29.02)	Unknown[d]	150 J	(RT 31.16)			
		Unknown[d]	110 J	(RT 30.09)	Unknown[d]	330 J	(RT 32.22)			
		Unknown[d]	74 J	(RT 31.16)	Unknown[d]	1600 J	(RT 33.09)			
		Unknown[d]	190 J	(RT 32.22)	Unknown[d]	230 J	(RT 33.31)			
		Unknown[d]	1700 J	(RT 33.09)	Unknown[d]	360 J	(RT 34.41)			
		Ci70 D12-Chrysene[e]	360 J	(RT 34.19)	Unknown[d]	340 J	(RT 36.92)			
		Unknown[d]	300 J	(RT 34.41)						
TIC Total	µg/kg		29099 (22)			24462 (21)			15800 (7)	

Table 3–6. Data Summary Table: Soil – Background Site, 178 th Tactical Fighter Group, Springfield ANGB, Springfield, Ohio (Continued)

Parameter	Units		MWBG–2–3			MWBG–2–3R			SB5–3–1	
SAIC ID Number			MWBG–2–3			MWBG–2–3R			SB5–3–1	
Laboratory ID Number			94913			94914			94803	
Collection Date			8–19–92			8–19–92			8–18–92	
Collection Depth (ft)			17.5–19.5			17.5–19.5			0.5–2.0	
Associated Field QC Sample			TB–6 EB3–1 FB3–1 SD5–FB			TB–6 EB3–1 FB3–1 SD5–FB			TB–5 EB5–1 FB5–1 SD5–FB	
TOTAL PETROLEUM HYDROCARBONS (SW 8015M)										
Diesel Fuel	mg/kg		39 J(FD)			4 J(FD)			<2	
Heavy Oil	mg/kg		97 J(FD)			2 J(FD)			12	
PRIORITY POLLUTANT METALS										
AA METALS										
Antimony (SW 3050/7041)	mg/kg		R(N)			R(N)			0.17 UJ(N)	
Arsenic (SW 3050/7060)	mg/kg		5.7 J(N)			3.8 J(N)			9.7 J(*)	
Lead (SW 3050/7421)	mg/kg		7.4			5.7			17.2 *	
Selenium (SW 3050/7740)	mg/kg		0.13 UJ(N,W)			0.16 UJ(MB,N,W)			0.13 UJ(N,W)	
Thallium (SW 3050/7841)	mg/kg		0.18 UJ(MB,W)			0.14 UJ(MB,W)			0.36 J(N)	
ICP METALS (SW 3050/6010)										
Beryllium	mg/kg		0.37 B			0.33 B			0.53	
Cadmium	mg/kg		0.94 U			0.88 U			0.18 U	
Chromium	mg/kg		8.8			7.6			12.5 J(N)	
Copper	mg/kg		21.7			13.6			18.7	
Nickel	mg/kg		21.7			13			20	
Silver	mg/kg		2.8 U(MB)			3 U(MB)			1.5	
Zinc	mg/kg		46.7 J(E)			39.7 J(E)			60.1 J(E)	
VOLATILE ORGANICS (SW 8240 [A])										
Acetone	µg/kg		12 UJ(SR)			13 U			11 U	
Benzene	µg/kg		3 J(SR)			13 U			11 U	
Toluene	µg/kg		14 J(SR)			6 J			11 U	
Ethylbenzene	µg/kg		10 J(SR)			13 U			11 U	
Xylene (total)	µg/kg		72 J(SR, FD))			13 U			11 U	
TICs	µg/kg	Ethyl Ester Acetic Acid[c]	19 J,N	(RT 10.16)		0 (0)			0 (0)	
		4H–Pyran–4–One, 2,6–Dimethyl[c]	34 J,N	(RT 27.02)						
		1–Ethyl–4–Methyl–Benzene[b]	36 J,N	(RT 27.11)						
		1,2,4–Trimethyl–Benzene[b]	38 J,N	(RT 27.29)						
TIC Total	µg/kg		127 (4)			0 (0)			0 (0)	
SEMIVOLATILE ORGANICS (SW 8270 [B])										
Fluoranthene	µg/kg		350 U			390 U			350 U	
Pyrene	µg/kg		350 U			390 U			350 U	
bis(2–Ethylhexyl)phthalate	µg/kg		350 U			390 U			350 U	
Benzo(b)fluoranthene	µg/kg		350 U			390 U			350 U	
TICs	µg/kg	4–Hydroxy–4–Methyl–2–Pentanone[a]	12000 B,J,N,A	(RT 5.37)	4–Hydroxy–4–Methyl–2–Pentanone[a]	13000 B,J,N,A	(RT 5.37)	4–Hydroxy–4–Methyl–2–Pentanone[a]	5000 B,J,N,A	(RT 4.67)
		Unknown[d]	110 J	(RT 12.50)	Unknown[d]	110 J	(RT 32.91)	9–Hexadecenoic Acid[f]	100 J,N	(RT 23.75)
		Unknown[d]	260 J	(RT 14.40)	Unknown[d]	84 J	(RT 34.99)	Hexadecanoic Acid[f]	98 J,N	(RT 23.89)
		Unknown[d]	80 J	(RT 15.75)				Unknown[d]	67 J	(RT 27.92)
		Unknown[d]	340 J	(RT 16.19)				Unknown[d]	120 J	(RT 29.04)
		Heptadecane, 2,6,10,14–Tetra[b]	210 J,N	(RT 17.19)				Unknown[d]	100 J	(RT 30.12)
		Unknown[d]	370 J	(RT 17.85)				Unknown[d]	96 J	(RT 31.19)
		Hexadecane[b]	310 J,N	(RT 19.45)				Unknown[d]	210 J	(RT 32.24)
		Unknown[d]	180 J	(RT 20.15)				Unknown[d]	220 J	(RT 33.32)
		Heptadecane[b]	470 J,N	(RT 20.95)				Unknown[d]	81 J	(RT 33.72)
		2,6–Dimethyl–Heptadecane[b]	350 J,N	(RT 21.00)				Unknown[d]	350 J	(RT 34.44)
		Unknown[d]	280 J	(RT 22.39)				Unknown[d]	440 J	(RT 36.89)
		Unknown[d]	240 J	(RT 22.47)				Unknown[d]	170 J	(RT 37.61)
		Unknown[d]	320 J	(RT 23.75)						
		Iron, Tricarbonyl[N–(Phenyl–[b]	270 J,N	(RT 25.06)						
		Unknown[d]	250 J	(RT 26.31)						
		Unknown[d]	300 J	(RT 28.64)						
		Unknown[d]	300 J	(RT 29.76)						
		Pentacosane[b]	270 J,N	(RT 30.84)						
		Octacosane[b]	200 J,N	(RT 31.89)						
		Unknown[d]	490 J	(RT 32.92)						
TIC Total	µg/kg		17600 (21)			13194 (3)			7052 (13)	

Table 3–6. Data Summary Table: Soil – Background Site, 178 th Tactical Fighter Group, Springfield ANGB, Springfield, Ohio (Continued)

SAIC ID Number		SB5–3–2	SB5–4–1	SB5–4–1R
Laboratory ID Number		94804	94805	94806
Collection Date		8–18–92	8–18–92	8–18–92
Collection Depth (ft)		26.5–28.5	0.5–2.5	0.5–2.5
Associated Field QC Sample		TB–5 EB5–1 FB5–1 SD5–FB	TB–5 EB5–1 FB5–1 SD5–FB	TB–5 EB5–1 FB5–1 SD5–FB
Parameter	Units			
TOTAL PETROLEUM HYDROCARBONS (SW 8015M)				
Diesel Fuel	mg/kg	65	2	4
Heavy Oil	mg/kg	27	11	13
PRIORITY POLLUTANT METALS				
AA METALS				
Antimony (SW 3050/7041)	mg/kg	0.18 UJ(N)	0.16 UJ(N)	0.16 J(N)
Arsenic (SW 3050/7060)	mg/kg	6.4 J(*)	8.7 J(*)	10.4 J(*)
Lead (SW 3050/7421)	mg/kg	9.1 S*	9.1 *	10.5 S*
Selenium (SW 3050/7740)	mg/kg	0.14 UJ(N,W)	0.13 UJ(N,W)	0.62 UJ(N,W)
Thallium (SW 3050/7841)	mg/kg	0.31 J(N)	0.34 J(N)	0.23 J(N)
ICP METALS (SW 3050/6010)				
Beryllium	mg/kg	0.23 B	0.29 B	0.33 B
Cadmium	mg/kg	0.24 B	0.17 U	0.17 U
Chromium	mg/kg	6 J(N)	7.3 J(N)	7.4 J(N)
Copper	mg/kg	15.2	13.8	17.1
Nickel	mg/kg	11.6	15.5	16
Silver	mg/kg	1.5	1.6	1.8
Zinc	mg/kg	41 J(E)	43.8 J(E)	46.8 J(E)
VOLATILE ORGANICS (SW 8240 [A])				
Acetone	µg/kg	12 U	11 U	11 U
Benzene	µg/kg	12 U	11 U	11 U
Toluene	µg/kg	12 U	10 J	14
Ethylbenzene	µg/kg	12 U	7 J	11 U
Xylene (total)	µg/kg	12 U	8 JX	11 U
TICs	µg/kg	0 (0)	0 (0)	0 (0)
TIC Total	µg/kg	0 (0)	0 (0)	0 (0)
SEMIVOLATILE ORGANICS (SW 8270 [B])				
Fluoranthene	µg/kg	340 U	340 U	370 U
Pyrene	µg/kg	340 U	340 U	370 U
bis(2–Ethylhexyl)phthalate	µg/kg	340 U	35 J	370 U
Benzo(b)fluoranthene	µg/kg	340 U	340 U	370 U
TICs	µg/kg	4–Hydroxy–4–Methyl–2–Pentanone[a] 4000 B,J,N,A (RT 4.65)	4–Hydroxy–4–Methyl–2–Pentanone[a] 4100 B,J,N,A (RT 4.65)	4–Hydroxy–4–Methyl–2–Pentanone[a] 7400 B,J,N,A (RT 4.68)
		2–Methyl–Nonane[b] 130 J,N (RT 11.99)	Hexadecanoic Acid[f] 140 J,N (RT 23.89)	Unknown[d] 90 J (RT 29.99)
		Unknown[d] 310 J (RT 13.85)	Unknown[d] 170 J (RT 32.24)	Unknown[d] 190 J (RT 32.11)
		Tetradecane[b] 290 J,N (RT 15.60)	Unknown[d] 87 J (RT 33.31)	Unknown[d] 120 J (RT 33.16)
		2,3,7–Trimethyl–Decane[b] 160 J,N (RT 16.60)	Unknown[d] 110 J (RT 33.37)	1,4–Hexadiene, 3,3,5–Trimeth[e] 120 J,N (RT 33.24)
		Unknown[d] 330 J (RT 17.27)	Unknown[d] 370 J (RT 34.44)	Unknown[d] 280 J (RT 34.29)
		Hexadecane[b] 320 J,N (RT 18.84)	Unknown[d] 440 J (RT 36.86)	Unknown[d] 280 J (RT 36.69)
		5–Propyl–Tridecane[b] 190 J,N (RT 19.52)		
		Heptadecane[b] 490 J,N (RT 20.32)		
		2,6–Dimethyl–Heptadecane[b] 320 J,N (RT 20.37)		
		Unknown[d] 320 J (RT 21.74)		
		Unknown[d] 190 J (RT 21.82)		
		Unknown[d] 370 J (RT 23.09)		
		Unknown[d] 230 J (RT 24.37)		
		Unknown[d] 160 J (RT 25.61)		
		Docosane[b] 340 J,N (RT 26.79)		
		Unknown[d] 330 J (RT 27.94)		
		Unknown[d] 300 J (RT 29.06)		
		Pentacosane[b] 240 J,N (RT 30.12)		
		Octacosane[b] 190 J,N (RT 31.19)		
		Unknown[d] 330 J (RT 32.26)		
TIC Total	µg/kg	9540 (21)	5417 (7)	8480 (7)

Table 3–6. Data Summary Table: Soil – Background Site
178th Tactical Fighter Group, Springfield ANGB, Springfield, Ohio (Continued)

SAIC ID Number			SB5–4–2	
Laboratory ID Number			94807	
Collection Date			8–18–92	
Collection Depth (ft)			28.5–30.5	
Associated Field QC Sample			TB–5 EB5–1 FB5–1 SD5–FB	
Parameter	Units			
TOTAL PETROLEUM HYDROCARBONS (SW 8015M)				
Diesel Fuel	mg/kg		36	
Heavy Oil	mg/kg		13	
PRIORITY POLLUTANT METALS				
AA METALS				
Antimony (SW 3050/7041)	mg/kg		0.2 J(N)	
Arsenic (SW 3050/7060)	mg/kg		4.4 J(*)	
Lead (SW 3050/7421)	mg/kg		7.6 S*	
Selenium (SW 3050/7740)	mg/kg		0.15 UJ(N,W)	
Thallium (SW 3050/7841)	mg/kg		0.2 UJ(N)	
ICP METALS (SW 3050/6010)				
Beryllium	mg/kg		0.19 B	
Cadmium	mg/kg		0.21 U	
Chromium	mg/kg		8.7 J(N)	
Copper	mg/kg		10.7	
Nickel	mg/kg		11.5	
Silver	mg/kg		1.5	
Zinc	mg/kg		35 J(E)	
VOLATILE ORGANICS (SW 8240 [A])				
Acetone	µg/kg		18	
Benzene	µg/kg		11 U	
Toluene	µg/kg		11 U	
Ethylbenzene	µg/kg		11 U	
Xylene (total)	µg/kg		11 U	
TICs	µg/kg		0 (0)	
TIC Total	µg/kg		0 (0)	
SEMIVOLATILE ORGANICS (SW 8270 [B])				
Fluoranthene	µg/kg		350 U	
Pyrene	µg/kg		350 U	
bis(2–Ethylhexyl)phthalate	µg/kg		350 U	
Benzo(b)fluoranthene	µg/kg		350 U	
TICs	µg/kg	4–Hydroxy–4–Methyl–2–Pentanone [a]	3200 B,J,N,A	(RT 4.63)
		2–Methyl–Nonane [b]	77 J,N	(RT 11.97)
		Unknown [d]	130 J	(RT 13.84)
		Unknown [d]	130 J	(RT 15.60)
		2,3,7–Trimethyl–Decane [b]	86 J,N	(RT 16.59)
		Unknown [d]	150 J	(RT 17.25)
		Hexadecane [b]	140 J,N	(RT 18.82)
		2,7,10–Trimethyl–Dodecane [b]	82 J,N	(RT 19.50)
		Heptadecane [b]	200 J,N	(RT 20.30)
		2,6–Dimethyl–Heptadecane [b]	160 J,N	(RT 20.35)
		Unknown [d]	140 J	(RT 21.72)
		Unknown [d]	86 J	(RT 21.80)
		Unknown [d]	170 J	(RT 23.07)
		Unknown [d]	110 J	(RT 24.37)
		Unknown [d]	86 J	(RT 25.61)
		Unknown [d]	130 J	(RT 26.79)
		Unknown [d]	150 J	(RT 27.94)
		Unknown [d]	180 J	(RT 29.04)
		Unknown [d]	140 J	(RT 30.12)
		Unknown [d]	110 J	(RT 31.19)
		Unknown [d]	210 J	(RT 32.26)
TIC Total	µg/kg		5867 (21)	

Table 3-6. Data Summary Table: Soil – Background Site, 178th Tactical Fighter Group, Springfield ANGB, Springfield, Ohio (Continued)

SAIC ID Number			SD3-1			SD3-2			SD3-2R	
Laboratory ID Number			9555			9556			9557	
Collection Date			5-21-93			5-21-93			5-21-93	
Collection Depth (ft)			0.0-0.5			0.0-0.5			0.0-0.5	
Associated Field QC Sample			TB52093 EB2-2, EB3-2 N/A FB2-2, FB3-2			TB52093 EB2-2, EB3-2 N/A FB2-2, FB3-2			TB52093 EB2-2, EB3-2 N/A FB2-2, FB3-2	
Parameter	Units									
TOTAL PETROLEUM HYDROCARBONS (SW 8015M)										
Gasoline	mg/kg		<0.05			<0.05			<0.05	
Diesel Fuel	mg/kg		37			24			23	
Heavy Oil	mg/kg		160			120			99	
PRIORITY POLLUTANT METALS										
AA METALS										
Antimony (SW 3050/7041)	mg/kg		0.21 J(N,W)			0.09 UJ(N,W)			0.15 J(N,W)	
Arsenic (SW 3050/7060)	mg/kg		11.3 J(N)			6.7 J(N)			7.2 J(N)	
Lead (SW 3050/7421)	mg/kg		126 J(N)			21.3 J(N)			17.7 J(N)	
Mercury (SW 3050/7471)	mg/kg		0.5			0.04 U			0.04 U	
Selenium (SW 3050/7740)	mg/kg		0.25 J(W)			0.14 UJ(W)			0.15 UJ(W)	
Thallium (SW 3050/7841)	mg/kg		0.4 J(W)			0.22 J(W)			0.23 UJ(W)	
ICP METALS (SW 3050/6010)										
Beryllium	mg/kg		0.55 B			0.34 U(MB)			0.4 B	
Cadmium	mg/kg		1.5			0.61 U			0.55 U	
Chromium	mg/kg		121			17.3			20.3	
Copper	mg/kg		48.7			15.2			18.6	
Nickel	mg/kg		61.5			13.7			13.8	
Silver	mg/kg		5.3			0.66 B			0.61 B	
Zinc	mg/kg		343 J(E)			65.1 J(E)			75.5 J(E)	
VOLATILE ORGANICS (SW 8240[A])										
	µg/kg		ND			ND			ND	
SEMIVOLATILE ORGANICS (SW 8270[B])										
Acenaphthylene	µg/kg		2 J			39 J			360 U	
Phenanthrene	µg/kg		6 J			150 J			380	
Anthracene	µg/kg		390 U			360 U			52 J	
Carbazole	µg/kg		390 UJ(CCV)			44 J			360 U	
Fluoranthene	µg/kg		18 J			330 J			550	
Pyrene	µg/kg		18 J			330 J			550	
Benzo(a)anthracene	µg/kg		11 J			190 J			220 J	
Chrysene	µg/kg		13 J			210 J			280 J	
Benzo(b)fluoranthene	µg/kg		25 J			330 J			410	
Benzo(k)fluoranthene	µg/kg		9 J			120 J			130 J	
Benzo(a)pyrene	µg/kg		12 J			190 J			250 J	
Indeno(1,2,3-c,d)pyrene	µg/kg		16 J			210 J			240 J	
Benzo(g,h,i)perylene	µg/kg		13 J			190 J			200 J	
TICs	µg/kg	Benzene, 1-Chloro-3-Isocyana[b]	8 J,N	(RT 9.24)	4-Hydroxy-4-Methyl-2-Pentanone[a]	19000 B,J,N,A	(RT 3.93)	4-Hydroxy-4-Methyl-2-Pentanone[a]	18000 B,J,N,A	(RT 3.93)
		Hexadecanoic Acid[f]	18 J,N	(RT 22.34)	Unknown[d]	220 J	(RT 18.77)	Unknown[d]	180 J	(RT 18.77)
		Unknown[d]	4 J	(RT 27.36)	Unknown[d]	130 J	(RT 20.15)	Unknown[d]	220 J	(RT 21.50)
		Unknown[d]	4 J	(RT 28.41)	Unknown[d]	210 J	(RT 21.50)	Hexadecanoic Acid[f]	270 J,N	(RT 22.35)
		Unknown[d]	3 J	(RT 29.94)	Hexadecanoic Acid[f]	360 J,N	(RT 22.35)	Unknown[d]	140 J	(RT 22.79)
		Unknown[d]	6 J	(RT 30.44)	Unknown[d]	130 J	(RT 22.79)	Unknown[d]	160 J	(RT 24.00)
		Unknown[d]	4 J	(RT 31.51)	Unknown[d]	290 J	(RT 24.00)	Unknown[d]	87 J	(RT 25.17)
		Unknown[d]	6 J	(RT 32.21)	Unknown[d]	110 J	(RT 25.17)	Unknown[d]	390 J	(RT 26.31)
		Unknown[d]	7 J	(RT 32.41)	Unknown[d]	200 J	(RT 26.31)	Hexanedioic Acid, Mono(2-Eth[c]	1700 J,N	(RT 27.27)
		Unknown[d]	5 J	(RT 32.47)	Unknown[d]	190 J	(RT 27.39)	Unknown[d]	250 J	(RT 27.39)
		Unknown[d]	12 J	(RT 33.82)	Unknown[d]	280 J	(RT 28.44)	Unknown[d]	1700 J	(RT 28.44)
		Unknown[d]	9 J	(RT 34.14)	Unknown[d]	320 J	(RT 29.44)	Unknown[d]	250 J	(RT 29.46)
		Unknown[d]	6 J	(RT 34.34)	Unknown[d]	610 J	(RT 30.46)	Unknown[d]	320 J	(RT 30.46)
		Unknown[d]	15 J	(RT 34.44)	Unknown[d]	400 J	(RT 31.42)	Unknown[d]	300 J	(RT 31.42)
		Unknown[d]	7 J	(RT 34.61)	Octacosane[b]	970 J,N	(RT 32.39)	Unknown[d]	510 J	(RT 32.39)
		Unknown[d]	14 J	(RT 35.46)	Pentatriacontane[b]	1200 J,N	(RT 34.31)	Pentatriacontane[b]	830 J,N	(RT 34.32)
		Unknown[d]	15 J	(RT 36.34)	Unknown[d]	860 J	(RT 35.42)	Unknown[d]	650 J	(RT 35.42)
		Unknown[d]	6 J	(RT 36.67)	Unknown[d]	910 J	(RT 35.71)	Unknown[d]	630 J	(RT 35.69)
		Unknown[d]	10 J	(RT 36.81)	Unknown[d]	2400 J	(RT 36.29)	Unknown[d]	1500 J	(RT 36.31)
		Unknown[d]	9 J	(RT 37.14)	Unknown[d]	3900 J	(RT 36.77)	Unknown[d]	550 J	(RT 36.72)
					Unknown[d]	760 J	(RT 37.11)	Unknown[d]	570 J	(RT 37.09)
TIC Total	µg/kg		168 (20)			33450 (21)			29207 (21)	

Table 3–6. Data Summary Table: Soil – Background Site, 178th Tactical Fighter Group, Springfield ANGB, Springfield, Ohio (Continued)

Validation note: All descriptive data qualifiers applied to the reported values by the laboratory are reported in parentheses. Each data point has been assessed to determine whether the value is considered usable (i.e., no qualifier), usable but estimated (i.e., "J"), or not usable (i.e., "R"). All usability qualifiers are followed by the applicable laboratory or field QC qualifier, presented in parentheses and defined below. Usability qualifiers were not applied to values qualified by the laboratory, but were not considered to have been adversely impacted by the applicable laboratory QC result (e.g., duplicated and matrix spike analysis).

A – samples were analyzed for VOCs using SW 8240, laboratory analyses followed methods outlined in the March 1990 CLP SOW for organic analyses
B – samples were analyzed for SVOCs using SW 3550/8270, laboratory analysis followed method details outlined in the March 1990 CLP SOW for organic analyses
NA – not analyzed
ND – not detected
N/A – not applicable
RT – retention time in minutes
TICs–tentatively identified compounds, total concentration is listed and the total number of tentatively identified compounds is inside the parentheses

Data Validation Qualifiers

J – associated numerical value is the approximate concentration
R – rejected value
U – compound/element was included in analysis, but was not detected
UJ – reported quantitation limit is approximate and may or may not represent the actual quantitation necessary to accurately and precisely measure the analyte

Explanatory Data Validation Qualifiers

CCV – continuing calibration verification
EB – compound/element was also detected in the associated equipment blank
MB – compound/element was also detected in the associated laboratory method blank
FD – field duplicates relatives percent differences (RPDs) outside the control limits
SR – surrogate recovery outside control limits

EPA–defined CLP SOW Laboratory Qualifiers

A(TICs) – suspects ALDOL–condensation product
B(metals) – the reported value is estimated because it is greater than the Instrument Detection Limit (IDL), but less than the Contract Required Detection Limit (CRDL)
B(organics) – compound was also detected in the associated laboratory method blank
E(metals) – the reported value is estimated due to the presence of interference
N – spiked sample recovery outside of control limits
N(TICs) – presumptive evidence of a compound
S – the reported value was determined by the Method of Standard Additions (MSA)
W – post–digestion spike for Graphite Furnace Atomic Absorption (GFAA) analysis is out of control limits (85–115%), while sample absorbance is less than 50% of the spike absorbance
X – compound is present, but does not meet CLP criteria
* – duplicate sample analysis outside of control limits

SAIC TIC Evaluation Categories

[a] – laboratory and extraction artifacts
[b] – petroleum or petroleum degradation products
[c] – other
[d] – unknown
[e] – polycyclic aromatic hydrocarbons
[f] – naturally occuring organic compounds

Table 3–7. Data Summary Table: Groundwater – Background Site, 178th Tactical Fighter Group, Springfield ANGB, Springfield, Ohio

SAIC ID Number Laboratory ID Number Collection Date Associated Field QC Sample Parameter	Units	MWBG-1-1 97309 9-30-92 TB-14 ERBG-2 FBBA-1 FBCE-1	MWBG-1-2 9573, 9589 5-21-93 TB52193 EB2-2, EB3-2 N/A FB2-2, FB3-2	MWBG-2-1 97271 9-29-92 TB-12,13 ERBG-2 FBBA-1 FBCE-1	MWBG-2-2 9574, 9590 5-21-93 TB52193 EB2-2, EB3-2 N/A FB2-2, FB3-2
TOTAL PETROLEUM HYDROCARBONS (SW 8015M)					
Gasoline	mg/L	NA	<0.25	NA	<0.25
Diesel Fuel	mg/L	<0.2	<0.13	<0.2	<0.13
Heavy Oil	mg/L	<0.2	<0.25	<0.2	<0.25
TOTAL PRIORITY POLLUTANT METALS					
AA METALS					
Antimony (SW 3020/7041)	μg/L	R(N)	1.5 J(N,W)	1.4 J(N)	1 J(N)
Arsenic (SW 3020/7060)	μg/L	16.2	2.8 J(N)	4 B	6 J(N)
Lead (SW 3020/7421)	μg/L	16.6 U(FB)	55 S	4.1 U(FB)	9.8
Mercury (SW 7470)	μg/L	0.1 U	0.1 U	0.1 U	0.1 U
Selenium (SW 7740)	μg/L	R(N)	R(N)	R(N)	R(N)
ICP METALS (SW 3005/6010)					
Beryllium	μg/L	0.57 B	2.6 B	0.3 U	0.46 B
Chromium	μg/L	23.1	78.6	9.1 B	18.1
Copper	μg/L	34.4 U(FB)	109	11.6 U(FB)	24.5 B
Nickel	μg/L	28.2 B	133	12.9 U	30.1 B
Silver	μg/L	3.8 U	3.3 J(N)	3.8 U	2.9 UJ(N)
Zinc	μg/L	132 U(FB)	511 J(E)	39.7 U(FB)	97.1 J(E)
DISSOLVED PRIORITY POLLUTANT METALS					
AA METALS					
Antimony (SW 3020/7041)	μg/L	NA	0.9 B	NA	1.2 B
Lead (SW 3020/7421)	μg/L	NA	0.6 U(EB)	NA	0.5 U
ICP METALS (SW 3005/6010)					
	μg/L	NA	ND	NA	ND
VOLATILE ORGANICS (A)					
1,2-Dichloroethene (total)	μg/L	0.5 U	0.5 U	0.5 U	0.5 U
Trichloroethene	μg/L	0.5 U	0.5 U	0.5 U	0.5 U
TICs	μg/L	0 (0)	0 (0)	0 (0)	0 (0)
TIC Total	μg/L	0 (0)	0 (0)	0 (0)	0 (0)
SEMIVOLATILE ORGANIC (SW 8270 [B])					
TICs	μg/L	4,5-Dimethyl-2-Hepten-3-Ol[e] 2 J,N (RT 7.4)	0 (0)	4-Diamine-1,3,5-Triazine-2[e] 4 J,N (RT 21.45)	6-Amino-Hexanoic Acid[f] 7 J,N (RT 11.87) 1,3,5-Triazine-2,4-Diamine,[e] 5 J,N (RT 19.67)
TIC Total	μg/L	2 (1)	0 (0)	4 (1)	12 (2)

Table 3–7. Data Summary Table: Groundwater – Background Site, 178th Tactical Fighter Group, Springfield ANGB, Springfield, Ohio (Continued)

SAIC ID Number		P–4–1	P–4–1R	P–5–1
Laboratory ID Number		9575, 9591	9576, 9592	9569, 9585
Collection Date		5–21–93	5–21–93	5–21–93
Associated Field QC Sample		TB52193 EB2–2, EB3–2 N/A FB2–2, FB3–2	TB52193 EB2–2, EB3–2 N/A FB2–2, FB3–2	TB52193 EB2–2, EB3–2 N/A FB2–2, FB3–2
Parameter	Units			
TOTAL PETROLEUM HYDROCARBONS (SW 8015M)				
Gasoline	mg/L	<0.25	<0.25	<0.25
Diesel Fuel	mg/L	<0.13	<0.13	<0.13
Heavy Oil	mg/L	<0.25	<0.25	<0.25
TOTAL PRIORITY POLLUTANT METALS				
AA METALS				
Antimony (SW 3020/7041)	µg/L	0.8 J(N)	0.9 J(N)	1.2 J(N,W)
Arsenic (SW 3020/7060)	µg/L	5.1 J(N)	4.7 J(N)	R(N)
Lead (SW 3020/7421)	µg/L	14	16.6	104
Mercury (SW 7470)	µg/L	0.1 U	0.1 U	0.16 B
Selenium (SW 7740)	µg/L	R(N)	R(N)	R(N)
ICP METALS (SW 3005/6010)				
Beryllium	µg/L	0.82 B	0.63 B	4.2 B
Chromium	µg/L	25.3	22.6	150
Copper	µg/L	38.8	38.8	210
Nickel	µg/L	23 B	20.3 B	247
Silver	µg/L	2.9 UJ(N)	2.9 UJ(N)	3.1 J(N)
Zinc	µg/L	157 J(E)	156 J(E)	763 J(E)
DISSOLVED PRIORITY POLLUTANT METALS				
AA METALS				
Antimony (SW 3020/7041)	µg/L	1 B	2.9 B	1.4 B
Lead (SW 3020/7421)	µg/L	0.6 U(EB)	13.1	0.5 U
ICP METALS (SW 3005/6010)				
	µg/L	ND	ND	ND
VOLATILE ORGANICS (A)				
1,2–Dichloroethene (total)	µg/L	0.6 X	0.5 X	0.5 U
Trichloroethene	µg/L	0.7	0.7	0.5 U
TICs	µg/L	6–Amino–Hexanoic Acid [f] 7 J,N (RT 11.87)	6–Amino–Hexanoic Acid [e] 13 J,N (RT 11.75)	0 (0)
TIC Total	µg/L	7 (1)	13 (1)	0 (0)
SEMIVOLATILE ORGANIC (SW 8270 [B])				
TICs	µg/L	6–Amino–Hexanoic Acid [f] 7 J,N (RT 11.87)	6–Amino–Hexanoic Acid [e] 13 J,N (RT 11.75)	Cyclohexane, 1–Ethyl–1,3–Dim [b] 2 J,N (RT 5.25) Unknown [d] 5 J (RT 5.37) 6–Amino–Hexanoic Acid [e] 36 J,N (RT 11.84)
TIC Totals	µg/L	7 (1)	13 (1)	43 (3)

Table 3-7. Data Summary Table: Groundwater – Background Site, 178th Tactical Fighter Group, Springfield ANGB, Springfield, Ohio (Continued)

Validation note: All descriptive data qualifiers applied to the reported values by the laboratory are reported in parentheses.
Each data point has been assessed to determine whether the value is considered usable (i.e., no qualifier), usable but estimated (*i.e.*, "J"), or not usable (i.e., "R"). All usability qualifiers are followed by the applicable laboratory or field QC qualifier, presented in parentheses and defined below. Usability qualifiers were not applied to values qualified by the laboratory, but were not considered to have been adversely impacted by the applicable laboratory QC result (e.g., duplicated and matrix spike analysis).

A – groundwater samples were analyzed for volatile halogenated compounds and volatile aromatic compounds by E 524.2 for samples collected in 1992 or SW 8240 (25 ml purge for low level volatiles) for samples collected in 1993; these methods have been modified to incorporate CLP-type QC requirements
B – SVOCs in groundwater and field QC blanks were analyzed using EPA method 3510/8270
NA – not analyzed
ND – not detected
N/A – not applicable
RT – retention time in minutes
TICs – tentatively identified compounds, total concentration is listed and the total number of tentatively identified compounds is inside the parenthases

Data Validation Qualifiers
J – associated numerical value is the approximate concentration
R – rejected value
U – compound/element was included in analysis, but was not detected
UJ – reported quantitation limit is approximate and may or may not represent the actual quantitation necessary to accurately and precisely measure the analyte

Explanatory Data Validation Qualifiers
CCV – continuing calibration verification
EB – compound/element was also detected in the associated equipment blank
FB – compound/element was also detected in the associated field blank

EPA-defined CLP SOW Laboratory Qualifiers
B(metals) – the reported value is estimated because it is greater than the Instrument Detection Limit (IDL), but less than the Contract Required Detection Limit (CRDL)
E(metals) – the reported value is estimated due to the presence of interference
N – spiked sample recovery outside of control limits
N(TICs) – presumptive evidence of a compound
S – the reported value was determined by the Method of Standard Additions (MSA)
W – post-digestion spike for Graphite Furnace Atomic Absorption (GFAA) analysis is out of control limits (85–115%), while sample absorbance is less than 50% of the spike absorbance
X – compound is present, but does not meet CLP criteria

SAIC TIC Evaluation Categories
^{b} – petroleum or petroleum degradation products
^{c} – other
^{d} – unknown
^{f} – naturally occuring organic compounds

Table 3–8. Applicable or Relevant and Appropriate Requirements for Groundwater: 178th Tactical Fighter Group, Springfield ANGB, Springfield, Ohio

PARAMETER	MCL	MCLG	Ohio State Drinking Water Standards[a] OMCL
METALS			
Antimony[b]	6	6	
Arsenic[c]	50		50
Beryllium[b]	4	4	
Cadmium[d]	5	5	5
Chromium (total)[d]	100	100	100
Copper[e,f]	1,300/1,000 *	1,300	
Lead[e,f]	15	0	15
Nickel[b]	100	100	100
Selenium[d]	50	50	50
Silver[g]	100 *		
Zinc	5,000 *		
ORGANICS			
1,2–Dichloroethene[d, h]	70/100	70/100	
Tetrachloroethylene[i]	5	0	5
Trichloroethene[i]	5	0	5

All units are μg/L for aqueous samples unless noted.

* – secondary MCL, not an enforceable requirement.

[a] Rules and Regulations: Public Water Systems (Updated 5/22/89) for groundwater and per telephone conversation with Jim Evans of the Ohio Environmental Protection Agency.

[b] 55 FR 30370 (July 25, 1990). Effective February 1992.

[c] 40 FR 59570 (December 24, 1975)

[d] 56 FR 3526 (January 30, 1991). Effective July 30, 1992.

[e] 56 FR 26460 (June 7, 1991). Effective December 7, 1992.

[f] This "action level" when measured in the 90th percentile at the consumer's tap, triggers initiation of corrective control studies and treatment requirements.

[g] 56 FR 3526 (January 30, 1991). Effective July 30, 1992.

[h] MCL and MCLG for cis– and trans– isomers of 1,2–dichloroethene, respectively

[i] 52 FR 25690 (July 8, 1987)

3.5 SITE 1 - FIRE TRAINING AREA NO. 1 (FTA-1)

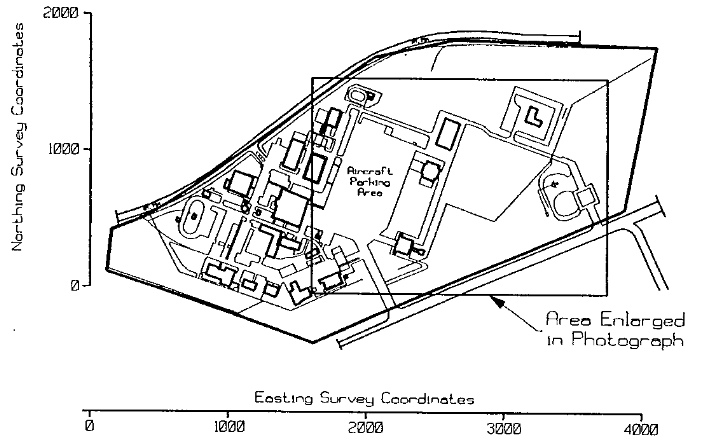
This section summarizes the field investigation and laboratory analytical results and presents the significance of findings for Site 1 - FTA-1. FTA-1 was in operation from 1957 to 1963. Its location was verified using a scaled aerial photograph taken in 1964, which clearly shows the burn pit. Using surveyed control points that have not changed since the photograph was taken, the burn pit was located and a soil organic vapor (SOV) survey was conducted at the site. Three soil borings (i.e., SB1-1, SB1-2, and SB1-3) were located within the burn pit based on the aerial photograph and SOV survey results, and one monitoring well (i.e., MW1-1) was located approximately 50 feet downgradient from the burn pit. The 1964 aerial photograph is reproduced as Figure 3-6 to show the location of FTA-1. Figure 3-7 shows the Site 1 sample locations. Tables containing information and analytical results for Site 1 (Tables 3-9 through 3-14) are presented at the end of Section 3.5.

Data collected during the field investigation showed petroleum hydrocarbons and metals present in Site 1 soil at concentrations that are indistinguishable from background levels detected on the Base. SVOCs were detected in only two samples. None of these contaminants exhibited identifiable distribution patterns or trends within the soil column above the water table. Therefore, it was impossible to conclusively determine the source of contaminants at Site 1. Site 1 has not contributed to degradation of groundwater quality; no site-related contaminants were detected in groundwater 50 feet downgradient from the burn pit.

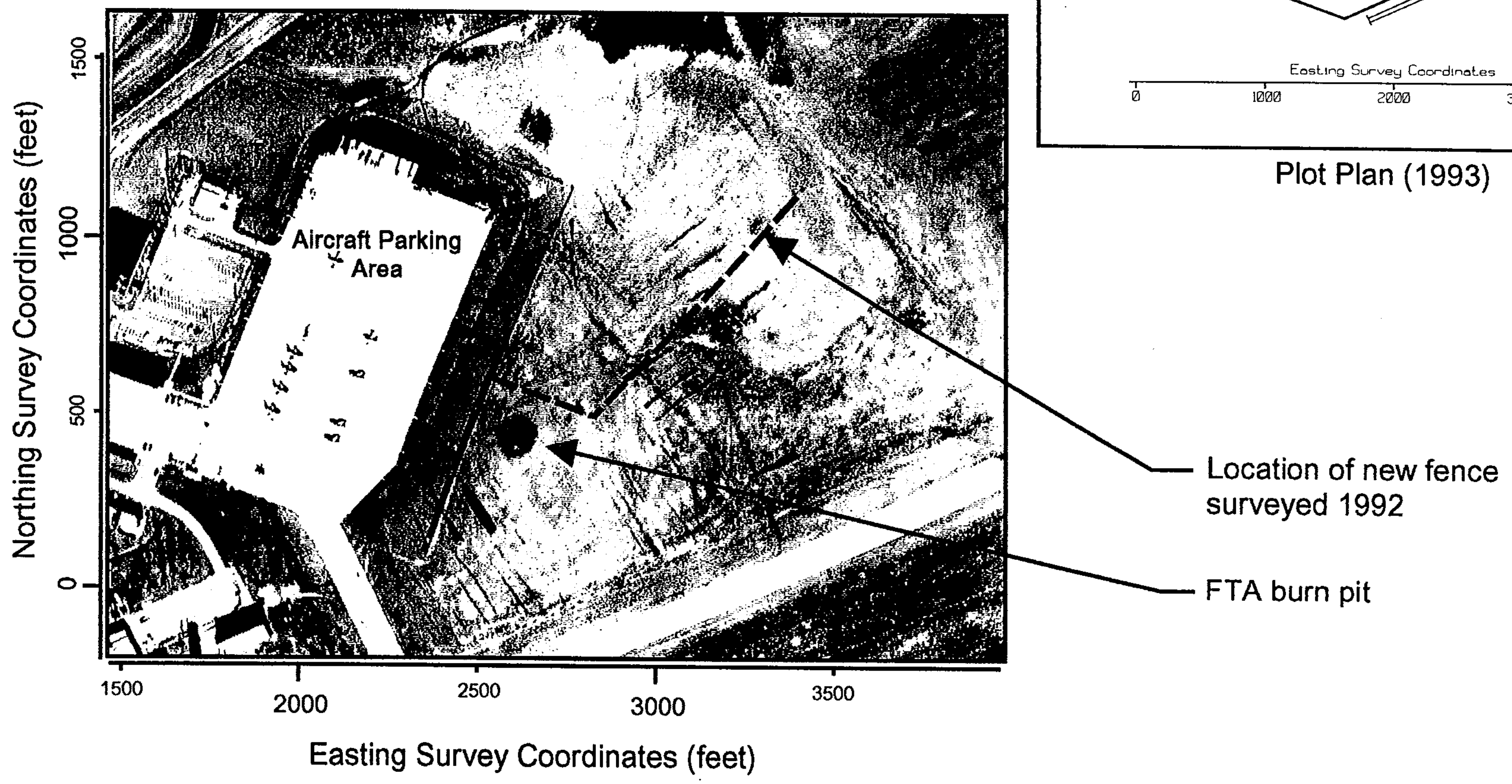
Detailed discussions of Site 1 lithology and chemicals detected at this site are presented in the remaining portion of this section.

3.5.1 Site 1 Lithology

Three basic lithologic types were encountered during drilling activities at Site 1: silty clay/clayey silt, stiff (lacustrine) clay, and sand and gravel. These units can be correlated across the site with varying unit thickness and are discussed below. A cross section, developed from soil boring and well log data obtained from Site 1, is shown in Figure 3-8.



Plot Plan (1993)



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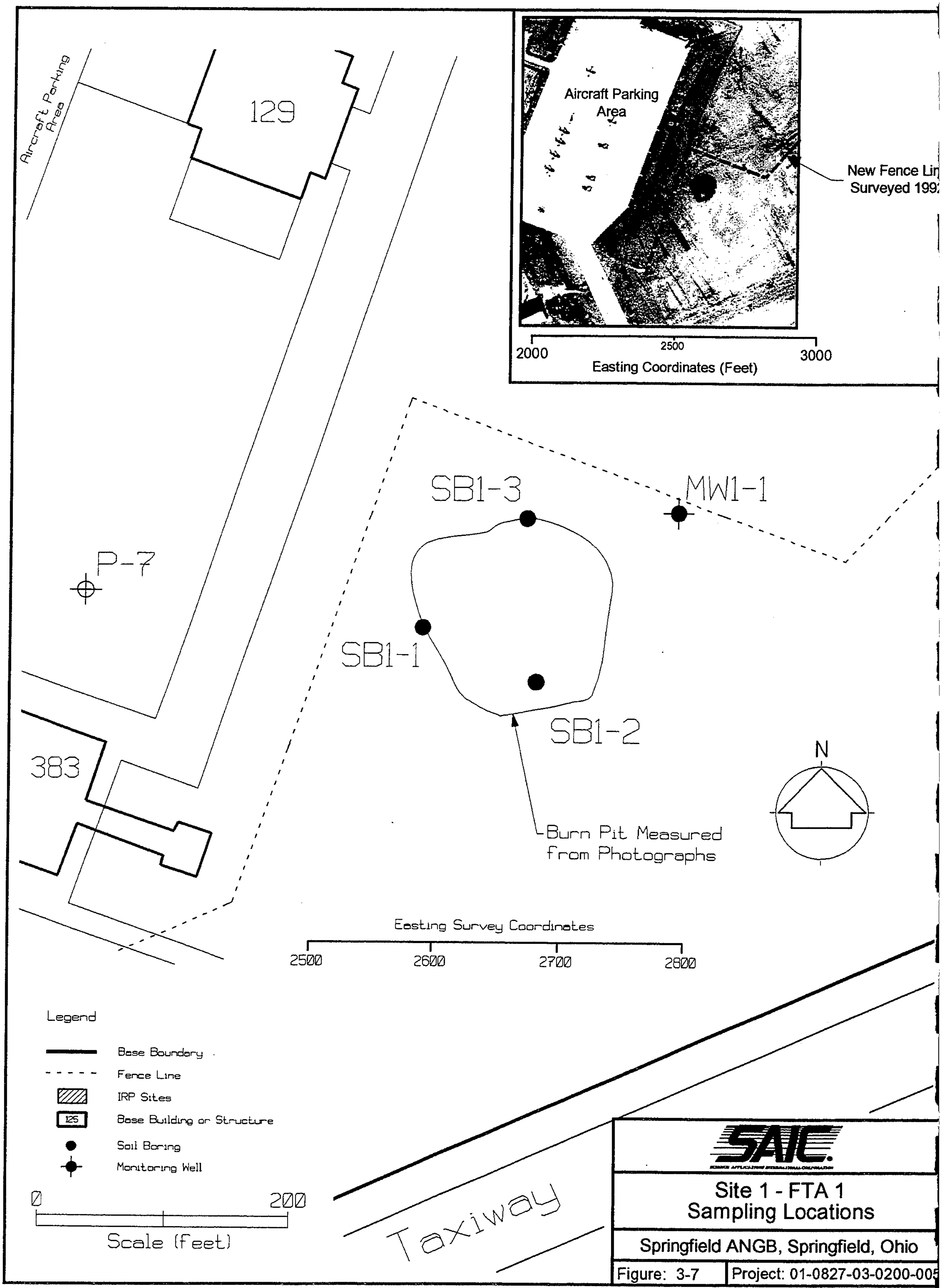
Science Applications International Corporation

Site 1 - FTA-1 Location, 1964 Aerial Photograph

Springfield ANGB, Springfield, Ohio

Figure: 3-6 | Project: 01-0827-03-0200-005

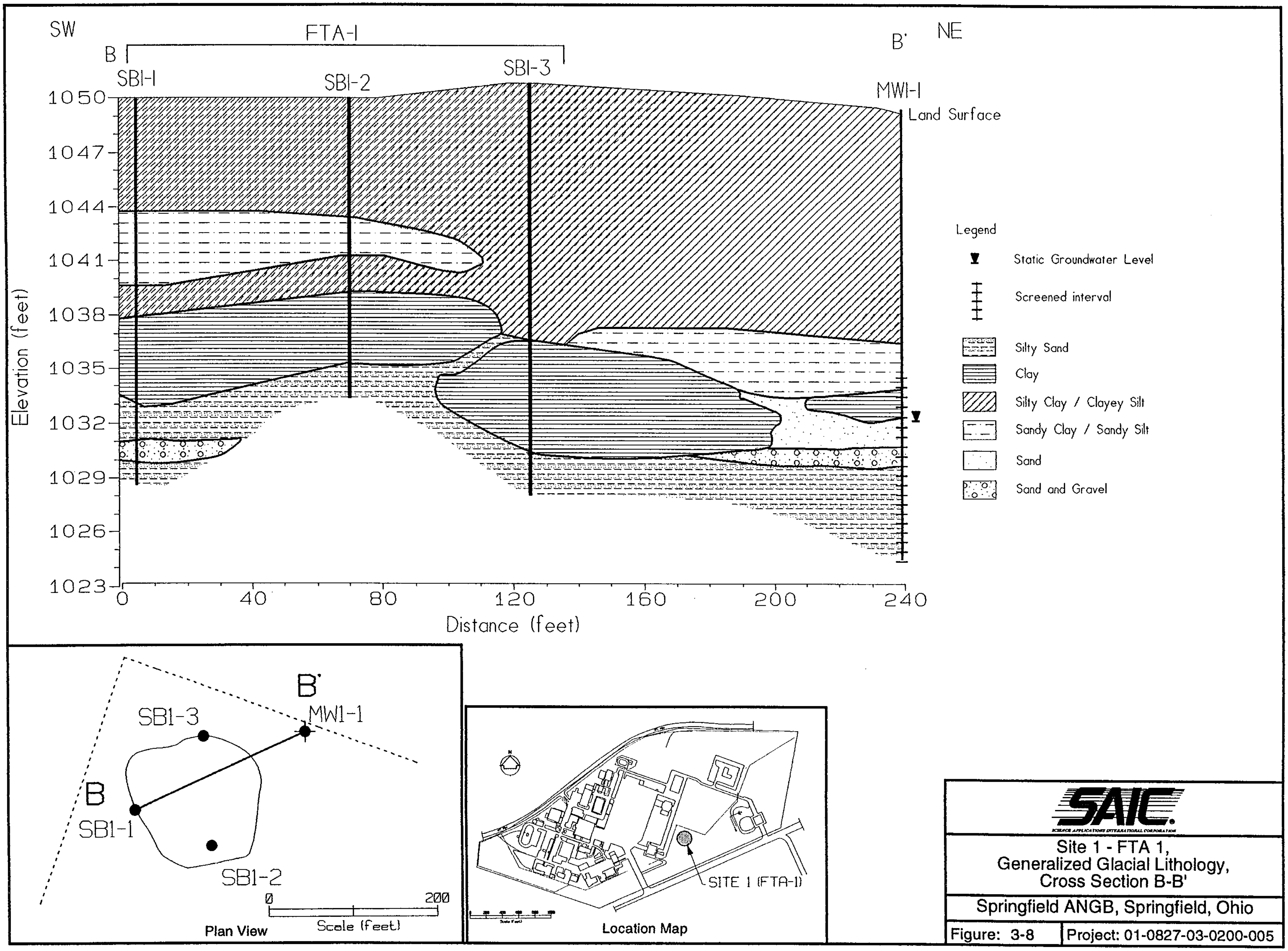


Site 1 - FTA 1
Sampling Locations

Springfield ANGB, Springfield, Ohio

Figure: 3-7

Project: 01-0827-03-0200-005



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Site 1 - FTA 1,
Generalized Glacial Lithology,
Cross Section B-B'

Springfield ANGB, Springfield, Ohio

Figure: 3-8 | Project: 01-0827-03-0200-005

The lithologic logs from Site 1 show a 10- to 15-foot thick, laterally continuous upper horizon of compact silty clay/clayey silt. This unit consists of predominantly fine-grained, moderate to high plasticity, clayey silt and silty clay interspersed occasionally with fine to medium grained sand. The sandy lenses were encountered in the southwest and northeast borings between approximate elevations of 1,036 and 1,044 feet above msl.

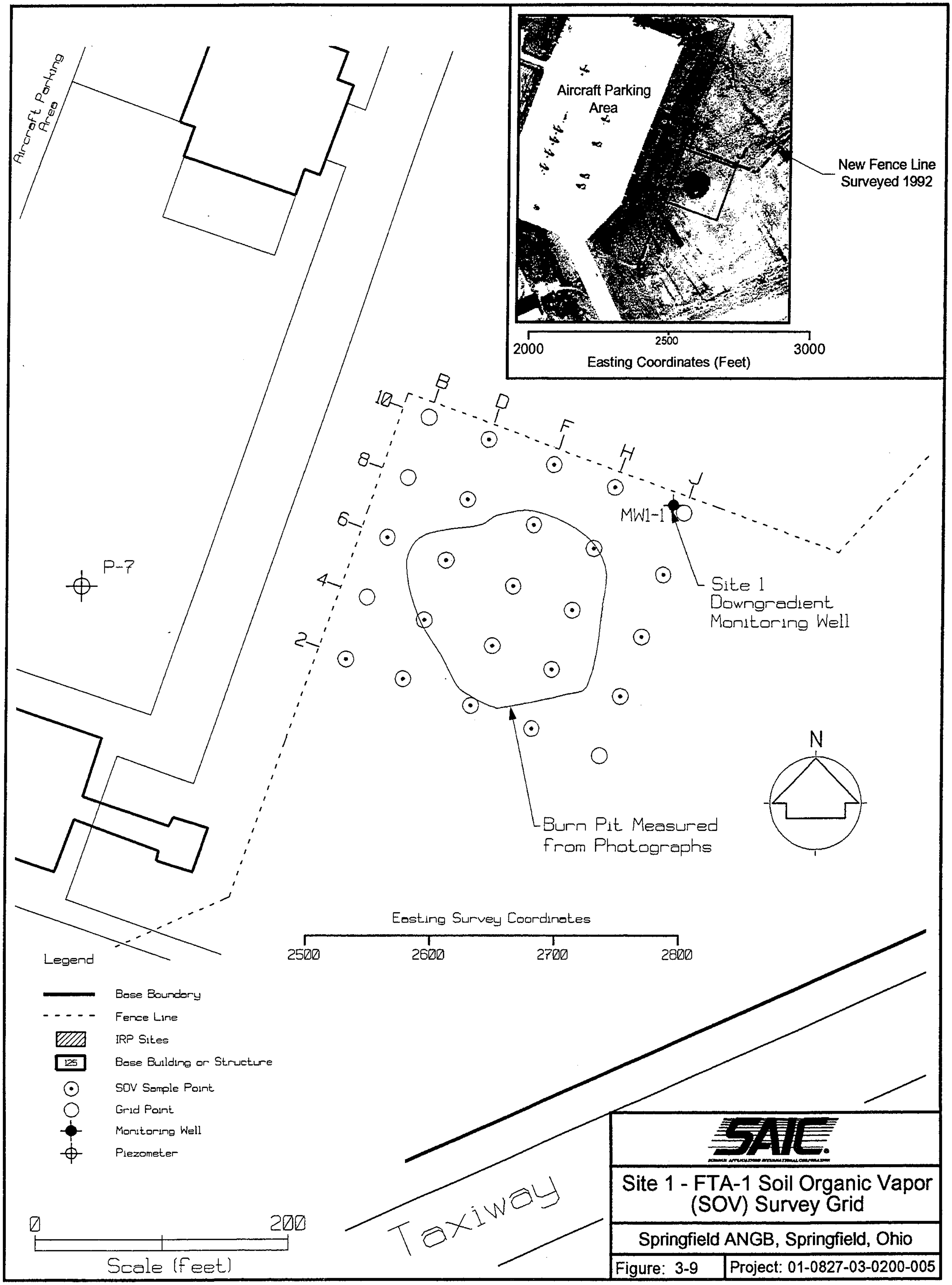
Low-permeability deposits of silts, clays, and fine sands underlie the silty clay/clayey silt strata at some locations. These deposits are dark gray, massive to finely laminated silt and clay with few coarse particles. Deposits ranged from 2 to 6 feet thick and are interfingered with other deposits.

At Site 1, saturated coarser deposits were encountered just below these fine-grained (silt/clay) deposits. The surficial aquifer consists of groundwater primarily under water table conditions, but artesian conditions in the fine silt/clay do exist locally. The interfingered units of silt, clay, sand, and gravel alluvium are representative of the type of glacial drift aquifer encountered at the Base.

3.5.2 Soil Organic Vapor Survey

An SOV survey was conducted at Site 1 - FTA-1 on May 3, 1992, which assessed the areal extent of the VOC contamination in shallow soil vapor and was used to locate soil borings at the site. The survey grid was located over the burn pit by scaling an aerial photograph of the Base and measuring from surveyed control points (Figure 3-6). Figure 3-9 illustrates the location and orientation of the SOV survey grid in relationship to the former burn pit. The survey included 19 sample points within a grid that covered an area of 250 by 300 feet. Twenty-three SOV samples were analyzed; three of the samples were QA samples and one was obtained at a previously sampled location (H-4), but was collected from a greater depth (7 feet). The SOV survey was conducted according to the procedures outlined in SOP FP 6-1. The analytical results of the survey are presented in Appendix C.

VOCs detected at FTA-1 included benzene, total volatile hydrocarbons (TVHC), trichloroethane (TCA), carbon tetrachloride (CCl_4), and trichloroethene (TCE). TVHC ranged



Site 1 - FTA-1 Soil Organic Vapor (SOV) Survey Grid

Springfield ANGB, Springfield, Ohio

Figure: 3-9

Project: 01-0827-03-0200-005

between 0.05 and 4 μg/L. The other VOCs were detected near their detection limits with maximum concentrations of 0.4 μg/L. Figure 3-10 presents the distribution of TVHC concentrations identified by the SOV survey. This map was used to locate three soil borings in the areas of maximum VOC concentrations, also shown in Figure 3-10.

3.5.3 Chemicals Detected in Soil

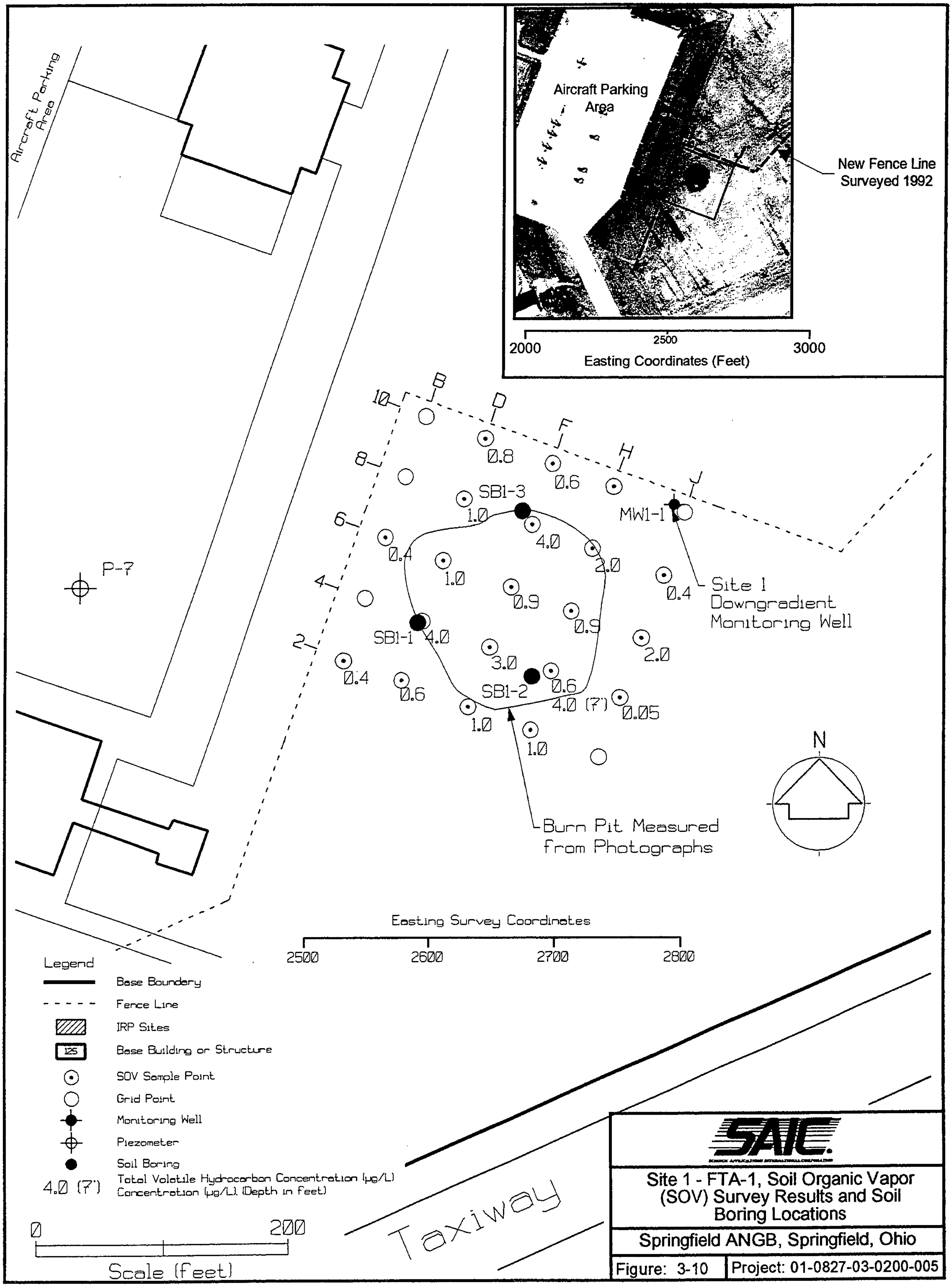
Borings SB1-1, SB1-2, and SB1-3 were drilled within the FTA burn pit to total depths of 21, 16, and 22.5 feet BLS, respectively (Figure 3-10). Soil samples were collected continuously at 2-foot intervals from the land surface to the soil-water interface using procedures outlined in Section 2.4. The surface soil and the soil-water interface samples were sent to the laboratory for analysis. An optional third sample was sent for laboratory analysis based on visual soil discoloration; the presence of a petroleum odor; or the presence of benzene, toluene, xylene, and total volatile organics (TVO) detected during the onsite GC screening. Table 3-9 shows the samples collected from each boring, the interval sampled, the onsite GC TVO values used to decide which samples would be sent to the laboratory, and the soil samples sent to the laboratory for chemical analysis. Figure 3-11 presents the vertical distribution of TVO concentrations within soil at Site 1. The detected TVO was confined to one boring (SB1-3) from 2 to 6 feet. These data indicate that very little residual volatile fuel remains in the soil. Samples sent to the laboratory were analyzed for the following parameters:

- TPH (SW Method 8015 modified)
- VOCs (SW Method 8240, CLP SOW 3/90)
- SVOCs (SW Method 8270, CLP SOW 3/90)
- Priority pollutant metals:

  ICP Metals: Be, Cd, Cr, Cu, Ni, Ag, and Zn (SW Method 6010)

  AA Metals: Sb (SW7041), As (7060), Pb (7421), Hg (7471), Se (7740), and Tl (7841).

The analytical results for the soil samples collected from Site 1 - FTA-1 are summarized in Table 3-10. A detailed discussion of the TICs detected in Site 1 soil samples is presented in Appendix G, Section G.4.



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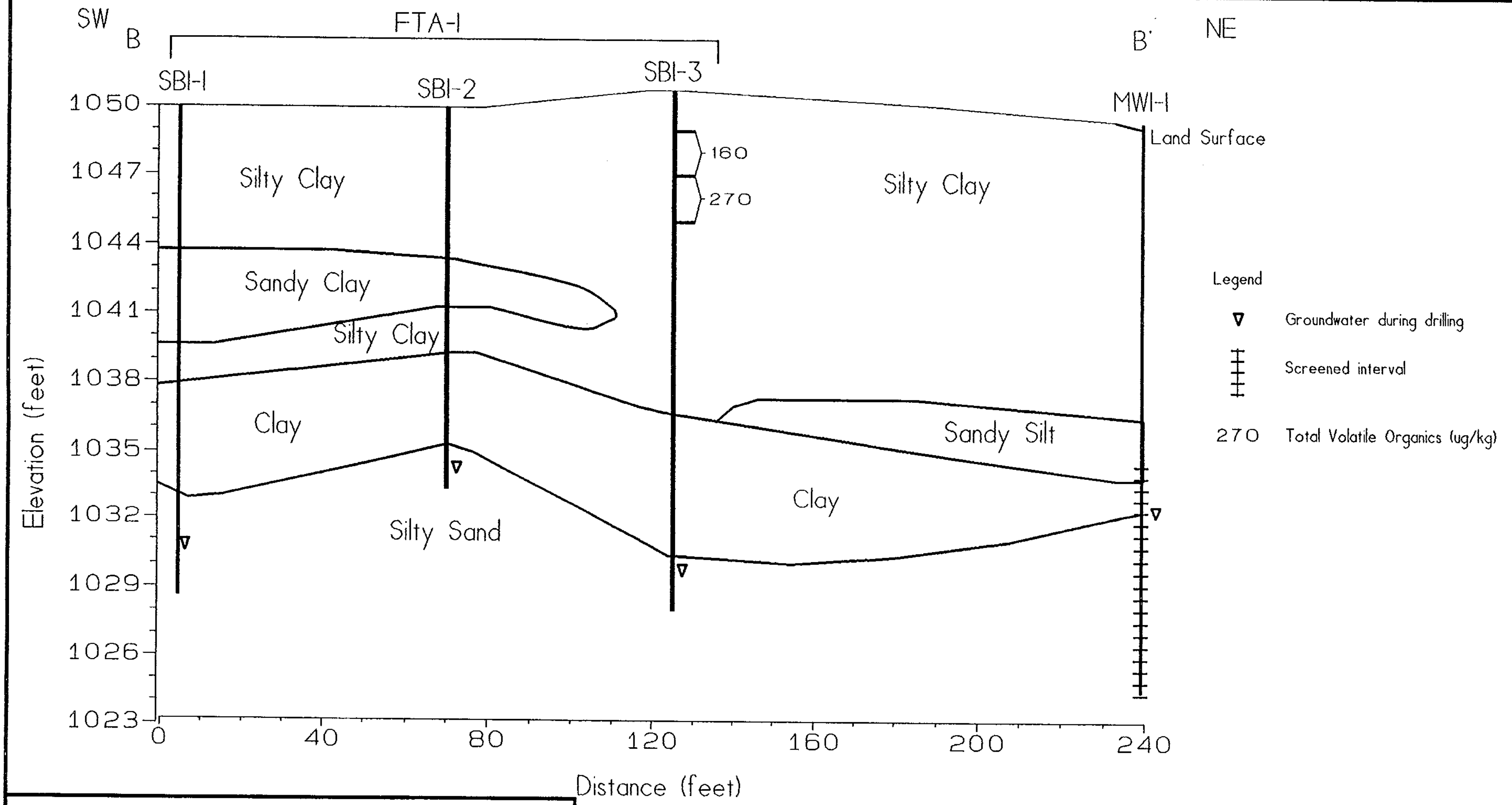
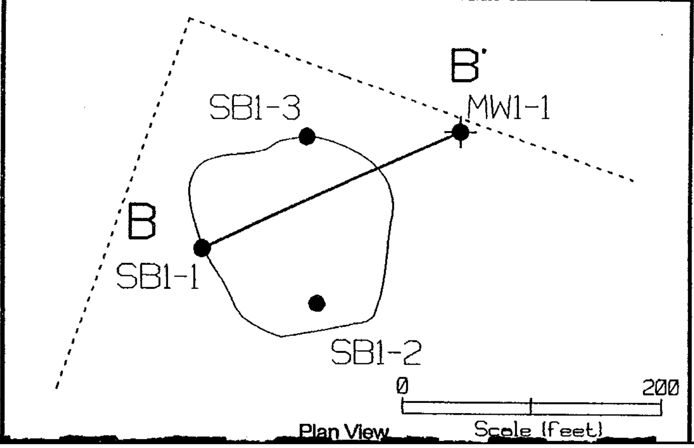
Site 1 - FTA-1, Soil Organic Vapor (SOV) Survey Results and Soil Boring Locations

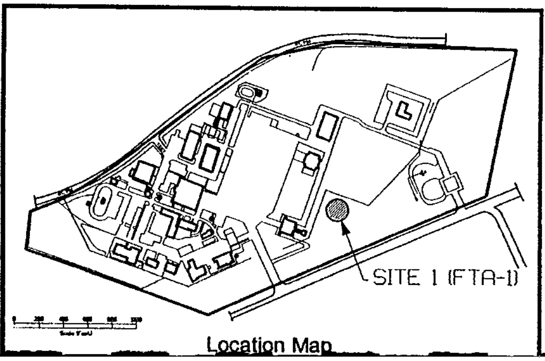
Springfield ANGB, Springfield, Ohio

Figure: 3-10	Project: 01-0827-03-0200-005





Plan View



Location Map

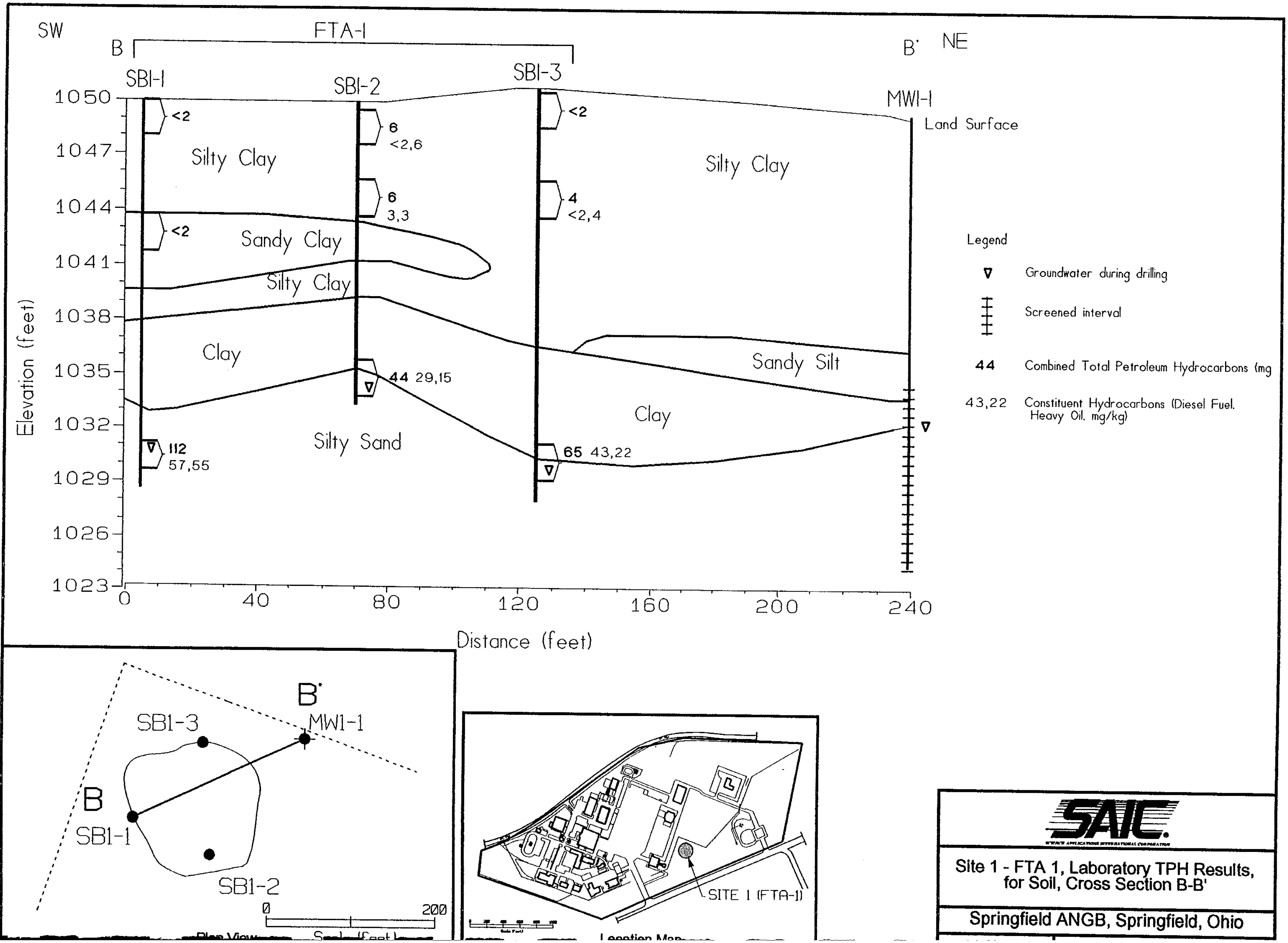
Site 1 - FTA 1, Onsite Gas Chromatography Results for Soil, Cross Section B-B'

Springfield ANGB, Springfield, Ohio

TPH were detected in all three soil borings drilled at Site 1 - FTA-1. TPH were detected in soil boring SB1-1 in sample SB1-1-6 (19.5 to 21 feet BLS), in all samples analyzed for soil boring SB1-2, and samples SB1-3-3, SB1-3-11, and SB1-3-11R collected from soil boring SB1-3. All detected values were reported as two separate constituents, diesel fuel and heavy oil, and quantified separately. The vertical distribution of these values is shown in Figure 3-12. Vertical distribution of TPH at Site 1 does not follow a trend indicative of contaminant migration from the former FTA. At Site 1, diesel fuel concentrations ranged between 2 and 57 mg/kg and the highest detected value was in SB1-1-6 (19.5 to 21 feet BLS). Heavy oil TPH concentrations detected at Site 1 were equivalent to the diesel fuel constituent results. Heavy oil concentrations ranged between 2 and 55 mg/kg and the highest TPH value detected for heavy oil also was recovered in SB1-1-6 (19.5 to 21 feet BLS). None of the TPH concentrations exceed the most conservative action levels for gasoline (105 mg/kg) or other than gasoline (380 mg/kg) in effect by the Ohio Division of State Fire Marshall, or the level set by OEPA DSIWM (105 mg/kg). TPH concentrations are compared to background criteria in Section 3.5.5.

Toluene was the only VOC target compound detected during the laboratory analysis of the soil samples recovered from the Site 1 borings. Toluene was detected in three Site 1 samples (i.e., SB1-1-1, SB1-3-11, and SB1-3-11R) and estimated concentrations ranged between 3J and 11J μg/kg; however, no toluene was detected in the shallow groundwater samples. Toluene is used for aviation gasoline, high-octane blending stock, and solvents. Trichlorofluoromethane was detected as a VOC TIC in sample SB1-3-11 (20.5 to 22.0 feet BLS) at a concentration of 8 μg/kg. Although this compound was not detected in the associated laboratory method blanks, trichlorofluoromethane is considered a common laboratory contaminant (EPA 1988) and was most likely introduced by the laboratory during analysis.

SVOCs detected in the soil analysis of the Site 1 samples included 2-methylnapthalene, phenanthrene, and bis(2-ethylhexyl)phthalate. Both 2-methylnapthalene and phenanthrene were detected in SB1-1-1 (0.5 to 2.5 feet BLS) and SB1-2-8 (14.5 to 16.0 feet BLS). The maximum concentrations detected were 190 and 93J μg/kg, respectively, obtained in SB1-2-8.



SAIC

Site 1 - FTA 1, Laboratory TPH Results, for Soil, Cross Section B-B'

Springfield ANGB, Springfield, Ohio

Bis(2-ethylhexyl)phthalate was detected in SB1-1-1 (0.5 to 2.5 feet BLS), SB1-1-3 (6.5 to 8.5 feet BLS), SB1-2-1 (0.5 to 2.5 feet BLS), SB1-3-3 (4.5 to 6.5 feet BLS), and SB1-3-11 (20.5 to 22.0 feet BLS). Estimated compound concentrations ranged between 34J and 71J μg/kg. Bis(2-ethylhexyl)phthalate also was detected in soil analysis of background well (MWBG-1).

Sample SB1-3-3 (4.5 to 6.5 feet BLS) had the highest SVOC TIC concentration at 41,820 μg/kg. SVOC TICs were detected in all 11 soil samples and ranged in concentration from 64 to 41,820 μg/kg. Two-hundred and eighteen SVOC TICs were detected in soil samples collected at Site 1 - FTA-1. Twenty-one of 218 SVOC TICs were identified as straight-chain alkanes or branched alkanes and were classified as petroleum or petroleum degradation products. 1,4,6-Trimethyl-naphthalene and 4-fluoro-1,1'-biphenyl detected in SB1-1-1 and 2,3-dimethyl-naphthalene detected in SB1-1-1 and SB1-2-8 were placed in the PAH category. 1-Methyl-hexadecanoic acid was categorized as a petroleum or petroleum degradation product. The straight-chain alkanes, branched alkanes, and PAH compounds are believed to be fuel and petroleum related compounds used in fire training activities. 4-Hydroxy-4-methyl-2-pentanone, which is prevalent in the majority of the samples, is an aldol condensation product of acetone (EPA 1988); therefore, it is believed to be a laboratory artifact and not site related. Trichloroeicosylsilane also was placed in the laboratory and extraction artifact category.

Dodecanamide, nonanamide, (Z)-9-octadecanamide, and D:B-friedo-B'A'-neogammacer were all classified in the other category because the source of contamination did not appear to be petroleum-related materials. Hexadecanoic acid was detected in SB1-3-1 at a concentration of 170 μg/kg, which is below the level detected in the background samples, and as a result, was placed in the naturally occurring organic compounds category. The remainder of the SVOC TICs were generally identified as unknown and could be possibly naturally occurring in soil, site related contamination, or of anthropogenic origin.

Metals detected in the soil at FTA-1 include arsenic, beryllium, chromium, copper, lead, nickel, and zinc. The maximum concentrations of metals found at FTA-1 are compared to the background metals concentrations in soil in Section 3.5.5 to determine if there is statistical evidence of site-related contamination using the procedures described in Section 3.3.

3.5.4 *Chemicals Detected in Groundwater*

The location of the monitoring well (MW1-1) installed at FTA-1 is shown in Figure 3-13. This well is located about 50 feet downgradient from Site 1 outside of the burn pit area.

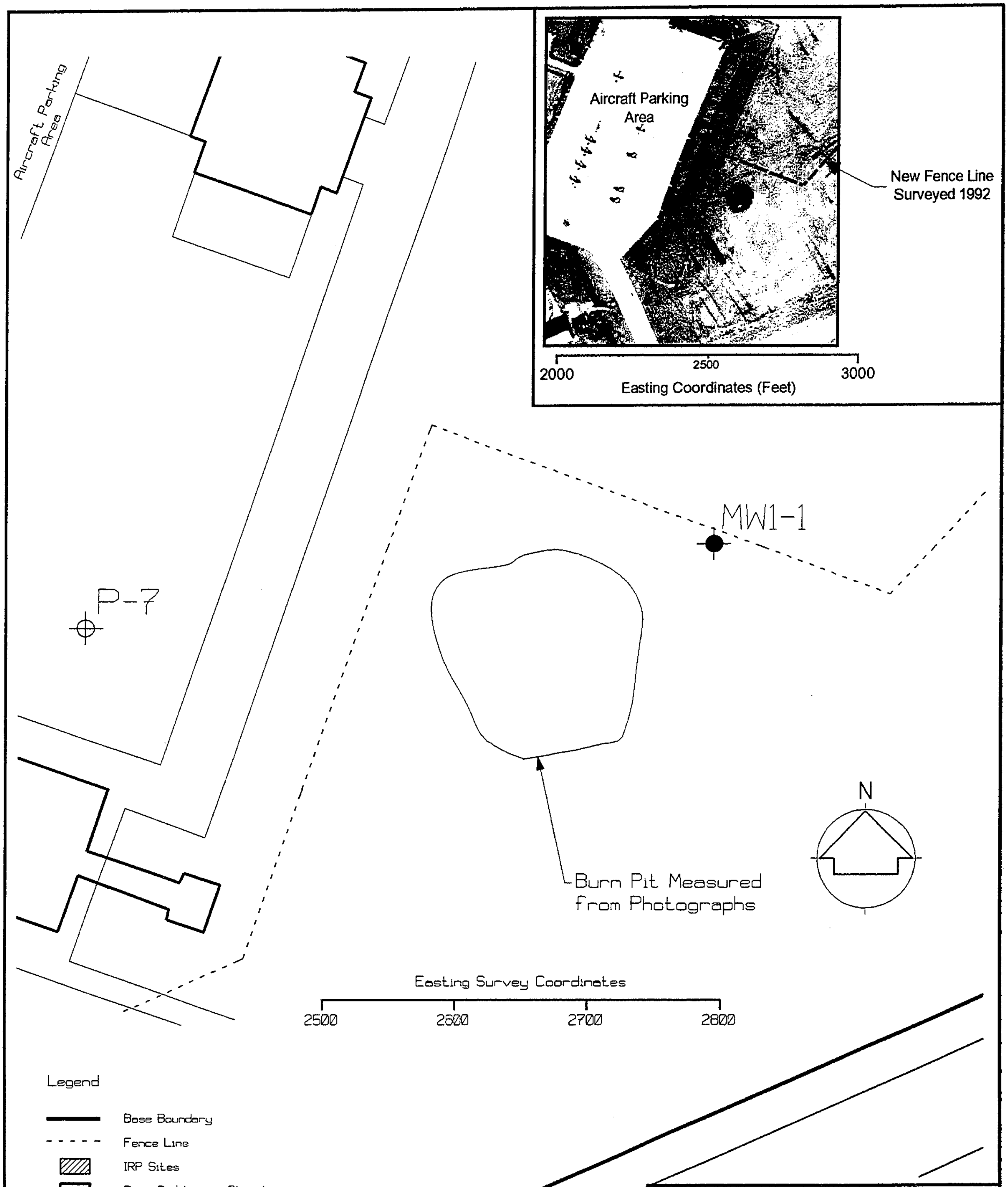
Monitoring well MW1-1 was sampled in September 1992 and May 1993. Both groundwater samples (MW1-1-1 and MW1-1-2) were analyzed by the laboratory for TPH, metals, VOCs, and SVOCs. The laboratory results are presented in Table 3-11. The large difference in metals between the first and second sampling rounds is due to the fact that the second round sample is darker in color, indicating a higher particulate matter. This is indicated by the higher metals concentrations. The analytical results for metals are compared to background criteria in Section 3.5.5 using the statistical methods discussed in Section 3.3. No TPH, VOCs, VOC TICs, or SVOCs were detected in the Site 1 groundwater analysis. One SVOC TIC classified as an unknown was detected in MW1-1-1. Sample MW1-1-2 had lead (31.8 μg/L) and nickel (110 μg/L) concentrations above the MCL of 15 μg/L and 100 μg/L, respectively.

3.5.5 *Comparison of Chemicals Detected to Background Criteria*

This section compares the background results to sample results from Site 1 - FTA-1. The criteria for the comparison are presented in Section 3.3 and in Tables 3-4 and 3-5.

Although TPH as diesel fuel, TPH as heavy oil, toluene, and phenanthrene are not normally considered naturally occurring, these contaminants were detected in soil samples at levels much lower than those in background samples (Table 3-13). Most of the inorganics were also detected at levels less than the UCL_{90}, except for antimony, arsenic, and beryllium. Some of the sample results for inorganic contaminants exceeded the UCL_{90} for these contaminants. The maximum detected results only slightly exceeded their respective UCL_{90}. The results do not provide convincing evidence that the measured contaminants are site related.

Seven inorganics were detected in Site 1 groundwater samples. None of the results exceeded the UCL_{90}, (Table 3-14); therefore, none of the results is considered to be related to the fire training activities at Site 1.



Site 1 - FTA-1, Monitoring Well Location

Springfield ANGB, Springfield, Ohio

Figure: 3-13 | Project: 01-0827-03-0200-005

3.5.6 Summary of Results

Based on the aerial photograph and the SOV survey results, the location of the former fire training area burn pit was identified. Using the SOV survey and onsite screening results, the samples with the highest degree of suspected contamination were then sent to the laboratory for analysis.

The levels of contamination identified in groundwater samples are not sufficiently high to be considered problematic. The concentrations of inorganic chemicals detected in groundwater are generally consistent with background concentrations and only two of the chemicals exceed regulatory criteria. Nickel slightly exceeds the MCL of 100 μg/L and lead exceeds the MCL of 15 μg/L. However, there is no current or anticipated future use of groundwater in the shallow unconsolidated aquifer (see Section 5.3.2.). Contaminant levels in soil also are not considered problematic. The levels of organic compounds did not exceed any established regulatory criteria and are less than background criteria. The level of investigation has adequately characterized the site and laboratory analyses have not identified contamination in the soil or groundwater.

3.6 SITE 2 - FIRE TRAINING AREA NO. 2 (FTA-2)

This section summarizes the field investigation and laboratory analytical results and presents the significance of findings for Site 2 - FTA-2. FTA-2 was in operation from 1967 to 1980 when fuel and other flammable liquids reportedly were used to create training fires. A propane-fueled fire training area was built over FTA-2 and is currently located at the site. The location of FTA-2 was verified through interviews with Base personnel and analysis of scaled aerial photographs.

Figure 3-14 shows the location of Site 2 on a 1985 photograph. An SOV survey was conducted at Site 2 and the surrounding area, which provided sufficient data to identify the areas of maximum potential contamination. These areas fell within the identified burn pit area. Two phases of soil, sediment, and groundwater sampling were conducted at Site 2. Collectively, the data from these two phases confirm the presence of site-related contaminants in the upper 9.5

Table 3—9. . Onsite Gas Chromatography Results for Soil at Site 1 – Fire Training Area 1, 178th Tactical Fighter Group, Springfield ANGB, Springfield, Ohio

Soil Boring	Sample Number	Depth (feet BLS)	Analytical Parameters (µg/kg)									Comments
			TVO	TCA	CCl_4	TCE	PCE	BEN	TOL	ETZ	XYL	
SB1–1	SB1–1–01	0.5–2.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	Sample sent to lab 8/13/92
	SB1–1–02	2.5–4.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	No recovery, no GC sample taken for 4.5–6.5 interval.
	SB1–1–03	6.5–8.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	GC sample from top and bottom of spoon. Sample sent to lab 8/14/92.
	SB1–1–04	8.5–10.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	
	SB1–1–05	10.5–12.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	
SB1–2	SB1–2–01	0.5–2.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	Sample sent to lab 8/13/92.
	SB1–2–02	2.5–4.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	
	SB1–2–03	4.5–6.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	Sample sent to lab 8/13/92.
	SB1–2–04	6.5–8.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	
	SB1–2–05	8.5–10.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	
	SB1–2–06	10.5–12.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	
	SB1–2–07	12.5–14.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	
	SB1–2–08	14.5–16.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	Saturated interval (soil/water interface). Sample sent to lab 8/13/92.
SB1–3	SB1–3–01	0.5–2.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	Sent sample to lab 8/14/92.
	SB1–3–02	2.5–4.5	160	ND	ND	ND	ND	41	10	ND	ND	Large piece of burnt wood lodged in split spoon.
	SB1–3–03	4.5–6.5	270	ND	ND	0.6	ND	ND	ND	ND	ND	Sample sent to lab 8/14/92.
	SB1–3–04	6.5–8.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	
	SB1–3–05	8.5–10.0	ND	2.5	ND	ND	ND	ND	ND	ND	ND	
	SB1–3–06	10.5–12.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	
	SB1–3–07	12.5–14.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	
	SB1–3–08	14.5–16.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	Replicate soil sample taken.
	SB1–3–09	16.5–18.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	
	SB1–3–10	18.5–20.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	
	SB1–3–11	20.5–22.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	Replicate soil sample taken at Saturated interval (soil/water interface). Sample and replicate sent to lab 8/14/92.

Table 3–10. Data Summary Table: Soil – Site 1 – Fire Training Area 1, 178th Tactical Fighter Group, Springfield ANGB, Springfield, Ohio

SAIC ID Number			SB1–1–1			SB1–1–3			SB1–1–6	
Laboratory ID Number			94524			94602			94532	
Collection Date			8–13–92			8–13–92			8–13–92	
Collection Depth (ft)			0.5–2.5			6.5–8.5			19.5–21.0	
Associated Field QC Sample			TB–2 on 8–13–92 ER1–1 FB1–1 SD5–FB			TB–3 ER1–1 FB1–1 SD5–FB			TB–2 on 8–13–92 ER1–1 FB1–1 SD5–FB	
Parameter	Units									
TOTAL PETROLEUM HYDROCARBONS (SW 8015M)										
Diesel Fuel	mg/kg		<2			<2			57	
Heavy Oil	mg/kg		<2			<2			55	
PRIORITY POLLUTANT METALS										
AA METALS										
Antimony (SW 3050/7041)	mg/kg		0.21 J(N,W)			0.22 J(N,r)			0.31 J(N,W)	
Arsenic (SW 3050/7060)	mg/kg		6.2			6.1 J(N)			12.6	
Lead (SW 3050/7421)	mg/kg		11.3			6.3			8.5	
Selenium (SW 3050/7740)	mg/kg		0.08 J(N,W)			0.11 UJ(N,W)			0.08 UJ(N,W)	
Thallium (SW 3050/7841)	mg/kg		0.13 J(N)			0.12 J(W)			0.11 J(N,W)	
ICP METALS (SW 3050/6010)										
Beryllium	mg/kg		0.31 B			0.27 B			0.14 B	
Chromium	mg/kg		7.7			7.2			4.1	
Copper	mg/kg		8.5			16.7			14.2	
Nickel	mg/kg		8.2			14.1			10.6	
Zinc	mg/kg		27.4 J(E)			46.7 J(E)			72.6 J(E)	
VOLATILE ORGANICS (SW 8240 [A])										
Toluene	µg/kg		3 J			11 U			11 U	
TICs	µg/kg		0 (0)			0 (0)			0 (0)	
TIC Total	µg/kg		0 (0)			0 (0)			0 (0)	
SEMIVOLATILE ORGANICS (SW 8270 [B])										
2–Methylnaphthalene	µg/kg		110 J			370 U			370 U	
Phenanthrene	µg/kg		45 J			370 U			370 U	
bis(2–Ethylhexyl)phthalate	µg/kg		64 J			40 J			370 U	
TICs	µg/kg	4–Hydroxy–4–Methyl–2–Pentanone^{a}	6400 B,J,N,A	(RT 4.70)	Unknown^{d}	140 J	(RT 21.40)	4–Hydroxy–4–Methyl–2–Pentanone^{a}	26000 B,J,N,A	(RT 4.87)
		2,3,7–Trimethyl–Octane^{b}	560 J,N	(RT 13.34)	Unknown^{d}	120 J	(RT 22.70)	Unknown^{d}	110 J	(RT 11.90)
		4–Fluoro–1,1'–Biphenyl^{c}	580 J,N	(RT 15.02)	Unknown^{d}	100 J	(RT 23.95)	2–Methyl–Nonane^{b}	180 J,N	(RT 13.77)
		2,7,10–Trimethyl–Dodecane^{b}	560 J,N	(RT 15.19)	Unknown^{d}	130 J	(RT 25.16)	Tetradecane^{b}	280 J,N	(RT 15.54)
		2,3–Dimethyl–Naphthalene^{c}	390 J,N	(RT 15.95)	Unknown^{d}	150 J	(RT 25.92)	Unknown^{d}	230 J	(RT 17.19)
		Heptadecane, 2,6,10,14–Tetra^{b}	970 J,N	(RT 16.64)	Unknown^{d}	120 J	(RT 26.31)	Hexadecane^{b}	290 J,N	(RT 18.77)
		Naphthalene, 1,4,6–Trimethyl^{c}	310 J,N	(RT 18.02)	Unknown^{d}	88 J	(RT 27.41)	Unknown^{d}	490 J	(RT 20.27)
		Unknown^{d}	220 J	(RT 18.10)	Dodecanamide^{c}	3200 B,J,N	(RT 28.22)	Unknown^{d}	250 J	(RT 21.67)
		Unknown^{d}	190 J	(RT 18.22)	Unknown^{d}	120 J	(RT 28.49)	2,7,10–Trimethyl–Dodecane^{b}	110 J,N	(RT 21.75)
		Unknown^{d}	240 J	(RT 18.29)	Unknown^{d}	110 J	(RT 29.51)	Unknown^{d}	220 J	(RT 23.02)
		Unknown^{d}	350 J	(RT 18.80)	Unknown^{d}	96 J	(RT 30.49)	Unknown^{d}	190 J	(RT 23.92)
		Unknown^{d}	1600 J	(RT 19.57)	Unknown^{d}	110 J	(RT 31.46)	Unknown^{d}	190 J	(RT 24.34)
		Unknown^{d}	220 J	(RT 19.89)	Unknown^{d}	1600 J	(RT 32.32)	Unknown^{d}	140 J	(RT 25.57)
		Pentadecane, 2,6,10,14–Tetra^{b}	3200 J,N	(RT 20.42)	Unknown^{d}	110 J	(RT 32.41)	Unknown^{d}	410 J	(RT 26.24)
		Unknown^{d}	300 J	(RT 20.79)	Unknown^{d}	96 J	(RT 32.71)	Dodecanamide^{c}	390 J,N	(RT 26.49)
		Unknown^{d}	150 J	(RT 20.95)	Unknown^{d}	130 J	(RT 33.32)	Docosane^{b}	210 J,N	(RT 26.76)
		Unknown^{d}	180 J	(RT 21.05)	Unknown^{d}	110 J	(RT 34.24)	Unknown^{d}	250 J	(RT 27.91)
		Unknown^{d}	1800 J	(RT 21.85)	Octacosane^{b}	150 J,N	(RT 35.17)	Unknown^{d}	7700 J	(RT 28.66)
		Unknown^{d}	170 J	(RT 22.29)	Unknown^{d}	270 J	(RT 36.41)	Unknown^{d}	170 J	(RT 29.02)
		Heptadecane, 2,6,10,14–Tetra^{b}	330 J,N	(RT 22.95)	Unknown^{d}	110 J	(RT 37.04)	Unknown^{d}	180 J	(RT 30.09)
		Unknown^{d}	150 J	(RT 25.27)				Unknown^{d}	2000 J	(RT 33.09)
TIC Total	µg/kg		18870 (21)			7060 (20)			39990 (21)	

Table 3-10. Data Summary Table: Soil – Site 1 – Fire Training Area 1, 178th Tactical Fighter Group, Springfield ANGB, Springfield, Ohio (Continued)

SAIC ID Number			SB1-2-1			SB1-2-3			SB1-2-8	
Laboratory ID Number			94525			94603			94523	
Collection Date			8-13-92			8-13-92			8-13-92	
Collection Depth (ft)			0.5-2.5			4.5-6.0			14.5-16.0	
Associated Field QC Sample			TB-2 on 8-13-92 ER1-1 FB1-1 SD5-FB			TB-3 ER1-1 FB1-1 SD5-FB			TB-2 on 8-13-92 ER1-1 FB1-1 SD5-FB	
Parameter	**Units**									
TOTAL PETROLEUM HYDROCARBONS (SW 8015M)										
Diesel Fuel	mg/kg		<2			3			29	
Heavy Oil	mg/kg		6			3			15	
PRIORITY POLLUTANT METALS										
AA METALS										
Antimony (SW 3050/7041)	mg/kg		0.19 J(N,W)			0.29 J(N,r)			0.19 UJ(N)	
Arsenic (SW 3050/7060)	mg/kg		4.8			6.8 J(N)			6.1	
Lead (SW 3050/7421)	mg/kg		6.1 S			7.2			5.4 S	
Selenium (SW 3050/7740)	mg/kg		R(W)			0.15 UJ(N,W)			0.08 UJ(N,W)	
Thallium (SW 3050/7841)	mg/kg		0.26 UJ(N,W)			0.21 J(W)			0.11 J(N,W)	
ICP METALS (SW 3050/6010)										
Beryllium	mg/kg		0.29 B			0.28 B			0.13 B	
Chromium	mg/kg		7.4			7			4.3	
Copper	mg/kg		16.1			16.2			10.4	
Nickel	mg/kg		12.4			12.5			10	
Zinc	mg/kg		42.3 J(E)			44.4 J(E)			44.6 J(E)	
VOLATILE ORGANICS (SW 8240 [A])										
Toluene	μg/kg		11 U			11 U			12 U	
TICs	μg/kg		0 (0)			0 (0)			0 (0)	
TIC Total	μg/kg		0 (0)			0 (0)			0 (0)	
SEMIVOLATILE ORGANICS (SW 8270 [B])										
2-Methylnaphthalene	μg/kg		330 U			360 U			190	
Phenanthrene	μg/kg		330 U			360 U			93 J	
bis(2-Ethylhexyl)phthalate	μg/kg		34 J			360 U			350 U	
TICs	μg/kg	4-Hydroxy-4-Methyl-2-Pentanone[a]	17000 B,J,N,A	(RT 4.82)	Unknown[d]	70 J	(RT 22.70)	4-Hydroxy-4-Methyl-2-Pentanone[a]	5800 B,J,N,A	(RT 4.67)
		Nonanamide[c]	130 J,N	(RT 23.92)	Nonanamide[c]	210 B,J,N	(RT 23.70)	7-Methyl-Tridecane[b]	750 J,N	(RT 13.35)
		Unknown[d]	67 J	(RT 24.32)	Unknown[d]	70 J	(RT 23.95)	2,6,11-Trimethyl-Dodecane[b]	430 J,N	(RT 15.14)
		Unknown[d]	64 J	(RT 25.57)	Unknown[d]	67 J	(RT 25.16)	2,7,10-Trimethyl-Dodecane[b]	1100 J,N	(RT 15.22)
		Unknown[d]	300 J	(RT 26.24)	Unknown[d]	250 J	(RT 25.94)	2,3-Dimethyl-Naphthalene[c]	570 J,N	(RT 15.99)
		Dodecanamide[c]	250 J,N	(RT 26.49)	Unknown[d]	94 J	(RT 26.31)	Unknown[d]	850 J	(RT 16.57)
		Unknown[d]	110 J	(RT 26.76)	Unknown[d]	67 J	(RT 27.41)	Unknown[d]	1300 J	(RT 16.67)
		Unknown[d]	95 J	(RT 27.41)	Unknown[d]	6000 J	(RT 28.26)	Unknown[d]	300 J	(RT 16.85)
		Unknown[d]	140 J	(RT 27.91)	Dodecanamide[c]	63 B,J,N	(RT 28.42)	Trichloroeicosyl-Silane[a]	270 J,N	(RT 17.22)
		Unknown[d]	5300 J	(RT 28.64)	Unknown[d]	89 J	(RT 28.49)	Unknown[d]	310 J	(RT 17.30)
		Unknown[d]	69 J	(RT 28.86)	Unknown[d]	99 J	(RT 29.51)	Unknown[d]	570 J	(RT 18.05)
		Unknown[d]	110 J	(RT 29.02)	Unknown[d]	85 J	(RT 30.49)	Unknown[d]	570 J	(RT 18.14)
		Unknown[d]	150 J	(RT 30.09)	Unknown[d]	120 J	(RT 31.46)	Unknown[d]	810 J	(RT 18.30)
		Unknown[d]	120 J	(RT 31.16)	Unknown[d]	1100 J	(RT 32.31)	Unknown[d]	570 J	(RT 18.89)
		Unknown[d]	240 J	(RT 32.22)	Unknown[d]	110 J	(RT 32.41)	5-Propyl-Tridecane[b]	2600 J,N	(RT 19.60)
		(Z)-9-Octadecenamide[c]	1400 J,N	(RT 33.09)	Unknown[d]	110 J	(RT 33.32)	Pentadecane, 2,6,10,14-Tetra[b]	5200 J,N	(RT 20.47)
		Unknown[d]	230 J	(RT 33.31)	Unknown[d]	100 J	(RT 34.24)	Unknown[d]	260 J	(RT 20.99)
		Unknown[d]	180 J	(RT 34.41)	Unknown[d]	81 J	(RT 35.17)	Unknown[d]	310 J	(RT 21.07)
		Unknown[d]	110 J	(RT 35.87)	Unknown[d]	85 J	(RT 35.49)	Unknown[d]	3300 J	(RT 21.90)
		Unknown[d]	180 J	(RT 36.79)				Unknown[d]	340 J	(RT 22.32)
								Heptadecane, 2,6,10,14-Tetra[b]	490 J,N	(RT 22.99)
TIC Total	μg/kg		26245 (20)			8870 (19)			26700 (21)	

Table 3–10. Data Summary Table: Soil – Site 1 – Fire Training Area 1, 178th Tactical Fighter Group, Springfield ANGB, Springfield, Ohio (Continued)

SAIC ID Number		SB1–3–1	SB1–3–3	SB1–3–11
Laboratory ID Number		94596	94604	94597
Collection Date		8–14–92	8–14–92	8–14–92
Collection Depth (ft)		0.5–2.5	4.5–6.5	20.5–22.0
Associated Field QC Sample		TB–3 ER1–1 FB1–1 SD5–FB	TB–3 ER1–1 FB1–1 SD5–FB	TB–3 ER1–1 FB1–1 SD5–FB
Parameter	Units			
TOTAL PETROLEUM HYDROCARBONS (SW 8015M)				
Diesel Fuel	mg/kg	<2	<2	14 J(FD)
Heavy Oil	mg/kg	<2	4	11 J(FD)
PRIORITY POLLUTANT METALS				
AA METALS				
Antimony (SW 3050/7041)	mg/kg	0.24 J(N,r)	0.28 J(N,r)	0.24 J(N,r)
Arsenic (SW 3050/7060)	mg/kg	12.2 J(N)	6.4 J(N)	9.4 J(N)
Lead (SW 3050/7421)	mg/kg	15.1	23.9	12.6
Selenium (SW 3050/7740)	mg/kg	0.13 UJ(N,W)	0.18 UJ(N,W)	0.12 UJ(N,W)
Thallium (SW 3050/7841)	mg/kg	0.35 B	0.29 J(W)	0.28 B
ICP METALS (SW 3050/6010)				
Beryllium	mg/kg	0.59	0.71	0.57
Chromium	mg/kg	15.4	18.4	14.6
Copper	mg/kg	19.6	22.2	26.8
Nickel	mg/kg	22	18.8	23.9
Zinc	mg/kg	54.4 J(E)	81.4 J(E)	85.8 J(E)
VOLATILE ORGANICS (SW 8240 [A])				
Toluene	μg/kg	11 U	14 U	11 J
TICs	μg/kg	0 (0)	0 (0)	Trichlorofluoro–Methane^{a} 8 J,N (RT 4.31)
TIC Total	μg/kg	0 (0)	0 (0)	8 (1)
SEMIVOLATILE ORGANICS (SW 8270 [B])				
2–Methylnaphthalene	μg/kg	370 U	450 U	390 U
Phenanthrene	μg/kg	370 U	450 U	390 U
bis(2–Ethylhexyl)phthalate	μg/kg	370 U	67 J	71 J
TICs	μg/kg	Unknown^{d} 120 J (RT 22.50)	Unknown^{d} 7500 J (RT 28.27)	Unknown^{d} 200 J (RT 20.04)
		Hexadecanoic Acid^{f} 170 J,N (RT 22.64)	Unknown^{d} 1000 J (RT 31.66)	Unknown^{d} 220 J (RT 20.12)
		Nonanamide^{c} 150 B,J,N (RT 22.75)	Unknown^{d} 1700 J (RT 32.34)	Octadecane^{b} 180 J,N (RT 21.40)
		Hexadecanoic Acid, 1–Methyle^{b} 79 J,N (RT 23.35)	Octacosane^{b} 570 J,N (RT 33.36)	Unknown^{d} 260 J (RT 22.72)
		Unknown^{d} 280 J (RT 25.00)	Unknown^{d} 520 J (RT 33.59)	Eicosane^{b} 230 J,N (RT 23.97)
		Dodecanamide^{c} 370 B,J,N (RT 25.22)	Unknown^{d} 370 J (RT 34.01)	Unknown^{d} 170 J (RT 25.17)
		Unknown^{d} 5100 J (RT 27.31)	Nonacosane^{b} 920 J,N (RT 35.21)	Unknown^{d} 180 J (RT 25.96)
		Unknown^{d} 96 J (RT 30.56)	Unknown^{d} 720 J (RT 35.82)	Docosane^{b} 210 J,N (RT 26.32)
		Unknown^{d} 620 J (RT 31.39)	Unknown^{d} 610 J (RT 36.67)	Unknown^{d} 150 J (RT 27.42)
		Unknown^{d} 66 J (RT 31.52)	Unknown^{d} 390 J (RT 37.01)	Unknown^{d} 4600 J (RT 28.29)
		Unknown^{d} 80 J (RT 31.81)	Unknown^{d} 700 J (RT 37.07)	Unknown^{d} 250 J (RT 28.51)
		Unknown^{d} 230 J (RT 34.31)	Unknown^{d} 420 J (RT 37.26)	Pentacosane^{b} 190 J,N (RT 29.51)
		Unknown^{d} 100 J (RT 35.62)	Unknown^{d} 1400 J (RT 37.41)	Hexacosane^{b} 190 J,N (RT 30.51)
		Unknown^{d} 180 J (RT 35.87)	Unknown^{d} 2500 J (RT 37.51)	Heptacosane^{b} 220 J,N (RT 31.49)
		Unknown^{d} 150 J (RT 36.21)	Unknown^{d} 3000 J (RT 37.77)	Unknown^{d} 1500 J (RT 32.36)
		Unknown^{d} 120 J (RT 38.36)	Unknown^{d} 290 J (RT 37.94)	Octacosane^{b} 220 J,N (RT 32.44)
			D:B–Friedo–B':A'–Neogammacer^{c} 200 J,N (RT 38.01)	Nonacosane^{b} 250 J,N (RT 33.36)
			Unknown^{d} 390 J (RT 38.51)	Unknown^{d} 230 J (RT 34.27)
			Unknown^{d} 620 J (RT 38.69)	Unknown^{d} 180 J (RT 35.19)
			Unknown^{d} 18000 J (RT 39.37)	Unknown^{d} 170 J (RT 35.52)
TIC Total	μg/kg	7911 (16)	41820 (20)	9800 (20)

Table 3–10. Data Summary Table: Soil – Site 1 – Fire Training Area 1, 178th Tactical Fighter Group Springfield ANGB, Springfield, Ohio (Continued)

SAIC ID Number			SB1-3-11R			SB1-3-11RRE	
Laboratory ID Number			94598			94598RE	
Collection Date			8-14-92			8-14-92	
Collection Depth (ft)			20.5-22.0			20.5-22.0	
Associated Field QC Sample			TB-3 ER1-1 FB1-1 SD5-FB			TB-3 ER1-1 FB1-1 SD5-FB	
Parameter	Units						
TOTAL PETROLEUM HYDROCARBONS (SW 8015M)							
Diesel Fuel	mg/kg		43 J(FD)			NA	
Heavy Oil	mg/kg		22 J(FD)			NA	
PRIORITY POLLUTANT METALS							
AA METALS							
Antimony (SW 3050/7041)	mg/kg		R(N)			NA	
Arsenic (SW 3050/7060)	mg/kg		3.7 J(N)			NA	
Lead (SW 3050/7421)	mg/kg		11.2			NA	
Selenium (SW 3050/7740)	mg/kg		0.13 UJ(N,W)			NA	
Thallium (SW 3050/7841)	mg/kg		0.32 B			NA	
ICP METALS (SW 3050/6010)							
Beryllium	mg/kg		0.27 B			NA	
Chromium	mg/kg		9			NA	
Copper	mg/kg		23			NA	
Nickel	mg/kg		17.7			NA	
Zinc	mg/kg		81.7 J(E)			NA	
VOLATILE ORGANICS (SW 8240 [A])							
Toluene	µg/kg		5 J			NA	
TICs	µg/kg		0 (0)			NA	
TIC Total	µg/kg		0 (0)			NA	
SEMIVOLATILE ORGANICS (SW 8270 [B])							
2-Methylnaphthalene	µg/kg		390 U			390 U	
Phenanthrene	µg/kg		390 U			390 U	
bis(2-Ethylhexyl)phthalate	µg/kg		390 UJ(IS)			390 U	
TICs	µg/kg	Tetradecane^b	440 J,N	(RT 14.50)	Tetradecane^b	410 J,N	(RT 14.87)
		2,7,10-Trimethyl-Dodecane^b	670 J,N	(RT 16.10)	2,7,10-Trimethyl-Dodecane^b	620 J,N	(RT 16.49)
		Hexadecane^b	820 J,N	(RT 17.64)	Hexadecane^b	760 J,N	(RT 18.02)
		Unknown^d	780 J	(RT 18.35)	Unknown^d	590 J	(RT 18.74)
		Heptadecane^b	740 J,N	(RT 19.10)	Heptadecane^b	770 J,N	(RT 19.47)
		Hexadecane, 2,6,10-Trimethyl^b	760 J,N	(RT 19.17)	Hexadecane, 2,6,10-Trimethyl^b	720 J,N	(RT 19.55)
		Octadecane^b	560 J,N	(RT 20.49)	Octadecane^b	520 J,N	(RT 20.85)
		Hexadecane, 2,6,10,14-Tetram^b	500 J,N	(RT 20.59)	Hexadecane, 2,6,10,14-Tetram^b	450 J,N	(RT 20.97)
		Unknown^d	880 J	(RT 21.80)	Unknown^d	620 J	(RT 22.17)
		Eicosane^b	660 J,N	(RT 23.05)	Eicosane^b	570 J,N	(RT 23.42)
		Heptadecane, 2,6,10,15-Tetra^b	490 J,N	(RT 24.25)	Heptadecane, 2,6,10,15-Tetra^b	420 J,N	(RT 24.62)
		Dodecanamide^c	200 B,J,N	(RT 25.26)	Docosane^b	390 J,N	(RT 25.77)
		Docosane^b	380 J,N	(RT 26.52)	Unknown^d	410 J	(RT 26.87)
		Unknown^d	3400 J	(RT 27.37)	Unknown^d	3500 J	(RT 27.71)
		Unknown^d	290 J	(RT 27.61)	Unknown^d	300 J	(RT 27.96)
		Pentacosane^b	280 J,N	(RT 28.62)	Pentacosane^b	340 J,N	(RT 28.97)
		Hexacosane^b	280 J,N	(RT 29.64)	Hexacosane^b	320 J,N	(RT 29.99)
		Heptacosane^b	270 J,N	(RT 30.61)	Unknown^d	310 J	(RT 30.96)
		Unknown^d	950 J	(RT 31.47)	Unknown^d	1100 J	(RT 31.81)
		Octacosane^b	250 J,N	(RT 31.56)	Octacosane^b	270 J,N	(RT 31.91)
TIC Total	µg/kg		13600 (20)			13390 (20)	

Table 3–10. Data Summary Table: Soil – Site 1 – Fire Training Area 1, 178th Tactical Fighter Group, Springfield ANGB, Springfield, Ohio (Continued)

Validation note: All descriptive data qualifiers applied to the reported values by the laboratory are reported in parentheses. Each data point has been assessed to determine whether the value is considered usable (i.e., no qualifier), usable but estimated (i.e., "J"), or not usable (i.e., "R"). All usability qualifiers are followed by the applicable laboratory or field QC qualifier, presented in parentheses and defined below. Usability qualifiers were not applied to values qualified by the laboratory, but were not considered to have been adversely impacted by the applicable laboratory QC result (e.g., duplicated and matrix spike analysis).

A – samples were analyzed for VOCs using SW 8240, laboratory analyses followed methods outlined in the March 1990 CLP SOW for organic analyses
B – samples were analyzed for SVOCs using SW 3550/8270, laboratory analysis followed method details outlined in the March 1990 CLP SOW for organic analyses
NA – not analyzed
RT – retention time in minutes
TICs–tentatively identified compounds, total concentration is listed and the total number of tentatively identified compounds is inside the parenthases

Data Validation Qualifiers

J – associated numerical value is the approximate concentration
R – rejected value
U – compound/element was included in analysis, but was not detected
UJ – reported quantitation limit is approximate and may or may not represent the actual quantitation necessary to accurately and precisely measure the analyte

Explanatory Data Validation Qualifiers

FD – field duplicates relative percent differences outside the control limits
IS – internal standard outside control limits
r – correlation coefficient for the calibration curve is less than 0.995

EPA–defined CLP SOW Laboratory Qualifiers

A(TICs) – suspects ALDOL–condensation product
B(metals) – the reported value is estimated because it is greater than the Instrument Detection Limit (IDL), but less than the Contract Required Detection Limit(CRDL)
B(organics) – compound was also detected in the associated laboratory method blank
E(metals) – the reported value is estimated due to the presence of interference
N – spiked sample recovery outside of control limits
N(TICs) – presumptive evidence of a compound
S – the reported value was determined by the Method of Standard Additions (MSA)
W – post–digestion spike for Graphite Furnace Atomic Absorption (GFAA) analysis is out of control limits (85–115%), while sample absorbance is less than 50% of the spike absorbance

SAIC TIC Evaluation Categories

[a] – laboratory and extraction artifacts
[b] – petroleum or petroleum degradation products
[c] – other
[d] – unknown
[e] – polycyclic aromatic hydrocarbons
[f] – naturally occuring organic compounds

Table 3−11. Data Summary Table: Groundwater − Site 1 − Fire Training Area 1
178th Tactical Fighter Group, Springfield ANGB, Springfield, Ohio

SAIC ID Number Laboratory ID Number Collection Date Associated Field QC Sample Parameter	Units	MW1−1−1 97310 9−30−92 TB−14 ERBG−2 FBBA−1 FBCE−1	MW1−1−2 9568, 9584 5−21−93 TB52193 EB2−2, EB3−2 N/A FB2−2, FB3−2
TOTAL PETROLEUM HYDROCARBONS (SW 8015M)			
Gasoline	mg/L	NA	<0.25
Diesel Fuel	mg/L	<0.2	<0.13
Heavy Oil	mg/L	<0.2	<0.25
TOTAL PRIORITY POLLUTANT METALS			
AA METALS			
Antimony (SW 3020/7041)	µg/L	R(N)	1.4 J(N)
Arsenic (SW 3020/7060)	µg/L	2.6 U(MB)	R(N)
Lead (SW 3020/7421)	µg/L	1.6 U(MB)	31.8
Selenium (SW 7740)	µg/L	R(N)	R(N)
ICP METALS (SW 3005/6010)			
Beryllium	µg/L	0.3 U	1.6 B
Chromium	µg/L	4.9 B	61.2
Copper	µg/L	9.5 U(FB)	90.1
Nickel	µg/L	12.9 U	110
Zinc	µg/L	24.5 U(FB)	490 J(E)
DISSOLVED PRIORITY POLLUTANT METALS			
AA METALS	µg/L	NA	ND
ICP METALS (SW 3005/6010)	µg/L	NA	ND
VOLATILE ORGANICS (A)	µg/L	ND	ND
SEMIVOLATILE ORGANIC (SW 8270 [B])			
TICs	µg/L	Unknown[d] 4 J,N (RT 25.71)	0 (0)
TIC Total	µg/L	4 (1)	0 (0)

Table 3–11. Data Summary Table: Groundwater – Site 1 – Fire Training Area 1
178th Tactical Fighter Group, Springfield ANGB, Springfield, Ohio (Continued)

Validation note: All descriptive data qualifiers applied to the reported values by the laboratory are reported in parentheses. Each data point has been assessed to determine whether the value is considered usable (i.e., no qualifier), usable but estimated (i.e., "J"), or not usable (i.e., "R"). All usability qualifiers are followed by the applicable laboratory or field QC qualifier, presented in parentheses and defined below. Usability qualifiers were not applied to values qualified by the laboratory, but were not considered to have been adversely impacted by the applicable laboratory QC result (e.g., duplicated and matrix spike analysis).

A – groundwater samples were analyzed for volatile halogenated compounds and volatile aromatic compounds by E 524.2 for samples collected in 1992 or SW 8240 (25 ml purge for low level volatiles) for samples collected in 1993; these methods have been modified to incorporate CLP–type QC requirements

B – SVOCs in groundwater and field QC blanks were analyzed using EPA method 3510/8270

NA – not analyzed

ND – not detected

N/A – not applicable

RT – retention time in minutes

TICs– tentatively identified compounds, total concentration is listed and the total number of tentatively identified compounds is inside the parenthases

Data Validation Qualifiers

J – associated numerical value is the approximate concentration

R – rejected value

U – compound/element was included in analysis, but was not detected

Explanatory Data Validation Qualifiers

FB – compound/element was also detected in the associated field blank

MB – compound/element was also detected in the associated laboratory method blank

EPA–defined CLP SOW Laboratory Qualifiers

B(metals) – the reported value is estimated because it is greater than the Instrument Detection Limit (IDL), but less than the Contract Required Detection Limit (CRDL)

E(metals) – the reported value is estimated due to the presence of interference

N – spiked sample recovery outside of control limits

N(TICs) – presumptive evidence of a compound

SAIC TIC Evaluation Categories

^{d} – unknown

Table 3-12. ARAR Comparison Table: Groundwater - Site 1 - Fire Training Area 1, 178th Tactical Fighter Group, Springfield ANGB, Springfield, Ohio

	CONCENTRATION IN GROUNDWATER (μg/L)		COMPARISON vs ARARS	
Parameter	Mean Detected Result	Maximum Detected Result	Mean Detected Result	Maximum Detected Result
METALS				
Antimony	1.4	1.4	- -	- -
Beryllium	.9	1.6	- -	- -
Chromium	33.1	61.2	- -	- -
Copper	47.4	90.1	- -	- -
Lead	16.3	31.8	>MCL; >OMCL	>MCL; >OMCL
Nickel	58.2	110	- -	>MCL; >OMCL
Zinc	251.1	490	- -	- -

- - ARAR not exceeded or ARAR not available (see Table 3-9)
MCL - Safe Drinking Water Act (SDWA) maximum contaminant level
OMCL - Ohio maximum contaminant level

NOTE: Unless otherwise indicated, results are for total metals detected in unfiltered groundwater.

Table 3-13. Comparison of Site 1, Fire Training Area 1, Results with Background Upper Tolerance Limits: Soil
178th Tactical Fighter Group, Springfield ANGB, Springfield, Ohio

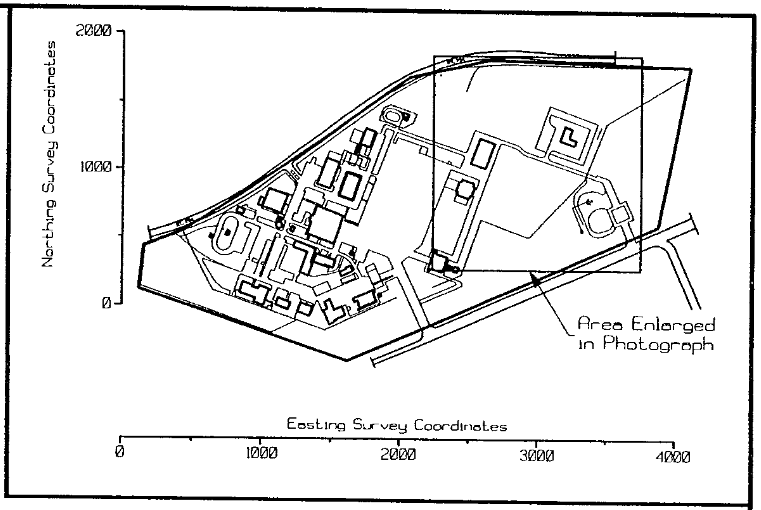
Parameter	Units	Proportion of Results Greater than Detection Limit	Minimum Detected Result	Mean Detected Result	Maximum Detected Result	Upper Tolerance Limit	Proportion of Results Greater than Upper Tolerance Limit
Diesel Fuel	mg/kg	1 / 6	3	1.333	3	37.00	0 / 6
Heavy Oil	mg/kg	3 / 6	3	2.667	6	160.00	0 / 6
INORGANICS							
Antimony	mg/kg	6 / 6	0.19	0.2383	0.29	0.21	4 / 6
Arsenic	mg/kg	6 / 6	4.8	7.083	12.2	11.30	1 / 6
Beryllium	mg/kg	6 / 6	0.27	0.4083	0.71	0.55	2 / 6
Chromium (III)	mg/kg	6 / 6	7	10.52	18.4	121.00	0 / 6
Copper	mg/kg	6 / 6	8.5	16.55	22.2	48.70	0 / 6
Lead	mg/kg	6 / 6	6.1	11.65	23.9	126.00	0 / 6
Nickel	mg/kg	6 / 6	8.2	14.67	22	61.50	0 / 6
Selenium	mg/kg	1 / 5	0.08	0.073	0.08	0.25	0 / 5
Thallium	mg/kg	5 / 6	0.12	0.205	0.35	0.40	0 / 6
Zinc	mg/kg	6 / 6	27.4	49.43	81.4	343.00	0 / 6
ORGANICS							
Phenanthrene	mg/kg	1 / 6	0.045	0.1642	0.045	0.27	0 / 6
Toluene	mg/kg	1 / 6	0.003	0.0053	0.003	0.01	0 / 6

Samples SB1-1-1, SB1-2-1, SB1-3-1, SB1-2-3, SB1-3-3, and SB1-1-3 were used in the comparison to background samples.

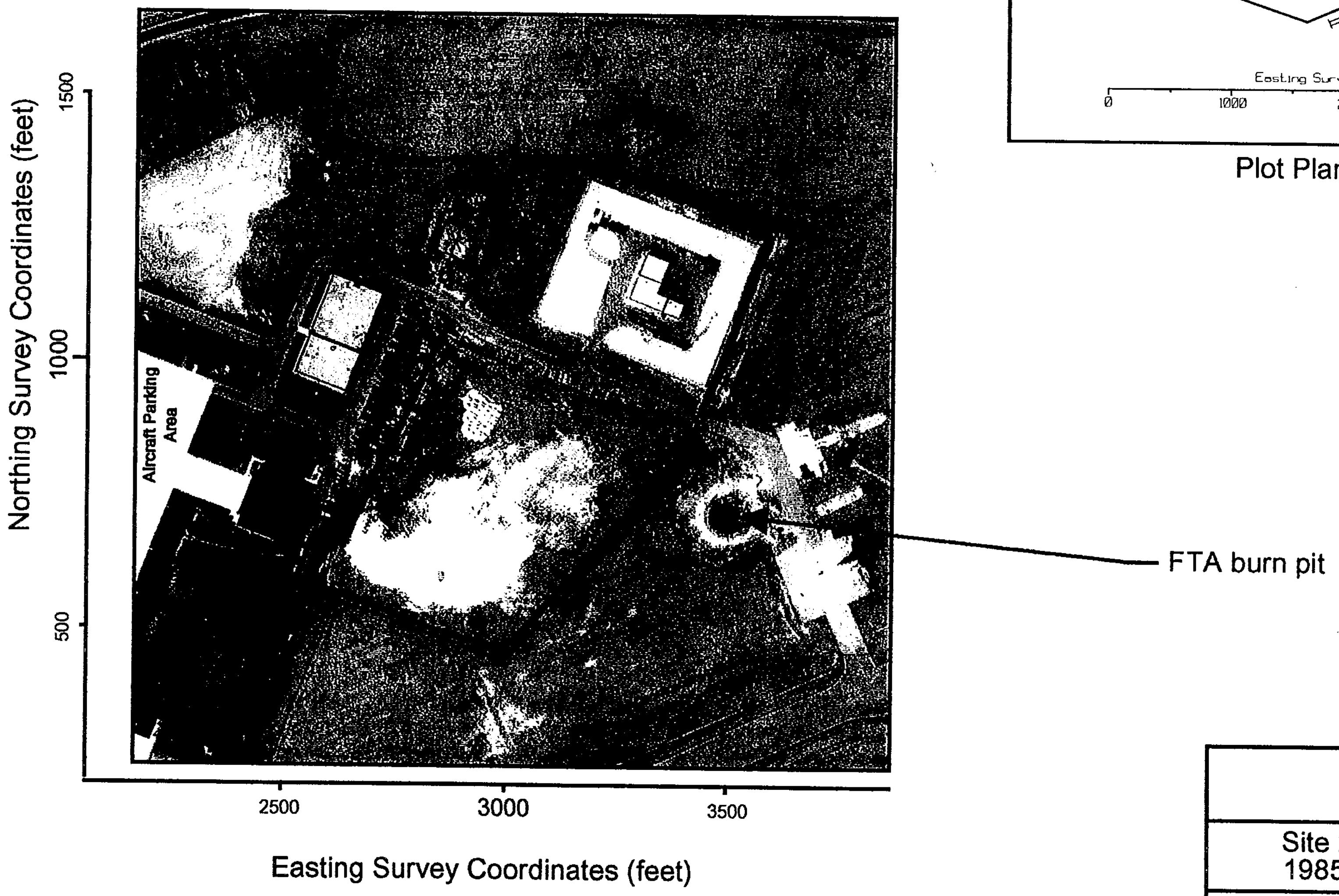
Table 3-14. Comparison of Site 1, Fire Training Area 1, Results with Background Upper Tolerance Limits: Groundwater
178th Tactical Fighter Group, Springfield ANGB, Springfield, Ohio

Parameter	Units	Proportion of Results Greater than Detection Limit	Minimum Detected Result	Mean Detected Result	Maximum Detected Result	Upper Tolerance Limit	Proportion of Results Greater than Upper Tolerance Limit
INORGANICS							
Antimony	mg/L	1 / 1	0.0014	0.0014	0.0014	0.0015	0 / 1
Beryllium	mg/L	1 / 2	0.0016	0.0009	0.0016	0.0042	0 / 2
Chromium (III)	mg/L	2 / 2	0.0049	0.0331	0.0612	0.1500	0 / 2
Copper	mg/L	1 / 2	0.0901	0.0474	0.0901	0.2100	0 / 2
Lead	mg/L	1 / 2	0.0318	0.0163	0.0318	0.1040	0 / 2
Nickel	mg/L	1 / 2	0.11	0.0582	0.11	0.2470	0 / 2
Zinc	mg/L	1 / 2	0.49	0.2511	0.49	0.7630	0 / 2

Samples MW1-1-1 and MW1-1-2 were used in the comparison to background samples.



Plot Plan (1993)



SAIC

Site 2 - FTA-2 Location,
1985 Aerial Photograph

Springfield ANGB, Springfield, Ohio

feet of soil within the former burn pit. Tables containing information and analytical results for Site 2 (Tables 3-15 through 3-22) are presented at the end of Section 3.6.

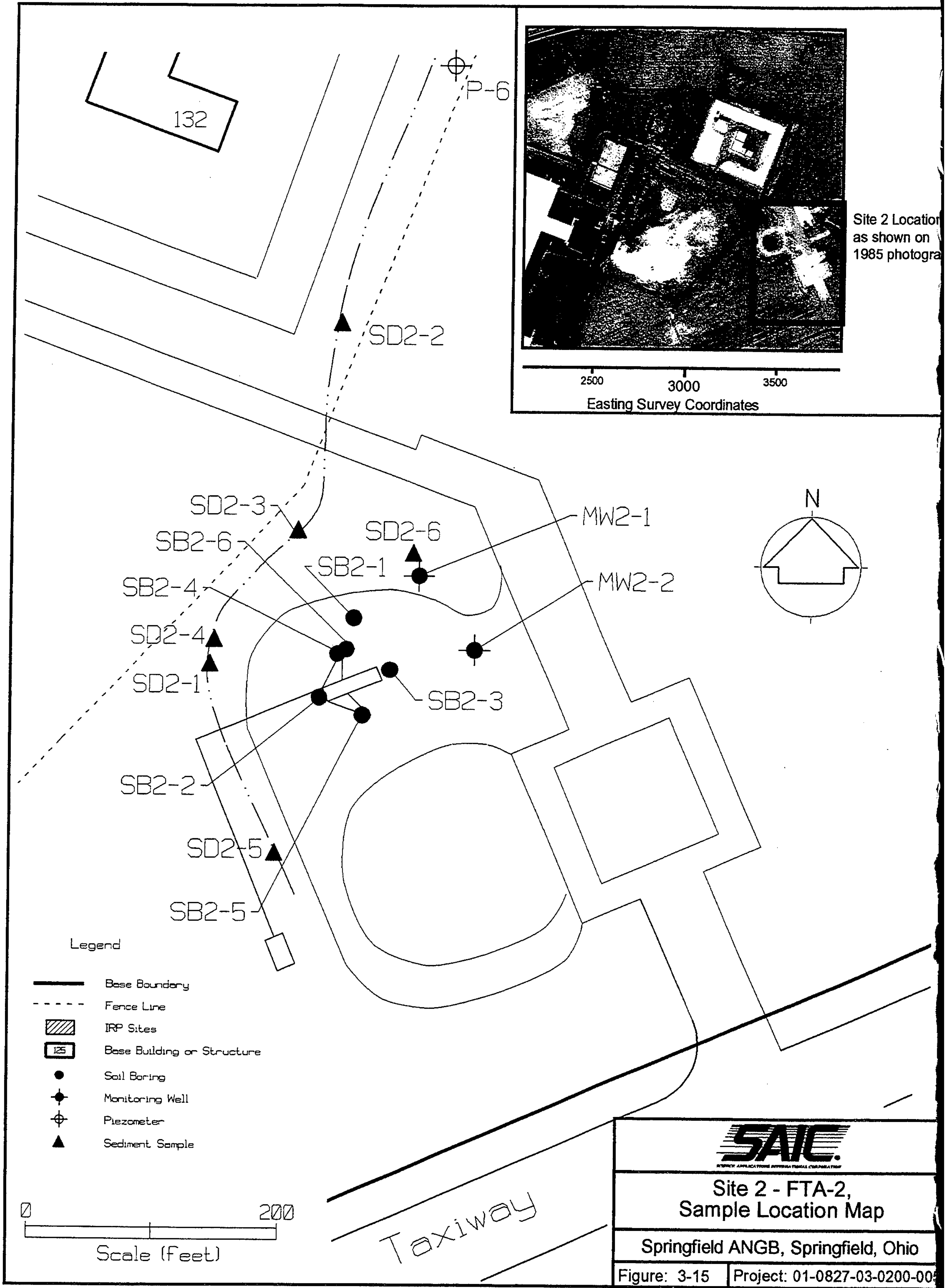
The contaminants detected within the burn pit are associated with petroleum products and include TPH, SVOCs (primarily PAHs), and BTEX. Deeper than 9.5 feet BLS, petroleum hydrocarbons diminish rapidly with depth and are not detected in groundwater. A dense layer of gray silt and clay at approximately 27 feet may be providing a site of preferential attachment for these contaminants because there is a slight increase in petroleum hydrocarbon concentrations at this depth.

Groundwater flow direction findings were adjusted slightly at Site 2 because of water levels measured in well MW2-1 installed at Site 2 during the first phase. A second monitoring well (MW2-2) was installed and sampled to ensure the analysis of groundwater downgradient from Site 2. Groundwater at Site 2 contained metals and trace amounts of diesel fuel.

Sediment in the drainage swale at Site 2 contained petroleum hydrocarbons and SVOCs. The contamination did not follow an identifiable distribution pattern, so its source was not conclusively determined. The source of sediment contamination was determined to be not site-related because out of 17 SVOCs detected at Site 2, only 4 SVOCs were common to both the drainage swale and the burn pit. In addition, the chief constituent of petroleum hydrocarbons detected in the drainage swale was heavy oil. In contrast, surface soil within the burn pit contained primarily diesel fuel. The locations of the soil borings, monitoring wells, and sediment samples are shown in Figure 3-15. Detailed soil boring logs and as-built diagrams are presented in Appendix A.

3.6.1 Site 2 Lithology

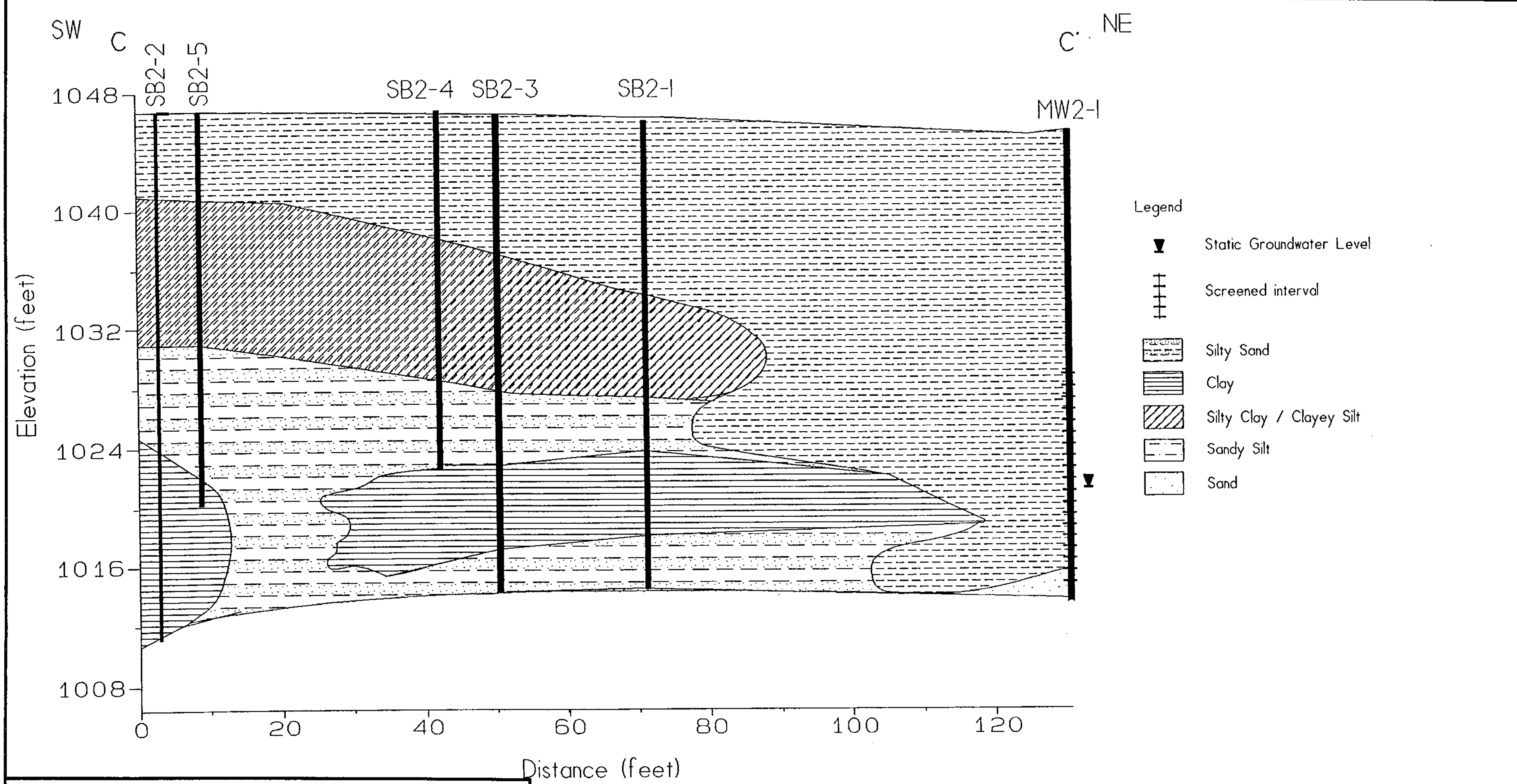
Much of the local stratigraphy at Site 2 has been disturbed by construction activities (i.e., fill placed in natural low-lying areas). A stratigraphic interpretation, illustrated in the cross section shown in Figure 3-16, was constructed from soil boring and well log data obtained during the SI. Some of the units encountered during drilling, particularly the glacio-fluvial deposits, are heterogeneous, sporadic, and thin. To facilitate correlation, these deposits have

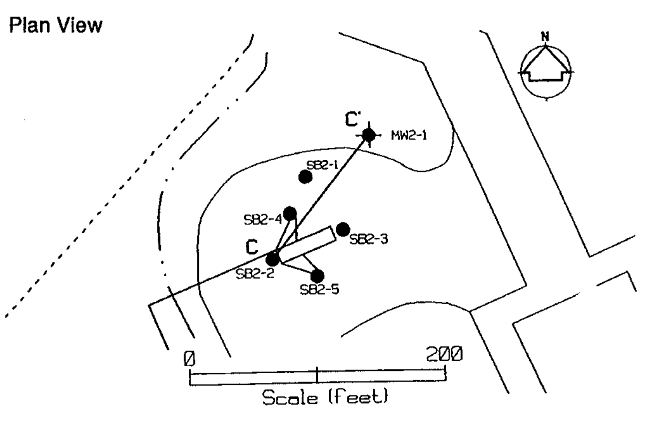


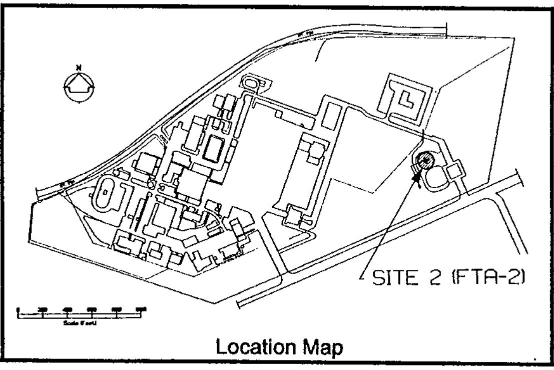
Site 2 - FTA-2,
Sample Location Map

Springfield ANGB, Springfield, Ohio

Figure: 3-15 | Project: 01-0827-03-0200-00




Plan View


Location Map

Site 2 - FTA-2, Generalized Glacial Lithology, Cross Section C-C'

Springfield ANGB, Springfield, Ohio

Figure: 3-16 | Project: 01-0827-03-0200-005

been broadly categorized as the following five lithological units: silty clay, clayey silt, stiff (lacustrine) clay, silty/clayey sand, or sand.

A homogeneous layer of gravel fill overlies the former FTA at Site 2. The surficial deposits at the site consist of a mixture of fine grained units (silt and clay) with local deposits of matrix supported sand. Lacustrine deposits, dark gray, massive to finely laminated silt and clay, lie below the mixture of silts and clays described above. This unit pinches out relatively quickly toward the northeast. The aquifer material was encountered just below the lacustrine deposits and groundwater occurs in both the sand and clay units.

3.6.2 Soil Organic Vapor Survey

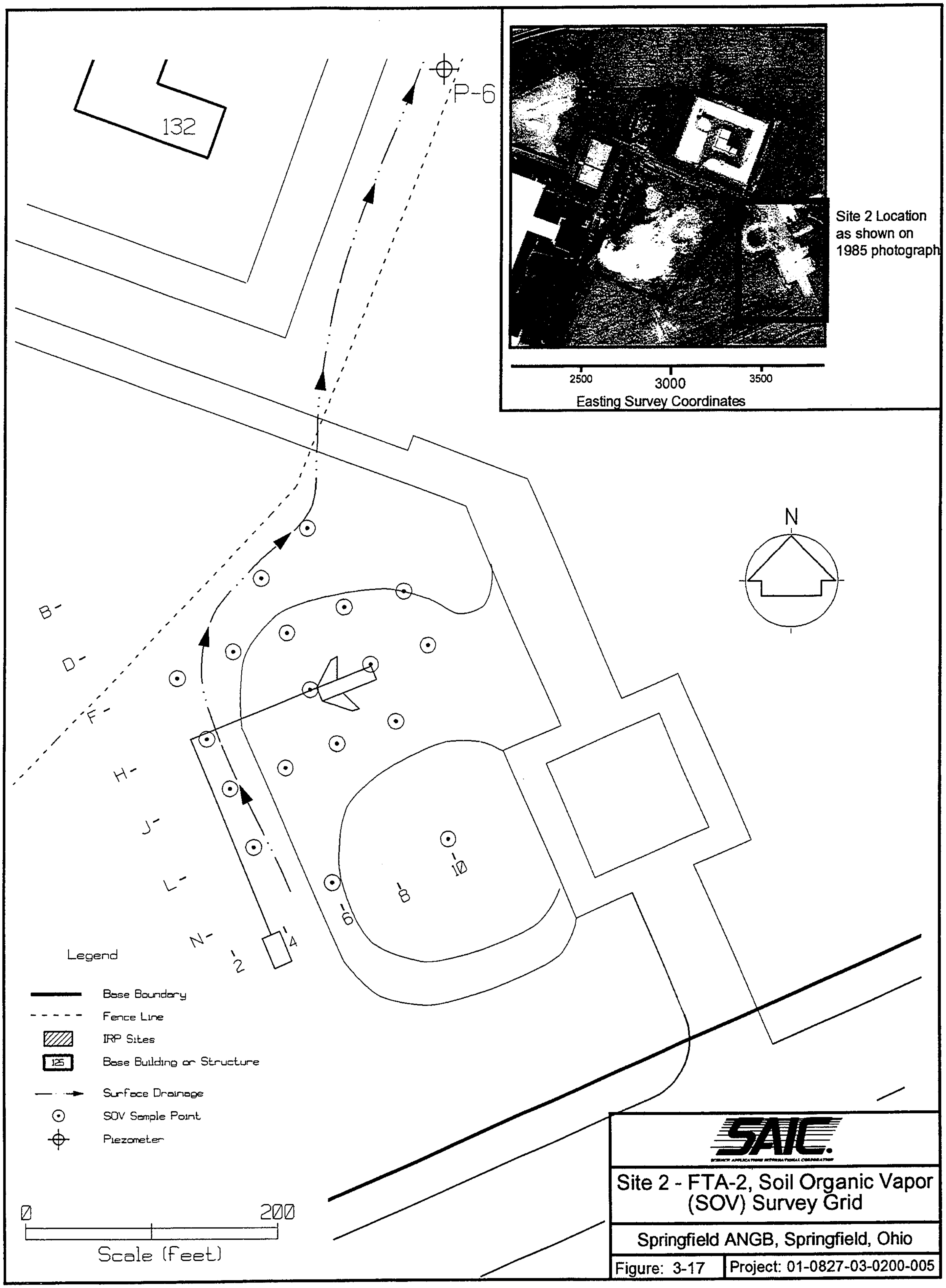
The initial activity performed at Site 2 - FTA-2 was an SOV survey, which assessed the distribution of VOCs present in soil vapor overlying the site. These data were used to locate soil borings at Site 2. The SOV survey was conducted in April 1992 and included a total of 20 samples within a grid that encompassed an area 200 by 350 feet. The SOV survey was conducted according to the procedures outlined in Section 2 and SOP FP 6-1.

The current fire training system operates at Site 2; however, it is fueled by propane and not considered to be a source of VOCs or SVOCs. Figure 3-17 illustrates the location and orientation of the SOV survey grid. SOV samples were analyzed in the field for BTEX, TVHC, TCA, TCE, PCE, and carbon tetrachloride. The SOV survey report, including descriptions of both the field and analytical procedures of this survey, is presented in Appendix C.

As shown in Figure 3-18, an isoconcentration map of TVHC was generated from the SOV survey data to illustrate the horizontal distribution of these compounds. This map shows that the highest concentrations of volatile hydrocarbons are within the area identified as the former burn pit.

3.6.3 Chemicals Detected in Soil

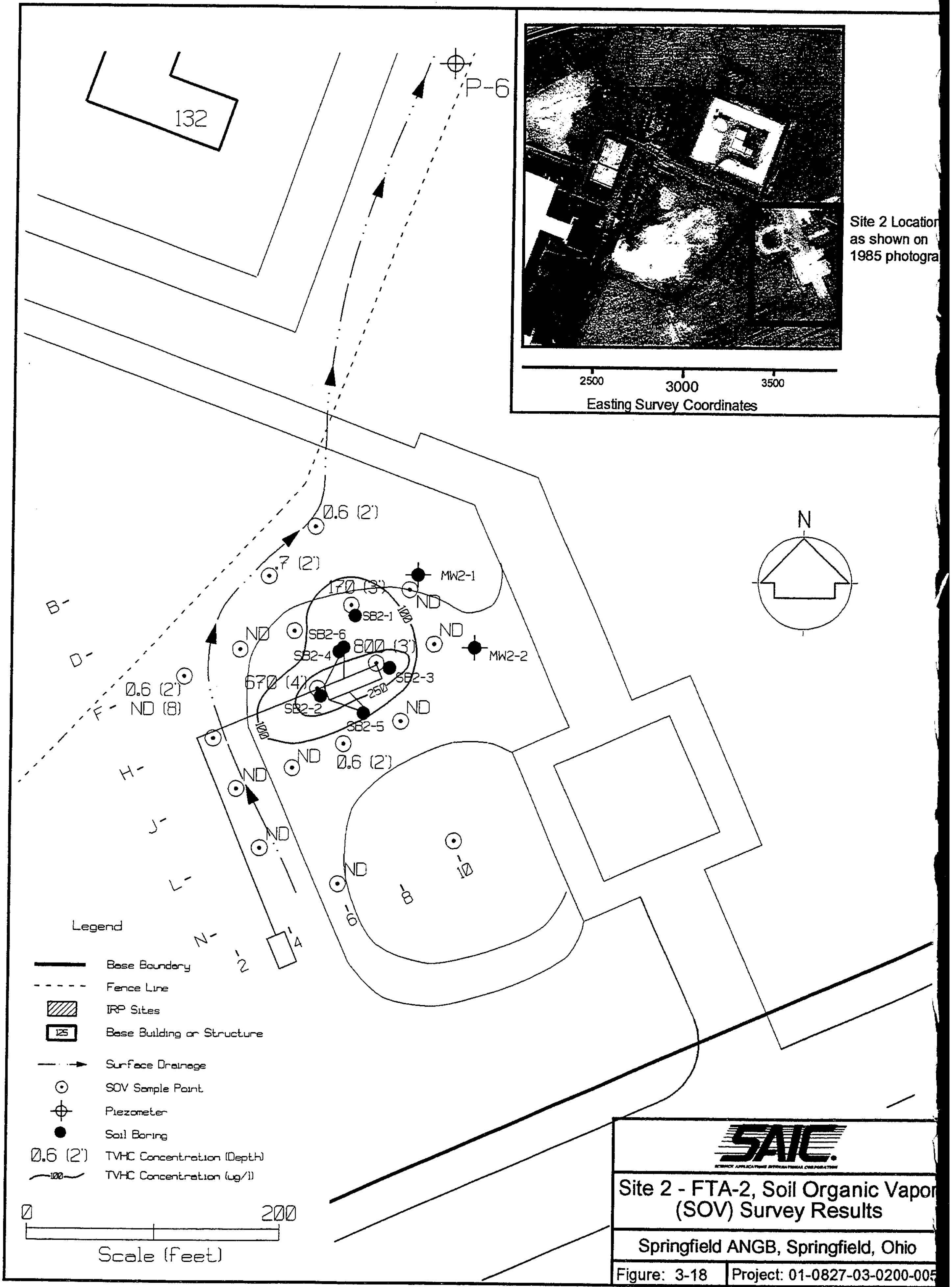
Six soil borings (i.e., SB2-1 through SB2-6) were drilled at FTA-2 at the locations shown in Figure 3-19. Borings were located in the areas of highest VOC concentration based on SOV



Site 2 - FTA-2, Soil Organic Vapor (SOV) Survey Grid

Springfield ANGB, Springfield, Ohio

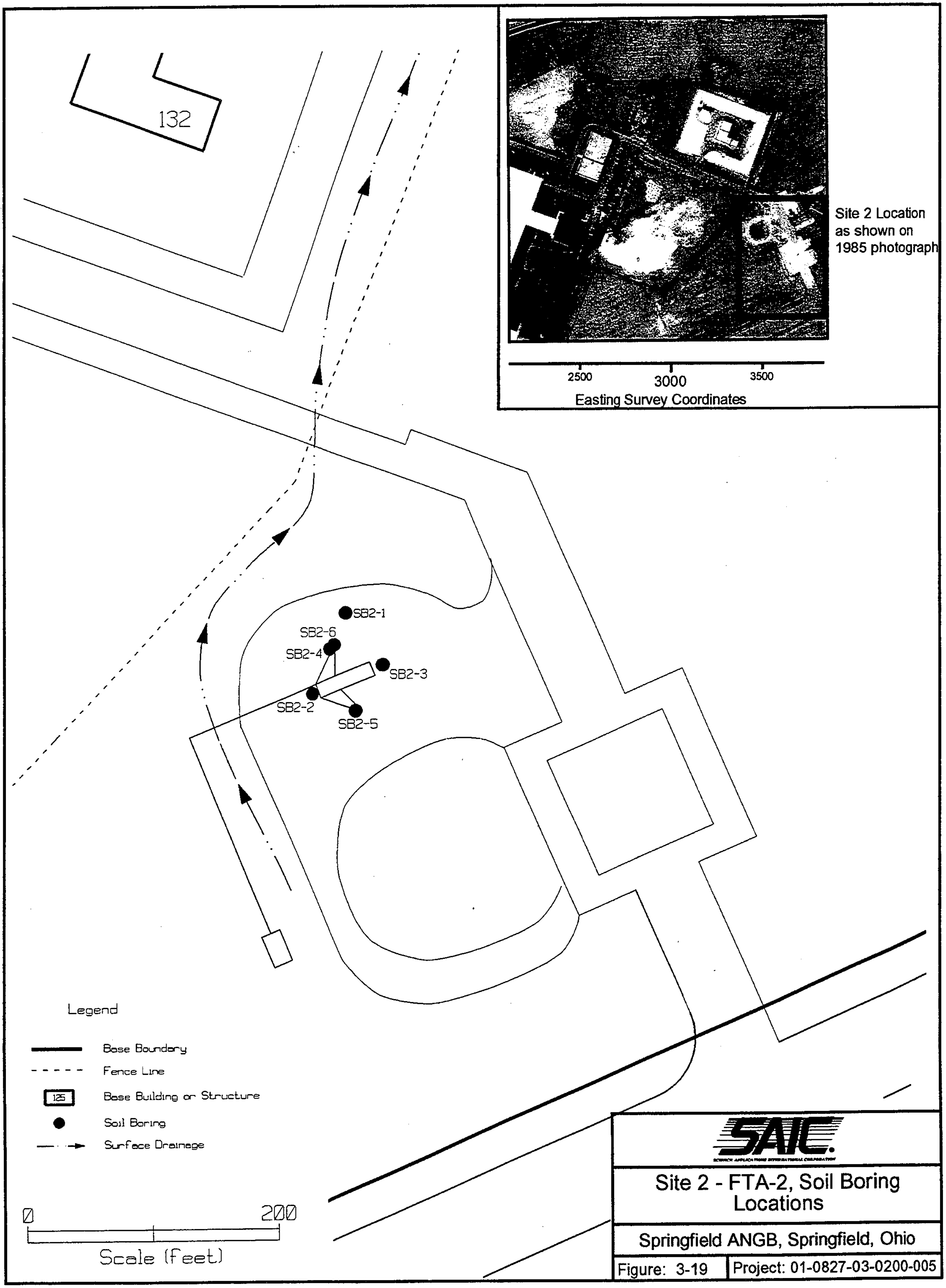
Figure: 3-17	Project: 01-0827-03-0200-005



Site 2 - FTA-2, Soil Organic Vapor (SOV) Survey Results

Springfield ANGB, Springfield, Ohio

Figure: 3-18 Project: 01-0827-03-0200-005



Site 2 - FTA-2, Soil Boring Locations

Springfield ANGB, Springfield, Ohio

Figure: 3-19

Project: 01-0827-03-0200-005

survey data. Borings were completed during two separate phases of field activity. Soil borings SB2-1, SB2-2 and SB2-3 were drilled during the initial field investigation. After review of the data collected during the first round of sampling, three additional soil borings (i.e, SB2-4, SB2-5, and SB2-6) were completed at the site. These borings were added to the SI to delineate the vertical distribution of contamination at the site.

Soil borings SB2-1, SB2-2, and SB2-3 were drilled and continuously sampled to the soil water interface; total depths of the borings were 30, 34, and 31.5 feet BLS, respectively. Soil samples were collected continuously at 2-foot intervals and screened onsite for VOCs with an HNu meter and mobile GC.

As discussed in Section 2, onsite GC screening for total volatile organics (TVO) was used to identify vertical distribution trends of potential contamination and select soil samples for laboratory analysis. Table 3-15 presents the onsite GC analytical results. As shown in Figure 3-20, the vertical distribution of TVO determined by the mobile GC is concentrated in the upper 9 feet of soil.

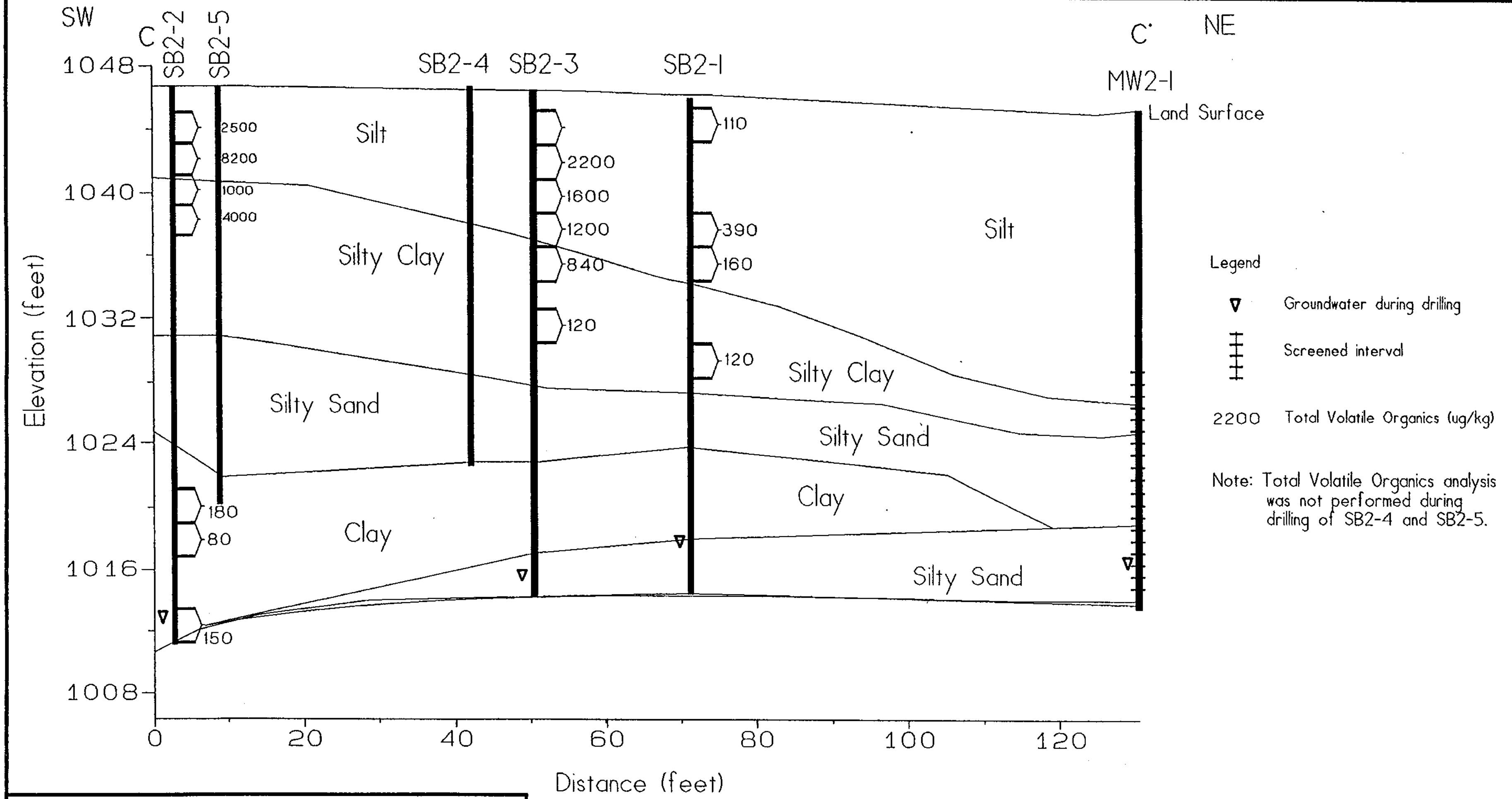
As a result of the information obtained from the onsite GC and observations during drilling, 7 of the 10 samples sent to the laboratory during the initial investigation at SB2-1, SB2-2 and SB2-3 were obtained within the interval above 9 feet BLS. Samples were analyzed for the following chemicals:

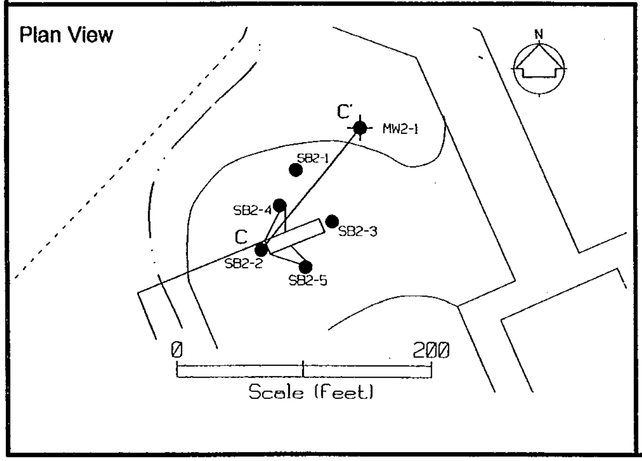
- TPH (SW Method 8015 modified)
- VOCs (EPA Method 8240, CLP SOW 3/90)
- SVOCs (SW Method 8270, CLP SOW 3/90)
- Priority pollutant metals:

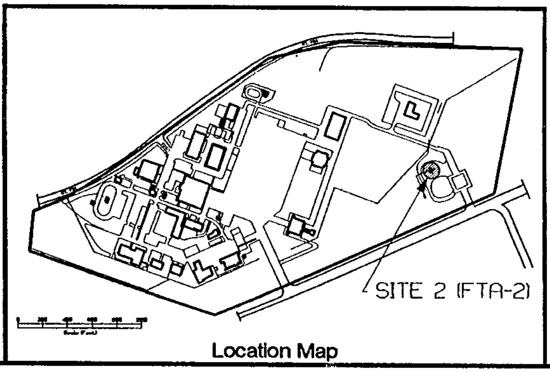
    ICP metals: Be, Cd, Cr, Cu, Ni, Ag, and Zn (SW Method 6010)

    AA metals: Sb (SW 7041), As (7060), Pb (7421), Hg (7471), Se (7740), and Tl (7841).

Soil analytical results of the samples selected showed that Site 2 contaminants were primarily SVOCs and petroleum hydrocarbons, not VOCs. A detailed discussion of the TICs







SAIC

Site 2 - FTA-2, Onsite Gas Chromatography Results for Soil, Cross Section C-C'

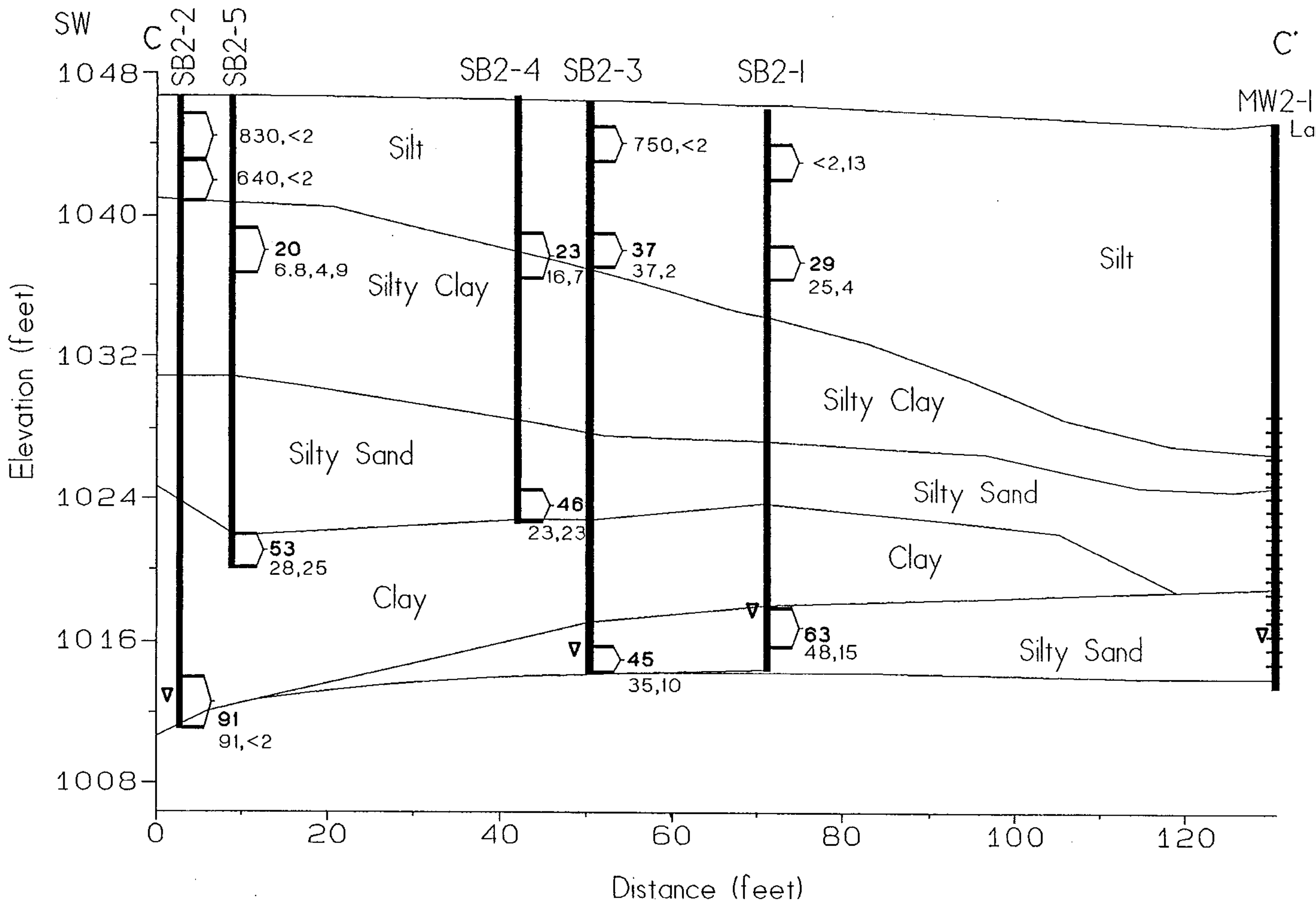
Springfield ANGB, Springfield, Ohio

Figure: 3-20 | Project: 01-0827-03-0200-005

detected in Site 2 soil samples is presented in Appendix G, Section G.4. Because the mobile GC detected VOC trends only, the vertical distribution (therefore, the maximum potential contamination) of the SVOCs and TPH was not identified. Data were still needed between 9.5 feet BLS and the water table to ensure that maximum potential contamination was identified.

During the second phase of borehole drilling, soil borings SB2-4, SB2-5, and SB2-6 were drilled to total depths of 23.5, 27, and 16.5 feet BLS, respectively. Samples and cuttings were screened onsite using an organic vapor analyzer (OVA). Screening results and field observations (odor or visual indications of contamination) were used to collect soil from contaminated intervals and collect the final sample in each boring below the vertical extent of contamination. During drilling of borings SB2-4 and SB2-5, samples were collected between 7 and 9 feet BLS at the interval of maximum contamination detected previously, and at 23.5 to 27 feet BLS where no indications of contamination were observed in the field. A pronounced hydrocarbon odor was present at 15 feet BLS in both borings, apparently in a continuous layer of soil. This layer was the only interval that had physical indications of contaminants. Therefore, boring SB2-6 was drilled alongside (within 1 foot) of SB2-4 to collect a sample from 14.5 to 16.5 feet BLS to characterize potential contaminants at this interval. Samples were analyzed following the same methods used during the first investigation phase. Soil analytical results are presented in Table 3-16. The analytical results of the three additional soil borings confirmed that site-related SVOC and TPH contamination is greatest in the upper 9.5 feet and diminishes with depth.

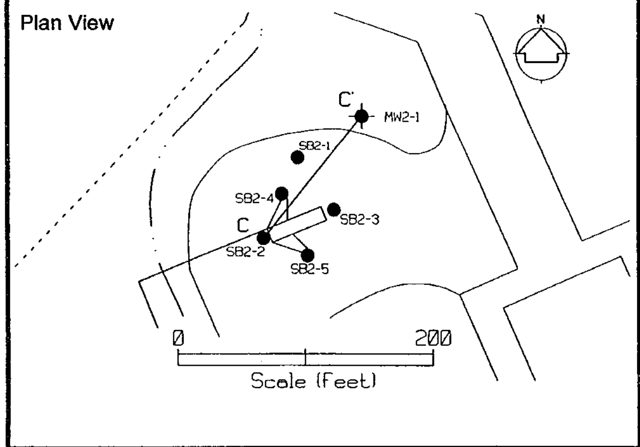
TPH were detected in all 16 soil samples collected from the 6 soil borings at FTA-2. The three constituents of TPH, gasoline, and diesel fuel and heavy oil were quantified separately. The three constituents varied greatly in concentration with the diesel fuel occurring more often and at greater concentrations. The diesel fuel was detected 15 times at a maximum value of 830 mg/kg, and heavy oil was detected 10 times as a maximum value of 63 mg/kg. Gasoline was only detected once at 6.8 mg/kg. The vertical distribution of TPH in soils at Site 2 is shown in Figure 3-21. This figure shows the maximum concentrations are within the upper 9.5 feet of the burn pit area.

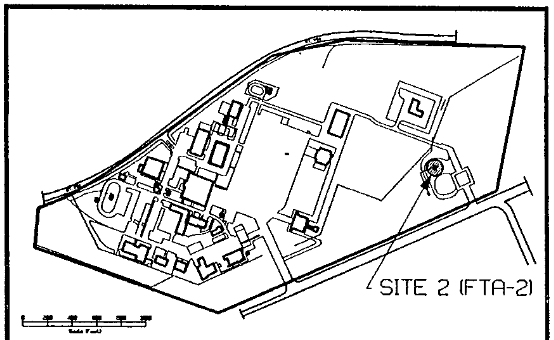


Legend

Note: Constituent TPH consisted of diesel fuel and heavy oil for SB2-1, SB2-2, and SB2-3; however constituents of TPH for SB2-4 and SB2-5 were gasoline, diesel fuel and heavy oil.

Plan View





Location Map

SAIC

Site 2 - FTA-2; Laboratory TPH Results for Soil, Cross Section C-C'

Springfield ANGB, Springfield, Ohio

Figure: 3-21 | Project: 01-0827-03-0200-005

Seven VOCs were detected in the soils at Site 2: acetone, 2-butanone, benzene, ethylbenzene, 4-methyl-2-pentanone, carbon disulfide, and xylene. Acetone was detected in all of the soil samples recovered from SB2-1 (i.e., SB2-1-1, SB2-1-4, SB2-1-4RE, and SB2-1-14) and ranged in concentration from 5 to 82 μg/kg. However, concentrations of acetone detected in SB2-1-4 and SB2-1-4RE were qualified ("SR") for surrogate recoveries, and therefore, are considered estimates. Acetone also was detected in soil boring SB-2 in the surface sample SB2-2-1R at a concentration of 36 μg/kg. In addition, acetone was detected in all of the soil samples collected from soil boring SB2-3 (i.e., SB2-3-1, SB2-3-4, SB2-3-4DL, and SB2-3-16). Acetone concentrations for soil borings SB2-3 ranged from 20 to 90 μg/kg. Two of these samples (i.e., SB2-3-4 and SB2-3-4DL) also were qualified ("IS"), denoting that the internal standard was outside the control limits.

In addition to acetone, petroleum-related VOCs also were detected in the Site 2 soil borings. Ethylbenzene and xylene were detected in sample SB2-1-14 of soil boring SB2-1 at estimated concentrations of 120J and 390J μg/kg. However, both were qualified ("IS"), which denotes that the internal standard was outside control limits. No VOC TICs were identified in soil boring SB2-1.

Petroleum-related VOCs detected in soil boring SB2-2 included benzene, ethylbenzene, and xylene. All three of these compounds were detected in the surficial soil sample SB2-2-1R at concentrations of 2J, 120 and 390X μg/kg, respectively. Xylene also was detected in SB2-2-1 and SB2-2-2 at estimated concentrations of 600JX and 1,400J μg/kg. Multiple petroleum-related VOC TICs were detected in SB2-2-1, SB2-2-1R, and SB2-2-2. No VOCs were detected in the other laboratory sample (SB2-2-17), which was collected at 33 to 35 feet BLS.

Soil analytical results from soil boring SB2-3 were similar to results from soil boring SB2-2. Petroleum-related VOCs (i.e., 2-butanone, benzene, ethylbenzene, and xylene) were detected in surficial soil samples. 2-Butanone was only detected in SB2-3-4 at an estimated concentration of 14J μg/kg; however, this estimation was qualified ("IS"), denoting that the internal standard was outside control limits. Other VOCs (i.e., benzene, ethylbenzene, and xylene) were detected in samples SB2-3-1, SB2-3-4, and SB2-3-4DL recovered at depths of 1.5

to 3.5, 7.5 to 9.5, and 7.5 to 9.5 feet BLS, respectively. Concentrations for the various constituents ranged between 8 and 450 μg/kg.

Petroleum-related VOCs detected in SB2-4 consisted of 2-butanone, benzene, and 4-methyl-2-pentanone. These three VOCs were detected in sample 2-4-1 at concentrations of 19, 42, and 50 μg/kg, respectively.

No VOCs were detected in any soil samples from SB2-5. However, three VOCs were detected in samples from SB2-6. 2-Butanone was detected in samples 2-6-1, SB2-6-1R, and SB2-6-1RE at concentrations of 32, 26, and 36 μg/kg, respectively. In addition, 4-methyl-2-pentenone also was detected in all three of these samples at estimated concentrations of 9J, 17J, and 26J(IS). Multiple VOC TICs also were identified in samples SB2-3-1, SB2-3-4, and SB2-3-4DL.

The majority of the VOC TIC detections at Site 2 are relatively low concentrations and most were identified as straight-chain alkanes or branched alkanes and alkyl benzenes. Three VOC TICs were identified as cycloalkanes. The VOC TICs identified as straight-chain alkanes, branched alkanes, cycloalkanes, and dialkyl benzene were placed in the petroleum or petroleum degradation products category. Some VOC TICs have been sporadically detected, and these exceptions are discussed further. 2-Pentanone-3-methyl was classified as a petroleum degradation product. Hexamethylcyclotrisiloxane, hexane, and cyclohexane methanol are considered common laboratory contaminants, and therefore, were placed in the laboratory and extraction artifacts category. 2,6-Dimethyl-1,6-octadiene, 2-methyldecalin, 2-pyrazoline-1-carboxamide, hexanal, butanol, formic acid butylester, and butanol 2-ethyl were placed in the other category. These detected VOC TICs are probably introduced through laboratory or field contamination. Eight VOC TICs were identified by the Weyerhaeuser Laboratory as unknown. The detection of these TICs is sporadic and inconsistent, so no conclusions could be made regarding the possibility that observed VOC TIC detections are due to site contamination or possibly cross contamination. As a result, they were placed in the unknown category.

SVOCs also were present in detected and estimated concentrations, as shown in Table 3-16. Identified SVOC contaminants were detected in samples from boring SB2-1, with the highest level detected in sample SB2-1-1 (2.0 to 3.5 feet BLS). This sample contained estimated concentrations of fluoranthene, pyrene, and bis(2-ethylhexyl)phthalate in concentrations of 47, 51, and 93 μg/kg, respectively. Sample SB2-1-4 (8.0 to 9.5 feet BLS) also contained estimated concentrations of pyrene and bis(2-ethylhexyl)phthalate. SVOC TICs were detected in all samples obtained from soil boring SB2-1 in concentrations ranging between 5,676 μg/kg (detected in sample SB2-1-4) and 14,059 μg/kg (detected in sample SB2-1-1).

SVOCs detected in boring SB2-2 contained estimated and detected values of isophorone, naphthalene, 2-methylnapthalene, phenanthrene, fluoranthene, and pyrene. SVOCs were detected in samples SB2-2-1, SB2-2-1R, and SB2-2-2. The SVOCs detected in boring SB2-3 were isophorone and bis(2-ethylhexyl)phthalate, which were detected in soil samples SB2-3-1 and SB2-3-16, respectively. In addition, SB2-4 contained an estimated detection of 130J μg/kg of pentachlorophenol. The majority of SVOCs detected at Site 2 are PAHs (i.e., naphthalene, 2-methylnaphthalene, phenanthrene, fluoranthene, and pyrene).

The majority of the SVOC TICs identified in soil samples collected at Site 2 - FTA-2 were straight-chain alkanes or branched alkanes. Five SVOC TICs were identified as alkyl benzene. Hexanedoic acid mono(2-ethylhexyl)ester, dodecanoic acid, and iron tricarbonyl-(N-[phenyl]) were placed in the petroleum or petroleum degradation products category. Eight SVOC TICs were classified as PAHs and three amides were placed in the other category. The sporadic nature of detections for these amides may indicate a heterogeneous source. Several compounds were placed in the other category. 4-Hydroxy-4-methyl-2-pentanone is considered a laboratory artifact, as it is an aldol reaction product of acetone common to SVOC analysis. Hexadecanoic acid and 9-hexadecanoic acid were detected at concentrations below those detected in the background samples, and were placed in the naturally occurring organic compounds category. The remainder of SVOC TICs were identified as unknown and possibly naturally occurring in soil or are of anthropogenic origin. They also could be a result of contamination during sampling or analysis activities. However, little can be interpreted from these detections of unknown compounds. Further study would be necessary to resolve the identification of these unknown compounds.

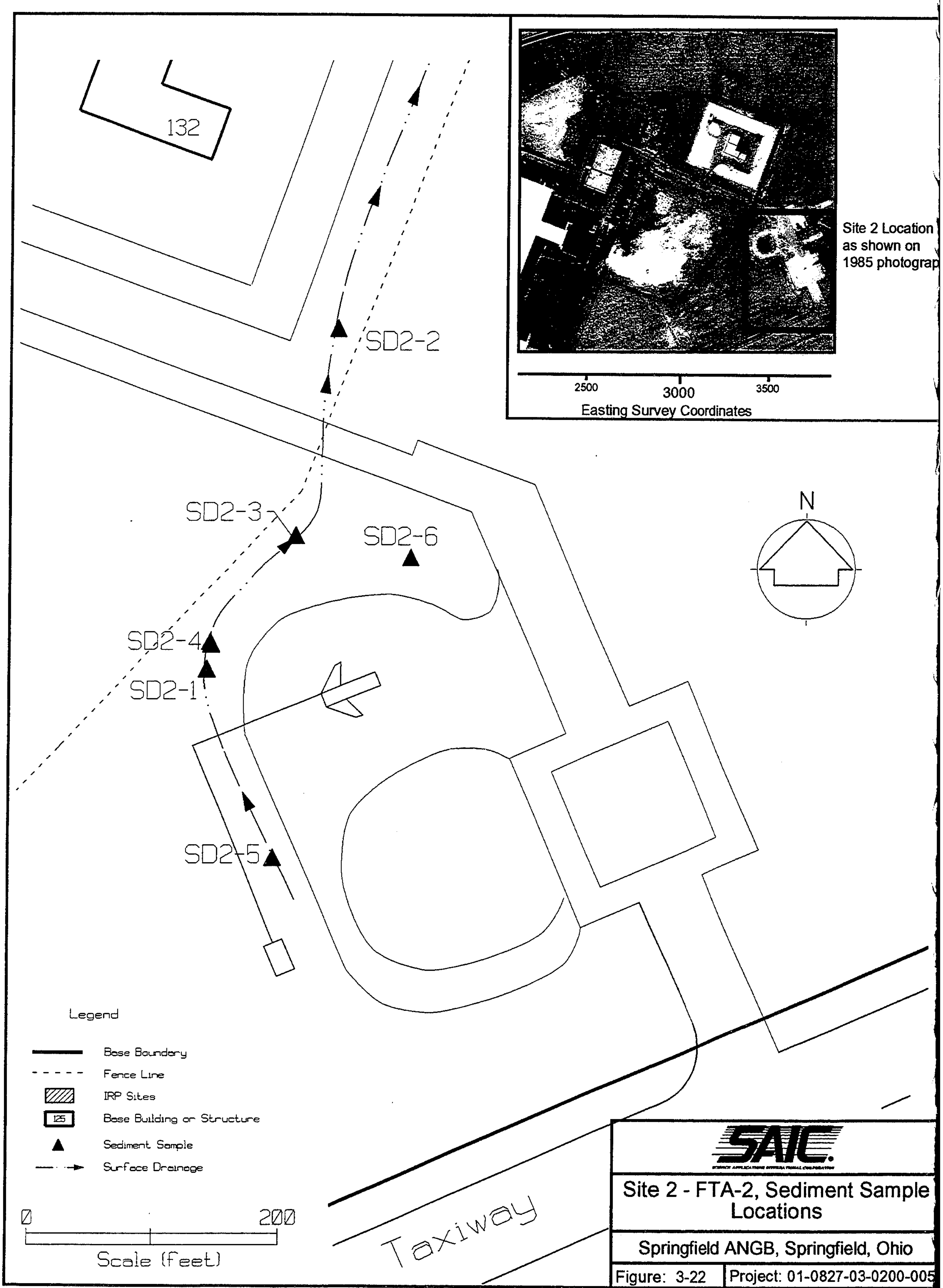
Metals detected in soil at FTA-2 include antimony, arsenic, beryllium, chromium, copper, lead, nickel, selenium, thallium, and zinc. The concentrations of metals are compared to background soil criteria in Section 3.6.5 to determine if statistical evidence of site-related contamination exists.

3.6.4 Chemicals Detected in Surface Sediment

Seven sediment samples (i.e., SD2-1, SD2-1R, and SD2-2 through SD2-6) were collected from six separate locations at Site 2 - FTA-2. Surface sediment samples were collected from the drainage swale, which skirts the southern and western perimeter of the site and from a low lying surface soil location close to MW2-1. The drainage ditch, which retains liquid only during intermittent periods of rainfall, receives runoff from FTA-2 as well as from the open fields adjacent to the ditch on the south and west and the taxiway south of the site. The samples were collected using a stainless steel trowel and bowl. Sample locations and flow direction of the drainage are shown in Figure 3-22. Samples were packed and shipped to the contracted laboratories for the same chemical analyses as noted for soil in Section 3.6.3. Table 3-17 summarizes the laboratory analytical results.

TPH concentrations as heavy oil exceed Ohio Division of State Fire Marshall and OEPA DSIWM regulatory criteria in sample SD2-1 at a concentration of 640 mg/kg. Diesel fuel was detected at 180 mg/kg in SD2-1. TPH values for field replicate sample SD2-1R, however, were very low relative to SD2-1 (<3 mg/kg diesel fuel and 5 mg/kg heavy oil). Petroleum hydrocarbons detected in samples SD2-2, SD2-3, SD2-5, and SD2-6 ranged from 3 to 85 mg/kg and did not exceed regulatory criteria.

VOCs detected at sediment sample location SD2-1 included acetone, carbon disulfide, and 2-butanone in concentrations of 280, 2, and 59 μg/kg, respectively. Acetone and 2-butanone also were detected in sediment sample SD2-2 at concentrations of 26 and 9J μg/kg, respectively. VOC TICs detected at SD2-1 included pentane, hexanal, and 2,4,4-trimethyl-1-pentene in



Site 2 - FTA-2, Sediment Sample Locations

Springfield ANGB, Springfield, Ohio

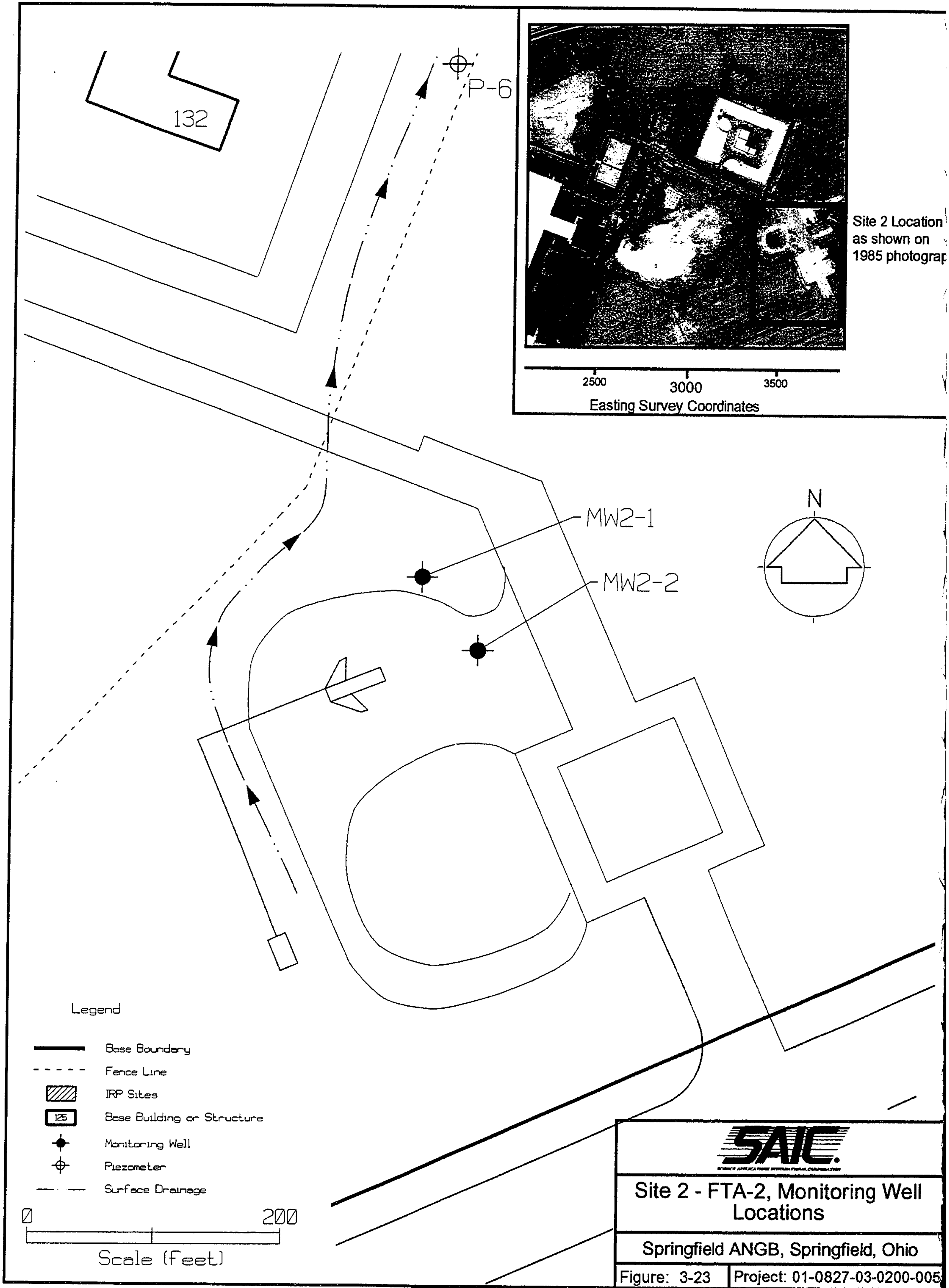
Figure: 3-22	Project: 01-0827-03-0200-005

concentrations of 9, 19, and 21 μg/kg, respectively, and were categorized as petroleum or petroleum degradation products. No other VOC TICs were detected in any of the remaining samples collected. Multiple SVOCs, primarily PAHs, were detected at estimated levels (990J to 36,000J μg/kg) at SD2-1. Similar SVOCs were detected in the remaining sediment samples; however, concentrations were generally several times lower.

The majority of the SVOC TICs identified in the sediment samples collected at Site 2 - FTA-2 were straight-chain alkanes or branched alkanes. Five SVOC TICs were identified as alkyl benzene. 7-Hexadecanoic acid methyl 9-hexadecanoic acid methyl, hexadecanoic acid, and octadecenoic acid were placed in the petroleum or petroleum degradation products category. Eight SVOC TICs were categorized as PAH. Three amides were placed in the other category. The sporadic nature of detections for these amides may indicate a heterogeneous source. Hexanal and 4-penten-2-ol were placed in the other category. 4-Hydroxy-4-methyl-2-pentanone is considered a laboratory artifact. This compound was considered nondetected in SD2-6, since the concentration is less than that detected in the associated method blank. 4-Hydroxy-4-methyl-2-pentanone is an aldol reaction product of acetone common to SVOC analyses. (3β,24S)-Stigmast-5-En-3-ol and (3β,22E)-stigmasta-5,22-dien-3-ol were placed in the laboratory and extraction artifacts category. These two compounds can be found in soy bean oil and this is probably the source of the contamination in the samples. The laboratory may have used vegetable oil instead of corn oil in the gel permeation chromatography (GPC) extract cleanup procedure. D-Friedoolean-14-En-3-one was placed in the other category. Hexadecanoic acid in SD2-3 was detected at concentrations below those detected in the background samples. As a result, hexadecanoic acid was placed in the naturally occurring organic compounds category. The remainder of SVOC TICs were identified as unknown and possibly naturally occurring in soil or are of anthropogenic origin. They also could be a result of contamination during sampling or analysis activities. However, little can be interpreted from these detections of unknown compounds. Further study may resolve the identification of these unknown compounds.

3.6.5 Chemicals Detected in Groundwater

Two groundwater monitoring wells (i.e., MW2-1 and MW2-2) were installed downgradient from the burn pit at Site 2 - FTA-2 (Figure 3-23). Three groundwater samples



Site 2 - FTA-2, Monitoring Well Locations

Springfield ANGB, Springfield, Ohio

Figure: 3-23 Project: 01-0827-03-0200-005

were collected from these two wells (i.e., MW2-1-1, MW2-1-2, and MW2-2-1). In addition, a groundwater sample (i.e., P-5-1) was collected from upgradient piezometer P-5, which was used to assess nonsite-related contaminants. Groundwater samples were analyzed for the following parameters:

- TPH (SW Method 8015 modified)
- VOCs (EPA Method 524.2, SW 8240 LDL, CLP SOW 3/90)
- SVOCs (SW Method 8270, CLP SOW 3/90)
- Priority pollutant metals:
  ICP metals: Be, Cd, Cr, Cu, Ni, Ag, and Zn (SW Method 6010)
  AA metals: Sb (SW 7041), As (7060), Pb (7421), Hg (7470), Se (7740), and Tl (7841).

Laboratory analytical results are presented in Table 3-18. A detailed discussion of the TICs detected in the groundwater samples is presented in Appendix G, Section G.4. The analytical results are compared to ARARs in Table 3-19.

TPH as diesel fuel was detected in unfiltered groundwater from 0.3 to 0.5 mg/L. Trace concentrations of TPH and diesel fuel were detected in the unfiltered groundwater samples. The concentrations ranged from 0.3 to 0.5 μg/L. Because these concentrations are so low, it is possible that most of the diesel fuel is adsorbed to the clay in the sediment and only trace concentrations are being released to the groundwater. The potential for further release is also reduced by the lack of any additional fuel being added to the site. The fuel system was changed to propane. Natural degradation will continue to reduce the residual concentrations of diesel fuel.

An estimated value of 0.2J μg/L of tetrachloroethene was the only detected VOC in the samples. No VOC TICs or SVOCs were detected in the Site 2 groundwater samples or from the piezometer sample. Nineteen unknown SVOC TICs were detected in the groundwater samples. Benzothizole, ethanol 2-(butoxyethoxy), and butane 1,1'(oxibix[2,1-ethyl]) were placed in the other category. In the same category were placed hexanoic acid 6-amino detected in MW2-2-1. Because of the sporadic and inconsistent nature of these results, no consistent trend can be established for groundwater samples, and therefore, results are interpreted as isolated laboratory, field, or cross contamination problems.

Samples collected from the Site 2 monitoring wells and upgradient piezometer P-5 contained the inorganic constituents arsenic, beryllium, chromium, lead, and nickel at concentrations greater than their respective maximum contaminant levels (MCLs) in unfiltered groundwater. Analysis of filtered groundwater detected only antimony, arsenic, and zinc. Metals occurring in unfiltered groundwater samples are indicative of the parent material, in this case the glacial till, plus any anthropogenic metals that are not soluble. Metals resulting from anthropogenic sources are more likely to be in soluble form because they would have had to migrate from the surface or disposal area down to groundwater, and that migration is most likely to occur as a soluble species. Because soluble species would be detected in filtered samples, it is likely that most of the metals detected only in unfiltered samples are the result of the glacial till parent material.

3.6.6 Comparison of Chemicals Detected to Background Criteria

This section compares the background results to sample results from Site 2 - FTA-2 using criteria presented in Section 3.3 and levels in Tables 3-4 and 3-5. Results from eight soil and six sediment samples are compared with the background UCL_{90} in Tables 3-20 and 3-21, respectively. Most of the results for inorganic constituents do not exceed the UCL_{90}. Some of the results only slightly exceed the UCL_{90}; however, no significant evidence exists that these contaminants are related to activities conducted at the site. The organic compounds, including diesel fuel, heavy oil, PAHs, and aromatic hydrocarbons, appear to be site related in the samples in which they were positively detected.

Nine inorganics were detected in unfiltered Site 2 groundwater samples (Table 3-22). The results of the statistical analyses indicate that the levels of inorganics detected in Site 2 groundwater samples statistically differ from the background results, and may be site related.

3.6.7 *Summary of Results*

Data collected during the field investigation determined that several fuel-related compounds, including TPH, BTEX, and PAHs, were present in the upper 9.5 feet of the site. Petroleum hydrocarbons are present at lesser concentrations throughout the soil column and diminish with depth until reaching the dense clay layer just above the surficial aquifer. Slightly greater concentrations of petroleum hydrocarbons at this level are interpreted as an accumulation of contaminants in the dense clay because of restricted mobility through the clay. PAHs were detected near the water table in one sample, although there is an overall trend of decreasing concentration with depth. Although contaminants have migrated between 9.5 feet and the water table, the relatively slow permeability (10^{-8} cm/sec) of the silts and clays underlying the site have restricted their vertical migration.

Elevated TPH and SVOC values in sediment may be the result of nonsite-related contamination of the sediments. Offsite sources of such contamination may include the paved access road north of the site, a trash burning area southwest of the FTA-2, or runoff from the runway east of the site.

Groundwater analytical results do not indicate significant degradation of groundwater quality. The magnitude of organic chemical concentrations, including diesel fuel and tetrachloroethene, was small and did not exceed regulatory criteria. Analysis of dissolved inorganic compounds detected only antimony and arsenic at less than ARARs. Inorganic compounds were detected in unfiltered groundwater at greater concentrations; however, these concentrations are considered to be associated with solids suspended in groundwater, and drinking water ARARs are not directly applicable.

To assess the risk to human health and to determine if remediation is needed, a risk assessment has been conducted for all detected chemicals for Site 2 (Section 5) whether or not they were determined to be site related.

Table 3—15. Onsite Gas Chromatography Results for Soil at Site 2 – Fire Training Area 2, 178th Tactical Fighter Group, Springfield ANGB, Springfield, Ohio

			Analytical Parameters (µg/kg)									
Soil Boring	Sample Number	Depth (feet BLS)	TVO	TCA	CCl_4	TCE	PCE	BEN	TOL	ETZ	XYL	Comments
SB2–1	SB2–1–01	2.0–3.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	Approximately two feet of gravel overlying FTA–2. Sample sent to lab 8/18/92.
	SB2–1–02	4.0–5.5	110	ND	ND	ND	ND	ND	ND	ND	ND	
	SB2–1–03	6.0–7.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	
	SB2–1–04	8.0–9.5	390	ND	ND	ND	ND	ND	ND	ND	ND	Sample sent to lab 8/18/92.
	SB2–1–05	10.0–11.5	160	ND	ND	ND	ND	85	ND	ND	ND	
	SB2–1–06	12.0–13.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	Replicate GC sample taken.
	SB2–1–07	14.0–15.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	
	SB2–1–08	16.0–17.5	120	ND	ND	ND	ND	ND	ND	ND	ND	
	SB2–1–09	18.0–19.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	
	SB2–1–10	20.0–21.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	
	SB2–1–11	22.0–23.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	
	SB2–1–12	24.0–25.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	
	SB2–1–13	26.0–27.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	
	SB2–1–14	28.0–30.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	Saturated interval (soil/water interface). Sample sent to lab 8/17/92.
	SB2–1–15	30.0–32.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	Saturated interval.
SB2–2	SB2–2–01	1.5–3.5	2500	ND	ND	ND	ND	64	297	158	1010	Approximately two feet of gravel overlying FTA–2. Replicate sample taken Sample and replicate sent to lab 8/17/92.
	SB2–2–02	3.5–5.0	8200	ND	ND	ND	ND	161	751	370	2740	Mild hydrocarbon odor present. Sample sent to lab 8/17/92.
	SB2–2–03	5.5–7.0	1000	ND	ND	ND	ND	21	64	29	221	
	SB2–2–04	7.5–9.0	4000	ND	ND	ND	ND	67	376	178	1150	
	SB2–2–05	9.5–11.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	
	SB2–2–06	11.5–13.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	
	SB2–2–07	13.5–15.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	
	SB2–2–08	15.5–17.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	
	SB2–2–09	17.5–19.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	
	SB2–2–10	19.5–21.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	
	SB2–2–11	21.5–23.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	
	SB2–2–12	23.5–25.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	
	SB2–2–13	25.5–27.5	180	ND	ND	ND	ND	ND	ND	ND	ND	
	SB2–2–14	27.5–29.5	80	ND	ND	ND	ND	ND	ND	ND	ND	
	SB2–2–15	29.5–31.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	
	SB2–2–16	31.0–33.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	
	SB2–2–17	33.0–35.0	150	ND	ND	ND	ND	ND	ND	ND	ND	Saturated interval (soil/water interface). Sample sent to lab 8/17/92.
SB2–3	SB2–3–01	1.5–3.5	3800	ND	ND	ND	0.4	100	86	204	450	Approximately two feet of gravel overlying FTA–2. Sample sent to lab 8/17/92.
	SB2–3–02	3.5–5.0	2200	ND	ND	ND	ND	94	93	488	689	Mild hydrocarbon odor present.
	SB2–3–03	5.5–7.5	1600	ND	ND	ND	ND	86	63	330	406	
	SB2–3–04	7.5–9.5	1200	ND	ND	ND	ND	57	59	335	416	Sample sent to lab 8/17/92.
	SB2–3–05	9.5–11.5	840	ND	ND	ND	ND	25	24	72	107	
	SB2–3–06	11.5–13.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	
	SB2–3–07	13.5–15.5	120	ND	ND	ND	ND	ND	ND	ND	ND	
	SB2–3–08A	15.5–17.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	Replicate GC sample taken in this interval.
	SB2–3–08B	15.5–17.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	
	SB2–3–09	17.5–19.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	
	SB2–3–10	19.5–21.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	
	SB2–3–11	21.5–23.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	
	SB2–3–12	23.5–25.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	
	SB2–3–13	25.5–27.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	
	SB2–3–14	27.5–29.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	
	SB2–3–15	29.5–31.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	
	SB2–3–16	31.5–33.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	Saturated interval (soil/water interface). Sample sent to lab 8/17/92.
MW2–1	MW2–1–01	6.0–8.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	

Table 3–16. Data Summary Table: Soil – Site 2 – Fire Training Area 2, 178th Tactical Fighter Group, Springfield ANGB, Springfield, Ohio

SAIC ID Number		SB2–1–1	SB2–1–4	SB2–1–4RE
Laboratory ID Number		94799	94800	94800RE
Collection Date		8–15–92	8–15–92	8–15–92
Collection Depth (ft)		2.0–3.5	8.0–9.5	8.0–9.5
Associated Field QC Sample		TB–5 EB2–1 FB2–1 SD5–FB	TB–5 EB2–1 FB2–1 SD5–FB	TB–5 EB2–1 FB2–1 SD5–FB
Parameter	Units			
TOTAL PETROLEUM HYDROCARBONS (SW 8015M)				
Gasoline	mg/kg	NA	NA	NA
Diesel Fuel	mg/kg	<2	4	NA
Heavy Oil	mg/kg	13	25	NA
PRIORITY POLLUTANT METALS				
AA METALS				
Antimony (SW 3050/7041)	mg/kg	0.2 UJ(N,W)	0.2 UJ(N)	NA
Arsenic (SW 3050/7060)	mg/kg	8.5 J(*)	7.2 J(*)	NA
Lead (SW 3050/7421)	mg/kg	31.8 *	8.5 *	NA
Selenium (SW 3050/7740)	mg/kg	0.26 UJ(MB,N)	0.15 UJ(N,W)	NA
Thallium (SW 3050/7841)	mg/kg	0.25 J(N,W)	0.26 J(N)	NA
ICP METALS (SW 3050/6010)				
Beryllium	mg/kg	0.32 B	0.27 B	NA
Cadmium	mg/kg	1.2	0.21 U	NA
Chromium	mg/kg	13.2 J(N)	7.5 J(N)	NA
Copper	mg/kg	13.9	14.7	NA
Nickel	mg/kg	8.2	15.8	NA
Silver	mg/kg	1.5	1.5	NA
Zinc	mg/kg	38.3 J(E)	45.9 J(E)	NA
VOLATILE ORGANICS (SW 8240 [A])				
Acetone	µg/kg	82	5 J(SR)	21 J(SR)
Carbon Disulfide	µg/kg	11 U	11 UJ(SR)	11 UJ(SR)
2–Butanone	µg/kg	11 U	11 UJ(SR)	11 UJ(SR)
Benzene	µg/kg	11 U	11 UJ(SR)	11 UJ(SR)
4–Methyl–2–pentanone	µg/kg	11 U	11 UJ(SR)	11 UJ(SR)
Ethylbenzene	µg/kg	11 U	11 UJ(SR)	11 UJ(SR)
Xylene (total)	µg/kg	11 U	11 UJ(SR)	11 UJ(SR)
TICs	µg/kg	0 (0)	0 (0)	0 (0)
TIC Total	µg/kg	0 (0)	0 (0)	0 (0)

Table 3-16. Data Summary Table: Soil – Site 2 – Fire Training Area 2, 178th Tactical Fighter Group, Springfield ANGB, Springfield, Ohio (Continued)

SAIC ID Number			SB2-1-1			SB2-1-4		SB2-1-4RE
Laboratory ID Number			94799			94800		94800RE
Collection Date			8-15-92			8-15-92		8-15-92
Collection Depth (ft)			2.0-3.5			8.0-9.5		8.0-9.5
Associated Field QC Sample			TB-5 EB2-1 FB2-1 SD5-FB			TB-5 EB2-1 FB2-1 SD5-FB		TB-5 EB2-1 FB2-1 SD5-FB
Parameter	Units							
SEMIVOLATILE ORGANICS (SW 8270 [B])								
Isophorone	µg/kg		340 U			330 U		NA
Naphthalene	µg/kg		340 U			330 U		NA
2-Methylnaphthalene	µg/kg		340 U			330 U		NA
Pentachlorophenol	µg/kg		820 U			800 U		NA
Phenanthrene	µg/kg		340 U			330 U		NA
Fluoranthene	µg/kg		47 J			330 U		NA
Pyrene	µg/kg		51 J			34 J		NA
bis(2-Ethylhexyl)phthalate	µg/kg		93 J			41 J		NA
TICs	µg/kg	4-Hydroxy-4-Methyl-2-Pentanone[a]	9900 B,J,N,A	(RT 4.65)	4-Hydroxy-4-Methyl-2-Pentanone[a]	4600 B,J,N,A	(RT 4.58)	NA
		Unknown[d]	94 J	(RT 13.60)	2-Butanone, 4-Chloro-4,4-Dif[c]	46 J,N	(RT 5.88)	
		Unknown[d]	95 J	(RT 20.15)	Unknown[d]	110 J	(RT 20.15)	
		Unknown[d]	150 J	(RT 21.57)	Unknown[d]	87 J	(RT 26.64)	
		Unknown[d]	130 J	(RT 22.92)	Unknown[d]	120 J	(RT 27.79)	
		9-Hexadecenoic Acid[f]	240 J,N	(RT 23.59)	Unknown[d]	81 J	(RT 28.91)	
		Hexadecanoic Acid[f]	150 J,N	(RT 23.75)	Unknown[d]	100 J	(RT 29.99)	
		Iron, Tricarbonyl[N-(Phenyl-[b]	140 J,N	(RT 24.22)	Unknown[d]	82 J	(RT 31.06)	
		Unknown[d]	140 J	(RT 25.47)	Unknown[d]	130 J	(RT 32.11)	
		2-Butyl-1-Octanol[b]	170 J,N	(RT 25.92)	Unknown[d]	100 J	(RT 33.19)	
		Docosane[b]	200 J,N	(RT 26.64)	Unknown[d]	100 J	(RT 33.26)	
		Unknown[d]	200 J	(RT 27.09)	Unknown[d]	120 J	(RT 34.31)	
		Unknown[d]	270 J	(RT 27.81)				
		Unknown[d]	140 J	(RT 28.21)				
		Unknown[d]	180 J	(RT 28.92)				
		Unknown[d]	130 J	(RT 29.27)				
		Unknown[d]	270 J	(RT 29.99)				
		Unknown[d]	190 J	(RT 31.06)				
		Unknown[d]	380 J	(RT 32.12)				
		Unknown[d]	430 J	(RT 33.21)				
		Pentatriacontane[b]	460 J,N	(RT 34.32)				
TIC Total	µg/kg		14059 (21)			5676 (12)		NA

Table 3–16. Data Summary Table: Soil – Site 2 – Fire Training Area 2, 178th Tactical Fighter Group, Springfield ANGB, Springfield, Ohio (Continued)

SAIC ID Number		SB2–1–14	SB2–2–1	SB2–2–1R
Laboratory ID Number		94673	94666	94667
Collection Date		8–15–92	8–16–92	8–16–92
Collection Depth (ft)		28.0–30.0	1.5–3.5	1.5–3.5
Associated Field QC Sample		TB–4 EB2–1 FB2–1 SD5–FB	TB–4 EB2–1 FB2–1 SD5–FB	TB–4 EB2–1 FB2–1 SD5–FB
Parameter	Units			
TOTAL PETROLEUM HYDROCARBONS (SW 8015M)				
Gasoline	mg/kg	NA	NA	NA
Diesel Fuel	mg/kg	48	135 J(FD)	830 J(FD)
Heavy Oil	mg/kg	15	<2	<2
PRIORITY POLLUTANT METALS				
AA METALS				
Antimony (SW 3050/7041)	mg/kg	0.24 J(N,W,r)	0.28 J(N,r)	R(N)
Arsenic (SW 3050/7060)	mg/kg	4.3 J(N)	6.8 J(N)	8.4 J(N)
Lead (SW 3050/7421)	mg/kg	6.6	7.6	7.5
Selenium (SW 3050/7740)	mg/kg	0.14 UJ(N,W)	0.12 UJ(N,W)	0.13 UJ(N,W)
Thallium (SW 3050/7841)	mg/kg	0.17 B	0.17 J(W)	0.16 J(W)
ICP METALS (SW 3050/6010)				
Beryllium	mg/kg	0.32 B	0.28 B	0.34 B
Cadmium	mg/kg	0.21 U	0.19 U	0.21 U
Chromium	mg/kg	8.1	7	9.1
Copper	mg/kg	23.7	12.5	19.5
Nickel	mg/kg	18.7	14.4	20.5
Silver	mg/kg	1.8 U(MB)	2 U(MB)	2.1 U(MB)
Zinc	mg/kg	47.1 J(E)	42.2 J(E)	52.3 J(E)
VOLATILE ORGANICS (SW 8240 [A])				
Acetone	µg/kg	53	1300 U	36
Carbon Disulfide	µg/kg	11 U	1300 U	11 U
2–Butanone	µg/kg	11 U	1300 U(MB)	11 U
Benzene	µg/kg	11 U	1300 U	2 J
4–Methyl–2–pentanone	µg/kg	11 UJ(IS)	1300 U	11 U
Ethylbenzene	µg/kg	120 J(IS)	1300 U	120
Xylene (total)	µg/kg	390 J(IS)	600 JX	390 X
TICs	µg/kg	0 (0)	Hexamethylcyclotrisiloxane^{a} 18 B,J,N (RT 18.64)	3–Methyl–Hexane^{b} 69 J,N (RT 11.19)
			3,5–Dimethyl–Heptane^{b} 29 J,N (RT 19)	Methyl–Cyclohexane^{b} 240 J,N (RT 14.17)
			2,6–Dimethyl–Octane^{b} 26 J,N (RT 23.5)	2–Methyl–Heptane^{b} 300 J,N (RT 15.72)
			4–(1–Methylethyl)–Heptane^{b} 18 J,N (RT 23.9)	3–Methyl–Heptane^{b} 300 J,N (RT 16.17)
			2,5–Dimethyl–Octane^{b} 27 J,N (RT 24.78)	3,5–Dimethyl–Heptane^{b} 71 J,N (RT 19.22)
			Benzene, Trimethyl– Isomer^{b} 19 J,N (RT 26.01)	Ethyl–Cyclohexane^{b} 110 J,N (RT 19.93)
			Decane^{b} 28 J,N (RT 26.41)	2,3,4–Trimethyl–Hexane^{b} 120 J,N (RT 20.63)
			Benzene, Trimethyl– Isomer^{b} 36 J,N (RT 26.99)	3–Methyl–Octane^{b} 96 J,N (RT 21.04)
			4–Methyl–Decane^{b} 22 J,N (RT 27.14)	Propyl–Benzene^{b} 110 J,N (RT 26.88)
			Undecane^{b} 42 J,N (RT 29.6)	1–Ethyl–2–Methyl–Benzene^{b} 140 J,N (RT 27.32)
			2,6–Dimethyl–1,6–Octadiene^{c} 31 J,N (RT 31.29)	
TIC Total	µg/kg	0 (0)	296 (11)	1556 (10)

Table 3-16. Data Summary Table: Soil – Site 2 – Fire Training Area 2, 178th Tactical Fighter Group, Springfield ANGB, Springfield, Ohio (Continued)

SAIC ID Number			SB2-1-14			SB2-2-1			SB2-2-1R	
Laboratory ID Number			94673			94666			94667	
Collection Date			8-15-92			8-16-92			8-16-92	
Collection Depth (ft)			28.0-30.0			1.5-3.5			1.5-3.5	
Associated Field QC Sample			TB-4 EB2-1 FB2-1 SD5-FB			TB-4 EB2-1 FB2-1 SD5-FB			TB-4 EB2-1 FB2-1 SD5-FB	
Parameter	Units									
SEMIVOLATILE ORGANICS (SW 8270 [B])										
Isophorone	μg/kg		360 U			370 U			1400 U	
Naphthalene	μg/kg		360 U			290 J			540 J	
2-Methylnaphthalene	μg/kg		360 U			770			1600	
Pentachlorophenol	μg/kg		860 UJ(CCV)			890 UJ(CCV)			3500 UJ(SR)	
Phenanthrene	μg/kg		360 U			370 U			270 J	
Fluoranthene	μg/kg		360 U			370 U			240 J	
Pyrene	μg/kg		360 U			370 U			250 J	
bis(2-Ethylhexyl)phthalate	μg/kg		360 U			370 U			1400 U	
TICs	μg/kg	3,8-Dimethyl-Undecane ^{b}	350 J,N	(RT 13.75)	1-Ethyl-3-Methyl-Benzene ^{b}	2000 J,N	(RT 6.57)	Pentane, 2,2,3,3-Tetramethyl ^{b}	2700 J,N	(RT 6.33)
		Tetradecane ^{b}	440 J,N	(RT 15.47)	5-Ethyl-2-Methyl-Heptane ^{b}	2300 J,N	(RT 8.13)	5-Ethyl-2-Methyl-Heptane ^{b}	4800 J,N	(RT 7.72)
		Unknown ^{d}	270 J	(RT 16.47)	Benzene, 4-Ethyl-1,2-Dimethy ^{b}	1300 J,N	(RT 8.94)	2,4,6-Trimethyl-Octane ^{b}	4800 J,N	(RT 9.39)
		2,7,10-Trimethyl-Dodecane ^{b}	490 J,N	(RT 17.09)	2,4,6-Trimethyl-Octane ^{b}	3400 J,N	(RT 9.90)	Unknown ^{d}	2000 J	(RT 11.07)
		Hexadecane ^{b}	560 J,N	(RT 18.62)	Benzene, 1,2,4,5-Tetramethyl ^{b}	3100 J,N	(RT 10.27)	Dodecane ^{b}	8600 J,N	(RT 11.40)
		Unknown ^{d}	630 J	(RT 20.05)	Benzene, 1,2,3,5-Tetramethyl ^{b}	2000 J,N	(RT 10.92)	2,6-Dimethyl-Undecane ^{b}	5900 J,N	(RT 11.65)
		Unknown ^{d}	590 J	(RT 20.12)	Unknown ^{d}	2000 J	(RT 11.04)	Unknown ^{d}	1400 J	(RT 12.49)
		Octadecane ^{b}	410 J,N	(RT 21.42)	3,7-Dimethyl-Nonane ^{b}	750 J,N	(RT 11.24)	2,10-Dimethyl-Undecane ^{b}	2000 J,N	(RT 12.57)
		Unknown ^{d}	360 J	(RT 21.54)	Unknown ^{d}	1700 J	(RT 11.64)	2,6,7-Trimethyl-Decane ^{b}	8600 J,N	(RT 12.75)
		Unknown ^{d}	500 J	(RT 22.72)	Dodecane ^{b}	5900 J,N	(RT 11.97)	3,8-Dimethyl-Undecane ^{b}	19000 J,N	(RT 13.27)
		Nonanamide ^{c}	220 B,J,N	(RT 23.72)	2,6-Dimethyl-Undecane ^{b}	7000 J,N	(RT 12.22)	1,4-Methanonaphthalene, 1,4- ^{e}	2300 J,N	(RT 13.39)
		Unknown ^{d}	360 J	(RT 23.97)	7-Methyl-Tridecane ^{b}	2200 J,N	(RT 13.32)	2,6,6-Trimethyl-Decane ^{b}	4300 J,N	(RT 13.54)
		Unknown ^{d}	230 J	(RT 25.17)	Unknown ^{d}	2600 J	(RT 13.84)	3-Ethyl-Undecane ^{b}	3900 J,N	(RT 14.32)
		Unknown ^{d}	260 J	(RT 25.96)	2-Methyl-Tridecane ^{b}	760 J,N	(RT 14.89)	Unknown ^{d}	7500 J	(RT 14.54)
		Docosane ^{b}	270 J,N	(RT 26.32)	Unknown ^{d}	1400 J	(RT 15.12)	2,3,5-Trimethyl-Decane ^{b}	25000 J,N	(RT 14.97)
		Unknown ^{d}	250 J	(RT 27.44)	Unknown ^{d}	4000 J	(RT 15.54)	2-Methyl-Tetradecane ^{b}	7200 J,N	(RT 15.94)
		Unknown ^{d}	380 J	(RT 28.11)	Unknown ^{d}	1300 J	(RT 16.50)	2,7,10-Trimethyl-Dodecane ^{b}	11000 J,N	(RT 16.54)
		Unknown ^{d}	5400 J	(RT 28.27)	2,7,10-Trimethyl-Dodecane ^{b}	1400 J,N	(RT 17.10)	Hexadecane ^{b}	4200 J,N	(RT 18.04)
		Unknown ^{d}	160 J	(RT 28.49)	Dodecanamide ^{c}	3800 B,J,N	(RT 28.22)	Unknown ^{d}	2000 J	(RT 19.47)
		Unknown ^{d}	1600 J	(RT 32.34)	Unknown ^{d}	2000 J	(RT 32.31)	Ci60 D10-Phenanthrene ^{e}	2100 J	(RT 20.55)
TIC Total	μg/kg		13730 (20)			50910 (20)			129300 (20)	

Table 3–16. Data Summary Table: Soil – Site 2 – Fire Training Area 2, 178th Tactical Fighter Group, Springfield ANGB, Springfield, Ohio (Continued)

SAIC ID Number		SB2-2-1RRE	SB2-2-2	SB2-2-2RE
Laboratory ID Number		94667RE	94668	94668RE
Collection Date		8-16-92	8-16-92	8-16-92
Collection Depth (ft)		1.5-3.5	3.5-5.0	3.5-5.0
Associated Field QC Sample		TB-4 EB2-1 FB2-1 SD5-FB	TB-4 EB2-1 FB2-1 SD5-FB	TB-4 EB2-1 FB2-1 SD5-FB
Parameter	Units			
TOTAL PETROLEUM HYDROCARBONS (SW 8015M)				
Gasoline	mg/kg	NA	NA	NA
Diesel Fuel	mg/kg	NA	640	NA
Heavy Oil	mg/kg	NA	<2	NA
PRIORITY POLLUTANT METALS				
AA METALS				
Antimony (SW 3050/7041)	mg/kg	NA	R(N)	NA
Arsenic (SW 3050/7060)	mg/kg	NA	8.8 J(N)	NA
Lead (SW 3050/7421)	mg/kg	NA	9.7	NA
Selenium (SW 3050/7740)	mg/kg	NA	0.13 UJ(N,W)	NA
Thallium (SW 3050/7841)	mg/kg	NA	0.08 J(W)	NA
ICP METALS (SW 3050/6010)				
Beryllium	mg/kg	NA	0.21 B	NA
Cadmium	mg/kg	NA	0.23 U	NA
Chromium	mg/kg	NA	5.2	NA
Copper	mg/kg	NA	9.7	NA
Nickel	mg/kg	NA	8.8	NA
Silver	mg/kg	NA	2.3 U(MB)	NA
Zinc	mg/kg	NA	38 J(E)	NA
VOLATILE ORGANICS (SW 8240 [A])				
Acetone	µg/kg	NA	1400 UJ(SR)	NA
Carbon Disulfide	µg/kg	NA	1400 UJ(SR)	NA
2-Butanone	µg/kg	NA	1400 UJ(SR)	NA
Benzene	µg/kg	NA	1400 UJ(SR)	NA
4-Methyl-2-pentanone	µg/kg	NA	1400 UJ(SR)	NA
Ethylbenzene	µg/kg	NA	1400 UJ(SR)	NA
Xylene (total)	µg/kg	NA	1400 J(SR)	NA
TICs	µg/kg	NA	3,5-Dimethyl-Heptane^b 92 J,N (RT 18.98)	NA
			3-Methyl-Nonane^b 98 J,N (RT 23.52)	
			4-Propyl-Heptane^b 66 J,N (RT 23.9)	
			4-Propyl-Heptane^b 95 J,N (RT 24.78)	
			Benzene, Trimethyl- Isomer^b 81 J,N (RT 26)	
			Decane^b 110 J,N (RT 26.4)	
			Benzene, Trimethyl- Isomer^b 130 J,N (RT 26.99)	
			4-Methyl-Decane^b 77 J,N (RT 27.14)	
			Undecane^b 130 J,N (RT 29.61)	
			2-Methyldecalin(Probably Tra^a 70 J,N (RT 30.55)	
			Cyclohexanemethanol^a 110 J,N (RT 31.29)	
TIC Total	µg/kg	NA	1059 (11)	NA

Table 3–16. Data Summary Table: Soil – Site 2 – Fire Training Area 2, 178th Tactical Fighter Group, Springfield ANGB, Springfield, Ohio (Continued)

SAIC ID Number			SB2–2–1RRE			SB2–2–2			SB2–2–2RE	
Laboratory ID Number			94667RE			94668			94668RE	
Collection Date			8–16–92			8–16–92			8–16–92	
Collection Depth (ft)			1.5–3.5			3.5–5.0			3.5–5.0	
Associated Field QC Sample			TB–4 EB2–1 FB2–1 SD5–FB			TB–4 EB2–1 FB2–1 SD5–FB			TB–4 EB2–1 FB2–1 SD5–FB	
Parameter	Units									
SEMIVOLATILE ORGANICS (SW 8270 [B])										
Isophorone	μg/kg		1400 U			660 J			2200 U	
Naphthalene	μg/kg		530 J			850 J			820 J	
2–Methylnaphthalene	μg/kg		1600			3200			2200 U	
Pentachlorophenol	μg/kg		3500 U			5400 UJ(CCV)			5400 UJ(CCV)	
Phenanthrene	μg/kg		260 J			2200 U			2200 U	
Fluoranthene	μg/kg		250 J			2200 U			2200 U	
Pyrene	μg/kg		270 J			2200 U			2200 U	
bis(2–Ethylhexyl)phthalate	μg/kg		1400 U			2200 U			2200 U	
TICs	μg/kg	Pentane, 2,2,3,3–Tetramethyl ^{b}	3800 J,N	(RT 6.33)	2,6–Dimethyl–Nonane ^{b}	5300 J,N	(RT 8.15)	2,6–Dimethyl–Nonane ^{b}	14000 J,N	(RT 7.92)
		5–Ethyl–2–Methyl–Heptane ^{b}	2800 J,N	(RT 7.72)	2,4,6–Trimethyl–Octane ^{b}	6000 J,N	(RT 9.92)	2–Methyl–Nonane ^{b}	7000 J,N	(RT 9.72)
		2–Methyl–Nonane ^{b}	3900 J,N	(RT 9.39)	Benzene, 4–Ethyl–1,2–Dimethy ^{b}	4200 J,N	(RT 10.29)	(1,1–Dimethylethyl)Benzene ^{b}	4900 J,N	(RT 10.07)
		Unknown ^{d}	1900 J	(RT 11.07)	Unknown ^{d}	3200 J	(RT 11.65)	Dodecane ^{b}	12000 J,N	(RT 11.80)
		Dodecane ^{b}	8200 J,N	(RT 11.40)	Dodecane ^{b}	12000 J,N	(RT 12.00)	2,6–Dimethyl–Undecane ^{b}	10000 J,N	(RT 12.05)
		2,6–Dimethyl–Undecane ^{b}	5700 J,N	(RT 11.65)	2,6–Dimethyl–Undecane ^{b}	9000 J,N	(RT 12.25)	Unknown ^{d}	2800 J	(RT 12.10)
		Unknown ^{d}	2600 J	(RT 12.40)	Unknown ^{d}	2700 J	(RT 12.32)	Unknown ^{d}	6300 J	(RT 12.44)
		2,10–Dimethyl–Undecane ^{b}	2000 J,N	(RT 12.55)	Unknown ^{d}	5100 J	(RT 12.65)	Unknown ^{d}	4500 J	(RT 12.75)
		2,6,7–Trimethyl–Decane ^{b}	8300 J,N	(RT 12.74)	Unknown ^{d}	4400 J	(RT 12.97)	Unknown ^{d}	2800 J	(RT 12.89)
		3,8–Dimethyl–Undecane ^{b}	17000 J,N	(RT 13.27)	Unknown ^{d}	2400 J	(RT 13.09)	Unknown ^{d}	2000 J	(RT 12.97)
		1–Methyl–Naphthalene ^{c}	2400 J,N	(RT 13.39)	2–Methyl–Dodecane ^{b}	2100 J,N	(RT 13.19)	2,6,7–Trimethyl–Decane ^{b}	14000 J,N	(RT 13.15)
		2,6,6–Trimethyl–Decane ^{b}	4200 J,N	(RT 13.52)	2,6,7–Trimethyl–Decane ^{b}	13000 J,N	(RT 13.35)	Cyclopentanone, 2–Methyl–4–(^{c}	2300 J,N	(RT 13.39)
		2–Methyl–Tridecane ^{b}	3700 J,N	(RT 14.30)	Cyclopentanone, 2–Methyl–4–(^{c}	2100 J,N	(RT 13.60)	1–Methyl–Naphthalene ^{c}	2500 J,N	(RT 13.45)
		2,7,10–Trimethyl–Dodecane ^{b}	7100 J,N	(RT 14.54)	3,8–Dimethyl–Undecane ^{b}	23000 J,N	(RT 13.87)	5,7–Dimethyl–Undecane ^{b}	24000 J,N	(RT 13.67)
		5,7–Dimethyl–Undecane ^{b}	23000 J,N	(RT 14.97)	Unknown ^{d}	2900 J	(RT 13.97)	2,6,6–Trimethyl–Decane ^{b}	5900 J,N	(RT 13.94)
		Unknown ^{d}	10000 J	(RT 15.92)	2,6,6–Trimethyl–Decane ^{b}	5300 J,N	(RT 14.14)	Unknown ^{d}	10000 J	(RT 14.94)
		Unknown ^{d}	11000 J	(RT 16.54)	2,7,10–Trimethyl–Dodecane ^{b}	10000 J,N	(RT 15.15)	Tetradecane ^{b}	28000 J,N	(RT 15.37)
		Hexadecane ^{b}	4200 J,N	(RT 18.02)	6–Ethyl–2–Methyl–Decane ^{b}	31000 J,N	(RT 15.59)	Unknown ^{d}	10000 J	(RT 16.32)
		Heptadecane ^{b}	3300 J,N	(RT 19.47)	Hexadecane ^{b}	14000 J,N	(RT 16.54)	2,7,10–Trimethyl–Dodecane ^{b}	9100 J,N	(RT 16.94)
		Unknown ^{d}	6400 J	(RT 27.64)	5–Propyl–Tridecane ^{b}	12000 J,N	(RT 17.14)	Hexadecane ^{b}	2900 J,N	(RT 18.40)
TIC Total	μg/kg		131500 (20)			169700 (20)			175000 (20)	

Table 3-16. Data Summary Table: Soil - Site 2 - Fire Training Area 2, 178th Tactical Fighter Group, Springfield ANGB, Springfield, Ohio (Continued)

SAIC ID Number		SB2-2-17	SB2-2-17RE	SB2-3-1	
Laboratory ID Number		94669	94669RE	94670	
Collection Date		8-16-92	8-16-92	8-17-92	
Collection Depth (ft)		33.0-35.0	33.0-35.0	1.5-3.5	
Associated Field QC Sample		TB-4 EB2-1 FB2-1 SD5-FB	TB-4 EB2-1 FB2-1 SD5-FB	TB-4 EB2-1 FB2-1 SD5-FB	
Parameter	Units				
TOTAL PETROLEUM HYDROCARBONS (SW 8015M)					
Gasoline	mg/kg	NA	NA	NA	
Diesel Fuel	mg/kg	91	NA	750	
Heavy Oil	mg/kg	<2	NA	<2	
PRIORITY POLLUTANT METALS					
AA METALS					
Antimony (SW 3050/7041)	mg/kg	0.39 J(N,r)	NA	R(N)	
Arsenic (SW 3050/7060)	mg/kg	9 J(N)	NA	8.8 J(N)	
Lead (SW 3050/7421)	mg/kg	10.7	NA	7.8	
Selenium (SW 3050/7740)	mg/kg	0.22 UJ(MB,N,W)	NA	0.15 UJ(N,W)	
Thallium (SW 3050/7841)	mg/kg	0.27 J(W)	NA	0.13 J(W)	
ICP METALS (SW 3050/6010)					
Beryllium	mg/kg	0.38 B	NA	0.28 B	
Cadmium	mg/kg	0.19 U(MB)	NA	0.21 U	
Chromium	mg/kg	8.1	NA	7.2	
Copper	mg/kg	25.8	NA	13.1	
Nickel	mg/kg	20.6	NA	14.2	
Silver	mg/kg	2.2 U(MB)	NA	2 U(MB)	
Zinc	mg/kg	65.4 J(E)	NA	43.3 J(E)	
VOLATILE ORGANICS (SW 8240 [A])					
Acetone	µg/kg	12 U	NA	90	
Carbon Disulfide	µg/kg	12 U	NA	64 U	
2-Butanone	µg/kg	12 U	NA	64 U	
Benzene	µg/kg	12 U	NA	8 J	
4-Methyl-2-pentanone	µg/kg	12 U	NA	64 U	
Ethylbenzene	µg/kg	12 U	NA	170	
Xylene (total)	µg/kg	12 U	NA	450 X	
TICs	µg/kg	0 (0)	NA	Hexane[a]	32 J,N (RT 7.83)
				Methyl-Cyclopentane[b]	32 J,N (RT 9.54)
				Heptane[b]	90 J,N (RT 11.28)
				Methyl-Cyclohexane[b]	130 J,N (RT 14.28)
				2-Methyl-Heptane[b]	160 J,N (RT 15.81)
				3-Methyl-Heptane[b]	170 J,N (RT 16.26)
				Cyclopentane, 1-Ethyl-3-Meth[b]	45 J,N (RT 19.98)
				4-Methyl-Octane[b]	64 J,N (RT 20.72)
				3-Methyl-Octane[b]	45 J,N (RT 21.12)
				Propyl-Benzene[b]	120 J,N (RT 26.99)
				1-Ethyl-2-Methyl-Benzene[b]	120 J,N (RT 27.38)
TIC Total	µg/kg	0 (0)	NA		1008 (11)

Table 3-16. Data Summary Table: Soil - Site 2 - Fire Training Area 2, 178th Tactical Fighter Group, Springfield ANGB, Springfield, Ohio (Continued)

SAIC ID Number		SB2-2-17			SB2-2-17RE			SB2-3-1		
Laboratory ID Number		94669			94669RE			94670		
Collection Date		8-16-92			8-16-92			8-17-92		
Collection Depth (ft)		33.0-35.0			33.0-35.0			1.5-3.5		
Associated Field QC Sample		TB-4 EB2-1 FB2-1 SD5-FB			TB-4 EB2-1 FB2-1 SD5-FB			TB-4 EB2-1 FB2-1 SD5-FB		
Parameter	Units									
SEMIVOLATILE ORGANICS (SW 8270 [B])										
Isophorone	µg/kg		380 U			380 U			830 J	
Naphthalene	µg/kg		380 U			380 U			2500 U	
2-Methylnaphthalene	µg/kg		380 U			380 U			2500 U	
Pentachlorophenol	µg/kg		910 UJ(CCV,IS)			910 UJ(CCV,IS)			6100 UJ(CCV,IS)	
Phenanthrene	µg/kg		380 UJ(IS)			380 UJ(IS)			2500 UJ(IS)	
Fluoranthene	µg/kg		380 UJ(IS)			380 UJ(IS)			2500 UJ(IS)	
Pyrene	µg/kg		380 UJ(IS)			380 UJ(IS)			2500 U	
bis(2-Ethylhexyl)phthalate	µg/kg		380 UJ(IS)			380 UJ(IS)			2500 U	
TICs	µg/kg	2,6,7-Trimethyl-Decane[b]	670 J,N	(RT 13.27)	2,6,7-Trimethyl-Decane[b]	590 J,N	(RT 13.05)	5-Ethyl-2-Methyl-Heptane[b]	6900 J,N	(RT 8.13)
		3,8-Dimethyl-Undecane[b]	1200 J,N	(RT 13.77)	3,8-Dimethyl-Undecane[b]	1100 J,N	(RT 13.57)	2,4,6-Trimethyl-Octane[b]	4900 J,N	(RT 9.92)
		Tetradecane[b]	1400 J,N	(RT 15.52)	2,3,5-Trimethyl-Decane[b]	1300 J,N	(RT 15.29)	Bicyclo[4.1.0]Heptan-3-One,[b]	4100 J,N	(RT 10.32)
		Unknown[d]	870 J	(RT 16.50)	Unknown[d]	750 J	(RT 16.29)	Dodecane[b]	11000 J,N	(RT 12.00)
		2,7,10-Trimethyl-Dodecane[b]	1900 J,N	(RT 17.14)	2,7,10-Trimethyl-Dodecane[b]	1600 J,N	(RT 16.90)	2,6-Dimethyl-Undecane[b]	18000 J,N	(RT 12.25)
		Hexadecane[b]	1800 J,N	(RT 18.65)	Hexadecane[b]	1600 J,N	(RT 18.42)	Unknown[d]	6700 J	(RT 13.00)
		Unknown[d]	1200 J	(RT 19.35)	5-Propyl-Tridecane[b]	1000 J,N	(RT 19.12)	Unknown[d]	3000 J	(RT 13.10)
		Heptadecane[b]	1200 J,N	(RT 20.09)	Heptadecane[b]	1100 J,N	(RT 19.87)	2,6,7-Trimethyl-Decane[b]	24000 J,N	(RT 13.39)
		2,6-Dimethyl-Heptadecane[b]	1500 J,N	(RT 20.19)	Hexadecane, 2,6,10-Trimethyl[b]	1300 J,N	(RT 19.95)	Unknown[d]	2200 J	(RT 13.62)
		Octadecane[b]	890 J,N	(RT 21.47)	Octadecane[b]	820 J,N	(RT 21.24)	Unknown[d]	17000 J	(RT 13.87)
		Hexadecane, 2,6,10,14-Tetram[b]	880 J,N	(RT 21.57)	Hexadecane, 2,6,10,14-Tetram[b]	780 J,N	(RT 21.34)	Unknown[d]	3100 J	(RT 14.00)
		Unknown[d]	1100 J	(RT 22.77)	Unknown[d]	1200 J	(RT 22.54)	Unknown[d]	4700 J	(RT 14.10)
		Eicosane[b]	930 J,N	(RT 24.02)	Unknown[d]	810 J	(RT 23.79)	2,6,6-Trimethyl-Decane[b]	2600 J,N	(RT 14.17)
		Heptadecane, 2,6,10,15-Tetra[b]	1100 J,N	(RT 25.22)	Unknown[d]	510 J	(RT 24.97)	2,7,10-Trimethyl-Dodecane[b]	12000 J,N	(RT 15.19)
		Docosane[b]	770 J,N	(RT 26.37)	Docosane[b]	460 J,N	(RT 26.12)	2,10-Dimethyl-Undecane[b]	15000 J,N	(RT 15.59)
		Unknown[d]	580 J	(RT 27.47)	Unknown[d]	520 J	(RT 27.22)	Unknown[d]	15000 J	(RT 16.59)
		Unknown[d]	3700 J	(RT 28.36)	Unknown[d]	3400 J	(RT 28.07)	Unknown[d]	12000 J	(RT 17.17)
		Unknown[d]	390 J	(RT 28.56)	7-Hexyl-Eicosane[b]	440 J,N	(RT 28.29)	5-Propyl-Tridecane[b]	6500 J,N	(RT 19.34)
		Pentacosane[b]	390 J,N	(RT 29.57)	Pentacosane[b]	360 J,N	(RT 29.31)	Hexadecane, 2,6,10-Trimethyl[b]	4900 J,N	(RT 20.15)
		Unknown[d]	590 J	(RT 32.41)	Unknown[d]	1200 J	(RT 32.14)	Unknown[d]	6600 J	(RT 28.22)
TIC Total	µg/kg		23060 (20)			20840 (20)			180200 (20)	

Table 3-16. Data Summary Table: Soil - Site 2 - Fire Training Area 2, 178th Tactical Fighter Group, Springfield ANGB, Springfield, Ohio (Continued)

SAIC ID Number		SB2-3-1RE	SB2-3-4			SB2-3-4DL		
Laboratory ID Number		94670RE	94671			94671DL		
Collection Date		8-17-92	8-17-92			8-17-92		
Collection Depth (ft)		1.5-3.5	7.5-9.5			7.5-9.5		
Associated Field QC Sample		TB-4 EB2-1 FB2-1 SD5-FB	TB-4 EB2-1 FB2-1 SD5-FB			TB-4 EB2-1 FB2-1 SD5-FB		
Parameter	Units							
TOTAL PETROLEUM HYDROCARBONS (SW 8015M)								
Gasoline	mg/kg	NA	NA			NA		
Diesel Fuel	mg/kg	NA	37			NA		
Heavy Oil	mg/kg	NA	<2			NA		
PRIORITY POLLUTANT METALS								
AA METALS								
Antimony (SW 3050/7041)	mg/kg	NA	R(N)			NA		
Arsenic (SW 3050/7060)	mg/kg	NA	6.2 J(N)			NA		
Lead (SW 3050/7421)	mg/kg	NA	7.4			NA		
Selenium (SW 3050/7740)	mg/kg	NA	0.15 UJ(N,W)			NA		
Thallium (SW 3050/7841)	mg/kg	NA	0.18 J(W)			NA		
ICP METALS (SW 3050/6010)								
Beryllium	mg/kg	NA	0.17 B			NA		
Cadmium	mg/kg	NA	0.19 U			NA		
Chromium	mg/kg	NA	6.8			NA		
Copper	mg/kg	NA	13.6			NA		
Nickel	mg/kg	NA	12.9			NA		
Silver	mg/kg	NA	2.1 U(MB)			NA		
Zinc	mg/kg	NA	51.5 J(E)			NA		
VOLATILE ORGANICS (SW 8240 [A])								
Acetone	µg/kg	NA	54 J(IS)			42 J(IS)		
Carbon Disulfide	µg/kg	NA	11 UJ(IS)			23 UJ(IS)		
2-Butanone	µg/kg	NA	14 J(IS)			23 UJ(IS)		
Benzene	µg/kg	NA	19			8 DJ		
4-Methyl-2-pentanone	µg/kg	NA	11 U			23 U		
Ethylbenzene	µg/kg	NA	280 E			140 D		
Xylene (total)	µg/kg	NA	300 X			160 DX		
TICs	µg/kg	NA	Methyl-Cyclohexane^{b}	70 J,N	(RT 14.12)	Methyl-Cyclohexane^{b}	21 J,N	(RT 14.22)
			2-Methyl-Heptane^{b}	56 J,N	(RT 15.63)	2-Methyl-Heptane^{b}	18 J,N	(RT 15.74)
			3-Methyl-Heptane^{b}	67 J,N	(RT 16.08)	3-Methyl-Heptane^{b}	30 J,N	(RT 16.2)
			Ethyl-Cyclohexane^{b}	41 J,N	(RT 19.83)	2,5-Dimethyl-Heptane^{b}	11 J,N	(RT 19.26)
			2,3-Dimethyl-Heptane^{b}	32 J,N	(RT 20.54)	Cyclopentane, 1-Ethyl-3-Meth^{b}	18 J,N	(RT 19.96)
			2-Pyrazoline-1-Carboxamide,^{c}	28 J,N	(RT 24.53)	4-Methyl-Octane^{b}	16 J,N	(RT 20.65)
			(1-Methylethyl)-Benzene^{b}	100 J,N	(RT 25.47)	3-Methyl-Octane^{b}	11 J,N	(RT 21.05)
			Propyl-Benzene^{b}	62 J,N	(RT 26.79)	(1-Methylethyl)-Benzene^{b}	16 J,N	(RT 25.56)
			1-Ethyl-2-Methyl-Benzene^{b}	59 J,N	(RT 27.19)	Propyl-Benzene^{b}	41 J,N	(RT 26.91)
			1,3,5-Trimethyl-Benzene^{b}	48 J,N	(RT 27.37)	1-Ethyl-2-Methyl-Benzene^{b}	37 J,N	(RT 27.31)
TIC Total	µg/kg	NA		563 (10)			219 (10)	

Table 3-16. Data Summary Table: Soil - Site 2 - Fire Training Area 2, 178th Tactical Fighter Group, Springfield ANGB, Springfield, Ohio (Continued)

SAIC ID Number		SB2-3-1RE	SB2-3-4	SB2-3-4DL
Laboratory ID Number		94670RE	94671	94671DL
Collection Date		8-17-92	8-17-92	8-17-92
Collection Depth (ft)		1.5-3.5	7.5-9.5	7.5-9.5
Associated Field QC Sample		TB-4 EB2-1 FB2-1 SD5-FB	TB-4 EB2-1 FB2-1 SD5-FB	TB-4 EB2-1 FB2-1 SD5-FB
Parameter	Units			
SEMIVOLATILE ORGANICS (SW 8270 [B])				
Isophorone	µg/kg	2500 U	370 U	NA
Naphthalene	µg/kg	2500 U	370 U	NA
2-Methylnaphthalene	µg/kg	2500 U	370 U	NA
Pentachlorophenol	µg/kg	6100 UJ(CCV,IS)	900 U	NA
Phenanthrene	µg/kg	2500 UJ(IS)	370 U	NA
Fluoranthene	µg/kg	2500 UJ(IS)	370 U	NA
Pyrene	µg/kg	2500 U	370 U	NA
bis(2-Ethylhexyl)phthalate	µg/kg	2500 U	370 U	NA
TICs	µg/kg	2,6-Dimethyl-Nonane[b] 9900 J,N (RT 7.92)	4-Hydroxy-4-Methyl-2-Pentanone[a] 23000 J,N,A (RT 4.23)	NA
		2-Methyl-Nonane[b] 4800 J,N (RT 9.72)	Benzaldehyde[c] 260 J,N (RT 6.35)	
		Unknown[d] 4000 J (RT 10.09)	Decane[b] 150 J,N (RT 7.22)	
		Dodecane[b] 9300 J,N (RT 11.80)	5-Ethyl-2-Methyl-Heptane[b] 250 J,N (RT 7.72)	
		2,6-Dimethyl-Undecane[b] 16000 J,N (RT 12.07)	2-Methyl-Nonane[b] 230 J,N (RT 9.37)	
		Unknown[d] 6800 J (RT 12.79)	Dodecane[b] 370 J,N (RT 11.34)	
		Unknown[d] 2800 J (RT 12.89)	2,6,7-Trimethyl-Decane[b] 380 J,N (RT 11.60)	
		2,6,7-Trimethyl-Decane[b] 20000 J,N (RT 13.17)	7-Methyl-Tridecane[b] 380 J,N (RT 12.67)	
		Cyclopentanone, 2-Methyl-4-([c] 2100 J,N (RT 13.42)	3,8-Dimethyl-Undecane[b] 500 J,N (RT 13.17)	
		5,7-Dimethyl-Undecane[b] 15000 J,N (RT 13.67)	2,7,10-Trimethyl-Dodecane[b] 290 J,N (RT 14.49)	
		Unknown[d] 3900 J (RT 13.89)	2,6,11-Trimethyl-Dodecane[b] 690 J,N (RT 14.89)	
		6-Methyl-Tridecane[b] 2300 J,N (RT 13.95)	Unknown[d] 230 J (RT 15.89)	
		2,7,10-Trimethyl-Dodecane[b] 9900 J,N (RT 14.99)	Unknown[d] 200 J (RT 16.49)	
		Unknown[d] 12000 J (RT 15.39)	Hexadecane[b] 130 J,N (RT 18.02)	
		Unknown[d] 12000 J (RT 16.37)	Unknown[d] 120 J (RT 19.54)	
		Unknown[d] 9400 J (RT 16.95)	Nonanamide[c] 190 B,J,N (RT 23.17)	
		Hexadecane[b] 3600 J,N (RT 18.42)	Dodecanamide[c] 300 B,J,N (RT 25.41)	
		Unknown[d] 6300 J (RT 19.12)	Unknown[d] 450 J (RT 25.62)	
		Pentadecane, 2,6,10,14-Tetra[b] 7000 J,N (RT 19.94)	Unknown[d] 6400 J (RT 27.74)	
		Unknown[d] 5900 J (RT 27.97)	Unknown[d] 78 J (RT 27.91)	
			Unknown[d] 1700 J (RT 31.81)	
TIC Total	µg/kg	163000 (20)	36298 (21)	NA

Table 3–16. Data Summary Table: Soil – Site 2 – Fire Training Area 2, 178th Tactical Fighter Group, Springfield ANGB, Springfield, Ohio (Continued)

SAIC ID Number		SB2–3–16	SB2–4–1	SB2–4–2
Laboratory ID Number		94672	9541	9542
Collection Date		8–17–92	5–19–93	5–19–93
Collection Depth (ft)		31.5–33.5	7.0–9.0	23.0–25.0
Associated Field QC Sample		TB–4 EB2–1 FB2–1 SD5–FB	TB52093 EB2–2, EB3–2 N/A FB2–2, FB3–2	TB52093 EB2–2, EB3–2 N/A FB2–2, FB3–2
Parameter	Units			
TOTAL PETROLEUM HYDROCARBONS (SW 8015M)				
Gasoline	mg/kg	NA	<0.05	<0.05
Diesel Fuel	mg/kg	35	16	23
Heavy Oil	mg/kg	10	7	23
PRIORITY POLLUTANT METALS				
AA METALS				
Antimony (SW 3050/7041)	mg/kg	0.2 J(N,r)	0.1 UJ(N,W)	0.1 UJ(N)
Arsenic (SW 3050/7060)	mg/kg	5.5 J(N)	5.9 J(N)	5.6 J(N)
Lead (SW 3050/7421)	mg/kg	4.6	7.1 J(N)	8.7 J(N)
Selenium (SW 3050/7740)	mg/kg	0.15 UJ(N,W)	0.15 UJ(W)	0.26 B
Thallium (SW 3050/7841)	mg/kg	0.17 B	0.24 U	0.23 UJ(W)
ICP METALS (SW 3050/6010)				
Beryllium	mg/kg	0.15 B	0.29 U(MB)	0.35 U(MB)
Cadmium	mg/kg	0.21 U	0.57 U	0.55 U
Chromium	mg/kg	3.8	8.5	10
Copper	mg/kg	15.4	14.4	16.4
Nickel	mg/kg	9.9	13.7	16.4
Silver	mg/kg	1.8 U(MB)	0.45 U	0.43 U
Zinc	mg/kg	36 J(E)	36.9 J(E)	37 J(E)
VOLATILE ORGANICS (SW 8240 [A])				
Acetone	µg/kg	20	55 U(EB)	11 U
Carbon Disulfide	µg/kg	11 U	11 U	11 U
2–Butanone	µg/kg	11 U	19	11 U
Benzene	µg/kg	11 U	42	11 U
4–Methyl–2–pentanone	µg/kg	11 U	50	11 U
Ethylbenzene	µg/kg	11 U	11 U	11 U
Xylene (total)	µg/kg	11 U	11 U	11 U
TICs	µg/kg	0 (0)	Butanal [c] 13 J,N (RT 10.31) Butyl Ester Formic Acid [c] 14 J,N (RT 16.47) 2–Ethyl–Butanal [c] 6 J,N (RT 21.63) Unknown Keytone [d] 7 J,N (RT 22.62)	0 (0)
TIC Total	µg/kg	0 (0)	40 (4)	0 (0)

Table 3-16. Data Summary Table: Soil – Site 2 – Fire Training Area 2, 178th Tactical Fighter Group, Springfield ANGB, Springfield, Ohio (Continued)

SAIC ID Number			SB2-3-16			SB2-4-1			SB2-4-2	
Laboratory ID Number			94672			9541			9542	
Collection Date			8-17-92			5-19-93			5-19-93	
Collection Depth (ft)			31.5-33.5			7.0-9.0			23.0-25.0	
Associated Field QC Sample			TB-4 EB2-1 FB2-1 SD5-FB			TB52093 EB2-2,EB3-2 N/A FB2-2,FB3-2			TB52093 EB2-2,EB3-2 N/A FB2-2,FB3-2	
Parameter	Units									
SEMIVOLATILE ORGANICS (SW 8270 [B])										
Isophorone	µg/kg		380 U			360 U			350 U	
Naphthalene	µg/kg		380 U			360 U			350 U	
2-Methylnaphthalene	µg/kg		380 U			360 U			350 U	
Pentachlorophenol	µg/kg		910 UJ(CCV)			130 J			850 U	
Phenanthrene	µg/kg		380 U			360 U			350 U	
Fluoranthene	µg/kg		380 U			360 U			350 U	
Pyrene	µg/kg		380 U			360 U			350 U	
bis(2-Ethylhexyl)phthalate	µg/kg		40 J			360 U(MB)			350 U(MB)	
TICs	µg/kg	2,6,7-Trimethyl-Decane ^{b}	530 J,N	(RT 13.75)	4-Hydroxy-4-Methyl-2-Pentanone ^{a}	20000 B,J,N,A	(RT 3.60)	4-Hydroxy-4-Methyl-2-Pentanone ^{a}	16000 B,J,N,A	(RT 3.77)
		2,6,11-Trimethyl-Dodecane ^{b}	610 J,N	(RT 15.47)	Unknown ^{d}	9700 J	(RT 12.35)	4,7-Dimethyl-Undecane ^{b}	540 J,N	(RT 12.27)
		Unknown ^{d}	380 J	(RT 16.47)	Unknown ^{d}	5600 J	(RT 12.69)	2,7,10-Trimethyl-Dodecane ^{b}	350 J,N	(RT 13.57)
		2,7,10-Trimethyl-Dodecane ^{b}	740 J,N	(RT 17.09)	Unknown ^{d}	1200 J	(RT 12.87)	Unknown ^{d}	780 J	(RT 14.00)
		Hexadecane ^{b}	820 J,N	(RT 18.62)	Unknown ^{d}	2400 J	(RT 13.04)	Unknown ^{d}	530 J	(RT 14.99)
		Unknown ^{d}	470 J	(RT 19.32)	.Alpha.-Benzeneacetic Acid ^{c}	270 J,N	(RT 13.30)	Unknown ^{d}	1100 J	(RT 15.65)
		Unknown ^{d}	720 J	(RT 20.05)	Unknown ^{d}	230 J	(RT 13.64)	Hexadecane ^{b}	1200 J,N	(RT 17.20)
		2,6-Dimethyl-Heptadecane ^{b}	740 J,N	(RT 20.14)	Dodecanoic Acid ^{b}	1200 J,N	(RT 16.60)	5-Propyl-Tridecane ^{b}	730 J,N	(RT 17.89)
		Octadecane ^{b}	490 J,N	(RT 21.42)	Unknown ^{d}	440 J	(RT 18.32)	Unknown ^{d}	1400 J	(RT 18.67)
		Unknown ^{d}	460 J	(RT 21.54)	Unknown ^{d}	200 J	(RT 19.70)	2,6-Dimethyl-Heptadecane ^{b}	830 J,N	(RT 18.70)
		Unknown ^{d}	600 J	(RT 22.72)	Unknown ^{d}	170 J	(RT 19.80)	Heptadecane, 2,6,10,14-Tetra ^{b}	820 J,N	(RT 20.05)
		Eicosane ^{b}	530 J,N	(RT 23.97)	Unknown ^{d}	280 J	(RT 21.04)	Unknown ^{d}	640 J	(RT 20.14)
		Unknown ^{d}	340 J	(RT 25.17)	Unknown ^{d}	230 J	(RT 22.30)	Unknown ^{d}	780 J	(RT 21.40)
		Docosane ^{b}	320 J,N	(RT 26.32)	Unknown ^{d}	380 J	(RT 23.52)	Unknown ^{d}	660 J	(RT 22.67)
		Unknown ^{d}	320 J	(RT 27.44)	Unknown ^{d}	280 J	(RT 24.69)	Unknown ^{d}	820 J	(RT 23.89)
		Unknown ^{d}	490 J	(RT 28.12)	Unknown ^{d}	270 J	(RT 25.81)	Unknown ^{d}	650 J	(RT 25.07)
		Unknown ^{d}	6300 J	(RT 28.31)	Unknown ^{d}	290 J	(RT 26.89)	Octacosane ^{b}	710 J,N	(RT 26.19)
		Unknown ^{d}	330 J	(RT 28.51)	Unknown ^{d}	260 J	(RT 27.94)	Unknown ^{d}	710 J	(RT 27.27)
		Pentacosane ^{b}	240 J,N	(RT 29.52)	Unknown ^{d}	260 J	(RT 28.96)	Unknown ^{d}	500 J	(RT 28.32)
		Unknown ^{d}	1900 J	(RT 32.34)	Unknown ^{d}	300 J	(RT 29.94)	Unknown ^{d}	390 J	(RT 29.34)
					Unknown ^{d}	260 J	(RT 30.91)	Unknown ^{d}	490 J	(RT 30.32)
TIC Total	µg/kg		17330 (20)			44220 (21)			30630 (21)	

Table 3–16. Data Summary Table: Soil – Site 2 – Fire Training Area 2, 178th Tactical Fighter Group, Springfield ANGB, Springfield, Ohio (Continued)

SAIC ID Number		SB2–5–1	SB2–5–2	SB2–6–1
Laboratory ID Number		9543	9544	9545
Collection Date		5–19–93	5–19–93	5–20–93
Collection Depth (ft)		8.0–10.0	25.0–27.0	16.5–17.5
Associated Field QC Sample		TB52093 EB2–2, EB3–2 N/A FB2–2, FB3–2	TB52093 EB2–2, EB3–2 N/A FB2–2, FB3–2	TB52093 EB2–2, EB3–2 N/A FB2–2, FB3–2
Parameter	Units			
TOTAL PETROLEUM HYDROCARBONS (SW 8015M)				
Gasoline	mg/kg	6.8	<0.05	<0.05
Diesel Fuel	mg/kg	4	28	31 J(FD)
Heavy Oil	mg/kg	9	25	35 J(FD)
PRIORITY POLLUTANT METALS				
AA METALS				
Antimony (SW 3050/7041)	mg/kg	0.12 UJ(N,W)	0.1 UJ(N,W)	0.09 UJ(N,W)
Arsenic (SW 3050/7060)	mg/kg	10.6 J(N)	5.1 J(N)	3.4 J(N)
Lead (SW 3050/7421)	mg/kg	12.9 J(N)	7.7 J(N)	7.3 J(N)
Selenium (SW 3050/7740)	mg/kg	0.17 U	0.15 B	0.14 UJ(W)
Thallium (SW 3050/7841)	mg/kg	0.27 UJ(W)	0.23 U	0.22 U
ICP METALS (SW 3050/6010)				
Beryllium	mg/kg	0.38 U(MB)	0.28 U(MB)	0.3 U(MB)
Cadmium	mg/kg	0.62 U	0.6 U	0.64 U
Chromium	mg/kg	10.5	9.6	9.1
Copper	mg/kg	16.7	14	14.2
Nickel	mg/kg	20.8	13.1	12.3
Silver	mg/kg	0.49 U	0.47 U	0.5 U
Zinc	mg/kg	61.5 J(E)	32 J(E)	35.9 J(E)
VOLATILE ORGANICS (SW 8240 [A])				
Acetone	µg/kg	11 U	11 U	120 U(EB)
Carbon Disulfide	µg/kg	11 U	11 U	2 J
2–Butanone	µg/kg	11 U	11 U	32
Benzene	µg/kg	11 U	11 U	11 U
4–Methyl–2–pentanone	µg/kg	11 U	11 U	9 J
Ethylbenzene	µg/kg	11 U	11 U	11 U
Xylene (total)	µg/kg	11 U	11 U	11 U
TICs	µg/kg	Unknown Cycloalkane[b] 7 J,N (RT 20.73)	0 (0)	Unknown[d] 10 J,N (RT 6.77) Unknown Alkane[d] 9 J,N (RT 8.55) Unknown Ketone[d] 20 J,N (RT 13.39)
TIC Total	µg/kg	7 (1)	0 (0)	39 (3)

Table 3-16. Data Summary Table: Soil – Site 2 – Fire Training Area 2, 178th Tactical Fighter Group, Springfield ANGB, Springfield, Ohio (Continued)

SAIC ID Number			SB2-5-1			SB2-5-2			SB2-6-1	
Laboratory ID Number			9543			9544			9545	
Collection Date			5-19-93			5-19-93			5-20-93	
Collection Depth (ft)			8.0-10.0			25.0-27.0			16.5-17.5	
Associated Field QC Sample			TB52093 EB2-2,EB3-2 N/A FB2-2,FB3-2			TB52093 EB2-2,EB3-2 N/A FB2-2,FB3-2			TB52093 EB2-2,EB3-2 N/A FB2-2,FB3-2	
Parameter	Units									
SEMIVOLATILE ORGANICS (SW 8270 [B])										
Isophorone	µg/kg		360 U			360 U			360 U	
Naphthalene	µg/kg		360 U			360 U			360 U	
2-Methylnaphthalene	µg/kg		360 U			360 U			360 U	
Pentachlorophenol	µg/kg		870 U			860 U			880 U	
Phenanthrene	µg/kg		360 U			360 U			360 U	
Fluoranthene	µg/kg		360 U			360 U			360 U	
Pyrene	µg/kg		360 U			360 U			360 U	
bis(2-Ethylhexyl)phthalate	µg/kg		360 U(MB)			360 U(MB)			430 U(MB)	
TICs	µg/kg	4-Hydroxy-4-Methyl-2-Pentanone [a]	17000 B,J,N,A	(RT 3.80)	4-Hydroxy-4-Methyl-2-Pentanone [a]	16000 B,J,N,A	(RT 3.82)	4-Hydroxy-4-Methyl-2-Pentanone [a]	15000 B,J,N,A	(RT 3.55)
		Unknown [d]	70 J	(RT 4.00)	2,4,6-Trimethyl-Octane [b]	240 J,N	(RT 10.45)	Unknown [d]	630 J	(RT 9.32)
		4-Penten-2-Ol [c]	120 J,N	(RT 4.15)	4,7-Dimethyl-Undecane [b]	480 J,N	(RT 12.29)	3,6-Dimethyl-Decane [b]	150 J,N	(RT 13.69)
		2,3-Dimethyl-Octane [b]	120 J,N	(RT 5.32)	Unknown [d]	220 J	(RT 13.59)	Unknown [d]	220 J	(RT 15.32)
		Dodecanamide, N,N-Bis(2-Hydr [c]	530 J,N	(RT 16.80)	3,8-Dimethyl-Undecane [b]	790 J,N	(RT 14.02)	2,6,11-Trimethyl-Dodecane [b]	260 J,N	(RT 16.87)
		2,6,11-Trimethyl-Dodecane [b]	130 J,N	(RT 17.20)	4,6-Dimethyl-Dodecane [b]	550 J,N	(RT 15.00)	Unknown [d]	230 J	(RT 17.54)
		Unknown [d]	130 J	(RT 17.87)	Unknown [d]	950 J	(RT 15.65)	Unknown [d]	430 J	(RT 18.32)
		Unknown [d]	410 J	(RT 18.67)	Hexadecane [b]	890 J,N	(RT 17.22)	Unknown [d]	360 J	(RT 18.35)
		Unknown [d]	160 J	(RT 20.05)	5-Propyl-Tridecane [b]	610 J,N	(RT 17.89)	Unknown [d]	310 J	(RT 19.72)
		Unknown [d]	170 J	(RT 20.14)	Unknown [d]	2300 J	(RT 18.69)	Unknown [d]	240 J	(RT 19.80)
		Unknown [d]	200 J	(RT 21.40)	Unknown [d]	860 J	(RT 20.09)	Unknown [d]	300 J	(RT 21.05)
		Unknown [d]	190 J	(RT 22.67)	Unknown [d]	660 J	(RT 20.15)	Heptadecane, 2,6,10,14-Tetra [b]	260 J,N	(RT 22.30)
		Unknown [d]	180 J	(RT 23.89)	Unknown [d]	870 J	(RT 21.42)	Unknown [d]	330 J	(RT 23.52)
		Unknown [d]	220 J	(RT 25.07)	Unknown [d]	670 J	(RT 22.69)	Unknown [d]	300 J	(RT 24.70)
		Unknown [d]	250 J	(RT 26.19)	Unknown [d]	620 J	(RT 23.90)	Unknown [d]	300 J	(RT 25.82)
		Unknown [d]	220 J	(RT 27.27)	Unknown [d]	670 J	(RT 25.09)	Hexanedioic Acid, Mono(2-Eth [b]	2000 J,N	(RT 26.77)
		Unknown [d]	250 J	(RT 28.32)	Unknown [d]	560 J	(RT 26.22)	Unknown [d]	250 J	(RT 26.91)
		Unknown [d]	200 J	(RT 29.34)	Unknown [d]	500 J	(RT 27.31)	Unknown [d]	250 J	(RT 27.94)
		Unknown [d]	230 J	(RT 30.34)	Unknown [d]	430 J	(RT 28.36)	Unknown [d]	230 J	(RT 28.96)
		Unknown [d]	200 J	(RT 31.32)	Unknown [d]	370 J	(RT 29.37)	Unknown [d]	270 J	(RT 29.94)
		Unknown [d]	170 J	(RT 32.27)	Unknown [d]	530 J	(RT 30.36)	Unknown [d]	280 J	(RT 30.92)
TIC Total	µg/kg		21150 (21)			29770 (21)			22600 (21)	

Table 3–16. Data Summary Table: Soil – Site 2 – Fire Training Area 2
178th Tactical Fighter Group, Springfield ANGB, Springfield, Ohio (Continued)

SAIC ID Number		SB2–6–1R	SB2–6–1RRE
Laboratory ID Number		9546	9546RE
Collection Date		5–20–93	5–20–93
Collection Depth (ft)		16.5–17.5	16.5–17.5
Associated Field QC Sample		TB52093 EB2–2, EB3–2 N/A FB2–2, FB3–2	TB52093 EB2–2, EB3–2 N/A FB2–2, FB3–2
Parameter	Units		
TOTAL PETROLEUM HYDROCARBONS (SW 8015M)			
Gasoline	mg/kg	<0.05	NA
Diesel Fuel	mg/kg	62 J(FD)	NA
Heavy Oil	mg/kg	63 J(FD)	NA
PRIORITY POLLUTANT METALS			
AA METALS			
Antimony (SW 3050/7041)	mg/kg	0.09 UJ(N,W)	NA
Arsenic (SW 3050/7060)	mg/kg	3 J(N)	NA
Lead (SW 3050/7421)	mg/kg	6.3 J(N)	NA
Selenium (SW 3050/7740)	mg/kg	0.14 U	NA
Thallium (SW 3050/7841)	mg/kg	0.27 J(W)	NA
ICP METALS (SW 3050/6010)			
Beryllium	mg/kg	0.33 U(MB)	NA
Cadmium	mg/kg	0.59 U	NA
Chromium	mg/kg	8.7	NA
Copper	mg/kg	12.6	NA
Nickel	mg/kg	15.4	NA
Silver	mg/kg	0.47 U	NA
Zinc	mg/kg	37.5 J(E)	NA
VOLATILE ORGANICS (SW 8240 [A])			
Acetone	µg/kg	95 U(EB)	120 U(EB)
Carbon Disulfide	µg/kg	11 U	2 J
2–Butanone	µg/kg	26	36
Benzene	µg/kg	11 U	11 U
4–Methyl–2–pentanone	µg/kg	17 J(IS)	26 J(IS)
Ethylbenzene	µg/kg	11 UJ(IS)	11 UJ(IS)
Xylene (total)	µg/kg	11 UJ(IS)	11 UJ(IS)
TICs	µg/kg	Unknown Ketone[d] 16 J,N (RT 13.50) 3–Methyl–2–Pentanone[b] 9 J,N (RT 18.19)	Unknown[d] 9 J,N (RT 6.79) 2–Methyl–Propanal[b] 8 J,N (RT 8.61) Unknown Ketone[d] 21 J,N (RT 13.44) Unknown Ketone[d] 10 J,N (RT 18.09)
TIC Total	µg/kg	25 (2)	48 (4)

Table 3–16. Data Summary Table: Soil – Site 2 – Fire Training Area 2
178th Tactical Fighter Group, Springfield ANGB, Springfield, Ohio (Continued)

SAIC ID Number		SB2–6–1R			SB2–6–1RRE
Laboratory ID Number		9546			9546RE
Collection Date		5–20–93			5–20–93
Collection Depth (ft)		16.5–17.5			16.5–17.5
Associated Field QC Sample		TB52093 EB2–2, EB3–2 N/A FB2–2, FB3–2			TB52093 EB2–2, EB3–2 N/A FB2–2, FB3–2
Parameter	Units				
SEMIVOLATILE ORGANICS (SW 8270 [B])					
Isophorone	μg/kg		360 UJ(EHT)		NA
Naphthalene	μg/kg		360 UJ(EHT)		NA
2–Methylnaphthalene	μg/kg		360 UJ(EHT)		NA
Pentachlorophenol	μg/kg		870 UJ(EHT)		NA
Phenanthrene	μg/kg		360 UJ(EHT)		NA
Fluoranthene	μg/kg		360 UJ(EHT)		NA
Pyrene	μg/kg		360 UJ(EHT)		NA
bis(2–Ethylhexyl)phthalate	μg/kg		360 UJ(EHT)		NA
TICs	μg/kg	Unknown ^{d}	350 J	(RT 13.69)	NA
		2,3,7–Trimethyl–Decane ^{b}	510 J,N	(RT 14.67)	
		Unknown ^{d}	1200 J	(RT 14.92)	
		2,6,11–Trimethyl–Dodecane ^{b}	1000 J,N	(RT 16.87)	
		5–Propyl–Tridecane ^{b}	430 J,N	(RT 17.55)	
		Unknown ^{d}	930 J	(RT 18.34)	
		2,6–Dimethyl–Heptadecane ^{b}	500 J,N	(RT 18.39)	
		Unknown ^{d}	610 J	(RT 19.74)	
		Unknown ^{d}	440 J	(RT 19.80)	
		Unknown ^{d}	620 J	(RT 21.05)	
		Unknown ^{d}	520 J	(RT 22.32)	
		Unknown ^{d}	770 J	(RT 23.54)	
		Unknown ^{d}	580 J	(RT 24.70)	
		Unknown ^{d}	660 J	(RT 25.82)	
		Unknown ^{d}	510 J	(RT 26.91)	
		Unknown ^{d}	490 J	(RT 27.96)	
		Octacosane ^{b}	350 J,N	(RT 28.96)	
		Unknown ^{d}	460 J	(RT 29.96)	
		Unknown ^{d}	290 J	(RT 30.92)	
		Unknown ^{d}	290 J	(RT 31.87)	
TIC Total	μg/kg		11510 (20)		NA

Table 3–16. Data Summary Table: Soil – Site 2 – Fire Training Area 2, 178th Tactical Fighter Group, Springfield ANGB, Springfield, Ohio (Continued)

Validation note: All descriptive data qualifiers applied to the reported values by the laboratory are reported in parentheses.
Each data point has been assessed to determine whether the value is considered usable (i.e., no qualifier), usable but estimated (i.e., "J"), or not usable (i.e., "R"). All usability qualifiers are followed by the applicable laboratory or field QC qualifier, presented in parentheses and defined below. Usability qualifiers were not applied to values qualified by the laboratory, but were not considered to have been adversely impacted by the applicable laboratory QC result (e.g., duplicated and matrix spike analysis).

A – samples were analyzed for VOCs using SW 8240, laboratory analyses followed methods outlined in the March 1990 CLP SOW for organic analyses
B – samples were analyzed for SVOCs using SW 3550/8270, laboratory analysis followed method details outlined in the March 1990 CLP SOW for organic analyses
NA – not analyzed
N/A – not applicable
RT – retention time in minutes
TICs–tentatively identified compounds, total concentration is listed and the total number of tentativeiy identified compounds is inside the parenthases

Data Validation Qualifiers
J – associated numerical value is the approximate concentration
R – rejected value
U – compound/element was included in analysis, but was not detected
UJ – reported quantitation limit is approximate and may or may not represent the actual quantitation necessary to accurately and precisely measure the analyte

Explanatory Data Validation Qualifiers
CCV – continuing calibration verification
D – the identified compound was analyzed at a secondary dilution factor after exceeding the calibration range of the instrument on the first analysis
EB – compound/element was also detected in the associated equipment blank
EHT – extraction holding time outside control limits
FD – field replicates relative percent differences (RPDs) outside the control limits
IS – internal standard outside control limits
MB – compound/element was also detected in the associated laboratory method blank
r – correlation coefficient for the calibration curve is less than 0.995
SR – surrogate recovery outside control limits

EPA–defined CLP SOW Laboratory Qualifiers
A(TICs) – suspects ALDOL–condensation product
B(metals) – the reported value is estimated because it is greater than the Instrument Detection Limit (IDL), but less than the Contract Required Detection Limit(CRDL)
B(organics) – compound was also detected in the associated laboratory method blank
E(metals) – the reported value is estimated due to the presence of interference
E(organics) – concentration exceeds the calibration range of the instrument; the sample must be diluted and reanalyzed
N – spiked sample recovery outside of control limits
N(TICs) – presumptive evidence of a compound
W – post–digestion spike for Graphite Furnace Atomic Absorption (GFAA) analysis is out of control limits (85–115%), while sample absorbance is less than 50% of the spike absorbance
X – compound is present, but does not meet CLP criteria
* – duplicate sample analysis outside of control limits

SAIC TIC Evaluation Categories
[a] – laboratory and extraction artifacts
[b] – petroleum or petroleum degradation products
[c] – other
[d] – unknown
[e] – polycyclic aromatic hydrocarbons
[f] – naturally occuring organic compounds

Table 3–17. Data Summary Table: Sediment – Site 2 – Fire Training Area 2, 178th Tactical Fighter Group Springfield ANGB, Springfield, Ohio

SAIC ID Number		SD2–1	SD2–1RE	SD2–1R
Laboratory ID Number		95268	95268RE	95269
Collection Date		8–26–92	8–26–92	8–26–92
Collection Depth (ft)		0.0–0.5	0.0–0.5	0.0–0.5
Associated Field QC Sample		TB–10 ERBG–1 FBBG–1 SD5–FB	TB–10 ERBG–1 FBBG–1 SD5–FB	TB–10 ERBG–1 FBBG–1 SD5–FB
Parameter	**Units**			
TOTAL PETROLEUM HYDROCARBONS (SW 8015M)				
Gasoline	mg/kg	NA	NA	NA
Diesel Fuel	mg/kg	180 J(EHT, FD)	NA	<3 UJ(EHT)
Heavy Oil	mg/kg	640 J(EHT, FD)	NA	5 J(EHT, FD)
PRIORITY POLLUTANT METALS				
AA METALS				
Antimony (SW 3050/7041)	mg/kg	0.94 J(N)	NA	R(N)
Arsenic (SW 3050/7060)	mg/kg	5.4 J(N,*)	NA	8.6 J(N,*)
Lead (SW 3050/7421)	mg/kg	154 *	NA	106 *
Mercury (SW 3050/7471)	mg/kg	0.22	NA	0.09 U
Selenium (SW 3050/7740)	mg/kg	R(N)	NA	R(N)
Thallium (SW 3050/7841)	mg/kg	0.22 J(W)	NA	0.19 B
ICP METALS (SW 3050/6010)				
Beryllium	mg/kg	0.39 B	NA	0.25 B
Cadmium	mg/kg	3.3	NA	0.2 U
Chromium	mg/kg	41.9 J(N,FD)	NA	6.7 J(N,FD)
Copper	mg/kg	27.7 J(FD)	NA	11.7 J(FD)
Nickel	mg/kg	19	NA	11.5
Zinc	mg/kg	284 J(N,E,FD)	NA	44.5 J(N,E,FD)
VOLATILE ORGANICS (SW 8240 [A])				
Acetone	µg/kg	280	200	12 U
Carbon Disulfide	µg/kg	2 J	29 U	12 U
2–Butanone	µg/kg	59	46	12 U
TICs	µg/kg	Pentane^{b} 9 J,N (RT 13.01) Hexanal^{c} 19 J,N (RT 20.22) 2,4,4–Trimethyl–1–Pentene^{b} 21 J,N (RT 22.23)	0 (0)	0 (0)
TIC Total	µg/kg	49 (3)	0 (0)	0 (0)
SEMIVOLATILE ORGANICS (SW 8270 [B])				
Phenanthrene	µg/kg	22000 J(SR)	NA	360 J
Anthracene	µg/kg	990 J(SR)	NA	370 U
Carbazole	µg/kg	5300 J(SR)	NA	70 J
Fluoranthene	µg/kg	36000 J(SR,FD)	NA	600 J(FD)
Pyrene	µg/kg	29000 J(SR,FD)	NA	540 J(FD)
Benzo(a)anthracene	µg/kg	9100 J(SR)	NA	200 J
Chrysene	µg/kg	22000 J(SR)	NA	370 J
bis(2–Ethylhexyl)phthalate	µg/kg	3600 J(SR)	NA	83 J
Benzo(b)fluoranthene	µg/kg	25000 J(SR)	NA	350 J
Benzo(k)fluoranthene	µg/kg	14000 J(SR)	NA	280 J
Benzo(a)pyrene	µg/kg	15000 J(SR)	NA	180 J
Indeno(1,2,3–c,d)pyrene	µg/kg	14000 J(SR)	NA	250 J
Benzo(g,h,i)perylene	µg/kg	10000 J(SR)	NA	220 J
TICs	µg/kg	Phenol, 4–(1,1,3,3–Tetrameth^{b} 23000 J,N (RT 18.12) Unknown^{d} 8500 J (RT 21.57) 9,10–Anthracenedione^{c} 11000 J,N (RT 22.95) Unknown^{d} 15000 J (RT 24.70) Unknown^{d} 9400 J (RT 27.69) Unknown^{d} 3700 J (RT 27.82) 7–Hexyl–Eicosane^{b} 9600 J,N (RT 28.82) Benz(A)Anthracene–7,12–Dione^{c} 8100 J,N (RT 29.82) Unknown^{d} 9300 J (RT 30.79) Unknown^{d} 6800 J (RT 31.39) Unknown^{d} 5700 J (RT 31.74) Unknown^{d} 4200 J (RT 32.01) Benzo[J]Fluoranthene^{c} 16000 J,N (RT 32.21) Nonacosane^{b} 8400 J,N (RT 32.67) Unknown^{d} 9600 J (RT 32.74) Unknown^{d} 6300 J (RT 33.57) Unknown^{d} 12000 J (RT 34.51) Unknown^{d} 10000 J (RT 34.72) Unknown^{d} 5400 J (RT 36.36) (3B,24S)–Stigmast–5–En–3–Ol^{c} 6600 J,N (RT 36.52)	NA	Unknown^{d} 520 J (RT 14.85) Phenol, 4–(1,1,3,3–Tetrameth^{b} 1700 J,N (RT 18.25) Unknown^{d} 860 J (RT 21.70) Hexadecanoic Acid^{b} 750 J,N (RT 23.12) Unknown^{d} 200 J (RT 25.19) Octadecanoic Acid^{b} 470 J,N (RT 25.44) Unknown^{d} 120 J (RT 26.84) Unknown^{d} 290 J (RT 27.79) Pentacosane^{b} 270 J,N (RT 28.92) Unknown^{d} 220 J (RT 29.91) Unknown^{d} 300 J (RT 30.89) Unknown^{d} 350 J (RT 31.47) Octacosane^{b} 190 J,N (RT 31.82) Unknown^{d} 180 J (RT 32.11) Benzo[J]Fluoranthene^{c} 190 J,N (RT 32.27) Nonacosane^{b} 390 J,N (RT 32.74) Unknown^{d} 240 J (RT 33.66) Unknown^{d} 880 J (RT 34.57) Unknown^{d} 330 J (RT 34.82) Unknown^{d} 440 J (RT 36.46)
TIC Total	µg/kg	188600 (20)	NA	8890 (20)

Table 3−17. Data Summary Table: Sediment − Site 2 − Fire Training Area 2, 178th Tactical Fighter Group, Springfield ANGB, Springfield, Ohio (Continued)

SAIC ID Number			SD2−2			SD2−3			SD2−4	
Laboratory ID Number			95270			9551			9552	
Collection Date			8−26−92			5−21−93			5−21−93	
Collection Depth (ft)			0.0−0.5			0.0−0.5			0.0−0.5	
Associated Field QC Sample			TB−10 ERBO−1 FBBO−1 SD5−FB			TB52093 EB2−2, EB3−2 N/A FB2−2, FB3−2			TB52093 EB2−2, EB3−2 N/A FB2−2, FB3−2	
Parameter	**Units**									
TOTAL PETROLEUM HYDROCARBONS (SW 8015M)										
Gasoline	mg/kg		NA			<0.05			<0.06	
Diesel Fuel	mg/kg		<3 UJ(EHT)			<19			3	
Heavy Oil	mg/kg		43 J(EHT)			63			10	
PRIORITY POLLUTANT METALS										
AA METALS										
Antimony (SW 3050/7041)	mg/kg		0.43 J(N)			0.64 J(N,W)			0.1 UJ(MB,N,W)	
Arsenic (SW 3050/7060)	mg/kg		10.6 J(N,*)			21.5 J(N)			9.7 J(N)	
Lead (SW 3050/7421)	mg/kg		13.6 *			19.3 J(N)			12.4 J(N)	
Mercury (SW 3050/7471)	mg/kg		0.12 U			0.05 U			0.05 U	
Selenium (SW 3050/7740)	mg/kg		R(N)			0.15 UJ(W)			0.16 UJ(W)	
Thallium (SW 3050/7841)	mg/kg		0.22 B			0.29 J(W)			0.24 J(W)	
ICP METALS (SW 3050/6010)										
Beryllium	mg/kg		0.3 B			0.27 U(MB)			0.52 B	
Cadmium	mg/kg		0.38 B			0.59 B			0.62 U	
Chromium	mg/kg		6.8 J(N)			8.1			13.4	
Copper	mg/kg		13.4			9.9			21	
Nickel	mg/kg		10.7			10.2			24.5	
Zinc	mg/kg		56.2 J(N,E)			34.2 J(E)			53 J(E)	
VOLATILE ORGANICS (SW 8240 [A])										
Acetone	µg/kg		26			11 U			11 U	
Carbon Disulfide	µg/kg		18 U			11 U			11 U	
2−Butanone	µg/kg		9 J			11 U			11 U	
TICs	µg/kg		0 (0)			0 (0)			0 (0)	
TIC Total	µg/kg		0 (0)			0 (0)			0 (0)	
SEMIVOLATILE ORGANICS (SW 8270 [B])										
Phenanthrene	µg/kg		360 J			370 J			370 U	
Anthracene	µg/kg		530 U			370 U			370 U	
Carbazole	µg/kg		530 U			170 J(CCV)			370 UJ(CCV)	
Fluoranthene	µg/kg		850			920			53 J	
Pyrene	µg/kg		850			820			49 J	
Benzo(a)anthracene	µg/kg		330 J			330 J			370 U	
Chrysene	µg/kg		640			580			370 U	
bis(2−Ethylhexyl)phthalate	µg/kg		140 J			370 U(MB)			370 U(MB)	
Benzo(b)fluoranthene	µg/kg		620			1000			65 J	
Benzo(k)fluoranthene	µg/kg		290 J			380			370 U	
Benzo(a)pyrene	µg/kg		310 J			410			370 U	
Indeno(1,2,3−c,d)pyrene	µg/kg		330 J			480			370 U	
Benzo(g,h,i)perylene	µg/kg		300 J			350 J			370 U	
TICs	µg/kg	7−Hexadecenoic Acid, Methyl [b]	1300 J,N	(RT 22.25)	4−Hydroxy−4−Methyl−2−Pentanone [a]	18000 B,J,N,A	(RT 3.80)	4−Hydroxy−4−Methyl−2−Pentanone [a]	11000 B,J,N,A	(RT 3.77)
		9−Hexadecenoic Acid, Methyl [b]	640 J,N	(RT 22.37)	Unknown [d]	480 J	(RT 18.65)	Unknown [d]	180 J	(RT 10.45)
		9−Octadecenoic Acid, 12−(Ace [b]	680 J,N	(RT 22.52)	5−Propyl−Tridecane [b]	330 J,N	(RT 19.25)	Unknown [d]	61 J	(RT 12.25)
		Unknown [d]	1500 J	(RT 23.00)	Unknown [d]	75 J	(RT 20.04)	Unknown [d]	130 J	(RT 13.54)
		Unknown [d]	1200 J	(RT 23.09)	Unknown [d]	170 J	(RT 21.37)	Unknown [d]	300 J	(RT 18.65)
		Hexadecanoic Acid [b]	1700 J,N	(RT 23.27)	Hexadecanoic Acid [f]	140 J,N	(RT 22.24)	Unknown [d]	78 J	(RT 21.37)
		Octadecanoic Acid [b]	600 J,N	(RT 25.49)	9,10−Phenanthrenedione [a]	160 J,N	(RT 22.37)	Unknown [d]	77 J	(RT 22.65)
		Unknown [d]	3800 J	(RT 28.96)	Unknown [d]	120 J	(RT 22.65)	Unknown [d]	150 J	(RT 23.54)
		Unknown [d]	1800 J	(RT 30.09)	Unknown [d]	130 J	(RT 23.87)	Unknown [d]	150 J	(RT 23.87)
		Octacosane [b]	550 J,N	(RT 30.91)	Unknown [d]	90 J	(RT 25.06)	Unknown [d]	130 J	(RT 25.06)
		Unknown [d]	2300 J	(RT 30.99)	Unknown [d]	130 J	(RT 26.17)	Unknown [d]	180 J	(RT 26.17)
		Unknown [d]	900 J	(RT 32.01)	Unknown [d]	170 J	(RT 27.27)	Unknown [d]	190 J	(RT 27.27)
		Unknown [d]	560 J	(RT 32.14)	Unknown [d]	88 J	(RT 28.31)	Unknown [d]	230 J	(RT 28.31)
		Nonacosane [b]	920 J,N	(RT 32.79)	Unknown [d]	120 J	(RT 29.34)	Unknown [d]	230 J	(RT 29.32)
		Unknown [d]	3000 J	(RT 32.91)	Unknown [d]	540 J	(RT 30.32)	Unknown [d]	370 J	(RT 30.32)
		Unknown [d]	2100 J	(RT 34.64)	Unknown [d]	380 J	(RT 30.89)	Octacosane [b]	250 J,N	(RT 31.29)
		Unknown [d]	1400 J	(RT 34.89)	Octacosane [b]	220 J,N	(RT 31.31)	Unknown [d]	100 J	(RT 31.39)
		Unknown [d]	2800 J	(RT 35.89)	Unknown [d]	230 J	(RT 31.39)	Unknown [d]	300 J	(RT 32.26)
		(3ß,22E)−Stigmasta−5,22−Dien−3−Ol [a]	1300 J,N	(RT 36.22)	Benzo[E]Pyrene [a]	440 J,N	(RT 31.81)	Unknown [d]	160 J	(RT 33.21)
		(3ß,24S)−Stigmast−5−En−3−Ol [a]	3300 J,N	(RT 36.79)	Unknown [d]	370 J	(RT 32.26)	Unknown [d]	200 J	(RT 34.17)
					Unknown [d]	490 J	(RT 34.19)	Unknown [d]	84 J	(RT 34.42)
TIC Total	µg/kg		32350 (20)			22873 (21)			14550 (21)	

Table 3-17. Data Summary Table: Sediment – Site 2 – Fire Training Area 2, 178th Tactical Fighter Group Springfield ANGB, Springfield, Ohio (Continued)

SAIC ID Number			SD2-5			SD2-6	
Laboratory ID Number			9553			9554	
Collection Date			5-21-93			5-21-93	
Collection Depth (ft)			0.0-0.5			0.0-0.5	
Associated Field QC Sample			TB52093 EB2-2, EB3-2 N/A FB2-2, FB3-2			TB52093 EB2-2, EB3-2 N/A FB2-2, FB3-2	
Parameter	Units						
TOTAL PETROLEUM HYDROCARBONS (SW 8015M)							
Gasoline	mg/kg		<0.06			<0.05	
Diesel Fuel	mg/kg		<21			<18	
Heavy Oil	mg/kg		85			70	
PRIORITY POLLUTANT METALS							
AA METALS							
Antimony (SW 3050/7041)	mg/kg		0.11 UJ(N,W)			0.10 UJ(N,W)	
Arsenic (SW 3050/7060)	mg/kg		6.3 J(N)			3.6 J(N)	
Lead (SW 3050/7421)	mg/kg		14.6 J(N)			12.5 J(N)	
Mercury (SW 3050/7471)	mg/kg		0.06 U			0.05 U	
Selenium (SW 3050/7740)	mg/kg		0.16 UJ(W)			0.15 U	
Thallium (SW 3050/7841)	mg/kg		0.25 U			0.23 UJ(W)	
ICP METALS (SW 3050/6010)							
Beryllium	mg/kg		0.72 B			0.23 U(MB)	
Cadmium	mg/kg		1.2			0.59 U	
Chromium	mg/kg		19.1			6.8	
Copper	mg/kg		19.9			7.3	
Nickel	mg/kg		18.2			6.3	
Zinc	mg/kg		59 J(E)			22.6 J(E)	
VOLATILE ORGANICS (SW 8240 [A])							
Acetone	µg/kg		13 U			11 U	
Carbon Disulfide	µg/kg		13 U			11 U	
2-Butanone	µg/kg		13 U			11 U	
TICs	µg/kg		0 (0)			0 (0)	
TIC Total	µg/kg		0 (0)			0 (0)	
SEMIVOLATILE ORGANICS (SW 8270 [B])							
Phenanthrene	µg/kg		420 U			54 J	
Anthracene	µg/kg		420 U			370 U	
Carbazole	µg/kg		420 UJ(CCV)			370 UJ(CCV)	
Fluoranthene	µg/kg		68 J			120 J	
Pyrene	µg/kg		59 J			120 J	
Benzo(a)anthracene	µg/kg		420 U			370 U	
Chrysene	µg/kg		420 U			83 J	
bis(2-Ethylhexyl)phthalate	µg/kg		420 U			370 U(MB)	
Benzo(b)fluoranthene	µg/kg		58 J			150 J	
Benzo(k)fluoranthene	µg/kg		420 U			370 U	
Benzo(a)pyrene	µg/kg		420 U			45 J	
Indeno(1,2,3-c,d)pyrene	µg/kg		420 U			370 U	
Benzo(g,h,i)perylene	µg/kg		420 U			370 U	
TICs	µg/kg	4-Hydroxy-4-Methyl-2-Pentanone[a]	17000 B,J,N,A	(RT 3.77)	Unknown[d]	170 J	(RT 12.25)
		4-Penten-2-Ol[e]	84 J,N	(RT 4.13)	2,4,6-Trimethyl-Decane[b]	170 J,N	(RT 15.64)
		Unknown[d]	310 J	(RT 12.25)	Unknown[d]	210 J	(RT 17.19)
		Unknown[d]	160 J	(RT 14.00)	Unknown[d]	610 J	(RT 18.67)
		4,6-Dimethyl-Undecane[b]	170 J,N	(RT 15.62)	Unknown[d]	200 J	(RT 20.05)
		Unknown[d]	220 J	(RT 18.65)	Unknown[d]	250 J	(RT 21.39)
		Unknown[d]	420 J	(RT 22.14)	Hexadecanoic Acid[b]	390 J,N	(RT 22.30)
		Hexadecanoic Acid[b]	610 J,N	(RT 22.30)	Unknown[d]	150 J	(RT 22.67)
		Unknown[d]	210 J	(RT 28.32)	Unknown[d]	220 J	(RT 23.89)
		Unknown[d]	450 J	(RT 30.34)	Unknown[d]	270 J	(RT 28.32)
		Unknown[d]	380 J	(RT 31.41)	Octacosane[b]	490 J,N	(RT 30.32)
		Unknown[d]	1100 J	(RT 32.27)	Unknown[d]	790 J	(RT 32.27)
		Unknown[d]	730 J	(RT 32.34)	Unknown[d]	1400 J	(RT 34.22)
		Unknown[d]	2700 J	(RT 34.24)	Unknown[d]	960 J	(RT 35.34)
		Unknown[d]	1200 J	(RT 35.32)	Unknown[d]	1100 J	(RT 35.59)
		Unknown[d]	810 J	(RT 35.57)	D-Friedoolean-14-En-3-One[e]	1100 J,N	(RT 35.99)
		(3B,24S)-Stigmast-5-En-3-Ol[e]	2300 J,N	(RT 36.19)	Unknown[d]	1500 J	(RT 36.21)
		Unknown[d]	510 J	(RT 36.54)	Unknown[d]	810 J	(RT 36.56)
		Unknown[d]	680 J	(RT 36.62)	Unknown[d]	720 J	(RT 36.66)
		Unknown[d]	970 J	(RT 36.89)	Unknown[d]	780 J	(RT 37.01)
		Unknown[d]	700 J	(RT 37.39)			
TIC Total	µg/kg		31714 (21)			12290 (20)	

Table 3-17. Data Summary Table: Sediment – Site 2 – Fire Training Area 2, 178th Tactical Fighter Group, Springfield ANGB, Springfield, Ohio (Continued)

Validation note: All descriptive data qualifiers applied to the reported values by the laboratory are reported in parentheses. Each data point has been assessed to determine whether the value is considered usable (i.e., no qualifier), usable but estimated (i.e., "J"), or not usable (i.e., "R"). All usability qualifiers are followed by the applicable laboratory or field QC qualifier, presented in parentheses and defined below. Usability qualifiers were not applied to values qualified by the laboratory, but were not considered to have been adversely impacted by the applicable laboratory QC result (e.g., duplicated and matrix spike analysis).

A – samples were analyzed for VOCs using SW 8240, laboratory analyses followed methods outlined in the March 1990 CLP SOW for organic analyses
B – samples were analyzed for SVOCs using SW 3550/8270, laboratory analysis followed method details outlined in the March 1990 CLP SOW for organic analyses
NA – not analyzed
N/A – not applicable
RT – retention time in minutes
TICs–tentatively identified compounds, total concentration is listed and the total number of tentatively identified compounds is inside the parenthases

Data Validation Qualifiers

J – associated numerical value is the approximate concentration
R – rejected value
U – compound/element was included in analysis, but was not detected
UJ – reported quantitation limit is approximate and may or may not represent the actual quantitation necessary to accurately and precisely measure the analyte

Explanatory Data Validation Qualifiers

CCV – continuing calibration verification
FD – field duplicate relative percent differences (RPDs) outside control limits
MB – compound/element was also detected in the associated laboratory method blank
SR – surrogate recovery outside control limits

EPA–defined CLP SOW Laboratory Qualifiers

A(TICs) – suspects ALDOL–condensation product
B(metals) – the reported value is estimated because it is greater than the Instrument Detection Limit (IDL), but less than the Contract Required Detection Limit(CRDL)
B(organics) – compound was also detected in the associated laboratory method blank
E(metals) – the reported value is estimated due to the presence of interference
N – spiked sample recovery outside of control limits
N(TICs) – presumptive evidence of a compound
W – post–digestion spike for Graphite Furnace Atomic Absorption (GFAA) analysis is out of control limits (85–115%), while sample absorbance is less than 50% of the spike absorbance
* – duplicate sample analysis outside of control limits

SAIC TIC Evaluation Categories

[a] – laboratory and extraction artifacts
[b] – petroleum or petroleum degradation products
[c] – other
[d] – unknown
[e] – polycyclic aromatic hydrocarbons
[f] – naturally occuring organic compounds

Table 3–18. Data Summary Table: Groundwater – Site 2 – Fire Training Area 2, 178th Tactical Fighter Group, Springfield ANGB, Springfield, Ohio

Parameter	Units			
SAIC ID Number		MW2–1–1	MW2–1–2	MW2–2–1
Laboratory ID Number		97396	9569, 9585	9570, 9586
Collection Date		10–1–92	5–21–93	5–21–93
Associated Field QC Sample		TB–15 ERBG–2 FBBA–1 FBCE–1	TB52193 EB2–2, EB3–2 N/A FB2–2, FB3–2	TB52193 EB2–2, EB3–2 N/A FB2–2, FB3–2
TOTAL PETROLEUM HYDROCARBONS (SW 8015M)				
Gasoline	mg/L	NA	<0.25	<0.25
Diesel Fuel	mg/L	0.3	0.42	0.50
Heavy Oil	mg/L	<0.2	<0.25	<0.25
TOTAL PRIORITY POLLUTANT METALS				
AA METALS				
Antimony (SW 3020/7041)	µg/L	1.9 J(N)	3 J(N,W)	0.6 UJ(N)
Arsenic (SW 3020/7060)	µg/L	78	11.6 J(N)	3.4 J(N)
Lead (SW 3020/7421)	µg/L	197 J(*)	54.1 S	121
Mercury (SW 7470)	µg/L	0.1 U	0.1 U	0.36
Selenium (SW 7740)	µg/L	R(N)	R(N)	R(N)
ICP METALS (SW 3005/6010)				
Beryllium	µg/L	4.2 B	1.6 B	10.3
Chromium	µg/L	251	99.9	348
Copper	µg/L	259	90.3	584
Nickel	µg/L	238	82.4	562
Silver	µg/L	19.5	2.9 UJ(N)	4 J(N)
Zinc	µg/L	1130 U(FB)	536 J(E)	1460 J(E)
DISSOLVED PRIORITY POLLUTANT METALS				
AA METALS				
Antimony (SW 3020/7041)	µg/L	NA	0.9 U	1.5 B
Arsenic (SW 3020/7060)	µg/L	NA	1.5 B	2.1 J(W)
ICP METALS (SW 3005/6010)				
Zinc	µg/L	NA	54.1	18.5 U(MB)
VOLATILE ORGANICS (A)				
Tetrachloroethene	µg/L	0.4 U	0.2 J	0.4 U
TICs	µg/L	0 (0)	0 (0)	0 (0)
TIC Total	µg/L	0 (0)	0 (0)	0 (0)
SEMIVOLATILE ORGANIC (SW 8270 [B])				
TICs	µg/L	Unknown[d] 3 J (RT 10.7)	4–Hydroxy–4–Methyl–2–Pentanone[a] 64 J,N,A (RT 3.90)	2–(2–Butoxyethoxy)–Ethanol[c] 38 J,N (RT 10.57)
		Unknown[d] 8 J (RT 11.34)	Unknown[d] 13 J (RT 5.00)	6–Amino–Hexanoic Acid[c] 140 J,N (RT 12.25)
		Unknown[d] 3 J (RT 11.82)	2–(2–Butoxyethoxy)–Ethanol[c] 4600 J,N (RT 11.29)	Unknown[d] 8 J (RT 14.00)
		Benzothiazole[c] 11 J,N (RT 12.92)	Unknown[d] 3500 J (RT 15.45)	Unknown[d] 3 J (RT 26.01)
		Unknown[d] 6 J (RT 16.15)	Unknown[d] 2 J (RT 23.85)	
		Unknown[d] 4 J (RT 17.27)	Butane, 1,1'–[Oxybis(2,1–Eth[c] 12 J,N (RT 24.05)	
		Unknown[d] 2 J (RT 25.82)	Unknown[d] 10 J (RT 25.96)	
		Unknown[d] 2 J (RT 32.82)	Unknown[d] 13 J (RT 26.06)	
		Unknown[d] 2 J (RT 33.87)	Unknown[d] 15 J (RT 26.14)	
		Unknown[d] 2 J (RT 33.99)	Unknown[d] 14 J (RT 26.21)	
TIC Total	µg/L	43 (10)	8243 (10)	189 (4)

Table 3-18. Data Summary Table: Groundwater – Site 2 – Fire Training Area 2 178th Tactical Fighter Group, Springfield ANGB, Springfield, Ohio (Continued)

SAIC ID Number			P-5-1		
Laboratory ID Number			9569, 9585		
Collection Date			5-21-93		
Associated Field QC Sample			TB52193 EB2-2, EB3-2 N/A FB2-2, FB3-2		
Parameter	Units				
TOTAL PETROLEUM HYDROCARBONS (SW 8015M)					
Gasoline	mg/L		<0.25		
Diesel Fuel	mg/L		<0.13		
Heavy Oil	mg/L		<0.25		
TOTAL PRIORITY POLLUTANT METALS					
AA METALS					
Antimony (SW 3020/7041)	μg/L		1.2 J(N,W)		
Arsenic (SW 3020/7060)	μg/L		R(N)		
Lead (SW 3020/7421)	μg/L		104		
Mercury (SW 7470)	μg/L		0.16 B		
Selenium (SW 7740)	μg/L		R(N)		
ICP METALS (SW 3005/6010)					
Beryllium	μg/L		4.2 B		
Chromium	μg/L		150		
Copper	μg/L		210		
Nickel	μg/L		247		
Silver	μg/L		3.1 J(N)		
Zinc	μg/L		763 J(E)		
DISSOLVED PRIORITY POLLUTANT METALS					
AA METALS					
Antimony (SW 3020/7041)	μg/L		1.4 B		
Arsenic (SW 3020/7060)	μg/L		0.6 UJ(W)		
ICP METALS (SW 3005/6010)					
Zinc	μg/L		17.6 U(MB)		
VOLATILE ORGANICS (A)					
Tetrachloroethene	μg/L		0.4 U		
TICs	μg/L		0 (0)		
TIC Total	μg/L		0 (0)		
SEMIVOLATILE ORGANIC (SW 8270 [B])					
TICs	μg/L	Cyclohexane, 1-Ethyl-1,3-Dim [b]		2 J,N	(RT 5.25)
		Unknown [d]		5 J	(RT 5.37)
		6-Amino-Hexanoic Acid [c]		36 J,N	(RT 11.84)
TIC Total	μg/L			43 (3)	

Table 3–18. Data Summary Table: Groundwater – Site 2 – Fire Training Area 2, 178th Tactical Fighter Group, Springfield ANGB, Springfield, Ohio (Continued)

Validation note: All descriptive data qualifiers applied to the reported values by the laboratory are reported in parentheses. Each data point has been assessed to determine whether the value is considered usable (i.e., no qualifier), usable but estimated (i.e., "J"), or not usable (i.e., "R"). All usability qualifiers are followed by the applicable laboratory or field QC qualifier, presented in parentheses and defined below. Usability qualifiers were not applied to values qualified by the laboratory, but were not considered to have been adversely impacted by the applicable laboratory QC result (e.g., duplicated and matrix spike analysis).

A – groundwater samples were analyzed for volatile halogenated compounds and volatile aromatic compounds by E 524.2 for samples collected in 1992 or SW 8240 (25 ml purge for low level volatiles) for samples collected in 1993; these methods have been modified to incorporate CLP–type QC requirements
B – SVOCs in groundwater and field QC blanks were analyzed using EPA method 3510/8270
NA – not analyzed
N/A – not applicable
RT – retention time in minutes
TICs–tentatively identified compounds, total concentration is listed and the total number of tentatively identified compounds is inside the parenthases

Data Validation Qualifiers

J – associated numerical value is the approximate concentration
R – rejected value
U – compound/element was included in analysis, but was not detected
UJ – reported quantitation limit is approximate and may or may not represent the actual quantitation necessary to accurately and precisely measure the analyte

Explanatory Data Validation Qualifiers

FB – compound/element was also detected in the associated field blank
MB – compound/element was also detected in the associated laboratory method blank

EPA–defined CLP SOW Laboratory Qualifiers

A(TICs) – suspects ALDOL–condensation product
B(metals) – the reported value is estimated because it is greater than the Instrument Detection Limit (IDL), but less than the Contract Required Detection Limit (CRDL)
E(metals) – the reported value is estimated due to the presence of interference
N – spiked sample recovery outside of control limits
N(TICs) – presumptive evidence of a compound
S – the reported value was determined by the Method of Standard Additions (MSA)
W – post–digestion spike for Graphite Furnace Atomic Absorption (GFAA) analysis is out of control limits (85–115%), while sample absorbance is less than 50% of the spike absorbance
* – duplicate sample analysis outside of control limits

SAIC TIC Evaluation Categories

[a] – laboratory and extraction artifacts
[b] – petroleum or petroleum degradation products
[c] – other
[d] – unknown

Table 3-19. ARAR Comparison Table: Groundwater - Site 2 - Fire Training Area 2, 178th Tactical Fighter Group, Springfield ANGB, Springfield, Ohio

	CONCENTRATION IN GROUNDWATER (µg/L)		COMPARISON vs ARARS	
Parameter	Mean Detected Result	Maximum Detected Result	Mean Detected Result	Maximum Detected Result
METALS				
Antimony	1.7	3.0	- -	- -
Antimony (dissolved	1.0	1.5	- -	- -
Arsenic	31.0	78.0	- -	>MCL; >OMCL
Arsenic (dissolved)	1.8	2.1	- -	- -
Beryllium	5.4	10.3	>MCL	>MCL
Chromium	233	348	>MCL; >OMCL	>MCL; >OMCL
Copper	311.1	584	- -	- -
Lead	124	197	>MCL; >OMCL	>MCL; >OMCL
Nickel	294.1	562	>MCL; >OMCL	>MCL; >OMCL
Silver	8.3	19.5	- -	- -
Zinc	853.7	1460	- -	- -
Zinc (dissolved)	31.7	54.1	- -	- -
ORGANICS				
Tetrachloroethylene	0.2	0.2	- -	- -

- - ARAR not exceeded or ARAR not available (see Table 3-9)
MCL - Safe Drinking Water Act (SDWA) maximum contaminant level
OMCL - Ohio maximum contaminant level

NOTE: Unless otherwise indicated, metals results are for total metals detected in unfiltered groundwater.

Table 3-20. Comparison of Site 2, Fire Training Area 2, Results with Background Upper Tolerance Limits: Soil 178th Tactical Fighter Group, Springfield ANGB, Springfield, Ohio

Parameter	Units	Proportion of Results Greater than Detection Limit	Minimum Detected Result	Mean Detected Result	Maximum Detected Result	Upper Tolerance Limit	Proportion of Results Greater than Upper Tolerance Limit
Diesel Fuel	mg/kg	7 / 8	4	241.8	750	37.00	3 / 8
Heavy Oil	mg/kg	4 / 8	7	7.25	25	160.00	0 / 8
INORGANICS							
Antimony	mg/kg	1 / 5	0.24	0.11	0.24	0.21	1 / 5
Arsenic	mg/kg	8 / 8	5.9	7.95	10.6	11.30	0 / 8
Beryllium	mg/kg	6 / 8	0.17	0.2369	0.32	0.55	0 / 8
Cadmium	mg/kg	1 / 8	1.2	0.2894	1.2	1.50	0 / 8
Chromium (III)	mg/kg	8 / 8	5.2	8.306	13.2	121.00	0 / 8
Copper	mg/kg	8 / 8	9.7	14.01	16.7	48.70	0 / 8
Lead	mg/kg	8 / 8	7.1	11.59	31.8	126.00	0 / 8
Nickel	mg/kg	8 / 8	8.2	13.98	20.8	61.50	0 / 8
Silver	mg/kg	2 / 8	1.5	0.9619	1.5	5.30	0 / 8
Thallium	mg/kg	6 / 8	0.08	0.165	0.26	0.40	0 / 8
Zinc	mg/kg	8 / 8	36.9	45.33	61.5	343.00	0 / 8
ORGANICS							
Ethylbenzene	mg/kg	3 / 8	0.14	0.1771	0.385	0.01	4 / 8
Fluoranthene	mg/kg	2 / 8	0.047	0.4149	0.2125	0.44	2 / 8
Phenanthrene	mg/kg	1 / 8	0.2275	0.4322	0.2275	0.27	2 / 8
Pyrene	mg/kg	3 / 8	0.034	0.3997	0.2175	0.44	2 / 8
Xylenes	mg/kg	4 / 8	0.16	0.3159	1.4	0.01	4 / 8

Samples SB2-1-1, SB2-1-4, SB2-2-1, SB2-2-2, SB2-3-1, SB2-3-4, SB2-4-1, and SB2-5-1 were used in the comparison to background samples.

Table 3-21. Comparison of Site 2, Fire Training Area 2, Results with Background Upper Tolerance Limits: Sediment
178th Tactical Fighter Group, Springfield ANGB, Springfield, Ohio

Parameter	Units	Proportion of Results Greater than Detection Limit	Minimum Detected Result	Mean Detected Result	Maximum Detected Result	Upper Tolerance Limit	Proportion of Results Greater than Upper Tolerance Limit
Diesel Fuel	mg/kg	2 / 6	3	20.71	90.75	37.00	1 / 6
Heavy Oil	mg/kg	6 / 6	10	98.92	322.5	160.00	1 / 6
INORGANICS							
Antimony	mg/kg	3 / 6	0.43	0.2983	0.64	0.21	3 / 6
Arsenic	mg/kg	6 / 6	3.6	9.783	21.5	11.30	1 / 6
Beryllium	mg/kg	4 / 6	0.3	0.3517	0.72	0.55	1 / 6
Cadmium	mg/kg	4 / 6	0.38	0.7458	1.7	1.50	1 / 6
Chromium (III)	mg/kg	6 / 6	6.8	13.08	24.3	121.00	0 / 6
Copper	mg/kg	6 / 6	7.3	15.2	21	48.70	0 / 6
Lead	mg/kg	6 / 6	12.4	33.73	130	126.00	1 / 6
Mercury	mg/kg	2 / 6	0.06	0.0546	0.1325	0.50	0 / 6
Nickel	mg/kg	6 / 6	6.3	14.19	24.5	61.50	0 / 6
Thallium	mg/kg	4 / 6	0.205	0.1992	0.29	0.40	0 / 6
Zinc	mg/kg	6 / 6	22.6	64.88	164.3	343.00	0 / 6
ORGANICS							
Anthracene	mg/kg	1 / 6	0.5875	0.2696	0.5875	0.12	6 / 6
Benzo(a)anthracene	mg/kg	3 / 6	0.33	0.9817	4.65	0.21	4 / 6
Benzo(a)pyrene	mg/kg	4 / 6	0.045	1.458	7.59	0.22	3 / 6
Benzo(b)fluoranthene	mg/kg	6 / 6	0.058	2.428	12.68	0.37	3 / 6
Benzo(g,h,i)perylene	mg/kg	3 / 6	0.3	1.057	5.11	0.20	3 / 6
Benzo(k)fluoranthene	mg/kg	3 / 6	0.29	1.398	7.14	0.13	6 / 6
Carbazole	mg/kg	2 / 6	0.17	0.6167	2.685	0.11	6 / 6
Chrysene	mg/kg	4 / 6	0.083	2.147	11.19	0.25	3 / 6
Fluoranthene	mg/kg	6 / 6	0.053	3.385	18.3	0.44	3 / 6
Indeno(1,2,3-cd)pyrene	mg/kg	3 / 6	0.33	1.419	7.125	0.23	3 / 6
Phenanthrene	mg/kg	4 / 6	0.054	2.06	11.18	0.27	3 / 6
Pyrene	mg/kg	6 / 6	0.049	2.778	14.77	0.44	3 / 6

Samples SD2-1, SD2-2, SD2-3, SD2-4, SD2-5, and SD2-6 were used in the comparison to background samples.

Table 3-22. Comparison of Site 2, Fire Training Area 2, Results with Background Upper Tolerance Limits: Groundwater 178th Tactical Fighter Group, Springfield ANGB, Springfield, Ohio

Parameter	Units	Proportion of Results Greater than Detection Limit	Minimum Detected Result	Mean Detected Result	Maximum Detected Result	Upper Tolerance Limit	Proportion of Results Greater than Upper Tolerance Limit
INORGANICS							
Antimony	mg/L	2 / 3	0.0019	0.0017	0.003	0.0015	2 / 3
Arsenic	mg/L	3 / 3	0.0034	0.031	0.078	0.0162	1 / 3
Beryllium	mg/L	3 / 3	0.0016	0.0054	0.0103	0.0042	1 / 3
Chromium (III)	mg/L	3 / 3	0.0999	0.233	0.348	0.1500	2 / 3
Copper	mg/L	3 / 3	0.0903	0.3111	0.584	0.2100	2 / 3
Lead	mg/L	3 / 3	0.0541	0.124	0.197	0.1040	2 / 3
Nickel	mg/L	3 / 3	0.0824	0.2941	0.562	0.2470	1 / 3
Silver	mg/L	2 / 3	0.004	0.0083	0.0195	0.0033	2 / 3
Zinc	mg/L	2 / 3	0.536	0.8537	1.46	0.7630	1 / 3
Antimony (dissolved)	mg/L	1 / 2	0.0015	0.001	0.0015	0.0020	0 / 2

* - Antimony was not detected in filtered samples

Samples MW2-1-1, MW2-1-2, and MW2-2-1 were used in the comparison to background samples.

3.7 SITE 3 - LEACH FIELD (LCH-3)

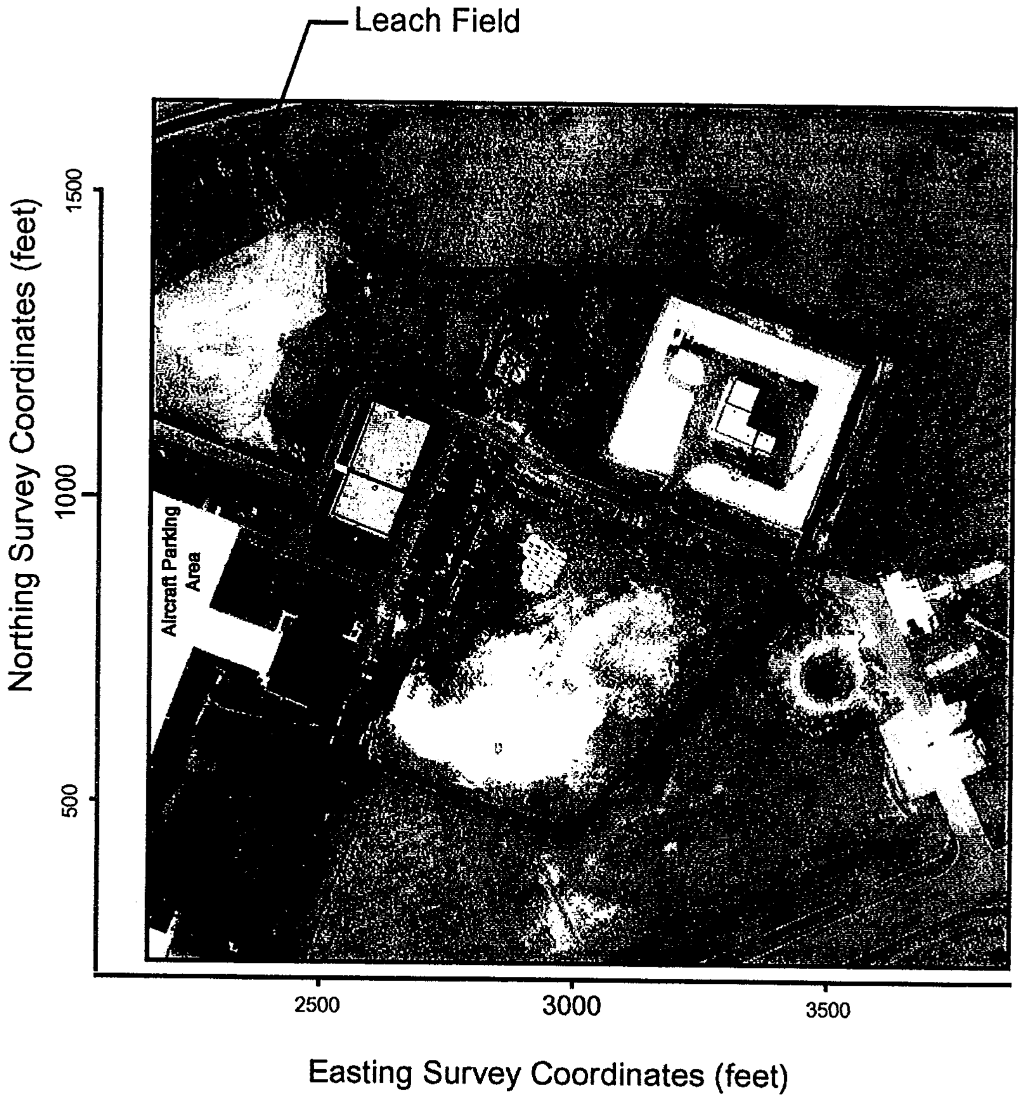
This section summarizes the field investigation and laboratory analytical results and presents the significance of findings for Site 3 - Leach Field. The Leach Field was in operation from 1950 to the 1980's when it collected effluent from oil/water separators located throughout the Base. Using surveyed landmarks present at both the site and on construction drawings, analysis of scaled aerial photographs, and information from interviews with Base personnel, the former leach field was located and an SOV survey conducted over the site.

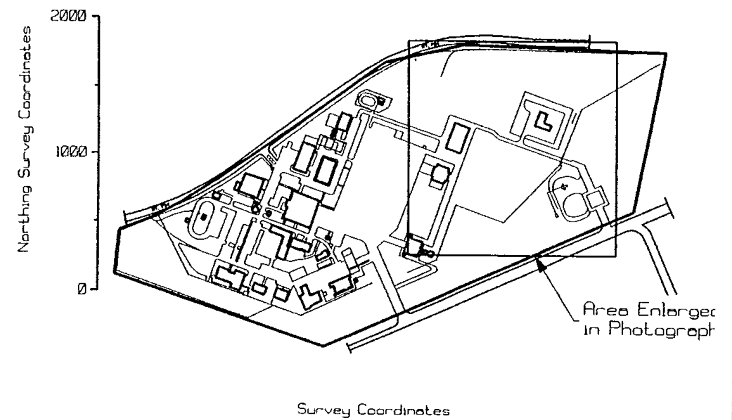
Figure 3-24 shows the location of Site 3 on a 1985 photograph. The SOV survey conducted at Site 3 - Leach Field and the surrounding area adequately characterized areas of maximum potential contamination. The greatest SOV concentrations were detected within the leach field boundaries. Two phases of soil and groundwater sampling were conducted at Site 3. Sample locations are shown in Figure 3-25. Tables containing information and analytical results for Site 3 (Tables 3-23 through 3-28) are presented at the end of Section 3.7.

Interviews with Base personnel and elevation changes at Site 3 noted on construction drawings (ODOT 1988) provide evidence that 2 to 3 feet of native soil fill was placed over the leach field area in 1988. Soil within this fill layer contained PAHs; however, the source could not conclusively be identified. The leach field filter bed was encountered during drilling of three of five soil borings. The filter bed was identified as a black, oily sand and gravel layer with pronounced hydrocarbon odor. Petroleum hydrocarbons, small quantities of VOCs, and PAHs were detected in the filter bed. PAH concentrations in the filter bed were less than surface concentrations. Site related contaminants were not confirmed in soil samples collected approximately 6 feet below the leach field filter bed at the soil-water interface. Based on filtered groundwater analyses, the leach field has not impacted downgradient groundwater.

3.7.1 Site 3 Lithology

Recording the lithologies occurring at Site 3 was complicated because much of the area was disturbed by construction and operation of the leach field, and filling and grading over the leach field. An interpretation of the lithology and location of the leach field is shown in Figure 3-26.



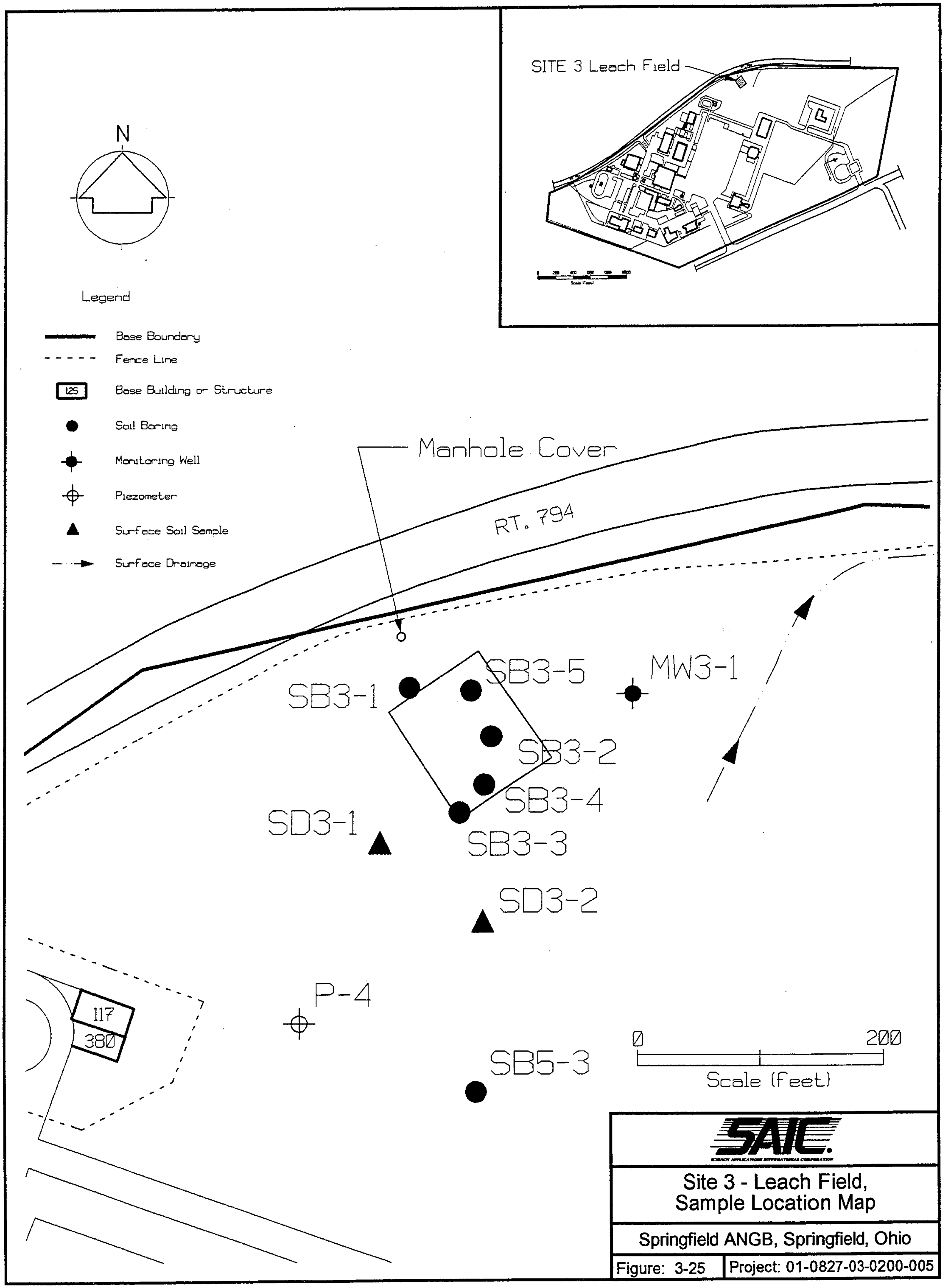


Plot Plan (1993)

SAIC

Site 3 - Leach Field Location, 1985 Aerial Photograph

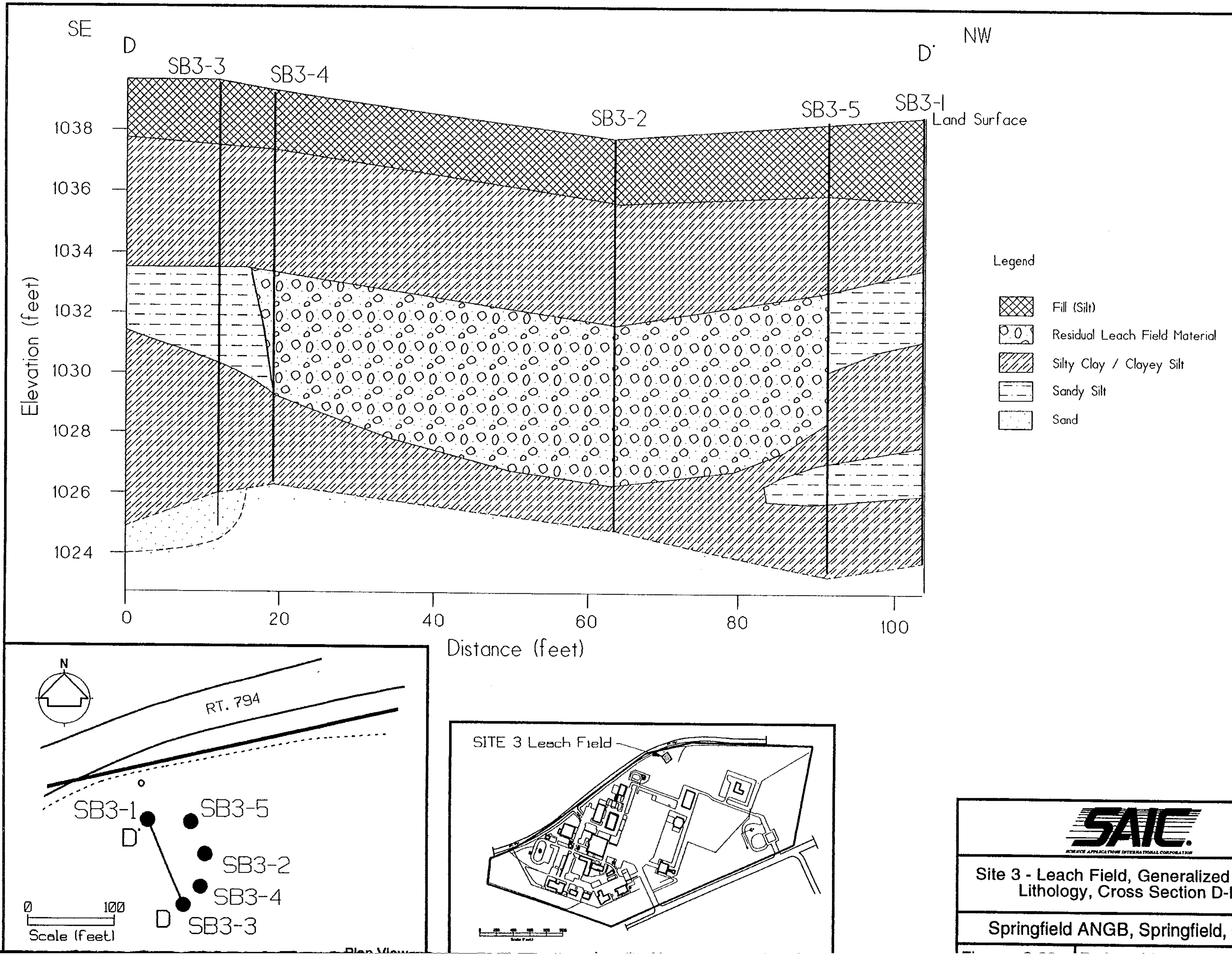
Springfield ANGB, Springfield, Ohio



Site 3 - Leach Field, Sample Location Map

Springfield ANGB, Springfield, Ohio

Figure: 3-25 Project: 01-0827-03-0200-005



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Site 3 - Leach Field, Generalized Glacial Lithology, Cross Section D-D'

Springfield ANGB, Springfield, Ohio

Soil borings logs of SB3-2, SB3-4, and SB3-5 indicate the presence of a coarse sand and gravel unit blackened by oily liquid with a hydrocarbon odor. This unit is located approximately 6 to 13 feet BLS.

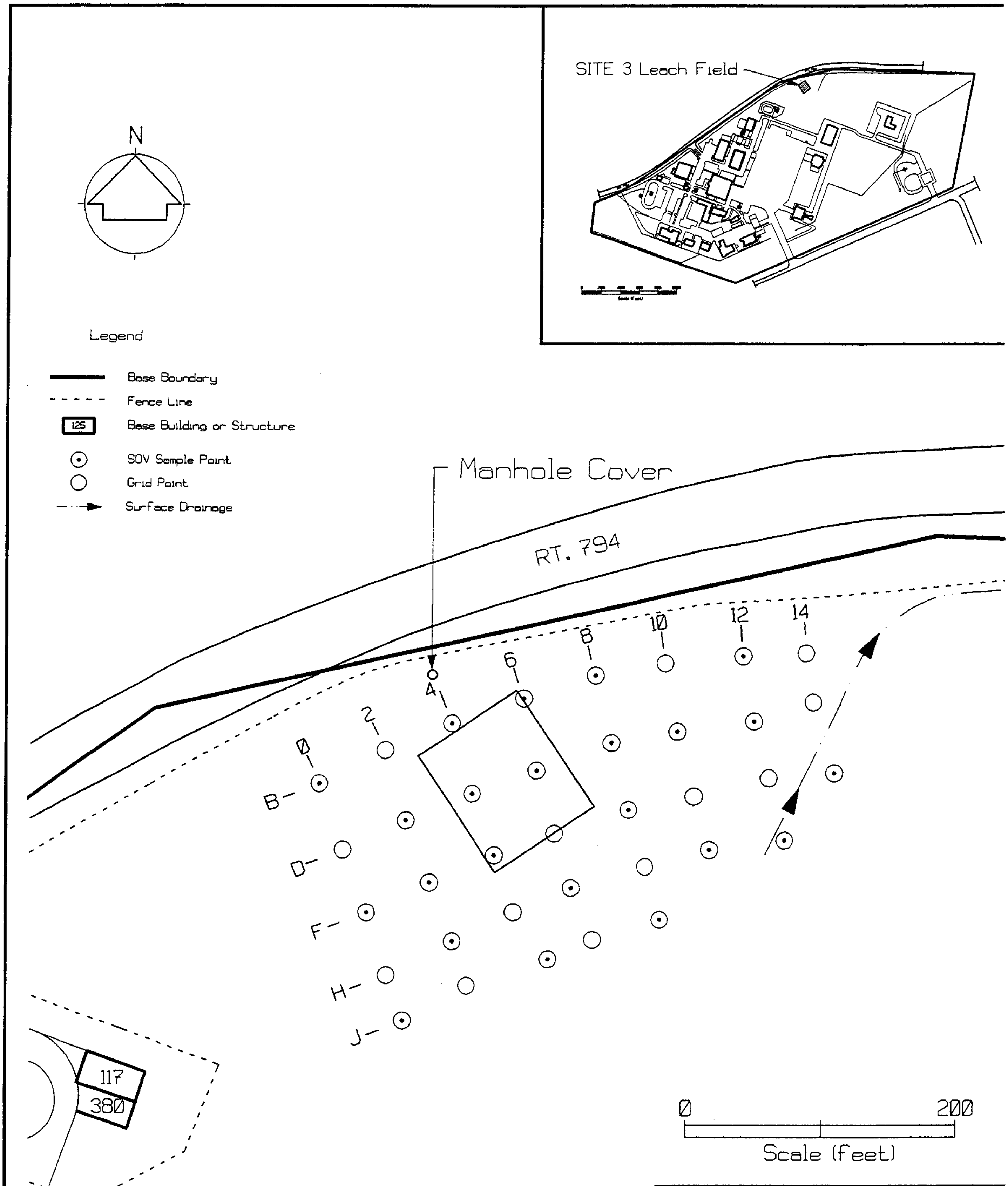
The remnants of the leach field overlie a lithology of silty clay and lacustrine deposits. This fine-grained unit is saturated at some locations (SB3-1 and SB3-2); however, this unit has limited permeability and serves as a confining layer at Sites 1 and 2. Sand and gravel lie directly below the fine grained material discussed above. Artesian conditions exist at the site.

3.7.2 Soil Organic Vapor Survey

An SOV survey conducted at Site 3 determined the areal extent of VOCs in the soil atmosphere and provided data for locating the four soil borings and one monitoring well. The survey grid, shown in Figure 3-27, was set up using 50-foot centers and covered an area 250 by 350 feet with the longest side oriented parallel to Blee Road (Route 794).

The SOV survey screened for TCA, CCl_4, TCE, PCE, BTEX, and TVHC. At Site 3, benzene was detected in the SOV throughout the site in concentrations ranging between .03 and 270 μg/L. TVHC concentrations generally were detected within the boundaries of the leach field at levels between 0.2 and 270 μg/L. Xylenes were detected at four locations in concentrations ranging from 3 to 13 μg/L. Low levels of TCA, TCE, PCE, and CCl_4 also were detected at this site in concentrations ranging from 0.0005 to 0.3 μg/L.

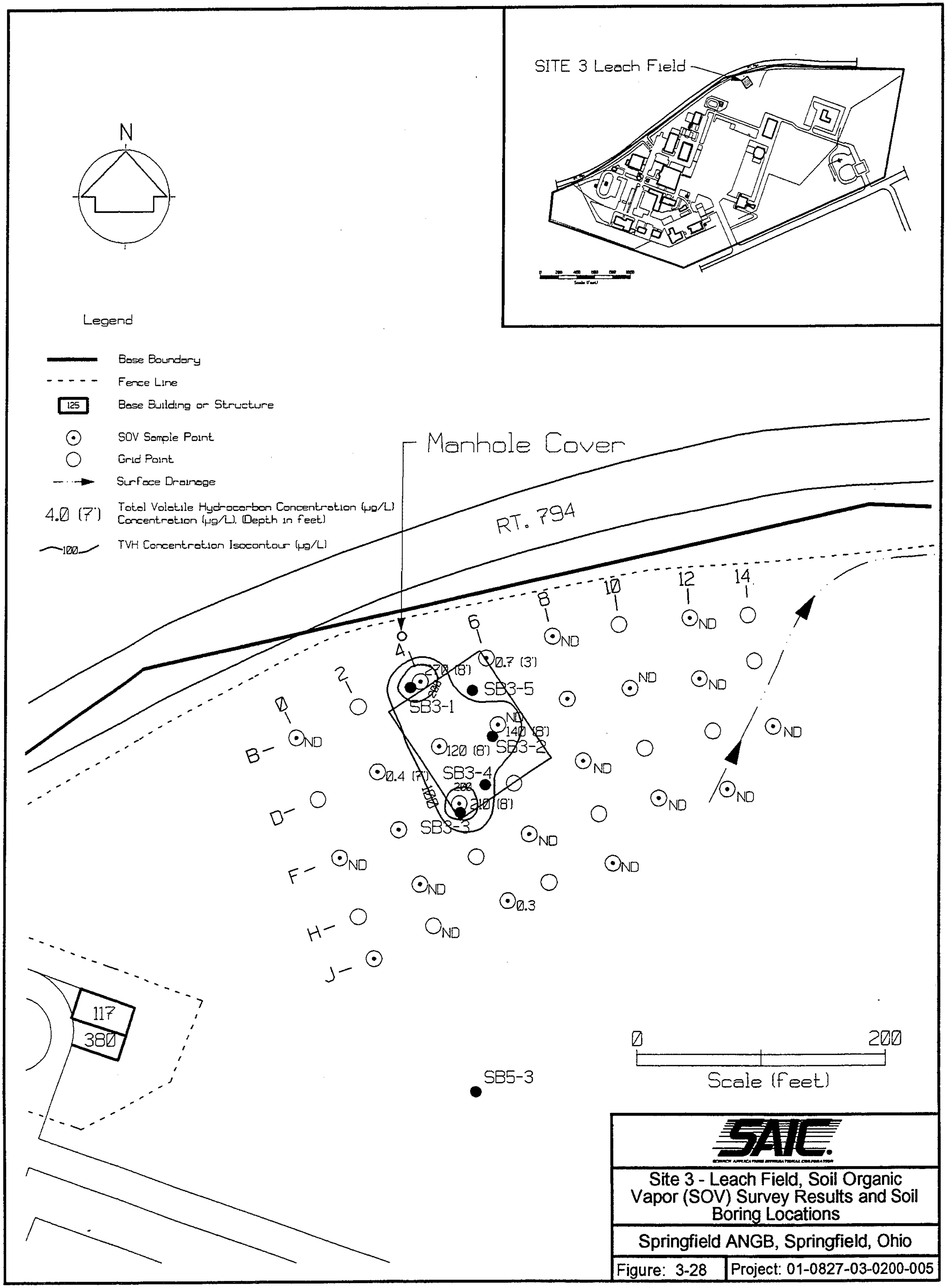
The locations for soil borings SB3-1, SB3-2, SB3-3, SB3-4, and SB3-5 were based on TVHC concentrations. The TVHC concentrations were plotted on an isoconcentration map of the site (Figure 3-28). The soil borings were located at the highest concentrations of the the TVHC,which indicated the areas with the greatest potential for contamination. These points were verified to be located within the leach field by measuring from a scaled engineering drawing (Ohio DOT 1988) and an aerial photograph (SCS 1985) that clearly show the leach field.



Site 3 - Leach Field, Soil Organic Vapor (SOV) Survey Grid

Springfield ANGB, Springfield, Ohio

Figure: 3-27 | Project: 01-0827-03-0200-005



Site 3 - Leach Field, Soil Organic Vapor (SOV) Survey Results and Soil Boring Locations

Springfield ANGB, Springfield, Ohio

Figure: 3-28 | Project: 01-0827-03-0200-005

3.7.3 Chemicals Detected in Soil

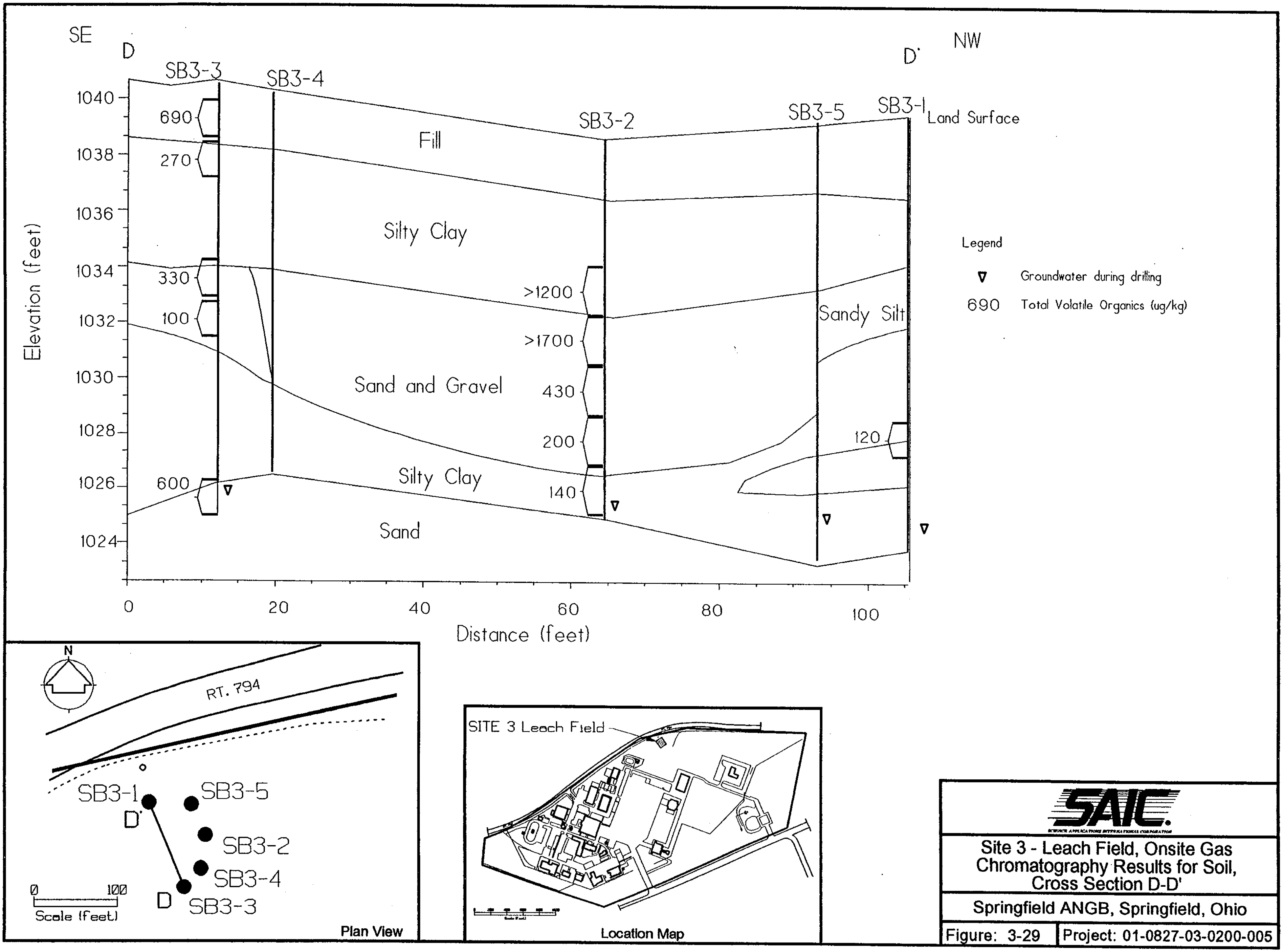
During the initial investigation, four soil borings (i.e., SB3-1, SB3-2, SB3-3, and MW3-1) were drilled and sampled at Site 3 using hollow-stem auger techniques. MW3-1 was completed as a monitoring well. Soil borings SB3-1, SB3-2, and SB3-3 were located based on results of the SOV survey, as discussed above. The fourth boring (i.e., MW3-1) was placed at a location considered to be downgradient (based on piezometer water level measurements) and 50 feet outside of Site 3 boundaries (based on the scaled engineering drawings and aerial photographs that included the leach field). The locations of the soil borings are shown in Figure 3-28.

Soil borings SB3-1, SB3-2, SB3-3, and MW3-1 were sampled continuously from land surface to the soil-water interface and ranged in depth between 12.5 and 16 feet BLS. The analytical laboratory and onsite GC samples were prepared as discussed in Section 2.4.2. Two soil samples were selected for laboratory analysis from each borehole: one surficial sample from the upper 2.5 feet of the boring and a second sample from the water table. A third optional sample (SB3-2-4) was selected for laboratory analysis based on visual soil discoloration; the presence of hydrocarbon odor; and concentrations of benzene, toluene, xylene, and TVO detected during the onsite GC screening. The samples collected, sampling interval, and GC screening results are shown in Table 3-23. Figure 3-29 shows the vertical distribution of TVO detected with the mobile GC. The greatest concentrations of TVO were detected within the leach field filter bed. Samples sent to the laboratory were analyzed for the following parameters:

- TPH (SW Method 8015 modified)
- VOCs (SW Method 8240, CLP SOW 3/90)
- SVOCs (SW Method 8270 CLP SOW 3/90)
- Priority pollutant metals:

    ICP metals: Be, Cd, Cr, Cu, Ni, Ag, and Zn (SW Method 6010)

    AA metals: Sb (SW 7041), As (7060), Pb (7421), Hg (7471), Se (7740), and Tl (7841).



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Site 3 - Leach Field, Onsite Gas Chromatography Results for Soil, Cross Section D-D'

Springfield ANGB, Springfield, Ohio

Figure: 3-29 | Project: 01-0827-03-0200-005

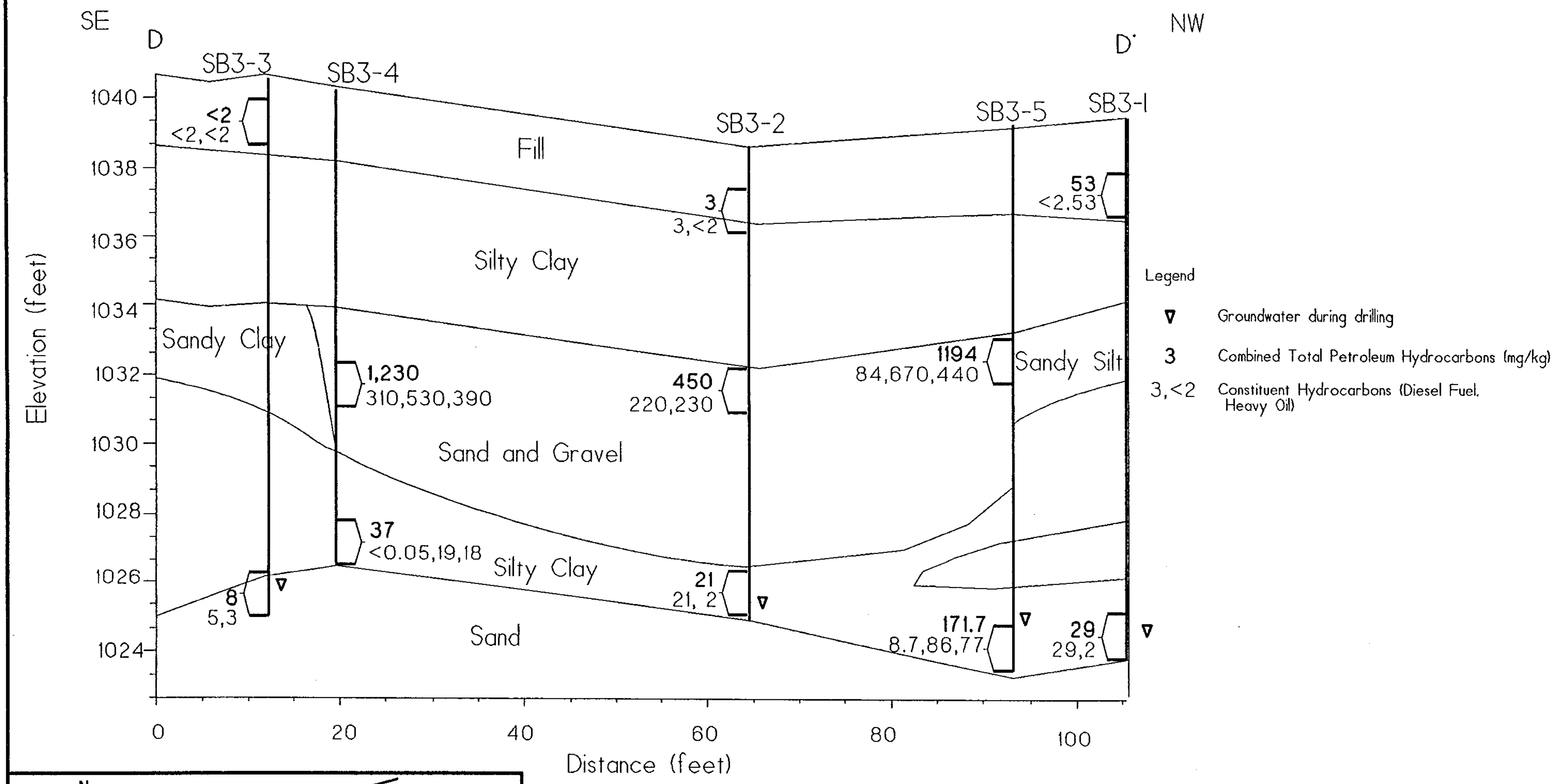
Soil analytical results from the initial phase of the field investigation identified that additional data were needed to assess the vertical extent of contaminants detected at Site 3 and the source of contaminants detected in the upper 2 feet of soil. To assess the vertical extent of contamination, soil borings SB3-4 and SB3-5 were drilled within the leach field boundaries located based on SOV survey results. These borings were sampled at the depth contaminants were previously detected (6 to 9 feet) and below the vertical extent of contamination based on previous results and field screening of samples with an OVA.

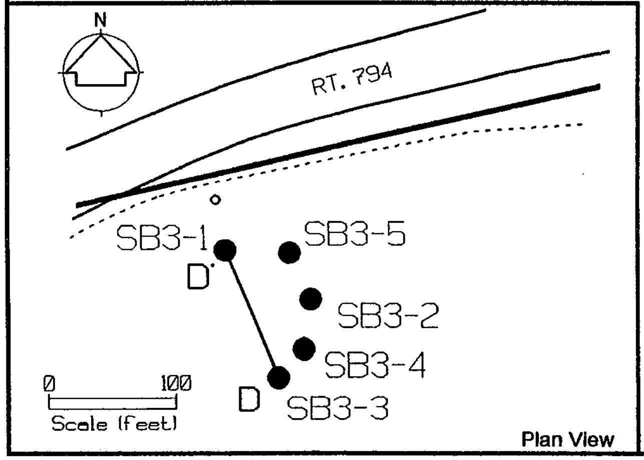
Two surface soils samples (i.e., SD3-1 and SD3-2) were collected upgradient and upslope of the leach field and analyzed to assess surface soil conditions not related to the SI sites. The data were used to evaluate the source of contaminants detected in Site 3 surficial soil samples and are presented in the background discussion in Section 3.4.

Laboratory analytical results for soil are summarized in Table 3-24. A detailed discussion of the TICs detected at Site 3 is presented in Appendix G, Section G.4.

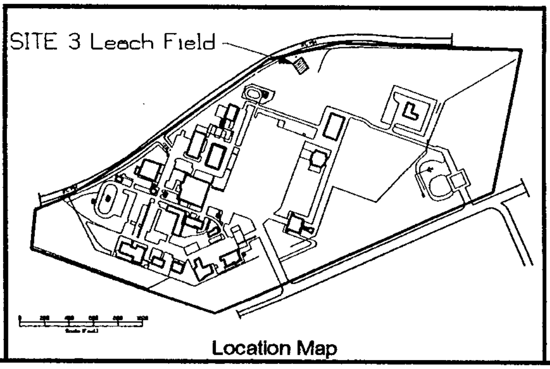
The vertical distribution of TPH detected during the SI is shown in Figure 3-30. Petroleum hydrocarbons were detected in surficial soils throughout Site 3 as diesel fuel and/or heavy oil, except in borings SB3-3-1. Diesel fuel concentrations ranged between 3 and 28 mg/kg in surficial samples and heavy oil concentrations ranged between 23 and 53 mg/kg.

A sample from soil boring SB3-2 (SB3-2-4) was sent to the laboratory based on visual observations (soil discoloration and petroleum odor) and onsite GC results that indicated possible contamination. Sample SB3-2-4 was collected at the interval between 6.5 and 8.5 feet BLS and showed concentrations of diesel fuel at 220 mg/kg and heavy oil at 230 mg/kg. This interval is associated with the leach field filter bed. Samples SB3-4-1 and SB3-5-1, collected during the second investigation phase from the interval associated with the filter bed, contained TPH as gasoline at 84 and 310 mg/kg, diesel fuel at 530 and 670 mg/kg, and heavy oil at 390 and 440 mg/kg, respectively. TPH within the filter bed exceeds the most conservative action level determined by the Ohio Division of State Fire Marshall for USTs for gasoline (105 mg/kg) and diesel fuel and heavy oil (380 mg/kg), and the action level set by OEPA's DSIWM (105 mg/kg).





Plan View



Location Map

SAIC

Site 3 - Leach Field, TPH Results for Soil, Cross Section D-D'

Springfield ANGB, Springfield, Ohio

Figure: 3-30 | Project: 01-0827-03-0200-005

TPH also were detected in soil samples collected below the former leach field in saturated soil (between 12 and 16 feet BLS). Gasoline was detected only in boring SB3-5 at 8.7 mg/kg. Diesel fuel concentrations ranged between 5 and 86 mg/kg and heavy oil concentrations ranged between 3 and 77 mg/kg.

VOCs detected at Site 3 were primarily within the interval associated with the leach field filter bed. Exceptions were acetone detected in samples SB3-1-8 (14.5 to 16.5 feet BLS) and SB3-2-7 (12.5 to 14 feet BLS) at concentrations of 14 and 20 μg/kg, respectively, and toluene detected at an estimated concentration of 2J μg/kg in MW3-1-R.

Within the leach field filter bed estimated concentrations of carbon disulfide, toluene, ethylbenzene, and xylenes were detected. Carbon disulfide was detected in SB3-5-1 at 2J μg/kg. Toluene was detected in SB3-5-1 at 3J μg/kg. Ethylbenzene was detected in SB3-4-1 and SB3-5-1 at 10J and 2J μg/kg, respectively. Xylenes were detected in SB3-2-4, SB3-4-1, and SB3-5-1 at 80X, 3JX, and 18X μg/kg, respectively. The "X" indicates that the detection did not meet all CLP QA criteria, but their presence is strongly suspected.

Eighteen SVOCs were detected in the surficial samples of Site 3 soil borings, as shown in Table 3-24. Thirteen of the 18 SVOCs detected are PAHs and include acenaphthene, fluorene, phenanthrene, anthracene, fluoranthene, pyrene, benzo(a)anthracene, chrysene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(a)pyrene, indeno(1,2,3-c,d) pyrene, and benzo(g,h,i)perylene.

SVOCs were detected at greatest concentrations in surficial soils and ranged from 35J to 1,600 μg/kg. SVOCs within the leach field filter bed ranged from 44J to 780 μg/kg. SVOCs were not detected below the filter bed in saturated soils.

Attenuation with depth appears to be the general trend at Site 3 and is presumably due to the low mobility characteristics of the PAHs and the presence of a dense silty clay/clayey silt layer generally found between land surface and 10 feet BLS at Site 3. This trend is supported by the lack of SVOCs in the soils at water table depth and in the shallow groundwater samples from the site.

VOC TICs were detected in samples collected from boring SB3-2 (samples SB3-2-1, SB3-2-4, and SB3-2-7) ranging from 8 to 14,000 μg/kg. VOC TICs were detected in seven soil samples collected from Site 3 soil borings. Eighteen of 44 VOC TICs were identified as cycloalkanes. Many nontarget VOCs were identified as branched alkanes. One VOC TIC was identified as a dialkyl benzene and two alcohols were detected. These VOC TICs identified as cycloalkanes, branched alkanes, dialkyl benzene, and alcohols may be oxidized petroleum material discharged through the sewer system. Therefore, they were placed in the petroleum or petroleum degradation products category. 1-Hexene-3,3,5-trimethyl detected in SB3-5-1 was classified as a petroleum or petroleum degradation product. Octamethylcyclotetrasiloxane and hexane are considered common laboratory contaminants; therefore, they were placed in the laboratory and extraction artifacts category. One VOC TIC was identified by the laboratory as unknown; therefore, this nontarget VOC was placed in the unknown category. The TICs found in samples SB3-2-4 and SB3-2-7 are believed to be fuel-related hydrocarbons from surface runoff and possible disposal of waste oils through the Base storm and sanitary sewer systems.

SVOC TICs were detected in every samples collected from the Site 3 soil borings. Fifty-seven of 296 SVOC TICs identified as straight-chain alkanes or branched alkanes were placed in the petroleum or petroleum degradation products category. One cyclic ketone was categorized as a petroleum or petroleum degradation product. Eighteen TICs placed in the PAH category were detected in soil samples collected from Site 3. Releases of PAHs due to Base activities may include combustion fuel-related products (including automobile exhaust) or improper disposal of used motor oil. 2-Methyl-octadecenoic acid, 1,2-benzenedicarboxylic acid, hexadecanoic acid, phenol 4-(1,1,3,3-tetramethyl), phenol 4-(2,2,3,3,-tetramethyl), phenol nonyl-2-nonylphenol, and 1-hexene 3,5,5,-trimethyl detected in selected samples were placed in the petroleum or petroleum degradation products category. The source of the contamination with these nontarget SVOCs may be oxidized petroleum products discharged through the sewer system. Hexadecanoic acid detected in SB3-3-1 at a concentration below that detected in the background samples is considered to be naturally occurring in the environmental media, and therefore, was placed in the naturally occurring organic compounds category. Phosphoric acid 2-ethylhexyl detected in SB3-5-1 and SB3-5-2 were placed in the other category. The detection of this compound is sporadic and inconsistent, so no conclusion could be made regarding the possibility that observed phosphoric acid 2-ethylhexyl is due to the site or possibly cross contamination. 4-Hydroxy-4-methyl-2-pentanone was detected in many soil samples collected from Site 3. As discussed previously, this is an aldol reaction product common to SVOC analyses, and as a result, is considered to be a laboratory artifact. 4-Hydroxy-4-methyl-2-pentanone concentrations in SB3-4-1 and SB3-5-1 were less than that detected in the associated method blank, and as a result, this TIC was considered nondetected in SB3-4-1 and SB3-5-1. The remaining compounds were identified as "unknown." No conclusions could be made regarding the possibility that observed SVOC TIC detections are due to site contamination or possibly cross contamination. Therefore, they were placed in the unknown category.

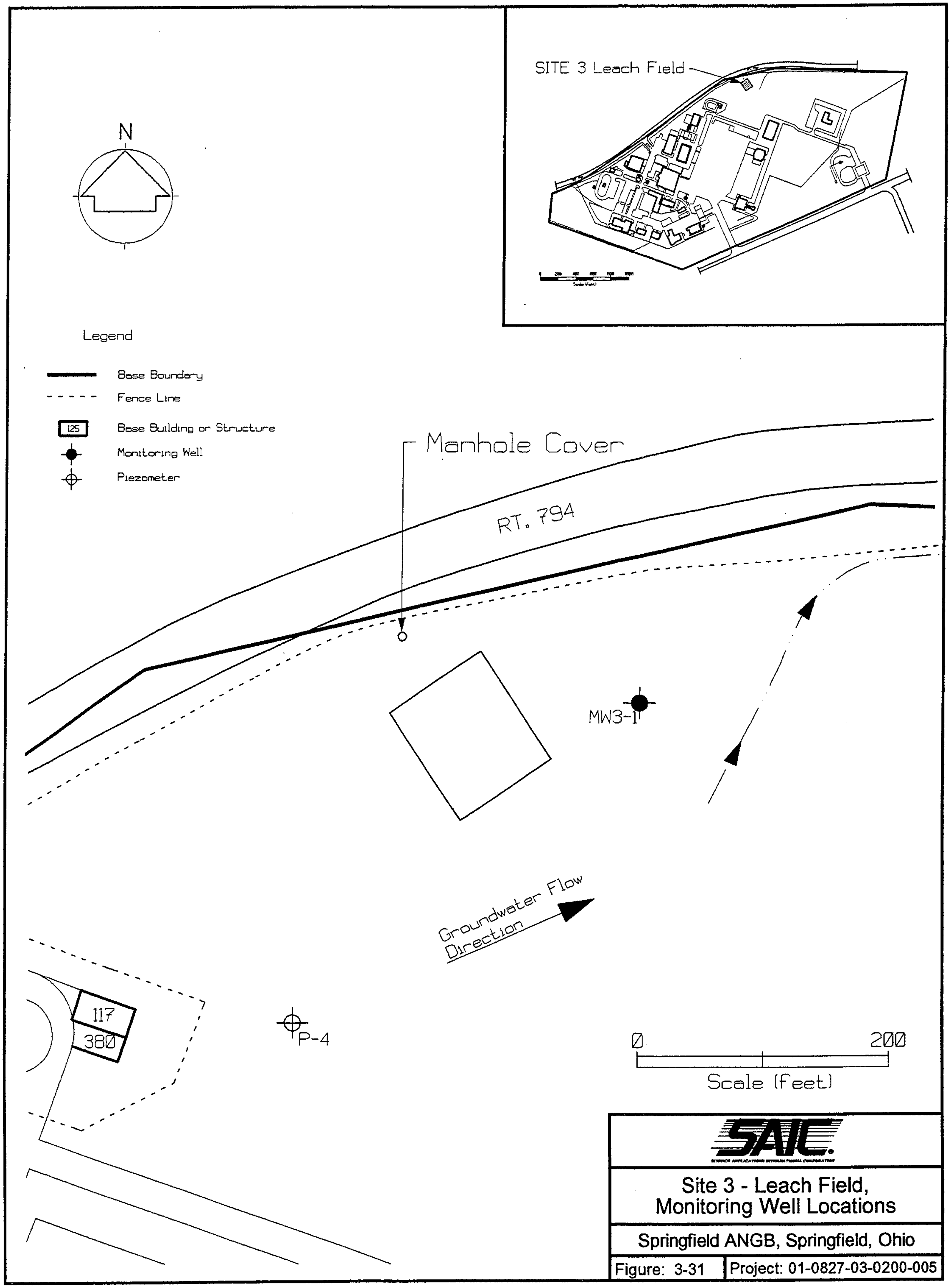
Inorganic elements, including 12 metals and arsenic, were detected in soil. Concentrations of inorganics detected in Site 3 soils are compared to background criteria in Section 3.7.5 following the procedures described in Section 3.3.

3.7.4 Chemicals Detected in Groundwater

One monitoring well (MW3-1) was installed and sampled at Site 3 - LCH-3. Based on the aerial photographs and construction drawings, which show the leach field location, MW3-1 was located about 50 feet beyond the leach field boundary in the downgradient direction. The general groundwater flow for the Base is considered to be in a northeast direction, as determined from water level measurements of piezometers installed earlier in the SI program. The location of monitoring well MW3-1 is shown in Figure 3-31. The monitoring well was installed following the procedures outlined in Section 2 after drilling to a total depth of 16 feet BLS.

Two groundwater sampling rounds, including one replicate, were collected from monitoring well MW3-1. The samples were sent to the laboratory for the following analyses:

- TPH (SW Method 8015 modified)
- VOCs (EPA Method 524.2, CLP SOW 3/90)



Site 3 - Leach Field, Monitoring Well Locations

Springfield ANGB, Springfield, Ohio

Figure: 3-31 | Project: 01-0827-03-0200-005

- SVOCs (SW Method 8270, CLP SOW 3/90)
- Priority pollutant metals:

  ICP metals: Be, Cd, Cr, Cu, Ni, Ag, and Zn (SW Method 6010)

  AA metals: Sb (SW 7041), As (7060), Pb (7420), Hg (7470), Se (7740), and Tl (7841).

Laboratory analytical results are presented in Table 3-25. A detailed discussion of the TICs detected in Site 3 groundwater is presented in Appendix G, Section G.4.

TPH, SVOCs, VOCs, and VOC TICs were not detected in groundwater samples MW3-1-1, MW3-1-1R, or MW3-1-2. Hexanoic acid 6-amino was identified as both a VOC and SVOC TIC. This TIC was placed in the naturally occurring category. 2-Methyl-octadecenoic acid was placed in the petroleum or petroleum degradation products category. 2-Propanol-1-(2-methoxy-1-M) and 2,5,8,10,14,17-hexaoxaoctade were placed in the other category. Three nontarget SVOCs detected in MW3-1-1 and MW3-1-2 were classified as unknown. 4-Hydroxy-4-methyl-2-pentanone in MW3-1-2 was classified as a laboratory and extraction artifact. Several inorganic compounds that exceed Federal and/or Ohio State MCLs were detected in unfiltered groundwater. These include arsenic, beryllium, chromium, lead, and nickel, and were shown to be associated with solids suspended in groundwater. Analysis of dissolved inorganic compounds did not detect contaminants. Table 3-26 presents detected groundwater contaminant concentrations and comparison with the associated MCLs.

3.7.5 Comparison of Chemicals Detected to Background Criteria

This section compares the background results, which are presented in Section 3.3 and in Tables 3-4 and 3-5, to sample results from Site 3 - LCH-3. Results from eight soil samples were compared with the background UCL_{90} (Table 3-27). Most of the results for inorganic constituents did not exceed the UCL_{90}. Some of the results, including the maximum detected result, only slightly exceeded the UCL_{90}; this supports the conclusion that no significant evidence exists that these contaminants are related to activities conducted at the site. Many organic compounds, including diesel fuel and heavy oil, appear site related, as shown in Table 3-27.

Nine inorganics were detected at low levels in Site 3 unfiltered groundwater samples. The results exceeded the background UCL_{90} (Table 3-28) for antimony, arsenic, and silver.

3.7.6 Summary of Results

The vertical extent of soil contaminants (i.e., TPH, VOCs, and SVOCs) detected at Site 3 was shown to be limited to the upper 12 feet of soil. Petroleum hydrocarbons were detected throughout Site 3 soil. Concentrations within the filter bed exceed background and regulatory criteria.

VOCs and VOC TICs were detected in soil samples. Carbon disulfide, toluene, ethylbenzene, and xylene appear to be site related based on their location within the filter bed; however, the source of acetone is unknown.

SVOCs were detected in every surficial soil sample (0 to 2.5 feet BLS) collected at Site 3 and SVOC TICs were detected in every sample. The full horizontal extent of the soil SVOC contamination at Site 3 is unknown, but it is present in greatest concentrations in the upper 2 feet and decreases with depth in the upper 10 feet, which indicates that the fill layer above the former leach field is the primary source of SVOC contamination.

Groundwater analyses of dissolved inorganic compounds did not detect contaminants. Analysis of unfiltered groundwater detected arsenic, beryllium, chromium, lead, and nickel above Federal and/or Ohio MCLs; however, these concentrations are considered to be associated with solids suspended in groundwater, and drinking water ARARs are not directly applicable. No VOCs, VOC TICs, or SVOCs were detected in groundwater samples.

To assess the risk to human health and the need for remediation, a risk assessment has been conducted (Section 5) for all detected chemicals whether or not they were determined to be site related.

Table 3—23. Onsite Gas Chromatography Results for Soil at Site 3 – Leach Field and Outfall, 178th Tactical Fighter Group, Springfield ANGB, Springfield, Ohio

Soil Boring	Sample Number	Depth (feet BLS)	Analytical Parameters (µg/kg) TVO	TCA	CCl_4	TCE	PCE	BEN	TOL	ETZ	XYL	Comments
SB3–1	SB3–1–01	0.5–2.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	Sample sent to lab 8/19/92.
	SB3–1–02	2.5–4.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	
	SB3–1–03	4.5–6.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	
	SB3–1–04	6.5–8.5	ND	0.2	ND	ND	ND	ND	ND	ND	ND	
	SB3–1–05	8.5–10.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	
	SB3–1–06	10.5–12.5	120	ND	ND	ND	ND	ND	ND	ND	ND	
	SB3–1–07	12.5–14.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	
	SB3–1–08	14.5–16.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	Saturated interval (soil/water interface). Sample sent to lab 8/20/92.
SB3–2	SB3–2–01	0.5–2.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	Sample sent to lab 8/20/92.
	SB3–2–02	2.5–4.5	ND	0.7	ND	ND	ND	ND	ND	ND	ND	
	SB3–2–03	4.5–6.5	>1200	ND	ND	ND	ND	18	18	172	390	Hydrocarbon odor.
	SB3–2–04	6.5–8.0	>1700	ND	ND	ND	ND	17	58	ND	1090	Pronounced hydrocarbon odor. Sample sent to lab 8/20/92.
	SB3–2–05	8.5–10.0	430	ND	ND	ND	ND	ND	ND	ND	55	Pronounced hydrocarbon odor.
	SB3–2–06	10.5–12.5	200	ND	ND	ND	ND	ND	ND	ND	185	Slight hydrocarbon odor.
	SB3–2–07A	12.5–14.0	140	ND	ND	ND	ND	ND	ND	ND	ND	Sample sent to lab 8/20/92.
	SB3–2–07B	12.5–14.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	Soil/water interface.
SB3–3	SB3–3–01	0.5–2.5	690	1.2	ND	0.4	ND	97	11	32	143	Sample sent to lab 8/20/92.
	SB3–3–02	2.5–4.5	270	0.2	ND	ND	ND	25	ND	ND	ND	
	SB3–3–03	4.5–6.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	
	SB3–3–04	6.5–8.5	330	ND	ND	ND	ND	ND	ND	ND	ND	
	SB3–3–05	8.5–10.5	100	ND	ND	ND	ND	ND	ND	ND	ND	
	SB3–3–06	10.5–12.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	
	SB3–3–07	12.5–14.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	
	SB3–3–08	14.5–16.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	Saturated interval (soil/water interface). Sample sent to lab 8/20/92.
	SB3–3–08D	14.5–16.5	600	0.3	ND	ND	ND	ND	ND	ND	ND	Replicate GC sample taken.
MW3–1	MW3–1–01	0.5–1.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	Sample sent to lab 8/21/92. Replicate sample collected.
	MW3–1–02	2.0–4.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	
	MW3–1–03	4.0–6.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	
	MW3–1–04	6.0–8.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	
	MW3–1–06	10.0–12.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	
	MW3–1–08	14.0–16.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	Saturated interval (soil/water interface). Sample sent to lab 8/21/92.

Table 3-24. Data Summary Table: Soil – Site 3 – Former Leach Field, 178th Tactical Fighter Group, Springfield ANGB, Springfield, Ohio

SAIC ID Number		SB3-1-1	SB3-1-8	SB3-2-1
Laboratory ID Number		94911	94972	94973
Collection Date		8-19-92	8-20-92	8-20-92
Collection Depth (ft)		0.5-2.0	14.5-16.0	0.5-2.5
Associated Field QC Sample		TB-6 EB3-1 FB3-1 SD5-FB	TB-7 EB3-1 FB3-1 SD5-FB	TB-7 EB3-1 FB3-1 SD5-FB
Parameter	Units			
TOTAL PETROLEUM HYDROCARBONS (SW 8015M)				
Gasoline	mg/kg	NA	NA	NA
Diesel Fuel	mg/kg	<2	29	3
Heavy Oil	mg/kg	53	<2	<2
PRIORITY POLLUTANT METALS				
AA METALS				
Antimony (SW 3050/7041)	mg/kg	R(N)	R(N)	R(N)
Arsenic (SW 3050/7060)	mg/kg	11 J(N)	4.3 J(N)	6.1 J(N)
Lead (SW 3050/7421)	mg/kg	44.5	6.3 S	8.1
Mercury (SW 3050/7471)	mg/kg	0.09 U	0.08 U	0.1 U
Selenium (SW 3050/7740)	mg/kg	0.15 UJ(N,W)	0.14 UJ(N,W)	0.11 UJ(N,W)
Thallium (SW 3050/7841)	mg/kg	0.29 U(MB)	0.1 UJ(MB,W)	0.14 UJ(MB,W)
ICP METALS (SW 3050/6010)				
Beryllium	mg/kg	0.47 B	0.29 B	0.43 B
Cadmium	mg/kg	0.22 U	0.9 U	0.84 U
Chromium	mg/kg	27.3	7.2	9.5
Copper	mg/kg	23.7	11.5	59.2
Nickel	mg/kg	24.3	12.2 B	20.7
Silver	mg/kg	2.1 U(MB)	3.2 U(MB)	3 U(MB)
Zinc	mg/kg	106 J(E)	41.8 J(E)	312 J(E)
VOLATILE ORGANICS (SW 8240[A])				
Acetone	µg/kg	11 U	14	11 U
Carbon Disulfide	µg/kg	11 U	13 U	11 U
Toluene	µg/kg	11 U	13 U	11 U
Ethylbenzene	µg/kg	11 U	13 U	11 U
Xylene (total)	µg/kg	11 U	13 U	11 U
TICs	µg/kg	0 (0)	0 (0)	Octamethylcyclotetrasiloxane* 9 J,N (RT 25.66)
TIC Total	µg/kg	0 (0)	0 (0)	9 (1)

Table 3-24. Data Summary Table: Soil - Site 3 - Former Leach Field, 178th Tactical Fighter Group, Springfield ANGB, Springfield, Ohio (Continued)

SAIC ID Number Laboratory ID Number Collection Date Collection Depth (ft) Associated Field QC Sample Parameter	Units	SB3-1-1 94911 8-19-92 0.5-2.0 TB-6 EB3-1 FB3-1 SD5-FB	SB3-1-8 94972 8-20-92 14.5-16.0 TB-7 EB3-1 FB3-1 SD5-FB	SB3-2-1 94973 8-20-92 0.5-2.5 TB-7 EB3-1 FB3-1 SD5-FB
SEMIVOLATILE ORGANICS (SW 8270 [B])				
N-Nitroso-di-N-propylamine	µg/kg	670 U	390 U	330 U
2-Methylnaphthalene	µg/kg	670 U	390 U	330 U
Acenaphthene	µg/kg	670 U	390 U	35 J
Fluorene	µg/kg	670 U	390 U	51 J
Phenanthrene	µg/kg	170 J	390 U	1100
Anthracene	µg/kg	670 U	390 U	130 J
Carbazole	µg/kg	670 U	390 U	75 J
Fluoranthene	µg/kg	480 J	390 U	3100 E
Pyrene	µg/kg	530 J	390 U	3400 E
Benzo(a)anthracene	µg/kg	220 J	390 U	1000
Chrysene	µg/kg	270 J	390 U	1200
bis(2-Ethylhexyl)phthalate	µg/kg	670 U	390 U	330 U
di-N-Octyl phthalate	µg/kg	670 UJ(CCV)	390 UJ(CCV)	330 U
Benzo(b)fluoranthene	µg/kg	330 J	390 U	1600
Benzo(k)fluoranthene	µg/kg	170 J	390 U	570
Benzo(a)pyrene	µg/kg	230 J	390 U	980
Indeno(1,2,3-c,d)pyrene	µg/kg	230 J	390 U	880
Benzo(gh,i)perylene	µg/kg	210 J	390 U	700
TICs	µg/kg	4-Hydroxy-4-Methyl-2-Pentanone[a] 22000 B,J,N,A (RT 5.37)	4-Hydroxy-4-Methyl-2-Pentanone[a] 14000 B,J,N,A (RT 5.23)	4-Hydroxy-4-Methyl-2-Pentanone[a] 20000 B,J,N,A (RT 5.30)
		Unknown[d] 80 J (RT 27.31)	Unknown[d] 130 J (RT 14.30)	Unknown[d] 150 J (RT 20.85)
		Octadecanoic Acid, 2-Methylp[b] 160 J,N (RT 29.59)	Unknown[d] 180 J (RT 16.09)	Unknown[d] 67 J (RT 23.64)
		Unknown[d] 170 J (RT 29.76)	4,6-Dimethyl-Dodecane[b] 150 J,N (RT 17.09)	2-Methyl-Anthracene[c] 170 J,N (RT 23.84)
		Octacosane[b] 190 J,N (RT 30.82)	Unknown[d] 250 J (RT 17.75)	Unknown[d] 260 J (RT 24.05)
		Unknown[d] 160 J (RT 31.89)	Hexadecane[b] 290 J,N (RT 19.35)	Unknown[d] 240 J (RT 24.75)
		Unknown[d] 410 J (RT 32.92)	Unknown[d] 150 J (RT 20.05)	Unknown[d] 66 J (RT 24.95)
		1,2-Benzenedicarboxylic Acid[b] 290 J,N (RT 33.09)	5-Propyl-Tridecane[b] 550 J,N (RT 20.85)	Unknown[d] 110 J (RT 26.21)
		Unknown[d] 140 J (RT 33.96)	Unknown[d] 320 J (RT 20.90)	Benzo[B]Naphtho[2,3-D]Furan[c] 83 J,N (RT 27.09)
		Unknown[d] 340 J (RT 34.09)	Unknown[d] 350 J (RT 22.29)	11H-Benzo[A]Fluorene[c] 250 J,N (RT 27.76)
		Benzo[J]Fluoranthene[c] 270 J,N (RT 34.57)	Unknown[d] 300 J (RT 22.37)	11H-Benzo[B]Fluorene[c] 110 J,N (RT 27.97)
		Unknown[d] 650 J (RT 35.02)	Unknown[d] 340 J (RT 23.64)	Unknown[d] 72 J (RT 28.06)
		Unknown[d] 840 J (RT 37.24)	Unknown[d] 310 J (RT 24.95)	Unknown[d] 120 J (RT 28.54)
		Unknown[d] 410 J (RT 38.59)	Unknown[d] 300 J (RT 26.21)	7H-Benz[De]Anthracen-7-One[c] 92 J,N (RT 29.34)
			Unknown[d] 350 J (RT 28.54)	Unknown[d] 130 J (RT 29.66)
			Pentacosane[b] 330 J,N (RT 29.64)	Unknown[d] 140 J (RT 29.79)
			Unknown[d] 400 J (RT 30.72)	Unknown[d] 61 J (RT 30.72)
			Octacosane[b] 270 J,N (RT 31.77)	Unknown[d] 150 J (RT 31.77)
			Unknown[d] 700 J (RT 32.82)	Unknown[d] 120 J (RT 32.82)
			Unknown[d] 410 J (RT 33.86)	Benzo[J]Fluoranthene[c] 160 J,N (RT 34.47)
			Unknown[d] 380 J (RT 34.91)	Unknown[d] 88 J (RT 34.91)
TIC Total	µg/kg	26110 (14)	20460 (21)	22639 (21)

Table 3–24. Data Summary Table: Soil – Site 3 – Former Leach Field, 178th Tactical Fighter Group, Springfield ANGB, Springfield, Ohio (Continued)

SAIC ID Number		SB3–2–1DL	SB3–2–4	SB3–2–7
Laboratory ID Number		94973DL	94974	94975
Collection Date		8–20–92	8–20–92	8–20–92
Collection Depth (ft)		0.5–2.5	6.5–8.0	12.5–14.0
Associated Field QC Sample		TB–7 EB3–1 FB3–1 SD5–FB	TB–7 EB3–1 FB3–1 SD5–FB	TB–7 EB3–1 FB3–1 SD5–FB
Parameter	Units			
TOTAL PETROLEUM HYDROCARBONS (SW 8015M)				
Gasoline	mg/kg	NA	NA	NA
Diesel Fuel	mg/kg	NA	220	21
Heavy Oil	mg/kg	NA	230	<2
PRIORITY POLLUTANT METALS				
AA METALS				
Antimony (SW 3050/7041)	mg/kg	NA	R(N)	R(N)
Arsenic (SW 3050/7060)	mg/kg	NA	13.4 J(N)	2.4 J(N)
Lead (SW 3050/7421)	mg/kg	NA	25.8	6.8 S
Mercury (SW 3050/7471)	mg/kg	NA	0.12	0.1 U
Selenium (SW 3050/7740)	mg/kg	NA	0.13 UJ(N,W)	0.17 UJ(MB,N,W)
Thallium (SW 3050/7841)	mg/kg	NA	0.14 UJ(MB,W)	0.11 UJ(MB,W)
ICP METALS (SW 3050/6010)				
Beryllium	mg/kg	NA	0.38 B	0.29 B
Cadmium	mg/kg	NA	0.68	0.9 U
Chromium	mg/kg	NA	19.6	7.9
Copper	mg/kg	NA	19.9	12.7
Nickel	mg/kg	NA	14.9	14.6 B
Silver	mg/kg	NA	16.4	3.2 B
Zinc	mg/kg	NA	78.6 J(E)	40.9 J(E)
VOLATILE ORGANICS (SW 8240 [A])				
Acetone	µg/kg	NA	57 U	20
Carbon Disulfide	µg/kg	NA	57 U	11 U
Toluene	µg/kg	NA	57 U	11 U
Ethylbenzene	µg/kg	NA	57 U	11 U
Xylene (total)	µg/kg	NA	80 X	11 U
TICs	µg/kg	NA	Cyclopentane, 1,1,3,4–Tetram ^{b} 130 J,N (RT 19.97) Cyclohexane, 1,2,4–Trimethyl ^{b} 92 J,N (RT 20.67) 3–Methyl–Octane ^{b} 69 J,N (RT 21.13) Cyclohexane, 1–Ethyl–2–Methy ^{b} 180 J,N (RT 23.59) 2,6–Dimethyl–Octane ^{b} 100 J,N (RT 23.97) 7–Methyl–3–Octyne ^{b} 92 J,N (RT 24.53) 4–Methyl–Nonane ^{b} 140 J,N (RT 25.3) 3,5,5–Trimethyl–1–Hexene ^{b} 240 J,N (RT 25.95) Cyclopentane, (2–Methylbutyl ^{b} 80 J,N (RT 26.71) 1,1–Dimethyl–Cyclohexane ^{b} 330 J,N (RT 26.92) 1–Ethyl–2–Methyl–Benzene ^{b} 57 J,N (RT 27.39)	Cyclohexane, 1–Ethyl–2–Methy ^{b} 8 J,N (RT 23.32) 2,5–Dimethyl–1,6–Octadiene ^{b} 12 J,N (RT 24.25) 1,1,2,3–Tetramethylcyclohexa ^{b} 13 J,N (RT 25.67) 1,1–Dimethyl–Cyclohexane ^{b} 13 J,N (RT 26.68)
TIC Total	µg/kg	NA	1510 (11)	46 (4)

Table 3–24. Data Summary Table: Soil – Site 3 – Former Leach Field, 178th Tactical Fighter Group, Springfield ANGB, Springfield, Ohio (Continued)

SAIC ID Number			SB3–2–1DL			SB3–2–4			SB3–2–7	
Laboratory ID Number			94973DL			94974			94975	
Collection Date			8–20–92			8–20–92			8–20–92	
Collection Depth (ft)			0.5–2.5			6.5–8.0			12.5–14.0	
Associated Field QC Sample			TB–7 EB3–1 FB3–1 SD5–FB			TB–7 EB3–1 FB3–1 SD5–FB			TB–7 EB3–1 FB3–1 SD5–FB	
Parameter	Units									
SEMIVOLATILE ORGANICS (SW 8270 [B])										
N–Nitroso–di–N–propylamine	µg/kg		980 U			360 U			340 U	
2–Methylnaphthalene	µg/kg		980 U			170 J			340 U	
Acenaphthene	µg/kg		980 U			360 U			340 U	
Fluorene	µg/kg		980 U			56 J			340 U	
Phenanthrene	µg/kg		560 DJ			190 J			340 U	
Anthracene	µg/kg		980 U			360 U			340 U	
Carbazole	µg/kg		980 U			360 U			340 U	
Fluoranthene	µg/kg		1500 D			320 J			340 U	
Pyrene	µg/kg		1700 D			340 J			340 U	
Benzo(a)anthracene	µg/kg		620 DJ			110 J			340 U	
Chrysene	µg/kg		750 DJ			130 J			340 U	
bis(2–Ethylhexyl)phthalate	µg/kg		980 U			140 J			340 U	
di–N–Octyl phthalate	µg/kg		980 U			360 UJ(CCV)			340 UJ(CCV)	
Benzo(b)fluoranthene	µg/kg		920 DJ			120 J			340 U	
Benzo(k)fluoranthene	µg/kg		380 DJ			37 J			340 U	
Benzo(a)pyrene	µg/kg		630 DJ			79 J			340 U	
Indeno(1,2,3–c,d)pyrene	µg/kg		550 DJ			78 J			340 U	
Benzo(gh,i)perylene	µg/kg		460 DJ			73 J			340 U	
TICs	µg/kg	4–Hydroxy–4–Methyl–2–Pentanone[a]	14000 B,J,N,A	(RT 5.08)	4–Hydroxy–4–Methyl–2–Pentanone[a]	5700 B,J,N,A	(RT 5.37)	4–Hydroxy–4–Methyl–2–Pentanone[a]	14000 B,J,N,A	(RT 5.40)
		Unknown[d]	280 J	(RT 32.71)	Unknown[d]	640 J	(RT 7.03)	2,6,7–Trimethyl–Decane[b]	73 J,N	(RT 12.75)
		Benzo[E]Pyrene[c]	200 J,N	(RT 33.86)	Pentane, 2,2,3,3–Tetramethyl[b]	850 J,N	(RT 7.62)	Unknown[d]	150 J	(RT 14.40)
		Benzo[J]Fluoranthene[c]	540 J,N	(RT 34.34)	5–Ethyl–2–Methyl–Heptane[b]	1800 J,N	(RT 8.95)	Unknown[d]	71 J	(RT 15.75)
		Unknown[d]	300 J	(RT 34.79)	Unknown[d]	1100 J	(RT 9.19)	Unknown[d]	250 J	(RT 16.19)
					Unknown[d]	810 J	(RT 9.75)	2,3,7–Trimethyl–Decane[b]	190 J,N	(RT 17.19)
					Unknown[d]	1900 J	(RT 10.92)	Unknown[d]	290 J	(RT 17.85)
					6–Ethyl–2–Methyl–Octane[b]	880 J,N	(RT 11.12)	Hexadecane[b]	310 J,N	(RT 19.45)
					3–Ethyl–2–Methyl–Heptane[b]	1600 J,N	(RT 11.65)	Unknown[d]	120 J	(RT 20.15)
					2,6–Dimethyl–Undecane[b]	1600 J,N	(RT 12.82)	Unknown[d]	430 J	(RT 20.95)
					2,3,7–Trimethyl–Octane[b]	2800 J,N	(RT 13.94)	2,7,10–Trimethyl–Dodecane[b]	240 J,N	(RT 21.00)
					2,6,10–Trimethyl–Dodecane[b]	2800 J,N	(RT 15.82)	Unknown[d]	240 J	(RT 22.39)
					1,3–Dimethyl–Naphthalene[c]	1700 J,N	(RT 16.65)	5–Propyl–Tridecane[b]	210 J,N	(RT 22.47)
					Heptadecane, 2,6,10,14–Tetra[b]	2900 J,N	(RT 17.27)	Unknown[d]	230 J	(RT 23.75)
					Unknown[d]	1900 J	(RT 19.50)	Iron, Tricarbonyl[N–(Phenyl–[c]	200 J,N	(RT 25.06)
					Phenol, 4–(1,1,3,3–Tetrameth[b]	4300 J,N	(RT 19.57)	Unknown[d]	240 J	(RT 26.31)
					Unknown[d]	860 J	(RT 20.19)	Unknown[d]	230 J	(RT 28.64)
					Unknown[d]	1100 J	(RT 21.00)	Unknown[d]	210 J	(RT 29.76)
					Unknown[d]	1500 J	(RT 21.05)	Pentacosane[b]	220 J,N	(RT 30.82)
					Unknown[d]	840 J	(RT 21.14)	Octacosane[b]	160 J,N	(RT 31.89)
					Unknown[d]	570 J	(RT 21.20)	Unknown[d]	300 J	(RT 32.92)
TIC Total	µg/kg		15320 (5)			38150 (21)			18364 (21)	

Table 3–24. Data Summary Table: Soil – Site 3 – Former Leach Field, 178th Tactical Fighter Group, Springfield ANGB, Springfield, Ohio (Continued)

SAIC ID Number		SB3–3–1	SB3–3–8	SB3–4–1		
Laboratory ID Number		94976	94977	9547		
Collection Date		8–20–92	8–20–92	5–19–93		
Collection Depth (ft)		0.5–2.5	14.5–16.5	7.5–9.0		
Associated Field QC Sample		TB–7 EB3–1 FB3–1 SD5–FB	TB–7 EB3–1 FB3–1 SD5–FB	TB52093 EB2–2, EB3–2 N/A FB2–2, FB3–2		
Parameter	Units					
TOTAL PETROLEUM HYDROCARBONS (SW 8015M)						
Gasoline	mg/kg	NA	NA	310		
Diesel Fuel	mg/kg	<2	5	530		
Heavy Oil	mg/kg	<2	3	390		
PRIORITY POLLUTANT METALS						
AA METALS						
Antimony (SW 3050/7041)	mg/kg	R(N)	R(N)	0.16 J(N,W)		
Arsenic (SW 3050/7060)	mg/kg	8.7 J(N)	3.2 J(N)	3.6 J(N)		
Lead (SW 3050/7421)	mg/kg	33.5	5.6 S	47.4 J(N)		
Mercury (SW 3050/7471)	mg/kg	0.09 U	0.11 U	0.05 B		
Selenium (SW 3050/7740)	mg/kg	0.14 UJ(N,W)	0.15 UJ(N)	0.18 B		
Thallium (SW 3050/7841)	mg/kg	0.19 UJ(MB,W)	0.08 UJ(W)	0.22 U		
ICP METALS (SW 3050/6010)						
Beryllium	mg/kg	0.36 B	0.23 B	0.23 U(MB)		
Cadmium	mg/kg	0.28 B	1 U	0.61 U		
Chromium	mg/kg	17	4.9 B	35.5		
Copper	mg/kg	22.4	8.2 B	16.1		
Nickel	mg/kg	20.2	5.1 U	14.7		
Silver	mg/kg	2.2 U(MB)	3.6 B	2.7		
Zinc	mg/kg	86.7 J(E)	35.4 J(E)	88.4 J(E)		
VOLATILE ORGANICS (SW 8240 [A])						
Acetone	µg/kg	11 U	12 U	13 U		
Carbon Disulfide	µg/kg	11 U	12 U	13 U		
Toluene	µg/kg	11 U	12 U	13 U		
Ethylbenzene	µg/kg	11 U	12 U	10 J		
Xylene (total)	µg/kg	11 U	12 U	3 JX		
TICs	µg/kg	0 (0)	0 (0)	Cyclohexane, 1–Ethyl–2–Methy[b]	320 J,N	(RT 24.32)
				2,6–Dimethyl–Octane[b]	330 J,N	(RT 24.71)
				Unknown[a]	210 J,N	(RT 25.22)
				5,6–Dimethyl–Undecane[b]	190 J,N	(RT 25.77)
				4,5–Dimethyl–Octane[b]	440 J,N	(RT 26.00)
				3,3,5–Trimethyl–1–Hexene[b]	550 J,N	(RT 26.66)
				1,1–Dimethyl–Cyclohexane[b]	720 J,N	(RT 27.61)
				3–Methyl–Dodecane[b]	190 J,N	(RT 28.22)
				4–Methyl–Heptane[b]	530 J,N	(RT 28.57)
				Cyclohexane, 1–Ethyl–4–Methy[b]	670 J,N	(RT 31.81)
				Nonacosanol[b]	540 J,N	(RT 32.44)
				6–Methylundecane[b]	290 J,N	(RT 33.87)
TIC Total	µg/kg	0 (0)	0 (0)		4980 (12)	

Table 3-24. Data Summary Table: Soil – Site 3 – Former Leach Field, 178th Tactical Fighter Group, Springfield ANGB, Springfield, Ohio (Continued)

Parameter	Units		SB3-3-1			SB3-3-8			SB3-4-1	
SAIC ID Number			SB3-3-1			SB3-3-8			SB3-4-1	
Laboratory ID Number			94976			94977			9547	
Collection Date			8-20-92			8-20-92			5-19-93	
Collection Depth (ft)			0.5-2.5			14.5-16.5			7.5-9.0	
Associated Field QC Sample			TB-7 EB3-1 FB3-1 SD5-FB			TB-7 EB3-1 FB3-1 SD5-FB			TB52093 EB2-2, EB3-2 N/A FB2-2, FB3-2	
SEMIVOLATILE ORGANICS (SW 8270 [B])										
N-Nitroso-di-N-propylamine	µg/kg		350 U			370 U			410U	
2-Methylnaphthalene	µg/kg		350 U			370 U			210J	
Acenaphthene	µg/kg		350 U			370 U			410U	
Fluorene	µg/kg		45 J			370 U			410U	
Phenanthrene	µg/kg		780			370 U			430	
Anthracene	µg/kg		130 J			370 U			410U	
Carbazole	µg/kg		58 J			370 U			410 UJ(CCV)	
Fluoranthene	µg/kg		2100			370 U			780	
Pyrene	µg/kg		2400			370 U			380J	
Benzo(a)anthracene	µg/kg		800			370 U			200J	
Chrysene	µg/kg		900			370 U			94J	
bis(2-Ethylhexyl)phthalate	µg/kg		70 J			370 U			850U(MB)	
di-N-Octyl phthalate	µg/kg		350 U			370 UJ(CCV)			44J	
Benzo(b)fluoranthene	µg/kg		1100			370 U			240J	
Benzo(k)fluoranthene	µg/kg		370			370 U			190J	
Benzo(a)pyrene	µg/kg		750			370 U			170J	
Indeno(1,2,3-c,d)pyrene	µg/kg		720			370 U			150J	
Benzo(gh,i)perylene	µg/kg		550			370 U			410U	
TICs	µg/kg	4-Hydroxy-4-Methyl-2-Pentanone[a]	17000 B,J,N,A	(RT 5.28)	4-Hydroxy-4-Methyl-2-Pentanone[a]	13000 B,J,N,A	(RT 5.40)	3-Ethyl-5-Methyl-Heptane[b]	3800 J,N	(RT 5.02)
		Unknown[d]	160 J	(RT 20.85)	Unknown[d]	120 J	(RT 20.95)	3-Ethyl-2-Methyl-Heptane[b]	4700 J,N	(RT 5.12)
		Unknown[d]	66 J	(RT 23.64)	2,6-Dimethyl-Heptadecane[b]	90 J,N	(RT 20.99)	3,5,5-Trimethyl-1-Hexene[b]	5200 J,N	(RT 5.55)
		1-Methyl-Anthracene[e]	75 J,N	(RT 23.75)	Unknown[d]	82 J	(RT 22.37)	Cyclopentanone, 2-Methyl-4-([b]	6100 J,N	(RT 6.00)
		2-Methyl-Anthracene[e]	84 J,N	(RT 23.84)	Unknown[d]	96 J	(RT 23.74)	5-Ethyl-2-Methyl-Heptane[b]	10000 J,N	(RT 6.85)
		Unknown[d]	190 J	(RT 24.05)	Unknown[d]	85 J	(RT 25.04)	Unknown[d]	5900 J	(RT 7.48)
		Hexadecanoic Acid[c]	120 J,N	(RT 24.44)	Unknown[d]	82 J	(RT 26.29)	Unknown[d]	4200 J	(RT 8.37)
		Unknown[d]	130 J	(RT 24.75)	Unknown[d]	140 J	(RT 28.64)	Unknown[d]	5400 J	(RT 8.64)
		Unknown[d]	75 J	(RT 24.95)	Unknown[d]	120 J	(RT 29.76)	Unknown[d]	3000 J	(RT 8.70)
		Unknown[d]	130 J	(RT 26.21)	Unknown[d]	110 J	(RT 30.82)	Unknown[d]	6600 J	(RT 8.90)
		11H-Benzo[A]Fluorene[e]	240 J,N	(RT 27.76)	Octacosane[b]	100 J,N	(RT 31.87)	Unknown[d]	4300 J	(RT 9.04)
		11H-Benzo[B]Fluorene[e]	110 J,N	(RT 27.97)	Unknown[d]	210 J	(RT 32.92)	Unknown[d]	4500 J	(RT 9.40)
		4-Methyl-Pyrene[e]	100 J,N	(RT 28.06)	Unknown[d]	150 J	(RT 33.96)	3,4-Dimethyl-Decane[b]	4900 J,N	(RT 10.50)
		Unknown[d]	120 J	(RT 28.54)	Unknown[d]	150 J	(RT 34.99)	7-Methyl-Tridecane[b]	5400 J,N	(RT 11.57)
		Unknown[d]	120 J	(RT 29.66)				2,7,10-Trimethyl-Dodecane[b]	11000 J,N	(RT 18.49)
		Unknown[d]	110 J	(RT 29.81)				Unknown[d]	13000 J	(RT 18.65)
		Unknown[d]	61 J	(RT 30.72)				Phenol, 4-(1,1,3,3-Tetrameth[b]	5800 J,N	(RT 19.17)
		Unknown[d]	140 J	(RT 31.79)				Nonyl-Phenol[b]	4000 J,N	(RT 19.25)
		Unknown[d]	120 J	(RT 32.82)				Unknown[d]	9800 J	(RT 33.72)
		Benzo[J]Fluoranthene[e]	160 J,N	(RT 34.49)				Unknown[d]	7900 J	(RT 34.09)
		Unknown[d]	200 J	(RT 34.92)						
TIC Total	µg/kg		19511 (21)			14535 (14)			125500 (20)	

Table 3–24. Data Summary Table: Soil – Site 3 – Former Leach Field, 178th Tactical Fighter Group, Springfield ANGB, Springfield, Ohio (Continued)

SAIC ID Number		SB3–4–2	SB3–5–1	SB3–5–2
Laboratory ID Number		9548	9549	9550
Collection Date		5–19–93	5–19–93	5–19–93
Collection Depth (ft)		12.0–14.0	6.0–8.0	13.0–15.0
Associated Field QC Sample		TB52093	TB52093	TB52093
		EB2–2, EB3–2	EB2–2, EB3–2	EB2–2, EB3–2
		N/A	N/A	N/A
Parameter	Units	FB2–2, FB3–2	FB2–2, FB3–2	FB2–2, FB3–2
TOTAL PETROLEUM HYDROCARBONS (SW 8015M)				
Gasoline	mg/kg	< 0.05	84	8.7
Diesel Fuel	mg/kg	19	670	86
Heavy Oil	mg/kg	18	440	77
PRIORITY POLLUTANT METALS				
AA METALS				
Antimony (SW 3050/7041)	mg/kg	0.10 UJ(N,W)	0.1 UJ(N,W)	0.09 UJ(N,W)
Arsenic (SW 3050/7060)	mg/kg	5.7 J(N)	3.2 J(N)	5.6 J(N)
Lead (SW 3050/7421)	mg/kg	7.5 J(N)	11.7 J(N)	7.5 J(N)
Mercury (SW 3050/7471)	mg/kg	0.05 U	0.05 U	0.05 U
Selenium (SW 3050/7740)	mg/kg	0.16 U	0.15 U	0.14 UJ(W)
Thallium (SW 3050/7841)	mg/kg	0.33 J(W)	0.24 U	0.22 UJ(W)
ICP METALS (SW 3050/6010)				
Beryllium	mg/kg	0.31 U(MB)	0.16 U(MB)	0.27 U(MB)
Cadmium	mg/kg	0.65 U	0.6 U	0.58 U
Chromium	mg/kg	8.2	35.1	8
Copper	mg/kg	12.2	13.5	13.4
Nickel	mg/kg	16.3	7.1	15.9
Silver	mg/kg	0.51 U	6.7	0.46 U
Zinc	mg/kg	32.4 J(E)	45.6 J(E)	52 J(E)
VOLATILE ORGANICS (SW 8240 [A])				
Acetone	µg/kg	11 U	52 U(EB)	12 U
Carbon Disulfide	µg/kg	11 U	2 J	12 U
Toluene	µg/kg	11 U	3 J	12 U
Ethylbenzene	µg/kg	11 U	2 J	12 U
Xylene (total)	µg/kg	11 U	18 X	12 U
TICs	µg/kg	Hexane [a] 8 J,N (RT 8.55)	Cyclohexane, 1,1,3–Trimethyl [b] 82 J,N (RT 20.73)	1,1,2,3–Tetramethylcyclohexane [b] 6 J,N (RT 26.47)
			4–Methyl–Octane [b] 78 J,N (RT 21.41)	Cyclopentane, 2–Isopropyl–1, [b] 7 J,N (RT 27.40)
			3–Methyl–Octane [b] 56 J,N (RT 21.84)	1–Heptacosanol [b] 16 J,N (RT 31.64)
			Cyclohexane, 1–Ethyl–2–Methy [b] 170 J,N (RT 24.27)	
			3,6–Dimethyl–Octane [b] 160 J,N (RT 24.65)	
			Propyl–Cyclohexane [b] 150 J,N (RT 25.41)	
			2,5,6–Trimethyl–Decane [b] 140 J,N (RT 25.72)	
			2,5–Dimethyl–Octane [b] 210 J,N (RT 25.95)	
			3,3,5–Trimethyl–1–Hexene [b] 370 J,N (RT 26.60)	
			Cyclohexane, 1,1,4,4–Tetrame [b] 92 J,N (RT 27.31)	
			Cyclopentane, 1–Methyl–3–(2– [b] 440 J,N (RT 27.55)	
			4–Methyl–Decane [b] 690 J,N (RT 28.51)	
TIC Total	µg/kg	8 (1)	2638 (12)	29 (3)

Table 3–24. Data Summary Table: Soil – Site 3 – Former Leach Field, 178th Tactical Fighter Group, Springfield ANGB, Springfield, Ohio (Continued)

SAIC ID Number		SB3–4–2			SB3–5–1			SB3–5–2		
Laboratory ID Number		9548			9549			9550		
Collection Date		5–19–93			5–19–93			5–19–93		
Collection Depth (ft)		12.0–14.0			6.0–8.0			13.0–15.0		
Associated Field QC Sample		TB52093 EB2–2, EB3–2 N/A FB2–2, FB3–2			TB52093 EB2–2, EB3–2 N/A FB2–2, FB3–2			TB52093 EB2–2, EB3–2 N/A FB2–2, FB3–2		
Parameter	Units									
SEMIVOLATILE ORGANICS (SW 8270 [B])										
N–Nitroso–di–N–propylamine	µg/kg		370 UJ(EHT)			370 U			400 U	
2–Methylnaphthalene	µg/kg		370 UJ(EHT)			69 J			400 U	
Acenaphthene	µg/kg		370 UJ(EHT)			370 U			400 U	
Fluorene	µg/kg		370 UJ(EHT)			96 J			400 U	
Phenanthrene	µg/kg		370 UJ(EHT)			220 J			400 U	
Anthracene	µg/kg		370 UJ(EHT)			370 U			400 U	
Carbazole	µg/kg		370 UJ(EHT, CCV)			370 UJ(CCV)			400 U	
Fluoranthene	µg/kg		370 UJ(EHT)			380			400 UJ(CCV)	
Pyrene	µg/kg		370 UJ(EHT)			370 U			400 U	
Benzo(a)anthracene	µg/kg		370 UJ(EHT)			370 U			400 U	
Chrysene	µg/kg		370 UJ(EHT)			370 U			400 U	
bis(2–Ethylhexyl)phthalate	µg/kg		370 UJ(EHT)			530 U(MB)			400 U	
di–N–Octyl phthalate	µg/kg		370 UJ(EHT)			370 U			400 U(MB)	
Benzo(b)fluoranthene	µg/kg		370 UJ(EHT)			370 U			400 U	
Benzo(k)fluoranthene	µg/kg		370 UJ(EHT)			370 U			400 U	
Benzo(a)pyrene	µg/kg		370 UJ(EHT)			370 U			400 U	
Indeno(1,2,3–c,d)pyrene	µg/kg		370 UJ(EHT)			370 U			400 U	
Benzo(gh,i)perylene	µg/kg		370 UJ(EHT)			370 U			400 U	
TICs	µg/kg	4–Hydroxy–4–Methyl–2–Pentanone[a]	10000 B,J,N,A	(RT 3.50)	3–Ethyl–2–Methyl–Heptane[b]	750 J,N	(RT 5.33)	4–Hydroxy–4–Methyl–2–Pentanone[a]	15000 B,J,N,A	(RT 3.77)
		4,7–Dimethyl–Undecane[b]	550 J,N	(RT 11.97)	5–Ethyl–2–Methyl–Heptane[b]	2500 J,N	(RT 7.02)	4,6–Dimethyl–Undecane[b]	430 J,N	(RT 13.57)
		Tetradecane[b]	850 J,N	(RT 13.70)	Unknown[d]	1400 J	(RT 9.10)	4,7–Dimethyl–Undecane[b]	740 J,N	(RT 14.00)
		Unknown[d]	530 J	(RT 14.67)	2,6–Dimethyl–Undecane[b]	2100 J,N	(RT 10.77)	Unknown[d]	660 J	(RT 14.99)
		2,7,10–Trimethyl–Dodecane[b]	1000 J,N	(RT 15.32)	2,3,7–Trimethyl–Octane[b]	1900 J,N	(RT 11.85)	2,6,11–Trimethyl–Dodecane[b]	570 J,N	(RT 15.65)
		Hexadecane[b]	1100 J,N	(RT 16.87)	Unknown[d]	1800 J	(RT 13.69)	Phenol, 4–(2,2,3,3–Tetrameth[b]	2900 J,N	(RT 17.27)
		Unknown[d]	520 J	(RT 17.55)	Unknown[d]	1900 J	(RT 15.10)	5–Propyl–Tridecane[b]	520 J,N	(RT 17.89)
		Heptadecane[b]	1800 J,N	(RT 18.34)	Phenol, 4–(2,2,3,3–Tetrameth[b]	6500 J,N	(RT 17.40)	Unknown[d]	2400 J	(RT 18.69)
		Unknown[d]	760 J	(RT 19.74)	Unknown[d]	1300 J	(RT 17.99)	Unknown[d]	610 J	(RT 18.80)
		Unknown[d]	570 J	(RT 19.80)	2,6–Dimethyl–Heptadecane[b]	5400 J,N	(RT 18.84)	2–Nonylphenol[b]	300 J,N	(T 18.94)
		Unknown[d]	720 J	(RT 21.05)	Unknown[d]	3700 J	(RT 18.97)	Phenol, 4–(1,1,3,3–Tetrameth[b]	290 J,N	(RT 19.37)
		Unknown[d]	830 J	(RT 22.34)	2–Nonylphenol[b]	5000 J,N	(RT 19.09)	Unknown[d]	740 J	(RT 20.07)
		Unknown[d]	720 J	(RT 23.54)	Unknown[d]	4600 J	(RT 19.24)	Unknown[d]	610 J	(RT 20.15)
		Unknown[d]	590 J	(RT 24.70)	Unknown[d]	5100 J	(RT 19.37)	Unknown[d]	1000 J	(RT 21.40)
		Docosane[b]	650 J,N	(RT 25.82)	Phenol, 4–(1,1,3,3–Tetrameth[b]	5900 J,N	(RT 19.50)	Unknown[d]	590 J	(RT 22.67)
		Unknown[d]	540 J	(RT 26.91)	Nonyl–Phenol[b]	4600 J,N	(RT 19.59)	Unknown[d]	760 J	(RT 23.90)
		Octacosane[b]	530 J,N	(RT 27.96)	Hexadecane, 2,6,10,14–Tetram[b]	3600 J,N	(RT 20.24)	Unknown[d]	560 J	(RT 25.07)
		Unknown[d]	440 J	(RT 28.97)	Phosphoric Acid, 2–Ethylhexy[c]	5900 J,N	(RT 27.54)	Unknown[d]	690 J	(RT 26.19)
		Unknown[d]	400 J	(RT 29.96)	Unknown[d]	7100 J	(RT 34.09)	Unknown[d]	620 J	(RT 27.29)
		Unknown[d]	370 J	(RT 30.92)	Unknown[d]	6500 J	(RT 34.44)	Phosphoric Acid, 2–Ethylhexy[c]	510 J,N	(RT 27.47)
		Unknown[d]	320 J	(RT 31.89)				Unknown[d]	610 J	(RT 28.32)
TIC Total	µg/kg		23790 (21)			77550 (20)			31110 (21)	

Table 3–24. Data Summary Table: Soil – Site 3 – Former Leach Field, 178th Tactical Fighter Group, Springfield ANGB, Springfield, Ohio (Continued)

SAIC ID Number		MW3–1–1	MW3–1–1R	MW3–1–1a
Laboratory ID Number		95266	95267	95031
Collection Date		8–26–92	8–26–92	8–21–92
Collection Depth (ft)		0.5–1.5	0.5–1.5	0.5–1.5
Associated Field QC Sample		TB–10 EB3–1 FB3–1 SD5–FB	TB–10 EB3–1 FB3–1 SD5–FB	TB–8 EB3–1 FB3–1 SD5–FB
Parameter	Units			
TOTAL PETROLEUM HYDROCARBONS (SW 8015M)				
Gasoline	mg/kg	NA	NA	NA
Diesel Fuel	mg/kg	<3 UJ(EHT)	<3 UJ(EHT)	28
Heavy Oil	mg/kg	23 J(EHT)	35 J(EHT)	<2
PRIORITY POLLUTANT METALS				
AA METALS				
Antimony (SW 3050/7041)	mg/kg	R(N)	R(N)	R(N)
Arsenic (SW 3050/7060)	mg/kg	10.6 J(N,*)	10.1 J(N,*)	7.7 J(N)
Lead (SW 3050/7421)	mg/kg	21.7 *	17.5 *	22.2 S
Mercury (SW 3050/7471)	mg/kg	0.08 U	0.09 U	0.08 U
Selenium (SW 3050/7740)	mg/kg	R(N)	R(N)	0.12 UJ(N,W)
Thallium (SW 3050/7841)	mg/kg	0.23 B	0.23 B	0.16 UJ(MB,W)
ICP METALS (SW 3050/6010)				
Beryllium	mg/kg	0.33 B	0.29 B	0.34 B
Cadmium	mg/kg	0.2 U	0.21 U	0.22 U
Chromium	mg/kg	14.8 J(N)	9.6 J(N)	16
Copper	mg/kg	16.8	13.9	17.6
Nickel	mg/kg	17.6	11.8	17.6
Silver	mg/kg	1.6 U(MB)	1.3 U(MB)	2.5 U(MB)
Zinc	mg/kg	70.2 J(N,E)	57.9 J(N,E)	68.9 J(E)
VOLATILE ORGANICS (SW 8240[A])				
Acetone	µg/kg	11 U	12 U	11 U
Carbon Disulfide	µg/kg	11 U	12 U	11 U
Toluene	µg/kg	11 U	2 J	11 U
Ethylbenzene	µg/kg	11 U	12 U	11 U
Xylene (total)	µg/kg	11 U	12 U	11 U
TICs	µg/kg	0 (0)	0 (0)	0 (0)
TIC Total	µg/kg	0 (0)	0 (0)	0 (0)

Table 3–24. Data Summary Table: Soil – Site 3 – Former Leach Field, 178th Tactical Fighter Group, Springfield ANGB, Springfield, Ohio (Continued)

SAIC ID Number			MW3–1–1			MW3–1–1R			MW3–1–1a	
Laboratory ID Number			95266			95267			95031	
Collection Date			8–26–92			8–26–92			8–21–92	
Collection Depth (ft)			0.5–1.5			0.5–1.5			0.5–1.5	
Associated Field QC Sample			TB–10 EB3–1 FB3–1 SD5–FB			TB–10 EB3–1 FB3–1 SD5–FB			TB–8 EB3–1 FB3–1 SD5–FB	
Parameter	Units									
SEMIVOLATILE ORGANICS (SW 8270 [B])										
N–Nitroso–di–N–propylamine	µg/kg		230 J			350 U			340 U	
2–Methylnaphthalene	µg/kg		350 U			350 U			340 U	
Acenaphthene	µg/kg		350 U			350 U			340 U	
Fluorene	µg/kg		350 U			350 U			340 U	
Phenanthrene	µg/kg		130 J			210 J			89 J	
Anthracene	µg/kg		350 U			37 J			340 U	
Carbazole	µg/kg		350 U			350 U			340 U	
Fluoranthene	µg/kg		320 J			500			230 J	
Pyrene	µg/kg		300 J			420			340 J	
Benzo(a)anthracene	µg/kg		140 J			190 J			120 J	
Chrysene	µg/kg		190 J			270 J			150 J	
bis(2–Ethylhexyl)phthalate	µg/kg		60 J			60 J			60 J	
di–N–Octyl phthalate	µg/kg		350 U			350 U			340 U	
Benzo(b)fluoranthene	µg/kg		220 J			270 J			180 J	
Benzo(k)fluoranthene	µg/kg		200 J			180 J			64 J	
Benzo(a)pyrene	µg/kg		160 J			220 J			120 J	
Indeno(1,2,3–c,d)pyrene	µg/kg		140 J			230 J			340 U	
Benzo(gh,i)perylene	µg/kg		110 J			160 J			340 U	
TICs	µg/kg	Unknown [d]	59 J	(RT 22.05)	Hexadecanoic Acid [b]	210 J,N	(RT 22.95)	4–Hydroxy–4–Methyl–2–Pentanone [a]	20000 B,J,N,A	(RT 5.27)
		Unknown [d]	130 J	(RT 24.50)	Unknown [d]	120 J	(RT 24.50)	Unknown [d]	120 J	(RT 16.09)
		Unknown [d]	65 J	(RT 26.74)	Unknown [d]	74 J	(RT 25.07)	Unknown [d]	120 J	(RT 19.24)
		Unknown [d]	88 J	(RT 27.82)	Unknown [d]	69 J	(RT 25.64)	Unknown [d]	150 J	(RT 20.75)
		Unknown [d]	130 J	(RT 28.84)	Unknown [d]	76 J	(RT 26.74)	2,7,10–Trimethyl–Dodecane [b]	110 J,N	(RT 20.79)
		Unknown [d]	140 J	(RT 29.84)	Unknown [d]	170 J	(RT 27.81)	Unknown [d]	83 J	(RT 22.17)
		Unknown [d]	200 J	(RT 30.79)	Pentacosane [b]	140 J,N	(RT 28.82)	Unknown [d]	87 J	(RT 22.27)
		Octacosane [b]	220 J,N	(RT 31.74)	Hexacosane [b]	160 J,N	(RT 29.81)	Unknown [d]	160 J	(RT 23.54)
		Unknown [d]	79 J	(RT 32.01)	Octacosane [b]	190 J,N	(RT 30.79)	Hexadecanoic Acid [b]	170 J,N	(RT 24.30)
		Benzo[J]Fluoranthene [a]	150 J,N	(RT 32.16)	Unknown [d]	190 J	(RT 31.72)	Heptadecane, 2,6,10,14–Tetra [b]	120 J,N	(RT 24.85)
		Nonacosane [b]	240 J,N	(RT 32.67)	Unknown [d]	150 J	(RT 32.01)	Unknown [d]	140 J	(RT 26.09)
		Unknown [d]	210 J	(RT 33.57)	Benzo[J]Fluoranthene [a]	260 J,N	(RT 32.14)	Docosane [b]	150 J,N	(RT 28.44)
		Unknown [d]	140 J	(RT 33.96)	Nonacosane [b]	200 J,N	(RT 32.64)	Unknown [d]	220 J	(RT 29.56)
		Unknown [d]	160 J	(RT 34.36)	Unknown [d]	130 J	(RT 33.56)	Unknown [d]	80 J	(RT 30.54)
		Unknown [d]	220 J	(RT 34.49)	Unknown [d]	92 J	(RT 33.94)	Octacosane [b]	150 J,N	(RT 30.62)
		Unknown [d]	130 J	(RT 34.62)	Unknown [d]	310 J	(RT 34.47)	Unknown [d]	150 J	(RT 31.67)
		Unknown [d]	260 J	(RT 34.74)	Unknown [d]	240 J	(RT 34.71)	Unknown [d]	570 J	(RT 32.72)
		Unknown [d]	290 J	(RT 35.62)	Unknown [d]	200 J	(RT 35.61)	Unknown [d]	150 J	(RT 33.76)
		Unknown [d]	200 J	(RT 36.36)	Unknown [d]	220 J	(RT 36.32)	Benzo[J]Fluoranthene [a]	210 J,N	(RT 34.36)
		Unknown [d]	400 J	(RT 36.52)	Unknown [d]	440 J	(RT 36.52)	Unknown [d]	770 J	(RT 34.81)
								Unknown [d]	550 J	(RT 37.09)
TIC Total	µg/kg	-	3511 (20)			3641 (20)			24260 (21)	

Table 3-24. Data Summary Table: Soil – Site 3 – Former Leach Field
178th Tactical Fighter Group, Springfield ANGB, Springfield, Ohio (Continued)

SAIC ID Number		MW3-1-8
Laboratory ID Number		95032
Collection Date		8-21-92
Collection Depth (ft)		14.0-16.0
Associated Field QC Sample		TB-8 EB3-1 FB3-1 SD5-FB
Parameter	Units	
TOTAL PETROLEUM HYDROCARBONS (SW 8015M)		
Gasoline	mg/kg	NA
Diesel Fuel	mg/kg	12
Heavy Oil	mg/kg	7
PRIORITY POLLUTANT METALS		
AA METALS		
Antimony (SW 3050/7041)	mg/kg	R(N)
Arsenic (SW 3050/7060)	mg/kg	5.2 J(N)
Lead (SW 3050/7421)	mg/kg	8.3
Mercury (SW 3050/7471)	mg/kg	0.09 U
Selenium (SW 3050/7740)	mg/kg	0.11 UJ(N,W)
Thallium (SW 3050/7841)	mg/kg	0.06 U
ICP METALS (SW 3050/6010)		
Beryllium	mg/kg	0.33 B
Cadmium	mg/kg	0.98 U
Chromium	mg/kg	9.5
Copper	mg/kg	13.3
Nickel	mg/kg	10.3 B
Silver	mg/kg	3.5 B
Zinc	mg/kg	53 J(E)
VOLATILE ORGANICS (SW 8240[A])		
Acetone	µg/kg	11 U
Carbon Disulfide	µg/kg	11 U
Toluene	µg/kg	11 U
Ethylbenzene	µg/kg	11 U
Xylene (total)	µg/kg	11 U
TICs	µg/kg	0 (0)
TIC Total	µg/kg	0 (0)

Table 3–24. Data Summary Table: Soil – Site 3 – Former Leach Field 178th Tactical Fighter Group, Springfield ANGB, Springfield, Ohio (Continued)

SAIC ID Number			MW3–1–8	
Laboratory ID Number			95032	
Collection Date			8–21–92	
Collection Depth (ft)			14.0–16.0	
Associated Field QC Sample			TB–8 EB3–1 FB3–1 SD5–FB	
Parameter	Units			
SEMIVOLATILE ORGANICS (SW 8270 [B])				
N–Nitroso–di–N–propylamine	µg/kg		340 U	
2–Methylnaphthalene	µg/kg		340 U	
Acenaphthene	µg/kg		340 U	
Fluorene	µg/kg		340 U	
Phenanthrene	µg/kg		340 U	
Anthracene	µg/kg		340 U	
Carbazole	µg/kg		340 U	
Fluoranthene	µg/kg		340 U	
Pyrene	µg/kg		340 U	
Benzo(a)anthracene	µg/kg		340 U	
Chrysene	µg/kg		340 U	
bis(2–Ethylhexyl)phthalate	µg/kg		340 U	
di–N–Octyl phthalate	µg/kg		340 UJ(CCV)	
Benzo(b)fluoranthene	µg/kg		340 U	
Benzo(k)fluoranthene	µg/kg		340 U	
Benzo(a)pyrene	µg/kg		340 U	
Indeno(1,2,3–c,d)pyrene	µg/kg		340 U	
Benzo(gh,i)perylene	µg/kg		340 U	
TICs	µg/kg	4–Hydroxy–4–Methyl–2–Pentanone[a]	8800 B,J,N,A	(RT 5.33)
		Unknown[d]	130 J	(RT 20.95)
		2,7,10–Trimethyl–Dodecane[b]	88 J,N	(RT 20.99)
		Unknown[d]	100 J	(RT 22.37)
		Unknown[d]	71 J	(RT 22.47)
		Unknown[d]	120 J	(RT 23.75)
		Iron, Tricarbonyl[N–(Phenyl–[c]	95 J,N	(RT 25.04)
		Unknown[d]	90 J	(RT 26.29)
		Unknown[d]	130 J	(RT 28.64)
		Unknown[d]	100 J	(RT 29.76)
		Unknown[d]	85 J	(RT 30.82)
		Octacosane[b]	83 J,N	(RT 31.87)
		Unknown[d]	140 J	(RT 32.92)
		Unknown[d]	150 J	(RT 33.96)
		Unknown[d]	79 J	(RT 34.99)
TIC Total	µg/kg		10261 (15)	

Table 3-24. Data Summary Table: Soil – Site 3 – Former Leach Field, 178th Tactical Fighter Group, Springfield ANGB, Springfield, Ohio (Continued)

Validation note: All descriptive data qualifiers applied to the reported values by the laboratory are reported in parentheses.
Each data point has been assessed to determine whether the value is considered usable (i.e., no qualifier), usable but estimated (i.e., "J"), or not usable (i.e., "R"). All usability qualifiers are followed by the applicable laboratory or field QC qualifier, presented in parentheses and defined below. Usability qualifiers were not applied to values qualified by the laboratory, but were not considered to have been adversely impacted by the applicable laboratory QC result (e.g., duplicated and matrix spike analysis).

a – sample MW3-1-1a was taken from a different borehole than samples MW3-1-1 and MW3-1-1R, the boring was moved because contamination was encountered
A – samples were analyzed for VOCs using SW 8240, laboratory analyses followed methods outlined in the March 1990 CLP SOW for organic analyses
B – samples were analyzed for SVOCs using SW 3550/8270, laboratory analysis followed method details outlined in the March 1990 CLP SOW for organic analyses
NA – not analyzed
N/A – not applicable
RT – retention time in minutes
TICs–tentatively identified compounds, total concentration is listed and the total number of tentatively identified compounds is inside the paranthases

Data Validation Qualifiers

J – associated numerical value is the approximate concentration
R – rejected value
U – compound/element was included in analysis, but was not detected
UJ – reported quantitation limit is approximate and may or may not represent the actual quantitation necessary to accurately and precisely measure the analyte

Explanatory Data Validation Qualifiers

CCV – continuing calibration verification
D – the identified compound was analyzed at a secondary dilution factor after exceeding the calibration range of the instrument on the first analysis
EB – compound/element was also detected in the associated equipment blank
EHT – extraction holding time outside control limits
FD – field duplicates relative percent differences (RPDs) outside control limits
MB – compound/element was also detected in the associated laboratory method blank

EPA-defined CLP SOW Laboratory Qualifiers

A(TICs) – suspects ALDOL-condensation product
B(metals) – the reported value is estimated because it is greater than the Instrument Detection Limit (IDL), but less than the Contract Required Detection Limit (CRDL)
B(organics) – compound was also detected in the associated laboratory method blank
E(metals) – the reported value is estimated due to the presence of interference
E(organics) – concentration exceeds the calibration range of the instrument; the sample must be diluted and reanalyzed
N – spiked sample recovery outside of control limits
N(TICs) – presumptive evidence of a compound
S – the reported value was determined by the Method of Standard Additions (MSA)
W – post-digestion spike for Graphite Furnace Atomic Absorption (GFAA) analysis is out of control limits (85-115%), while sample absorbance is less than 50% of the spike absorbance
X – compound is present, but does not meet CLP criteria
* – duplicate sample analysis outside of control limits

SAIC TIC Evaluation Categories

[a] – laboratory and extraction artifacts
[b] – petroleum or petroleum degradation products
[c] – other
[d] – unknown
[e] – polycyclic aromatic hydrocarbons
[f] – naturally occuring organic compounds

Table 3–25. Data Summary Table: Groundwater – Site 3 – Former Leach Field, 178th Tactical Fighter Group, Springfield ANGB, Springfield, Ohio

SAIC ID Number		MW3-1-1	MW3-1-1R	MW3-1-2
Laboratory ID Number		97311	97314	9571, 9587
Collection Date		9-30-92	9-30-92	5-21-93
Associated Field QC Sample		TB-14 ERBG-2 FBBA-1 FBCE-1	TB-14 ERBG-2 FBBA-1 FBCE-1	TB52193 EB2-2, EB3-2 N/A FB2-2, FB3-2
Parameter	**Units**			
TOTAL PETROLEUM HYDROCARBONS (SW 8015M)				
Gasoline	mg/L	NA	NA	<0.25
Diesel Fuel	mg/L	<0.2	<0.2	<0.13
Heavy Oil	mg/L	<0.2	<0.2	<0.25
TOTAL PRIORITY POLLUTANT METALS				
AA METALS				
Antimony (SW 3020/7041)	μg/L	1.3 J(N)	R(N)	1.9 J(N,W)
Arsenic (SW 3020/7060)	μg/L	62.4 J(FD)	30.9 J(FD)	2.3 J(N)
Lead (SW 3020/7421)	μg/L	59.2 J(*,FD)	33.3 J(*,+,FD)	62.4 S
Selenium (SW 7740)	μg/L	R(N)	R(N)	R(N)
ICP METALS (SW 3005/6010)				
Beryllium	μg/L	3.3 J(FD)	1.4 J(FD)	2.6 B
Cadmium	μg/L	2.1 U	2.1 U	3.8 B
Chromium	μg/L	90.6 J(FD)	45.3 J(FD)	84.4
Copper	μg/L	152 J(FD)	71.6 J(FD)	124
Nickel	μg/L	170 J(FD)	83.9 J(FD)	128
Silver	μg/L	10.5	11.1	2.9 UJ(N)
Zinc	μg/L	570 U(FB)	287 U(FB)	428 J(E)
DISSOLVED PRIORITY POLLUTANT METALS				
AA METALS				
Antimony (SW 3020/7041)	μg/L	NA	NA	0.9 U
Lead (SW 3020/7421)	μg/L	NA	NA	0.7 U(EB)
ICP METALS (SW 3005/6010)				
	μg/L	NA	NA	ND
VOLATILE ORGANICS (A)				
1,2-Dichloroethene (total)	μg/L	0.5 U	0.5 U	0.5 UJ(SR)
Trichloroethene	μg/L	0.5 U	0.5 U	0.5 U
TICs	μg/L	0 (0)	0 (0)	0 (0)
TIC Total	μg/L	0 (0)	0 (0)	0 (0)
SEMIVOLATILE ORGANIC (SW 8270 [B])				
TICs	μg/L	Unknown[d] 7 J (RT 5.88) Unknown[d] 2 J (RT 8.15) 2-Propanol, 1-(2-Methoxy-1-M[c] 2 J,N (RT 8.23) 2,5,8,10,14,17-Hexaoxaoctade[c] 18 J,N (RT 17.6) Octadecanoic Acid, 2-Methylp[b] 3 J,N (RT 29.34)	2,5,8,11,14,17-Hexaoxaoctade[c] 18 J,N (RT 17.6)	4-Hydroxy-4-Methyl-2-Pentanone[a] 4 J,N,A (RT 3.80) 2,5,8,11,14,17-Hexaoxaoctade[c] 3 J,N (RT 15.87) Unknown[d] 2 J (RT 30.52)
TIC Totals	μg/L	32 (5)	18 (1)	9 (3)

Table 3-25. Data Summary Table: Groundwater – Site 3 – Former Leach Field, 178th Tactical Fighter Group Springfield ANGB, Springfield, Ohio (Continued)

SAIC ID Number		P-4-1	P-4-1R
Laboratory ID Number		9575, 9591	9576, 9592
Collection Date		5-21-93	5-21-93
Associated Field QC Sample		TB52193 EB2-2, EB3-2 N/A FB2-2, FB3-2	TB52193 EB2-2, EB3-2 N/A FB2-2, FB3-2
Parameter	Units		
TOTAL PETROLEUM HYDROCARBONS (SW 8015M)			
Gasoline	mg/L	<0.25	<0.25
Diesel Fuel	mg/L	<0.13	<0.13
Heavy Oil	mg/L	<0.25	<0.25
TOTAL PRIORITY POLLUTANT METALS			
AA METALS			
Antimony (SW 3020/7041)	μg/L	0.8 J(N)	0.9 J(N)
Arsenic (SW 3020/7060)	μg/L	5.1 J(N)	4.7 J(N)
Lead (SW 3020/7421)	μg/L	14	16.6
Selenium (SW 7740)	μg/L	R(N)	R(N)
ICP METALS (SW 3005/6010)			
Beryllium	μg/L	0.82 B	0.63 B
Cadmium	μg/L	3.7 U	3.7 U
Chromium	μg/L	25.3	22.6
Copper	μg/L	38.8	38.8
Nickel	μg/L	23 B	20.3 B
Silver	μg/L	2.9 UJ(N)	2.9 UJ(N)
Zinc	μg/L	157 J(E)	156 J(E)
DISSOLVED PRIORITY POLLUTANT METALS			
AA METALS			
Antimony (SW 3020/7041)	μg/L	1 B	2.9 B
Lead (SW 3020/7421)	μg/L	0.6 U(EB)	13.1
ICP METALS (SW 3005/6010)			
	μg/L	ND	ND
VOLATILE ORGANICS (A)			
1,2-Dichloroethene (total)	μg/L	0.6 X	0.5 X
Trichloroethene	μg/L	0.7	0.7
TICs	μg/L	6-Amino-Hexanoic Acid[f] 7 J,N (RT 11.87)	6-Amino-Hexanoic Acid[c] 13 J,N (RT 11.75)
TIC Total	μg/L	7 (1)	13 (1)
SEMIVOLATILE ORGANIC (SW 8270 [B])			
TICs	μg/L	6-Amino-Hexanoic Acid[f] 7 J,N (RT 11.87)	6-Amino-Hexanoic Acid[c] 13 J,N (RT 11.75)
TIC Totals	μg/L	7 (1)	13 (1)

Table 3–25. Data Summary Table: Groundwater – Site 3 – Former Leach Field, 178th Tactical Fighter Group, Springfield ANGB, Springfield, Ohio (Continued)

Validation note: All descriptive data qualifiers applied to the reported values by the laboratory are reported in parentheses.
Each data point has been assessed to determine whether the value is considered usable (i.e., no qualifier), usable but estimated (i.e., "J"), or not usable (i.e., "R"). All usability qualifiers are followed by the applicable laboratory or field QC qualifier, presented in parentheses and defined below. Usability qualifiers were not applied to values qualified by the laboratory, but were not considered to have been adversely impacted by the applicable laboratory QC result (e.g., duplicated and matrix spike analysis).

A – groundwater samples were analyzed for volatile halogenated compounds and volatile aromatic compounds by E 524.2 for samples collected in 1992 or SW 8240 (25 ml purge for low level volatiles) for samples collected in 1993; these methods have been modified to incorporate CLP–type QC requirements
B – SVOCs in groundwater and field QC blanks were analyzed using EPA method 3510/8270
NA – not analyzed
ND – not detected
N/A – not applicable
RT – retention time in minutes
TICs – tentatively identified compounds, total concentration is listed and the total number of tentatively identified compounds is inside the parenthases

Data Validation Qualifiers

J – associated numerical value is the approximate concentration
R – rejected value
U – compound/element was included in analysis, but was not detected
UJ – reported quantitation limit is approximate and may or may not represent the actual quantitation necessary to accurately and precisely measure the analyte

Explanatory Data Validation Qualifiers

EB – compound/element was also detected in the associated equipment blank
FB – compound/element was also detected in the associated field blank
FD – field duplicate relative percent differences (RPDs) outside control limits
SR – surrogate recovery outside control limits

EPA–defined CLP SOW Laboratory Qualifiers

A(TICs) – suspects ALDOL–condensation product
B(metals) – the reported value is estimated because it is greater than the Instrument Detection Limit (IDL), but less than the Contract Required Detection Limit(CRDL)
E(metals) – the reported value is estimated due to the presence of interference
N – spiked sample recovery outside of control limits
N(TICs) – presumptive evidence of a compound
S – the reported value was determined by the Method of Standard Additions (MSA)
W – post–digestion spike for Graphite Furnace Atomic Absorption (GFAA) analysis is out of control limits (85–115%), while sample absorbance is less than 50% of the spike absorbance
X – compound is present, but does not meet CLP criteria
* – duplicate sample analysis outside of control limits
+ – correlation coefficient for the Method of Standard Additions is less than 0.995

SAIC TIC Evaluation Categories

[a] – laboratory and extraction artifacts
[b] – petroleum or petroleum degradation products
[c] – other
[d] – unknown
[f] – naturally occuring organic compounds

Table 3-26. ARAR Comparison Table: Groundwater - Site 3 - Former Leach Field, 178th Tactical Fighter Group, Springfield ANGB, Springfield, Ohio

	CONCENTRATION IN GROUNDWATER (µg/L)		COMPARISON vs ARARS	
Parameter	Mean Detected Result	Maximum Detected Result	Mean Detected Result	Maximum Detected Result
METALS				
Antimony	1.6	1.9	- -	- -
Arsenic	24.5	46.7	- -	- -
Beryllium	2.5	2.6	- -	- -
Cadmium	2.4	3.8	- -	- -
Chromium	76.2	84.4	- -	- -
Copper	117.9	124	- -	- -
Lead	54.3	62.4	>MCL; >OMCL	>MCL; >OMCL
Nickel	127.5	128	>MCL; >OMCL	>MCL; >OMCL
Silver	6.1	10.8	- -	- -
Zinc	321.1	428	- -	- -

- - ARAR not exceeded or ARAR not available (see Table 3-9)
MCL - Safe Drinking Water Act (SDWA) maximum contaminant level
OMCL - Ohio maximum contaminant level

NOTE: Unless otherwise indicated, results are for total metals detected in unfiltered groundwater.

Table 3-27. Comparison of Site 3, Leach Field, Results with Background Upper Tolerance Limits: Soil
178th Tactical Fighter Group, Springfield ANGB, Springfield, Ohio

Parameter	Units	Proportion of Results Greater than Detection Limit	Minimum Detected Result	Mean Detected Result	Maximum Detected Result	Upper Tolerance Limit	Proportion of Results Greater than Upper Tolerance Limit
Diesel Fuel	mg/kg	5 / 8	3	181.8	670	37.00	3 / 8
Heavy Oil	mg/kg	5 / 8	29	143.1	440	160.00	3 / 8
INORGANICS							
Antimony	mg/kg	1 / 2	0.16	0.105	0.16	0.21	0 / 2
Arsenic	mg/kg	8 / 8	3.2	8.006	13.4	11.30	1 / 8
Beryllium	mg/kg	6 / 8	0.31	0.3106	0.47	0.55	0 / 8
Cadmium	mg/kg	2 / 8	0.28	0.2884	0.68	1.50	0 / 8
Chromium (III)	mg/kg	8 / 8	9.5	21.53	35.5	121.00	0 / 8
Copper	mg/kg	8 / 8	13.5	23.47	59.2	48.70	1 / 8
Lead	mg/kg	8 / 8	8.1	26.6	47.4	126.00	0 / 8
Mercury	mg/kg	2 / 8	0.05	0.0522	0.12	0.50	0 / 8
Nickel	mg/kg	8 / 8	7.1	16.78	24.3	61.50	0 / 8
Selenium	mg/kg	1 / 7	0.18	0.0829	0.18	0.25	0 / 7
Silver	mg/kg	3 / 8	2.7	3.928	16.4	5.30	2 / 8
Thallium	mg/kg	1 / 8	0.23	0.115	0.23	0.40	0 / 8
Zinc	mg/kg	8 / 8	45.6	106.3	312	343.00	0 / 8
ORGANICS							
Anthracene	mg/kg	3 / 8	0.106	0.1801	0.13	0.12	7 / 8
Benzo(a)anthracene	mg/kg	7 / 8	0.11	0.3025	0.8	0.21	3 / 8
Benzo(a)pyrene	mg/kg	7 / 8	0.079	0.2943	0.75	0.22	3 / 8
Benzo(b)fluoranthene	mg/kg	7 / 8	0.12	0.415	1.1	0.37	2 / 8
Benzo(g,h,i)perylene	mg/kg	5 / 8	0.073	0.2485	0.55	0.20	2 / 8
Benzo(k)fluoranthene	mg/kg	7 / 8	0.037	0.1983	0.38	0.13	6 / 8
Carbazole	mg/kg	2 / 8	0.058	0.1729	0.075	0.11	6 / 8
Chrysene	mg/kg	7 / 8	0.094	0.3386	0.9	0.25	3 / 8
Ethylbenzene	mg/kg	2 / 8	0.002	0.0085	0.01	0.01	2 / 8
Fluoranthene	mg/kg	8 / 8	0.23	0.775	2.1	0.44	4 / 8
Indeno(1,2,3-cd)pyrene	mg/kg	6 / 8	0.078	0.2835	0.72	0.23	2 / 8
Phenanthrene	mg/kg	8 / 8	0.089	0.3261	0.78	0.27	3 / 8
Pyrene	mg/kg	7 / 8	0.34	0.7794	2.4	0.44	3 / 8
Toluene	mg/kg	2 / 8	0.003	0.008	0.0038	0.01	1 / 8
Xylenes	mg/kg	3 / 8	0.003	0.0161	0.08	0.01	2 / 8

Samples MW3-1-1as, MW3-1-1s, SB3-1-1, SB3-2-1, SB3-3-1, SB3-2-4, SB3-4-1, and SB3-5-1were used in the comparison to background samples.

Table 3-28. Comparison of Site 3, Leach Field, Results with Background Upper Tolerance Limits: Groundwater
178th Tactical Fighter Group, Springfield ANGB, Springfield, Ohio

Parameter	Units	Proportion of Results Greater than Detection Limit	Minimum Detected Result	Mean Detected Result	Maximum Detected Result	Upper Tolerance Limit	Proportion of Results Greater than Upper Tolerance Limit
INORGANICS							
Antimony	mg/L	2 / 2	0.0013	0.0016	0.0019	0.0015	1 / 2
Arsenic	mg/L	2 / 2	0.0023	0.0245	0.0467	0.0162	1 / 2
Beryllium	mg/L	2 / 2	0.0024	0.0025	0.0026	0.0042	0 / 2
Chromium (III)	mg/L	2 / 2	0.068	0.0762	0.0844	0.1500	0 / 2
Copper	mg/L	2 / 2	0.1118	0.1179	0.124	0.2100	0 / 2
Lead	mg/L	2 / 2	0.0463	0.0543	0.0624	0.1040	0 / 2
Nickel	mg/L	2 / 2	0.127	0.1275	0.128	0.2470	0 / 2
Silver	mg/L	1 / 2	0.0108	0.0061	0.0108	0.0033	1 / 2
Zinc	mg/L	1 / 2	0.428	0.3211	0.428	0.7630	0 / 2

Samples MW3-1-1 and MW3-1-2 were used in the comparison to background samples.

3.8 SITE 4 - POL STORAGE AREA

Site 4 was the location of an approximately 1,000-gallon JP-4 jet fuel spill. The locationof the spill is well-defined because the boundaries of the POL area where the spill occurred

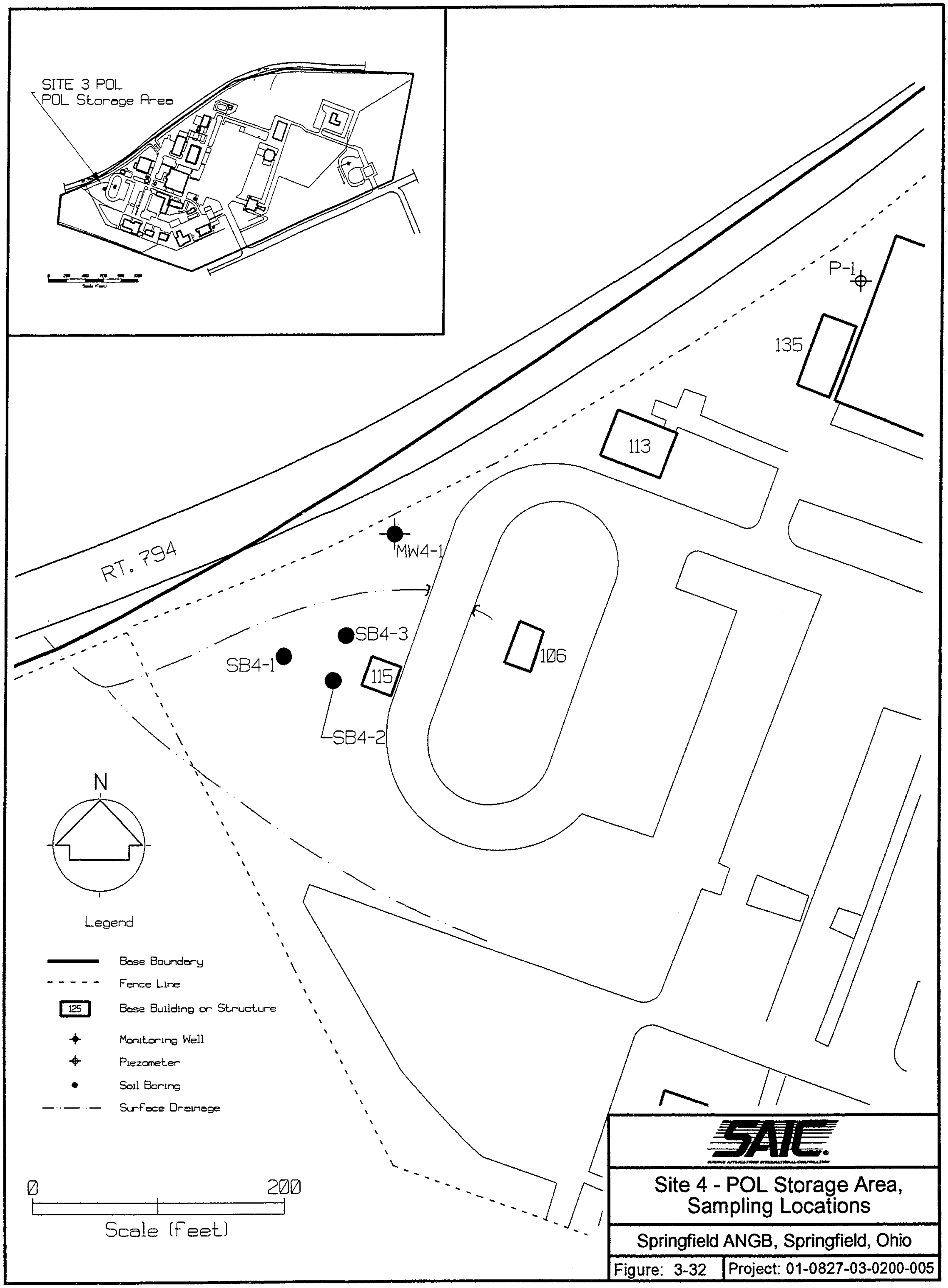
remained essentially unchanged from the time of the spill until the present. An SOV survey was performed beginning directly over the spill site and working away from the site until no VOCs were detected. The tables containing information and analytical results for Site 4 (Tables 3-29 through 3-34) are presented at the end of Section 3.8.

Three soil borings (i.e., SB4-1, SB4-2, and SB4-3) were drilled at the site in the area of maximum VOC concentrations. A fourth soil boring (i.e., MW4-1) was drilled, sampled, and completed as a monitoring well downgradient from the spill area and sampled for groundwater. Soil and water samples were screened using an onsite GC to assist in estimating the vertical extent of VOC contaminants and selecting soil samples to submit for laboratory analyses. Sample locations are shown in Figure 3-32.

Data collected during the SI confirmed the absence of contaminants related to the diesel spill being investigated. Petroleum compounds were detected in one boring at Site 4; however, they do not exhibit the distribution trend expected of bulk hydrocarbon spill residue and appear to be the result of a recent, very localized, small release.

Onsite GC and laboratory analytical results confirmed the presence of chlorinated solvents in soil at the soil-water interface and in groundwater downgradient from the site. Extensive review of the operation and maintenance procedures of the POL yard did not indicate a potential source of the chlorinated solvents. The source and extent of these compounds is unknown; however, they are not believed to be site related.

The following subsections discuss the field investigation results. The significance of the findings also are discussed with respect to ARARs, background compound concentrations, and limitations of the data collected.



Site 4 - POL Storage Area, Sampling Locations

Springfield ANGB, Springfield, Ohio

Figure: 3-32 Project: 01-0827-03-0200-005

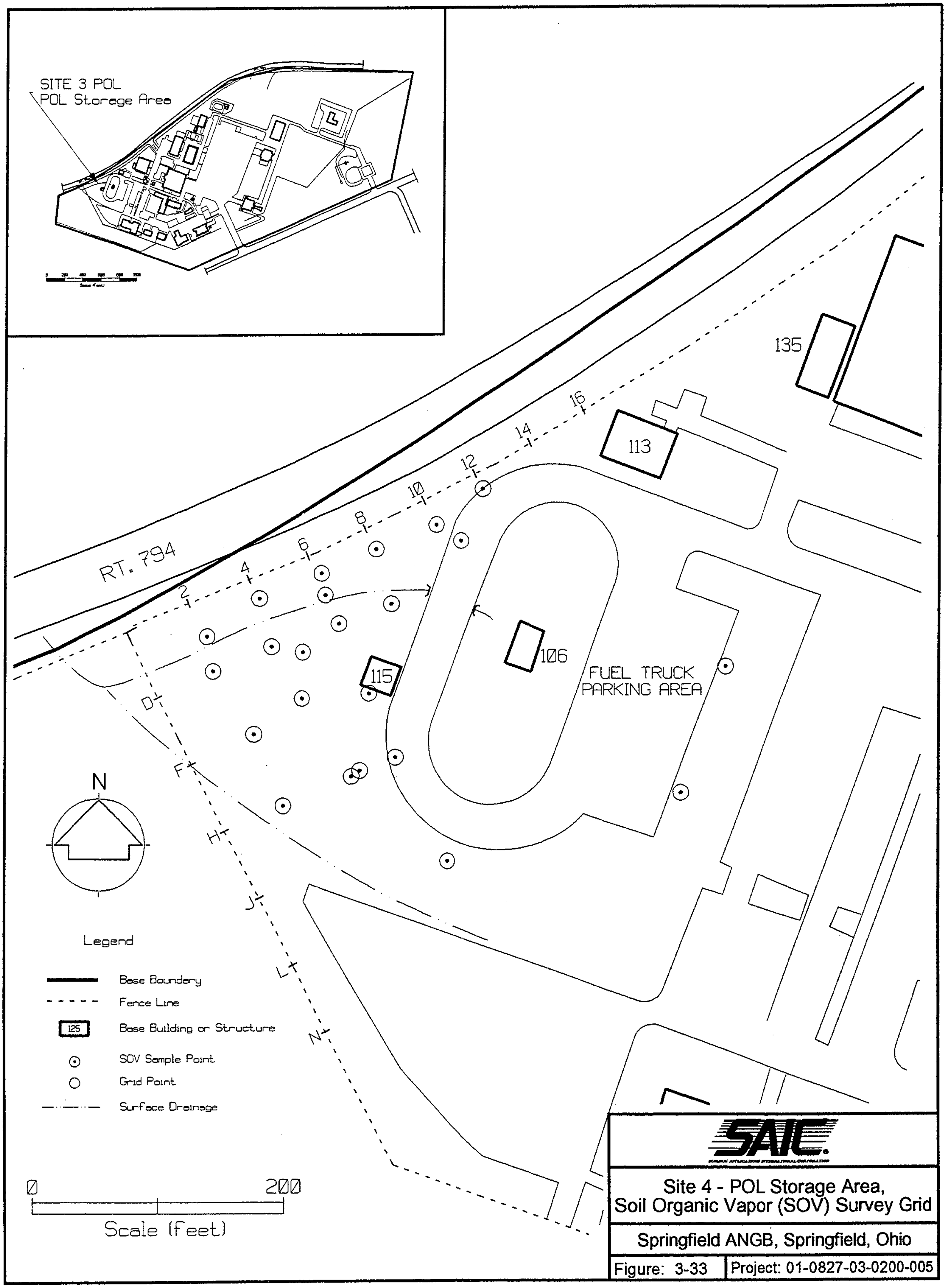
3.8.1 Site 4 Lithology

The lithologies encountered during the SI at Site 4 are similar to the stratigraphic relationships identified at the other sites investigated. A thick layer of fine-grained clayey silt and/or silty clay intermixed with a moderate amount of fine to coarse grained sand overlies the site. Stratigraphically below this silty clay/clayey silt unit lies the dark gray, fine grained unit. However, because relatively shallow borings were drilled at this site, this unit was only observed during the drilling of the monitoring well. This gray, fine-grained unit overlies the shallow aquifer material, which consists of coarse grained sand and gravel. A geologic cross section is not illustrated for Site 4 because only one lithologic unit could be correlated between the soil borings.

3.8.2 Soil Organic Vapor Survey

To determine the possible presence and extent of volatile organic contamination in the soil atmosphere at the POL storage area, an SOV survey was conducted over the suspected area of contamination. A survey grid with sample points spaced 50 feet apart was established east of Building 106 and the fuel truck parking area at the location of the previously discussed JP-4 fuel spill. Figure 3-33 shows the location of the SOV survey grid and the POL yard, including the fuel truck parking area. Twenty-two sample points within the grid were used to perform the SOV survey. Three additional ambient air samples were analyzed for QA/QC. The survey was initiated in the center of the grid area and extended toward the Base boundary. The survey continued until the extent of VOCs in the soil vapor at Site 4 was determined. The SOV samples were tested for the analytes described in Section 2. The complete results of the SOV survey and sample analyses are provided in a report prepared by Tracer Research Corporation (Appendix C).

A TVHC concentration of 170 μg/L was detected at grid point D6 located approximately 30 feet east of Building 115. The grid spacing near D6 was reduced to evaluate the D6 results. Two additional SOV samples were collected and analyzed at points 25 feet downslope from D6. The maximum TVHC concentration for adjacent grid point samples (0.09 μg/L) did not indicate a pattern of contamination. These data indicate that D6 may be an isolated pocket of hydrocarbon contamination, possibly resulting from an undocumented, recent, small spill of



Site 4 - POL Storage Area,
Soil Organic Vapor (SOV) Survey Grid

Springfield ANGB, Springfield, Ohio

Figure: 3-33 Project: 01-0827-03-0200-005

petroleum product. The data also indicate that VOC concentration within the remainder of Site 4 soil vapor does not contain residual volatile compounds from the JP-4 spill. A map showing TVHC concentrations (Figure 3-32) was generated from the SOV data and used to locate three soil borings which are also shown in Figure 3-34.

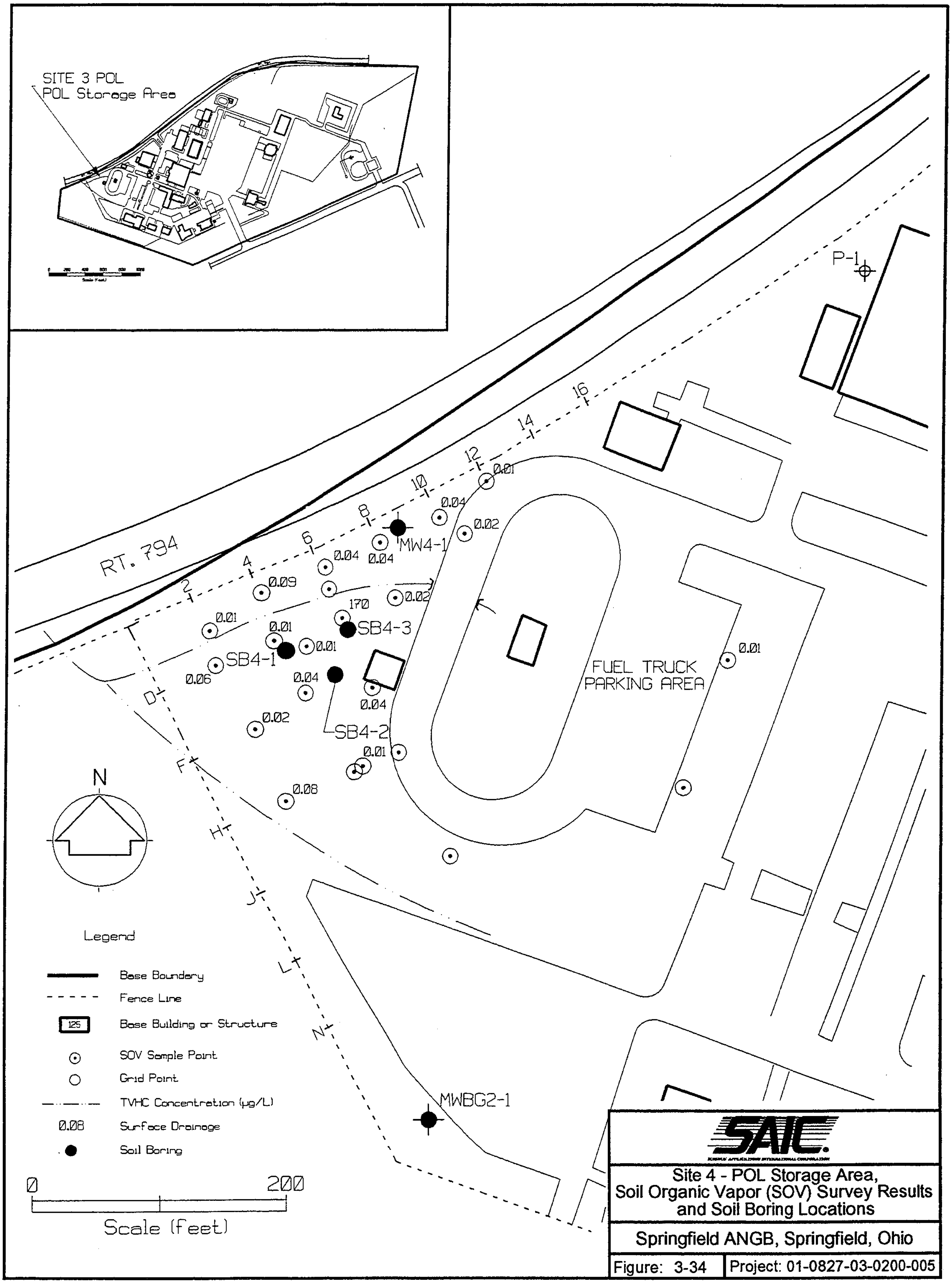
3.8.3 Chemicals Detected in Soil

Four borings were drilled at Site 4 (i.e., SB4-1, SB4-2, SB4-3, and MW4-1), with one boring (i.e., MW4-1) being completed as a groundwater monitoring well. These sample locations are shown in Figure 3-34. The borings were located based on maximum potential contamination determined by the SOV survey and assessment of groundwater flow direction to locate the monitoring well downgradient from the spill area. The 170 μg/L TVHC SOV datum, detected at SOV coordinate D6 immediately to the east of Building 115, served as the primary basis for the location of soil borings. Soil boring SB4-3 was located at D6 with SB4-2 located 40 feet downslope. Soil boring SB4-1 also was located about 35 feet downslope from SB4-3 and along the former ditch that drained the JP-4 fuel spill. Monitoring well MW4-1 was located downgradient from the former 1,000-gallon fuel spill and SOV coordinate D6 in order to determine if contamination was migrating downgradient and offsite.

All borings were sampled at continuous 2-foot intervals to the saturated soil interval. Upon collection, all soil samples were analyzed in the field with a mobile GC laboratory for 1,1-TCA, CCl_4, TCE, PCE, and BTEX. The results of the onsite GC screening were used to guide field procedures and to determine if additional soil samples should be collected for laboratory analysis. Onsite screening results are presented in Table 3-29.

Onsite GC screening data from borings within the spill area show that volatile organic concentrations are localized at the location of SB4-3. This location also was identified as a local source of VOCs in the SOV survey and in the laboratory analytical results.

Onsite GC analysis detected TCE concentrations in the saturated soil samples collected from MW4-1. Onsite screening results indicated that soil intervals above the saturated zone do not contain detectable concentrations of TCE. The screening results for TCE correlate with the



Site 4 - POL Storage Area,
Soil Organic Vapor (SOV) Survey Results
and Soil Boring Locations

Springfield ANGB, Springfield, Ohio

Figure: 3-34 | Project: 01-0827-03-0200-005

not contain detectable concentrations of TCE. The screening results for TCE correlate with the laboratory analytical results for groundwater and soil, which are discussed below.

Two soil samples were collected for laboratory analysis from SB4-1 and SB4-2. Three soil samples were collected from SB4-3 and MW4-1 for laboratory analysis. The additional sample collected from SB4-3 was because of elevated concentrations of TVOs detected during the onsite GC analysis. The additional sample collected from MW4-1 was due to the detection of TCE and benzene detected during the onsite GC analysis. Laboratory analytical results are summarized in Table 3-30. A detailed discussion of the TICs detected at Site 4 is presented in Appendix G, Section G.4.

Soils encountered during the drilling operations were primarily clays and silts with only two exceptions: at a depth of 6.5 to 8.5 feet in SB4-2 and 8 to 10 feet in SB4-1. In these intervals, there was a greater percentage of sand than silts or clay. The predominance of fine sediments (clays and silts) at the POL storage area is significant in that these soils inhibit the vertical and lateral migration of contaminants. Evidence of minimal vertical migration of petroleum constituents is apparent when observing the trend of decreasing TPH with depth. Where concentrations (15 to 77 mg/kg) of petroleum constituents were detected in near-surface soil samples (SB4-1 and SB4-3), subsequent samples from greater depths in the same borings indicated decreasing TPH concentrations (not detected to 15 mg/kg). Maximum TPH concentrations (77 mg/kg heavy oil, 42 mg/kg diesel fuel) in soil at Site 4 were less than regulatory criteria and are compared to background criteria in Section 3.8.5.

Inorganic constituents were detected in soils, including beryllium, chromium, copper, nickel, and zinc, and also are compared to background criteria in Section 3.8.5.

Estimated TCE concentrations of 9 μg/kg were detected in the soil collected from MW4-1 at 8 to 10 feet BLS. TCE concentrations were not detected in the interval immediately above the 8- to 10-foot interval. The source and extent of TCE contamination are unknown. Eleven nontarget VOCs were identified in only one sample (i.e., SB4-3-3) collected from Site 4. All VOC TICs were identified as branched alkanes or cycloalkanes. They were placed in the petroleum or petroleum degradation products category. The source of the contamination may be related to the JP-4 fuel spill.

3.8.4 Chemicals Detected in Groundwater

Two rounds of groundwater samples were collected from the downgradient monitoring well (MW4-1). The first round groundwater sample (MW4-1-1) was analyzed for TPH, lead, ICP metals, VOCs, and SVOCs using the methods previously described for groundwater. AA metals, except for lead, were not suspected diesel fuel constituents and were not included. The second round groundwater sample was analyzed for the above methods plus AA metals because a different, unidentified source of contamination was suspected other than the JP-4 spill. The location of MW4-1 is shown in Figure 3-35. Table 3-31 summarizes the groundwater analytical data.

VOCs detected in samples collected from MW4-1 include TCE, 1,2-dichloroethene (total) (1,2-DCE), and benzene. TCE and 1,2-DCE were detected in sample MW4-1-1 at concentrations of 71E and 3X μg/L, respectively. The 1,2-DCE concentration of 3X μg/L is well below the Federal MCL of 70 μg/L established by the Safe Drinking Water Act (SDWA[1]). The TCE concentration of 71E μg/L is an order of magnitude greater than the MCL of 5 μg/L. The second round groundwater sample (MW4-1-2) contained 1,2-DCE, TCE, and benzene at 10J, 12OE, and 0.4J μg/L, respectively. TPH were not detected in the sample collected from MW4-1. Metals concentrations for the unfiltered samples collected from MW4-1 did not exceed ARARs and dissolved inorganic compounds were not detected. The groundwater analytical results for MW4-1 are compared to ARARs in Table 3-32.

3.8.5 Comparison of Chemicals Detected to Background Criteria

This section compares background results (presented in Section 3.3 and Tables 3-4 and 3-5), to sample results from Site 4 - POL Storage Area. Results from four soil samples were compared with the background UCL_{90} (Table 3-33). Most of the results for inorganic

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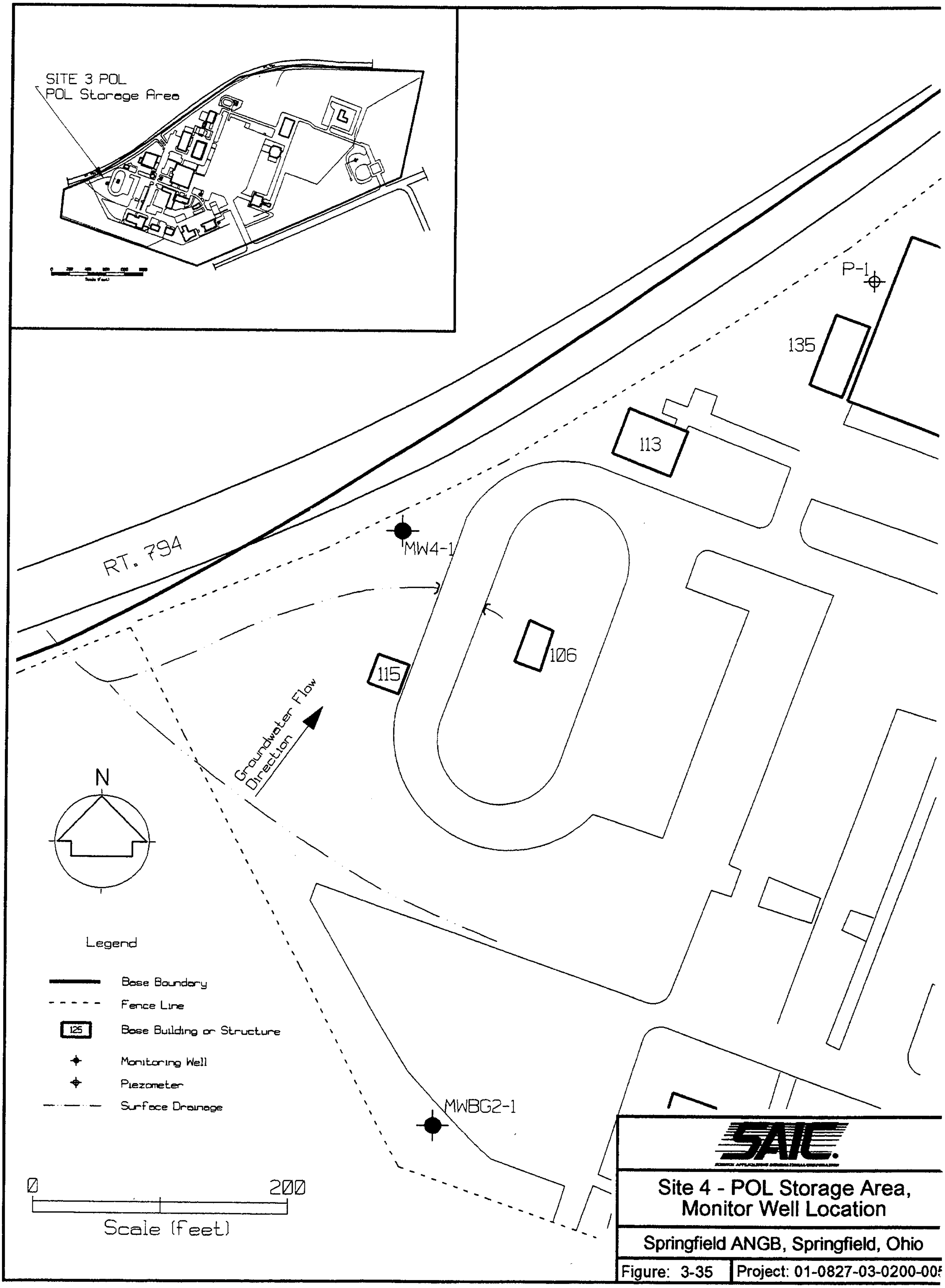
[1] Federal MCLs actually provide concentrations for two types of 1,2-DCEs: cis-1,2-DCE and trans-1,2-DCE. The lowest concentration of these two is cis-1,2-DCE at 70 μg/L.



Site 4 - POL Storage Area, Monitor Well Location

Springfield ANGB, Springfield, Ohio

Figure: 3-35

Project: 01-0827-03-0200-00

constituents did not exceed the UCL_{90}. Some of the results, including the maximum detected result, only slightly exceeded the UCL_{90}; this supports the conclusion that no statistically significant evidence suggests that these contaminants are related to activities conducted at the site. TPH as diesel fuel was detected at the site in two borings. Only one sample slightly exceeded the background UCL_{90}.

Nine inorganics and two organic compounds were detected in Site 4 unfiltered groundwater samples. Although some of the results for inorganic constituents exceeded the UCL_{90} (Table 3-34), the results do not provide significant evidence of site contamination, with the possible exception of antimony, copper, or silver. 1,2-Dichloroethylene and trichloroethylene were detected at levels greater than the background UCL_{90}; however, their source has not been identified and is not considered related to the diesel fuel spill.

3.8.6 Summary of Results

The SOV survey, onsite screening, and laboratory analysis results indicate that petroleum constituents are present at Site 4 in only one localized area; concentrations do not exceed regulatory criteria and are less than background criteria. Based on the limited extent and highly localized nature of detected petroleum contaminants at Site 4, it appears that no residue from the former fuel spill is present in the soil or groundwater at the POL storage area.

Laboratory analytical results confirm the presence of TCE and 1,2-DCE in groundwater samples. TCE concentrations in groundwater are above MCLs. In addition, TCE was detected in the soil sample from MW4-1 at the water table. The source and extent of contamination by the above chlorinated solvents in soil and groundwater are unknown. Tank cleaning procedures promulgated by the ANG do not, and have not, allowed the use of solvents for tank or tank truck cleaning. Base personnel near the site were interviewed to determine if sources of TCE were used in any past or present procedures; however, no TCE sources were found.

Table 3—29. Onsite Gas Chromatography Results for Soil at Site 4 – POL Storage Area, 178th Tactical Fighter Group, Springfield ANGB, Springfield, Ohio

Soil Boring	Sample Number	Depth (feet BLS)	Analytical Parameters (μg/kg) TVO	TCA	CCl_4	TCE	PCE	BEN	TOL	ETZ	XYL	Comments
SB4–1	SB4–1–01	0.5–2.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	Sample sent to lab 8/13/92.
	SB4–1–02	2.5–4.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	Soil/water interface. Soil Sample sent to lab 8/13/92.
	SB4–1–03	4.5–6.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	Saturated interval.
SB4–2	SB4–2–01	0.5–2.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	Sample sent to lab 8/13/92.
	SB4–2–02	2.5–4.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	Soil/water interface. Sample sent to lab 8/13/92.
	SB4–2–03	4.5–6.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	
	SB4–2–04	6.5–8.5	120	0.3	ND	ND	ND	ND	ND	ND	ND	Saturated interval.
SB4–3	SB4–3–01	0.5–2.5	260	ND	ND	ND	ND	ND	ND	ND	ND	Replicate sample taken. Sample and replicate sample sent to lab 8/13/92.
	SB4–3–02	2.5–4.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	Sample sent to lab 8/13/92.
	SB4–3–03	4.5–6.5	5900	ND	ND	ND	ND	68	214	622	674	Soil/water interface. Sample sent to lab 8/13/92.
	SB4–3–04	6.5–8.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	Saturated interval.
MW4–1	MW4–1–01	0.5–2.5	400	ND	ND	ND	ND	ND	ND	ND	ND	Sample sent to lab 8/26/92.
	MW4–1–02	2.5–4.0	2700	ND	ND	ND	ND	13	ND	ND	ND	
	MW4–1–03	4.5–6.0	1100	ND	ND	ND	ND	ND	ND	ND	ND	
	MW4–1–04	6.0–7.5	3300	ND	ND	ND	ND	32	ND	ND	ND	Sample sent to lab 8/26/92.
	MW4–1–05	8.0–9.5	6400	ND	ND	157	ND	10	ND	ND	ND	Soil/water interface. Sample sent to lab 8/26/92.
	MW4–1–06	10.0–12.0	25000	ND	ND	193	ND	ND	ND	ND	ND	
	MW4–1–07	12.0–14.0	2500	ND	ND	5	ND	ND	ND	ND	ND	

Table 3–30. Data Summary Table: Soil – Site 4 – POL Storage Area, 178th Tactical Fighter Group Springfield ANGB, Springfield, Ohio

SAIC ID Number		SB4–1–1	SB4–1–2	SB4–2–1	SB4–2–2
Laboratory ID Number		94530	94528	94529	94531
Collection Date		8–12–92	8–12–92	8–12–92	8–12–92
Collection Depth (ft)		0.5–2.5	2.5–4.5	0.5–2.5	2.5–4.5
Associated Field QC Sample		TB–1 on 8–12–92 ER1–1 FB1–1 SD5–FB	TB–1 on 8–12–92 ER1–1 FB1–1 SD5–FB	TB–1 on 8–12–92 ER1–1 FB1–1 SD5–FB	TB–1 on 8–12–92 ER1–1 FB1–1 SD5–FB
Parameter	Units				
TOTAL PETROLEUM HYDROCARBONS (SW 8015M)					
Diesel Fuel	mg/kg	42	<2	<2	<2
Heavy Oil	mg/kg	77	<2	<2	<2
PRIORITY POLLUTANT METALS					
AA METALS					
Lead (SW 3050/7421)	mg/kg	16.9	21.4	17.7	17.4
ICP METALS (SW 3050/6010)					
Beryllium	mg/kg	0.34 B	0.48	0.99	0.83
Cadmium	mg/kg	0.31 B	0.19 U	0.21 U	0.27 U
Chromium	mg/kg	7.3	10.3	19.3	19.3
Copper	mg/kg	10.3	14.9	26.2	40.6
Nickel	mg/kg	9.6	13.6	34.5	36.6
Zinc	mg/kg	33.7 J(E)	52 J(E)	70.1 J(E)	73.7 J(E)
VOLATILE ORGANICS (SW 8240 [A])					
Trichloroethene	μg/kg	11 U	13 U	13 U	12 U
Toluene	μg/kg	11 U	13 UJ(IS)	13 U	12 U
TICs	μg/kg	0 (0)	0 (0)	0 (0)	0 (0)
TIC Totals	μg/kg	0 (0)	0 (0)	0 (0)	0 (0)
SEMIVOLATILE ORGANICS	μg/kg	NA	NA	NA	NA

Table 3–30. Data Summary Table: Soil – Site 4 – POL Storage Area, 178th Tactical Fighter Group Springfield ANGB, Springfield, Ohio (Continued)

SAIC ID Number		SB4–3–1	SB4–3–1R	SB4–3–2	SB4–3–3
Laboratory ID Number		94535	94536	94538	94537
Collection Date		8–12–92	8–12–92	8–12–92	8–12–92
Collection Depth (ft)		0.5–2.5	0.5–2.5	2.5–4.5	4.5–6.5
Associated Field QC Sample		TB–1 on 8–12–92 ER1–1 FB1–1 SD5–FB	TB–1 on 8–12–92 ER1–1 FB1–1 SD5–FB	TB–1 on 8–12–92 ER1–1 FB1–1 SD5–FB	TB–1 on 8–12–92 ER1–1 FB1–1 SD5–FB
Parameter	Units				
TOTAL PETROLEUM HYDROCARBONS (SW 8015M)					
Diesel Fuel	mg/kg	15 J(FD)	<2	26	10
Heavy Oil	mg/kg	34 J(FD)	<2	59	15
PRIORITY POLLUTANT METALS					
AA METALS					
Lead (SW 3050/7421)	mg/kg	19.5	17.7	15.2	22.7
ICP METALS (SW 3050/6010)					
Beryllium	mg/kg	0.63	0.6	0.71	0.79
Cadmium	mg/kg	0.2 U	0.22 U	0.23 U	0.23 U
Chromium	mg/kg	12.1	14.3	18.1	16.3
Copper	mg/kg	19.2	15.5	18.3	19.5
Nickel	mg/kg	12.8	14.3	16.9	23.8
Zinc	mg/kg	44.5 J(E)	41.3 J(E)	52.3 J(E)	59.6 J(E)
VOLATILE ORGANICS (SW 8240 [A])					
Trichloroethene	μg/kg	12 U	12 U	12 U	12 U
Toluene	μg/kg	12 U	12 U	3 J	12 U
TICs	μg/kg	0 (0)	0 (0)	0 (0)	2,4–Dimethyl–Hexane[b] 47 J,N (RT 13.87) Cyclopentane, 1,2,4–Trimethy[b] 14 J,N (RT 14.58) 2,3–Dimethyl–Hexane[b] 14 J,N (RT 15.49) 3–Ethyl–Hexane[b] 47 J,N (RT 16.13) 2,2–Dimethyl–3–Hexanone[b] 10 J,N (RT 18.74) 3,5–Dimethyl–Heptane[b] 27 J,N (RT 19.17) Cyclohexane, 1,2,4–Trimethyl[b] 20 J,N (RT 19.81) 4–Methyl–Octane[b] 36 J,N (RT 20.54) 3,5–Dimethyl–Heptane[b] 18 J,N (RT 21) Cyclohexane, 1–Ethyl–2–Methy[b] 10 J,N (RT 23.44) Cyclopentane, 1–Methyl–3–(2–[b] 12 J,N (RT 26.8)
TIC Totals	μg/kg	0 (0)	0 (0)	0 (0)	255 (11)
SEMIVOLATILE ORGANICS	μg/kg	NA	NA	NA	NA

Table 3–30. Data Summary Table: Soil – Site 4 – POL Storage Area
178th Tactical Fighter Group, Springfield ANGB, Springfield, Ohio (Continued)

SAIC ID Number		MW4–1–1S	MW4–1–4S	MW4–1–5S
Laboratory ID Number		95273	95274	95275
Collection Date		8–26–92	8–26–92	8–26–92
Collection Depth (ft)		0.5–2.5	6.0–7.5	8.0–9.5
Associated Field QC Sample		TB–10 EB4–1 FB4–1 SD5–FB	TB–10 EB4–1 FB4–1 SD5–FB	TB–10 EB4–1 FB4–1 SD5–FB
Parameter	Units			
TOTAL PETROLEUM HYDROCARBONS (SW 8015M)				
Diesel Fuel	mg/kg	<3 UJ(EHT)	<3 UJ(EHT)	<3 UJ(EHT
Heavy Oil	mg/kg	<3 UJ(EHT)	4 J(EHT)	13 J(EHT)
PRIORITY POLLUTANT METALS				
AA METALS				
Lead (SW 3050/7421)	mg/kg	19 J(*)	8.3 J(*)	4.8 J(*)
ICP METALS (SW 3050/6010)				
Beryllium	mg/kg	0.53	0.27 B	0.14 B
Cadmium	mg/kg	0.19 U	0.19 U	0.18 U
Chromium	mg/kg	11.4 J(N)	7.6 J(N)	3.8 J(N)
Copper	mg/kg	20.3	15.3	11.9
Nickel	mg/kg	22.5	15.1	7
Zinc	mg/kg	72.9 J(N,E)	48.1 J(N,E)	34.4 J(N,E)
VOLATILE ORGANICS (SW 8240 [A])				
Trichloroethene	µg/kg	12 U	11 U	9 J
Toluene	µg/kg	12 U	11 U	12 U
TICs	µg/kg	0 (0)	0 (0)	0 (0)
TIC Totals	µg/kg	0 (0)	0 (0)	0 (0)
SEMIVOLATILE ORGANICS	µg/kg	NA	NA	NA

Table 3–30. Data Summary Table: Soil – Site 4 – POL Storage Area, 178th Tactical Fighter Group Springfield ANGB, Springfield, Ohio (Continued)

Validation note: All descriptive data qualifiers applied to the reported values by the laboratory are reported in parentheses. Each data point has been assessed to determine whether the value is considered usable (i.e., no qualifier), usable but estimated (i.e., "J"), or not usable (i.e., "R"). All usability qualifiers are followed by the applicable laboratory or field QC qualifier, presented in parentheses and defined below. Usability qualifiers were not applied to values qualified by the laboratory, but were not considered to have been adversely impacted by the applicable laboratory QC result (e.g., duplicated and matrix spike analysis).

A – samples were analyzed for VOCs using SW 8240, laboratory analyses followed methods outlined in the March 1990 CLP SOW for organic analyses
NA – not analyzed
RT – retention time in minutes
TICs – tentatively identified compounds, total concentration is listed and the total number of tentatively identified compounds is inside the parenthases

Data Validation Qualifiers

J – associated numerical value is the approximate concentration
U – compound/element was included in analysis, but was not detected
UJ – reported quantitation limit is approximate and may or may not represent the actual quantitation necessary to accurately and precisely measure the analyte

Explanatory Data Validation Qualifiers

EHT – extraction holding times outside control limit
IS – internal standard outside control limits

EPA–defined CLP SOW Laboratory Qualifiers

B(metals) – the reported value is estimated because it is greater than the Instrument Detection Limit (IDL), but less than the Contract Required Detection Limit (CRDL)
E(metals) – the reported value is estimated due to the presence of interference
N – spiked sample recovery outside of control limits
N(TICs) – presumptive evidence of a compound
* – duplicate sample analysis outside of control limits

SAIC TIC Evaluation Categories

[b] – petroleum or petroleum degradation products

Table 3–31. Data Summary Table: Groundwater – Site 4 – POL Storage Area 178th Tactical Fighter Group, Springfield ANGB, Springfield, Ohio

SAIC ID Number		MW4–1–1	MW4–1–1DL	MW4–1–2	MW4–1–2DL
Laboratory ID Number		97272	97272DL	9572, 9588	9572DL
Collection Date		9–29–92	9–29–92	5–21–93	5–21–93
Associated Field QC Sample		TB–12,13 ERBG–2 FBBA–1 FBCE–1	TB–12,13 ERBG–2 FBBA–1 FBCE–1	TB52193 EB2–2, EB3–2 N/A FB2–2, FB3–2	TB52193 EB2–2, EB3–2 N/A FB2–2, FB3–2
Parameter	Units				
TOTAL PETROLEUM HYDROCARBONS (SW 8015M)					
Gasoline	mg/L	NA	NA	<0.25	NA
Diesel Fuel	mg/L	<0.2	NA	<0.13	NA
Heavy Oil	mg/L	<0.2	NA	<0.25	NA
TOTAL PRIORITY POLLUTANT METALS					
AA METALS					
Antimony (SW 3020/7041)	μg/L	NA	NA	2.2 J(N,W)	NA
Arsenic (SW 3020/7060)	μg/L	NA	NA	2.9 J(N)	NA
Lead (SW 3020/7421)	μg/L	4.3 U(MB)	NA	69	NA
Mercury (SW 7470)	μg/L	NA	NA	0.16 B	NA
Selenium (SW 7740)	μg/L	NA	NA	R(N)	NA
Thallium (SW 3020/7841)	μg/L	NA	NA	1.9 J(W)	NA
ICP METALS (SW 3005/6010)					
Beryllium	μg/L	0.3 U	NA	4.1 B	NA
Cadmium	μg/L	2.1 U	NA	10.9	NA
Chromium	μg/L	7.3 B	NA	127	NA
Copper	μg/L	13.4 U(FB)	NA	212	NA
Nickel	μg/L	20.7 B	NA	216	NA
Silver	μg/L	3.8 U	NA	3.6 J(N)	NA
Zinc	μg/L	50.3 U(FB)	NA	709 J(E)	NA
DISSOLVED PRIORITY POLLUTANT METALS					
AA METALS	μg/L	NA	NA	ND	NA
ICP METALS (SW 3005/6010)	μg/L	NA	NA	ND	NA
VOLATILE ORGANICS (A)					
1,2–Dichloroethene (total)	μg/L	3 X	3 DX	10 J(SR)	9 DX
Trichloroethene	μg/L	71 E	61 D	120 E	110 D
Benzene	μg/L	0.5 U	0.9 U	0.4 J	0.5 DJ
TICs	μg/L	0 (0)	0 (0)	0 (0)	0 (0)
TIC Total	μg/L	0 (0)	0 (0)	0 (0)	0 (0)
SEMIVOLATILE ORGANIC (SW 8270 [B])					
TICs	μg/L	Decanoic Acid[b] 10 J,N (RT 27.09)	NA	0 (0)	NA
TIC Total	μg/L	10 (1)	NA	0 (0)	NA

Table 3–31. Data Summary Table: Groundwater – Site 4 – POL Storage Area
178th Tactical Fighter Group, Springfield ANGB, Springfield, Ohio (Continued)

Validation note: All descriptive data qualifiers applied to the reported values by the laboratory are reported in parentheses. Each data point has been assessed to determine whether the value is considered usable (i.e., no qualifier), usable but estimated (i.e., "J"), or not usable (i.e., "R"). All usability qualifiers are followed by the applicable laboratory or field QC qualifier, presented in parentheses and defined below. Usability qualifiers were not applied to values qualified by the laboratory, but were not considered to have been adversely impacted by the applicable laboratory QC result (e.g., duplicated and matrix spike analysis).

A – groundwater samples were analyzed for volatile halogenated compounds and volatile aromatic compounds by E 524.2 for samples collected in 1992 or SW 8240 (25 ml purge for low level volatiles) for samples collected in 1993; these methods have been modified to incorporate CLP–type QC requirements
B – SVOCs in groundwater and field QC blanks were analyzed using EPA method 3510/8270
NA – not analyzed
N/A – not applicable
RT – retention time in minutes
TICs–tentatively identified compounds, total concentration is listed and the total number of tentatively identified compounds is inside the parenthases

Data Validation Qualifiers

J – associated numerical value is the approximate concentration
R – rejected value
U – compound/element was included in analysis, but was not detected

Explanatory Data Validation Qualifiers

D – the identified compound was analyzed at a secondary dilution factor after exceeding the calibration range of the instrument on the first analysis
FB – compound/element was also detected in the associated field blank
MB – compound/element was also detected in the associated laboratory method blank
SR – surrogate recovery outside control limits

EPA–defined CLP SOW Laboratory Qualifiers

B(metals) – the reported value is estimated because it is greater than the Instrument Detection Limit (IDL), but less than the Contract Required Detection Limit(CRDL)
E(metals) – the reported value is estimated due to the presence of interference
E(organics) – concentration exceeds the calibration range of the instrument; the sample must be diluted and reanalyzed
N – spiked sample recovery outside of control limits
N(TICs) – presumptive evidence of a compound
W – post–digestion spike for Graphite Furnace Atomic Absorption (GFAA) analysis is out of control limits (85–115%), while sample absorbance is less than 50% of the spike absorbance
X – compound is present, but does not meet CLP criteria

SAIC TIC Evaluation Categories

[b] – petroleum or petroleum degradation products

Table 3-32. ARAR Comparison Table: Groundwater - Site 4 - POL Storage Area, 178th Tactical Fighter Group, Springfield ANGB, Springfield, Ohio

	CONCENTRATION IN GROUNDWATER (µg/L)		COMPARISON vs ARARS	
Parameter	Mean Detected Result	Maximum Detected Result	Mean Detected Result	Maximum Detected Result
METALS				
Antimony	2.2	2.2	- -	- -
Arsenic	2.9	2.9	- -	- -
Beryllium	2.1	4.1	- -	>MCL
Chromium	67.2	127	- -	>MCL; >OMCL
Copper	109.4	212	- -	- -
Lead	35.6	69	>MCL; >OMCL	>MCL; >OMCL
Nickel	118.4	216	>MCL; >OMCL	>MCL; >OMCL
Silver	2.8	3.6	- -	- -
Zinc	367.1	709	- -	- -
ORGANICS				
1,2-Dichloroethylene	6.5	10	- -	- -
Trichloroethylene	95.5	120	>MCL; >OMCL	>MCL; >OMCL

- - ARAR not exceeded or ARAR not available (see Table 3-9)
MCL - Safe Drinking Water Act (SDWA) maximum contaminant level
OMCL - Ohio maximum contaminant level

NOTE: Unless otherwise indicated, metals results are for total metals detected in unfiltered groundwater.

Table 3-33. Comparison of Site 4, POL Storage Area, Results with Background Upper Tolerance Limits: Soil 178th Tactical Fighter Group, Springfield ANGB, Springfield, Ohio

Parameter	Units	Proportion of Results Greater than Detection Limit	Minimum Detected Result	Mean Detected Result	Maximum Detected Result	Upper Tolerance Limit	Proportion of Results Greater than Upper Tolerance Limit
Diesel Fuel	mg/kg	2 / 4	15	14.88	42	37.00	1 / 4
Heavy Oil	mg/kg	2 / 4	34	28.38	77	160.00	0 / 4
INORGANICS							
Beryllium	mg/kg	4 / 4	0.34	0.6225	0.99	0.55	2 / 4
Cadmium	mg/kg	1 / 4	0.31	0.1525	0.31	1.50	0 / 4
Chromium (III)	mg/kg	4 / 4	7.3	12.53	19.3	121.00	0 / 4
Copper	mg/kg	4 / 4	10.3	19	26.2	48.70	0 / 4
Lead	mg/kg	4 / 4	16.9	18.28	19.5	126.00	0 / 4
Nickel	mg/kg	4 / 4	9.6	19.85	34.5	61.50	0 / 4
Zinc	mg/kg	4 / 4	33.7	55.3	72.9	343.00	0 / 4

Samples MW4-1-1s, SB4-1-1, SB4-2-1, and SB4-3-1 were used in the comparison to background samples.

Table 3-34. Comparison of Site 4, POL Storage Area, Results with Background Upper Tolerance Limits: Groundwater 178th Tactical Fighter Group, Springfield ANGB, Springfield, Ohio

Parameter	Units	Proportion of Results Greater than Detection Limit	Minimum Detected Result	Mean Detected Result	Maximum Detected Result	Upper Tolerance Limit	Proportion of Results Greater than Upper Tolerance Limit
INORGANICS							
Antimony	mg/L	1 / 1	0.0022	0.0022	0.0022	0.0015	1 / 1
Arsenic	mg/L	1 / 1	0.0029	0.0029	0.0029	0.0162	0 / 1
Beryllium	mg/L	1 / 2	0.0041	0.0021	0.0041	0.0042	0 / 2
Chromium (III)	mg/L	2 / 2	0.0073	0.0672	0.127	0.1500	0 / 2
Copper	mg/L	1 / 2	0.212	0.1094	0.212	0.2100	1 / 2
Lead	mg/L	1 / 2	0.069	0.0356	0.069	0.1040	0 / 2
Nickel	mg/L	2 / 2	0.0207	0.1184	0.216	0.2470	0 / 2
Silver	mg/L	1 / 2	0.0036	0.0028	0.0036	0.0033	1 / 2
Zinc	mg/L	1 / 2	0.709	0.3671	0.709	0.7630	0 / 2
ORGANICS							
1,2-Dichloroethylene	mg/L	2 / 2	0.003	0.0065	0.01	0.0006	2 / 2
Trichloroethylene	mg/L	2 / 2	0.071	0.0955	0.12	0.0007	2 / 2

Samples MW4-1-1 and MW4-1-2 were used in the comparison to background samples.

3.9 SITE 5 - RAMP DRAINAGE DITCH (RDD)

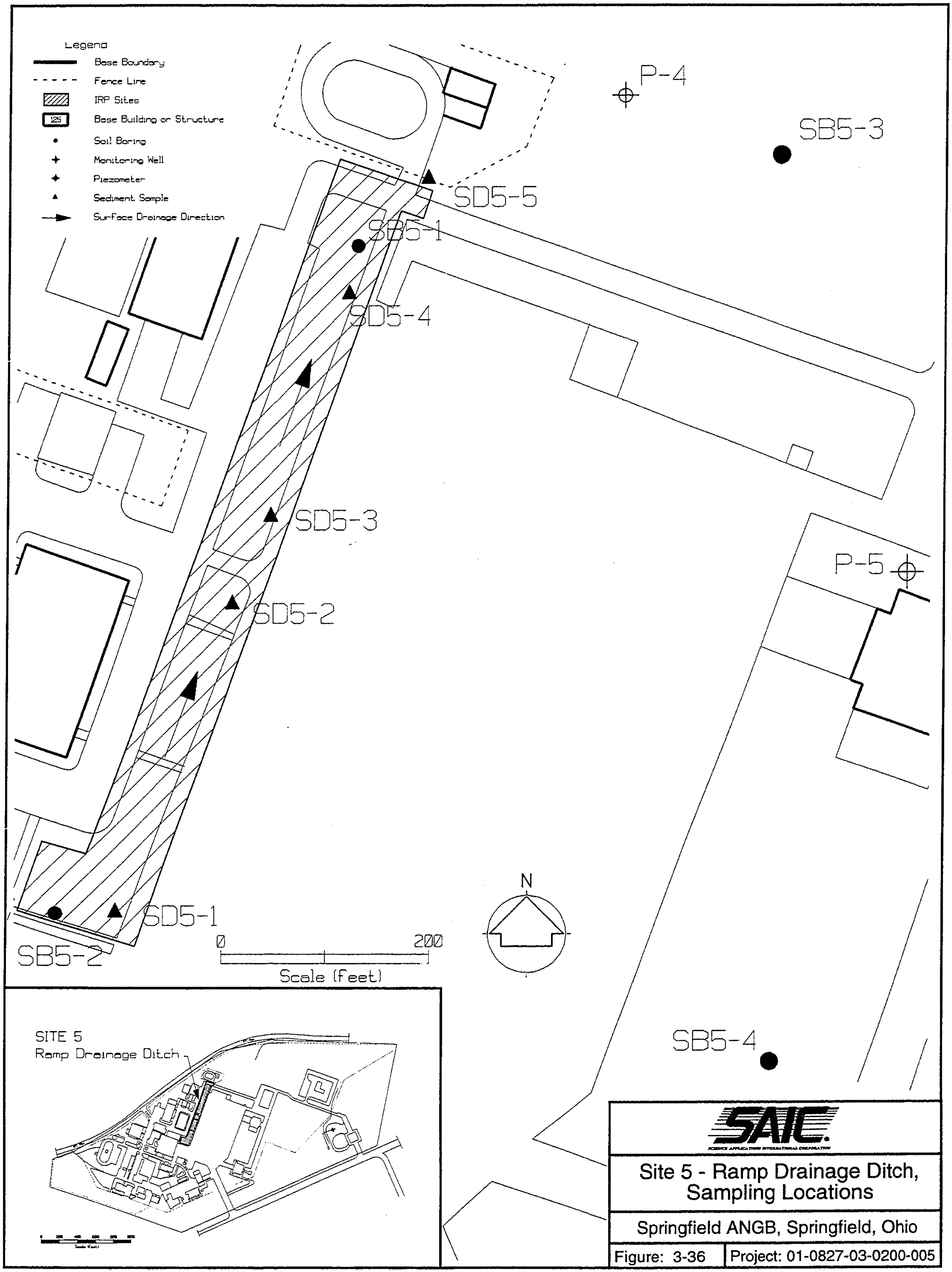
The RDD is located along the aircraft parking apron and collects surface runoff from the parking apron, a paved road that runs parallel to the RDD, and an aircraft maintenance hangar ramp. Because an oily sheen was observed floating on water in the RDD, five sediment samples (i.e., SD5-1 through SD5-5) were collected at regularly spaced intervals along the RDD. Analysis of the sediment confirmed the presence of petroleum-related contaminants (TPH and PAHs) in the upper 0.5 feet BLS. Maximum TPH values were detected in SD5-1 (diesel fuel at 400 mg/kg) and SD5-4 (diesel fuel at 120 and heavy oil at 260 mg/kg). Two soil borings (i.e., SB5-1 and SB5-2) were drilled and sampled to the water table at these locations to determine the vertical extent of petroleum contaminants at the points of maximum potential contamination. To determine ambient concentrations of contaminants, two additional borings (i.e., SB5-3 and SB5-4) were located at areas near the aircraft parking apron, but at sufficient distance from Site 5 to avoid any site-related contaminants. Soil boring SB5-4 was later completed as a piezometer. Samples from these borings were included in the background data set. Soil boring and sediment sampling locations are presented in Figure 3-36. Soil boring logs are presented in Appendix A. The tables containing the information and analytical results for Site 5 (Tables 3-35 through 3-39) are presented at the end of Section 3.9.

Although sediment samples show surface contamination from the parking apron runoff, soil samples from the borings indicate that contamination above regulatory criteria is generally confined to surface soil and sediments in the RDD. Petroleum contaminants detected in the site subsurface soil borings are within background criteria.

The above is a general characterization of the field investigation results. A detailed discussion of the site sampling results and the laboratory analyses are contained below. Petroleum contamination was confirmed in sediments from the RDD; however, site-related petroleum contaminants appear to be confined to the surface and have not migrated vertically.

3.9.1 Chemicals Detected in Surface Sediments

Five surface sediment samples (i.e., SD5-1 through SD5-5) were collected from five separate locations at Site 5 - RDD. The samples were collected from a drainage ditch that lies



Site 5 - Ramp Drainage Ditch, Sampling Locations

Springfield ANGB, Springfield, Ohio

Figure: 3-36 Project: 01-0827-03-0200-005

adjacent to the western edge of the airplane parking apron. This ditch acts as the main drainage area for the airplane parking apron and also receives runoff from a moderately traveled paved road. The samples were collected using a stainless steel trowel and bowl. Sample locations as well as the flow direction of drainage are shown in Figure 3-36. Table 3-35 summarizes the laboratory analytical results. A detailed discussion of the TICs detected at Site 5 is presented in Appendix G, Section G.4. Samples were packed and shipped to the contracted laboratories for the analyses listed below:

- TPH (SW Method 8015 modified)
- VOCs (SW Method 8240, CLP SOW 3/90)
- SVOCs (SW Method 8270, CLP SOW 3/90)
- Priority pollutant metals:
  ICP metals: Be, Cd, Cr, Cu, Ni, Ag, and Zn (SW Method 6010)
  AA metals: Sb (SW 7041), As (7060), Pb (7421), Hg (7471), Se (7740), and Tl (7841).

TPH were detected in all sediment samples collected from Site 5; however, the concentration of the separate constituents (diesel fuel and heavy oil) varied considerably. Concentrations for the diesel fuel component of TPH ranged between 4 and 400 mg/kg. The highest concentration for diesel fuel (400 mg/kg) was detected in sample SD5-1 and exceeds the most conservative action level determined for diesel fuel by the Ohio Division of State Fire Marshall (Ohio 1991) of 380 mg/kg. Concentrations of the heavy oil constituent of TPH varied between non-detected (<2 mg/kg for SD5-1 and SD5-3) and 320 mg/kg in SD5-5.

These elevated values of TPH at the surface indicate that surface contamination problems are associated with the runoff in the area; however, no VOCs or VOC TICs were detected in any of the sediment samples. Multiple SVOCs, detected in each of the six samples, confirm the presence of petroleum-related surface contamination in the ditch. The concentrations of the SVOCs were flagged as estimates because the extraction holding times were exceeded. This flagging causes some doubt as to the exact concentrations of the compounds, but the large number and concentrations positively indicate that the sediments are contaminated.

The concentrations of SVOC TICs also were high. Sample SD5-3 had the highest SVOC TIC concentration at 43,890 μg/kg. SVOC TICs were detected in all six soil samples and ranged in concentration from 4,860 to 43,890 J μg/kg. Of the SVOC TICs detected in the Site 5 soil samples, the major concentrations are from laboratory artifacts and are not considered site related.

Two-hundred and ninety-nine SVOC TICs were detected in the soil and sediment samples collected from Site 5. Several of the SVOC TICs were identified by the laboratory as straight-chain alkanes or branched alkanes. They are believed to be petroleum or petroleum degradation products. Twenty-nine SVOC TICs were categorized as PAHs. The contamination with these nontarget PAHs detected in sediment samples collected from Site 5 may have been caused by the runoff from the aircraft parking area and adjacent road. 1-Heptadecane and hexadecanoic acid were placed in the petroleum or petroleum degradation products category. 9-Hexadecanoic acid was detected at concentrations below those of the background samples. Therefore, it is considered a naturally occurring organic compounds. The remainder of the SVOC TICs were identified by the laboratory as unknown and are possibly naturally occurring organic compounds or are of anthropogenic origin. Further study may resolve the identification of these unknown compounds. 4-Hydroxy-4-methyl-2-pentanone detected in many soil samples is a common laboratory artifact of the analytical procedure and not site related.

Metals detected in the sediment at Site 5 - RDD include arsenic, copper, lead, and nickel. A relatively high concentration of lead (268 mg/kg) was detected in one of the sediment samples (SD5-1). These concentrations are compared to background criteria in Section 3.9.3.

3.9.2 Chemicals Detected in Soil

Four soil borings were drilled at Site 5 - RDD at the locations shown in Figure 3-36. Two borings (i.e., SB5-1 and SB5-2) were located in the regions of maximum contamination determined during sediment sampling. Two of the soil borings (i.e., SB5-3 and SB5-4) were drilled to obtain ambient contaminant data for soil at locations not associated with Site 5, but which may be influenced by routine airport and Base operations.

Borings SB5-1, SB5-2, SB5-3, and SB5-4 were drilled to 27, 31, 26.5, and 32.5 feet BLS, respectively. Soil samples were collected continuously at 2-foot intervals until the soil-water interface was encountered. At that point, a final soil sample was collected. All samples were screened with an HNu meter and an onsite GC. Samples from 5 to 7 feet (SB5-1 and SB5-2) or the surface (SB5-3 and SB5-4) and the soil-water interface were analyzed in the laboratory. As shown in Table 3-36, no contaminants detected during continuous sampling in either boring exceeded concentrations detected in the upper laboratory sample; therefore, only two samples from each boring were sent for laboratory analysis. Samples that were sent to the laboratory were analyzed for the following parameters:

- TPH (SW Method 8015 modified)
- VOCs (SW Method 8240, CLP SOW 3/90)
- SVOCs (SW Method 8270, CLP SOW 3/90)
- Priority pollutant metals:
    - ICP metals: Be, Cd, Cr, Cu, Ni, Ag, and Zn (SW Method 6010)
    - AA metals: Sb (SW 7041), As (7060), Pb (7421), Hg (7471), Se (7740), and Tl (7841).

The analytical results for the soil samples collected from Site 5 - RDD are presented in Table 3-37. A detailed discussion of the TICs detected at Site 5 is presented in Appendix G, Section G.4.

TPH were detected in all samples recovered from the four soil borings drilled at Site 5. TPH values were again reported as two separate constituents (diesel fuel and heavy oil) and quantified separately. Diesel fuel concentrations ranged between 2 and 79 mg/kg with the highest value detected in SB5-2-2 (24 to 26 feet BLS). Heavy oil TPH concentrations detected at Site 5 ranged between 5 and 34 mg/kg and the highest TPH value detected for heavy oil also was recovered in SB5-2-2.

TPH were detected in soil boring samples recovered from the ambient borings SB5-3, SB-5, and both background monitoring wells (i.e., MWBG-1 and MWBG-2); the concentrations of the compounds in SB5-1 and SB5-2 were within background criteria, as discussed in

Section 3.9.3. For this reason, TPH detected in soil borings appear to be ambient constituents of the soil possibly related to aircraft emissions or Base runoff.

Four VOCs were detected in the laboratory analysis of the soil samples recovered from the Site 5 borings: acetone, toluene, ethylbenzene, and xylene. Acetone was detected in four samples from three separate borings (i.e., SB5-1, SB5-2, and SB5-4). Concentrations ranged between 12 and 34 μg/kg; however, acetone was not detected in any of the five sediment samples collected from the site.

Toluene was detected only in the surficial soil samples (i.e., SB5-4-1 and SB5-4-1R) of boring SB5-4. The detected values were 10J and 14 μg/kg. The lack of toluene in the sediment samples indicate that the source of toluene is not likely to have resulted from any past site activities, but may have occurred through sampling or laboratory analytical procedures.

Ethylbenzene and xylene were detected at an estimated concentration of 7J and 8JX μg/kg in sample SB5-4-1 from soil boring SB5-4. The low estimated concentrations and the fact that no other boring or sediment sample analysis detected these compounds indicate that the contaminants are not widespread throughout the soil. An estimated value of 14 J μg/kg was the only VOC TIC detected in the soil boring and sediment samples obtained at Site 5 - RDD. Dimethoxymethane identified in SB5-1-1 was placed in the petroleum or petroleum degradation products category.

SVOCs detected during the soil analysis of the Site 5 samples included two compounds: fluoranthene and bis(2-ethylhexyl)phthalate. These compounds were detected only in the borings at estimated concentrations from 35 J to 59 J μg/kg. However, fluoranthene also was detected in the background soil sample (MWBG2-1) at an estimated concentration of 82J. Likewise, bis(2-ethylhexyl)phthalate was detected in a background soil sample (MWBG1-2) at an estimated concentration of 36 μg/kg.

Two-hundred and ninety-nine SVOC TICs were detected in the soil and sediment samples collected from Site 5. The majority of SVOC TICs were identified by the laboratory as straight-chain alkanes or branched alkanes. They are believed to be petroleum or petroleum degradation products. Iron-tricarbonyl[N-(phenol]) detected in SB5-2-2 also was placed in the petroleum or petroleum degradation products category. 1,4-Hexadiene-3,3,5-trimethyl was placed in the petroleum or petroleum degradation products category. Hexadecanoic acid and 9-hexadecanoic acid were detected at concentrations below those of the background samples. Therefore, they are considered naturally occurring organic compounds. Two amides detected in SB5-1-1, and 3,3,5 trimethyl-1,4-hexadiene were placed in the other category. The source of the contamination does not appear to be petroleum materials. The remainder of the SVOC TICs were identified by the laboratory as unknown and are possibly naturally occurring organic compounds or are of anthropogenic origin. They also could be a result of contamination during sampling or analysis activities. Further study may resolve the identification of these unknown compounds. 4-Hydroxy-4-methyl-2-pentanone detected in many soil samples is a common laboratory artifact of the analytical procedure and should not be considered site related.

Metals detected in the soil at Site 5 - RDD soil boring samples include chromium, copper, lead, nickel, and zinc. These concentrations of metals were compared with background concentrations in Section 3.9.3 to determine if statistical evidence of site-related metal contamination exists. The only metals detected that statistically exceed the background range were copper, nickel, and zinc.

3.9.3 Comparison of Chemicals Detected to Background Criteria

This section compares the background results to sample results from Site 5 - RDD. Two soil and five sediment samples were collected and compared against the background data set (Tables 3-38 and 3-39, respectively). In most cases, the concentrations of inorganics measured in the soil and sediment samples did not exceed the background UCL_{90}. With the exception of antimony, cadmium, lead, and zinc in sediment samples, the maximum detected result in site samples only slightly exceeded the background UCL_{90}. Based on the results of the statistical comparison, the presence of antimony, cadmium, lead, and zinc in sediment may be site related.

Organic compounds, including TPH as diesel fuel and heavy oil, are present in soil and sediment samples. One diesel fuel sample result exceeded the background upper tolerance limit.

In sediments, however, a large proportion of the detected organic compounds and TPH exceed the background UCL_{90} and, therefore, appear to be site-related.

3.9.4 Summary and Data Gaps

Petroleum-related contamination was confirmed in surface sediments of the Ramp Drainage Ditch. It appears that the site-related petroleum contamination is restricted to the surface and near surface. Although the mobile GC laboratory did not detect volatile contamination during continuous sampling, the vertical extent of sediment/soil contamination has not been precisely quantified. To assess the need for remediation, a risk assessment has been conducted (Section 5) for all detected chemicals whether or not they were determined to be site related.

Table 3-35. Data Summary Table: Sediment – Site 5 – Ramp Drainage Ditch, 178th Tactical Fighter Group, Springfield ANGB, Springfield, Ohio

SAIC ID Number		SD5-1	SD5-1DL	SD5-2
Laboratory ID Number		89650	89650DL	89651
Collection Date		5-6-92	5-6-92	5-6-92
Collection Depth (ft)		0.0-0.5	0.0-0.5	0.0-0.5
Associated Field QC Sample		SP-TB SD5-ER N/A SD5-FB	SP-TB SD5-ER N/A SD5-FB	SP-TB SD5-ER N/A SD5-FB
Parameter	Units			
TOTAL PETROLEUM HYDROCARBONS (SW 8015M)				
Diesel Fuel	mg/kg	400 J(EHT)	NA	36 J(EHT)
Heavy Oil	mg/kg	<2 UJ(EHT)	NA	85 J(EHT)
PRIORITY POLLUTANT METALS				
AA METALS				
Antimony (SW 3050/7041)	mg/kg	0.52 J(N)	NA	0.46 J(N)
Arsenic (SW 3050/7060)	mg/kg	8.5	NA	9.5
Lead (SW 3050/7421)	mg/kg	268 *	NA	42.1 J(FD)
Mercury (SW 3050/7471)	mg/kg	0.09 B	NA	0.06 U
Thallium (SW 3050/7841)	mg/kg	0.23 B	NA	0.25 B
ICP METALS (SW 3050/6010)				
Beryllium	mg/kg	0.47 B	NA	0.48 B
Cadmium	mg/kg	10.1 J(N)	NA	3.2 J(N)
Chromium	mg/kg	126 J(E)	NA	37 J(E,FD)
Copper	mg/kg	37.2	NA	25.2
Nickel	mg/kg	22.3	NA	18.6
Zinc	mg/kg	198 J(N,E)	NA	122 J(N,E)
VOLATILE ORGANICS (SW 8240 [A])				
	µg/kg	ND	NA	ND
SEMIVOLATILE ORGANIC (SW 8270 [B])				
Naphthalene	µg/kg	450 J(EHT)	6000 UJ(EHT)	400 UJ(EHT)
2-Methylnaphthalene	µg/kg	2800 J(EHT)	3200 J(EHT)	400 UJ(EHT)
Acenaphthene	µg/kg	440 J(EHT)	6000 UJ(EHT)	400 UJ(EHT)
Dibenzofuran	µg/kg	220 J(EHT)	6000 UJ(EHT)	400 UJ(EHT)
Fluorene	µg/kg	450 J(EHT)	6000 UJ(EHT)	400 UJ(EHT)
Phenanthrene	µg/kg	5100 J(EHT)	8200 J(EHT)	790 J(EHT)
Anthracene	µg/kg	1200 J(EHT)	1400 J(EHT)	110 J(EHT)
Carbazole	µg/kg	950 J(EHT)	1200 J(EHT)	59 J(EHT)
Fluoranthene	µg/kg	7300 J(EHT)	24000 J(EHT)	1600 J(EHT)
Pyrene	µg/kg	12000 J(EHT)	30000 J(EHT)	1800 J(EHT)
Benzo(a)anthracene	µg/kg	9400 J(EHT)	16000 J(EHT)	540 J(EHT)
Chrysene	µg/kg	10000 J(EHT)	16000 J(EHT)	720 J(EHT)
bis(2-Ethylhexyl)phthalate	µg/kg	1000 J(EHT)	6000 UJ(MB,EHT)	400 UJ(MB,EHT)
di-N-Octyl phthalate	µg/kg	400 UJ(EHT)	6000 UJ(EHT)	400 UJ(EHT)
Benzo(b)fluoranthene	µg/kg	23000 J(EHT)	28000 J(EHT)	1000 J(EHT)
Benzo(k)fluoranthene	µg/kg	2800 J(EHT)	10000 J(EHT)	410 J(EHT)
Benzo(a)pyrene	µg/kg	8300 J(EHT)	17000 J(EHT)	660 J(EHT)
Indeno(1,2,3-c,d)pyrene	µg/kg	11000 J(EHT)	18000 J(EHT)	830 J(EHT)
Dibenzo(a,h)anthracene	µg/kg	4100 J(EHT)	4500 J(EHT)	400 UJ(EHT)
Benzo(g,h,i)perylene	µg/kg	6200 J(EHT)	13000 J(EHT)	870 J(EHT)
TICs	µg/kg	4-Hydroxy-4-Methyl-2-Pentanone[a] 3400 B,J,N (RT 5.30)	4-Hydroxy-4-Methyl-2-Pentanone[a] 3900 B,J,N (RT 4.97)	4-Hydroxy-4-Methyl-2-Pentanone[a] 6500 B,J,N (RT 5.12)
		1-Ethylidene-1H-Indene[a] 1500 J,N (RT 14.82)	1-Ethylidene-1H-Indene[a] 1800 J,N (RT 14.47)	Unknown[d] 200 J (RT 24.07)
		2,3-Dimethyl-Naphthalene[a] 790 J,N (RT 16.70)	Unknown[d] 2500 J (RT 23.92)	Hexadecanoic Acid[b] 300 J,N (RT 24.34)
		2-Methyl-Anthracene[a] 440 J,N (RT 24.09)	9H-Fluoren-9-One[a] 1600 J,N (RT 24.62)	9H-Fluoren-9-One[a] 100 J,N (RT 24.62)
		Unknown[d] 900 J (RT 24.34)	Benzo[B]Naphtho[2,3-D]Furan[a] 1100 J,N (RT 26.96)	Unknown[d] 110 J (RT 26.57)
		2-Phenylnaphthalene[a] 710 J,N (RT 25.02)	11H-Benzo[A]Fluorene[a] 2900 J,N (RT 27.62)	Unknown[d] 150 J (RT 28.44)
		11H-Benzo[A]Fluorene[a] 1100 J,N (RT 28.06)	Unknown[d] 1500 J (RT 27.86)	Unknown[d] 180 J (RT 29.56)
		Unknown[d] 560 J (RT 28.27)	4-Methyl-Pyrene[a] 1400 J,N (RT 27.92)	Unknown[d] 140 J (RT 30.64)
		Unknown[d] 580 J (RT 28.36)	Benzo[B]Naphtho[1,2-D]Thioph[a] 1100 J,N (RT 29.57)	Octacosane[b] 320 J,N (RT 31.41)
		Unknown[d] 690 J (RT 30.12)	Unknown[d] 1900 J (RT 29.69)	Unknown[d] 180 J (RT 31.71)
		3,4-Dihydrocyclopenta(Cd)Pyr[a] 650 J,N (RT 31.17)	3,4-Dihydrocyclopenta(Cd)Pyr[a] 1800 J,N (RT 30.71)	Unknown[d] 550 J (RT 31.94)
		Octacosane[b] 740 J,N (RT 32.27)	Unknown[d] 2000 J (RT 31.94)	Unknown[d] 540 J (RT 32.04)
		Unknown[d] 1300 J (RT 32.39)	Unknown[d] 2300 J (RT 32.02)	Unknown[d] 450 J (RT 32.09)
		Unknown[d] 1600 J (RT 32.54)	Unknown[d] 1600 J (RT 32.07)	Unknown[d] 1300 J (RT 32.21)
		Unknown[d] 730 J (RT 32.67)	Unknown[d] 2800 J (RT 32.17)	Unknown[d] 710 J (RT 32.34)
		Unknown[d] 960 J (RT 32.72)	Unknown[d] 1500 J (RT 32.31)	Nonacosane[b] 1100 J,N (RT 32.37)
		Unknown[d] 690 J (RT 32.82)	Unknown[d] 2600 J (RT 32.36)	Unknown[d] 560 J (RT 32.46)
		Unknown[d] 2300 J (RT 33.19)	Unknown[d] 13000 J (RT 32.81)	Unknown[d] 7300 J (RT 32.82)
		Pentatriacontane[b] 3100 J,N (RT 33.79)	Octacosane[b] 20000 J,N (RT 33.37)	Unknown[d] 2100 J (RT 33.02)
		Benzo[J]Fluoranthene[a] 1200 J,N (RT 35.24)	Benz[E]Acephenanthrylene[a] 3600 J,N (RT 33.97)	Unknown[d] 10000 J (RT 33.41)
		Unknown[d] 1000 J (RT 35.36)	Benzo[J]Fluoranthene[a] 12000 J,N (RT 34.47)	Unknown[d] 1200 J (RT 34.92)
TIC Total	µg/kg	24940 (21)	82900 (21)	33990 (21)

Table 3–35. Data Summary Table: Sediment – Site 5 – Ramp Drainage Ditch, 178th Tactical Fighter Group, Springfield ANGB, Springfield, Ohio (Continued)

SAIC ID Number			SD5–3			SD5–3R			SD5–4	
Laboratory ID Number			89652			89658			89653	
Collection Date			5–6–92			5–6–92			5–6–92	
Collection Depth (ft)			0.0–0.5			0.0–0.5			0.0–0.5	
Associated Field QC Sample			SP–TB SD5–ER N/A			SP–TB SD5–ER N/A			SP–TB SD5–ER N/A	
Parameter	Units		SD5–FB			SD5–FB			SD5–FB	
TOTAL PETROLEUM HYDROCARBONS (SW 8015M)										
Diesel Fuel	mg/kg		190 J(EHT, FD)			4 J(EHT, FD)			120 J(EHT)	
Heavy Oil	mg/kg		<2 UJ(EHT)			16 J(EHT, FD)			260 J(EHT)	
PRIORITY POLLUTANT METALS										
AA METALS										
Antimony (SW 3050/7041)	mg/kg		0.35 J(N)			0.47 J(N)			0.77 J(N)	
Arsenic (SW 3050/7060)	mg/kg		5.9			9			7.2	
Lead (SW 3050/7421)	mg/kg		24.8 J(FD)			68.9 J(FD)			256 J(FD)	
Mercury (SW 3050/7471)	mg/kg		0.06 U			0.06 U			0.1 B	
Thallium (SW 3050/7841)	mg/kg		0.17 B			0.16 B			0.18 B	
ICP METALS (SW 3050/6010)										
Beryllium	mg/kg		0.26 B			0.37 B			0.5 B	
Cadmium	mg/kg		2.9 J(N)			5.6 J(N)			21 J(N)	
Chromium	mg/kg		18.8 J(E,FD)			42 J(E,FD)			122 J(E,FD)	
Copper	mg/kg		13.4			18.3			48.6	
Nickel	mg/kg		7.7			12.9			19.4	
Zinc	mg/kg		224 J(N,E)			236 J(N,E)			643 J(N,E)	
VOLATILE ORGANICS (SW 8240 [A])										
	µg/kg		ND			ND			ND	
SEMIVOLATILE ORGANIC (SW 8270 [B])										
Naphthalene	µg/kg		570 UJ(EHT)			400 UJ(EHT)			570 UJ(EHT)	
2–Methylnaphthalene	µg/kg		570 UJ(EHT)			400 UJ(EHT)			570 UJ(EHT)	
Acenaphthene	µg/kg		87 J(EHT)			400 UJ(EHT)			190 J(EHT)	
Dibenzofuran	µg/kg		63 J(EHT)			400 UJ(EHT)			100 J(EHT)	
Fluorene	µg/kg		130 J(EHT)			400 UJ(EHT)			250 J(EHT)	
Phenanthrene	µg/kg		1800 J(EHT,FD)			570 J(EHT,FD)			3500 J(EHT)	
Anthracene	µg/kg		210 J(EHT)			60 J(EHT)			600 J(EHT)	
Carbazole	µg/kg		120 J(EHT)			400 UJ(EHT)			240 J(EHT)	
Fluoranthene	µg/kg		2400 J(EHT,FD)			970 J(EHT,FD)			4500 J(EHT)	
Pyrene	µg/kg		2500 J(EHT,FD)			1200 J(EHT,FD)			6900 J(EHT)	
Benzo(a)anthracene	µg/kg		720 J(EHT)			330 J(EHT)			2400 J(EHT)	
Chrysene	µg/kg		1100 J(EHT,FD)			540 J(EHT,FD)			3800 J(EHT)	
bis(2–Ethylhexyl)phthalate	µg/kg		890 J(EHT)			500 J(EHT)			460 J(EHT)	
di–N–Octyl phthalate	µg/kg		84 J(EHT)			400 UJ(EHT)			570 UJ(EHT)	
Benzo(b)fluoranthene	µg/kg		1500 J(EHT,FD)			730 J(EHT,FD)			6100 J(EHT)	
Benzo(k)fluoranthene	µg/kg		690 J(EHT)			270 J(EHT)			2400 J(EHT)	
Benzo(a)pyrene	µg/kg		930 J(EHT)			470 J(EHT,FD)			3600 J(EHT)	
Indeno(1,2,3–c,d)pyrene	µg/kg		910 J(EHT,FD)			510 J(EHT,FD)			4500 J(EHT)	
Dibenzo(a,h)anthracene	µg/kg		140 J(EHT)			400 UJ(EHT)			900 J(EHT)	
Benzo(g,h,i)perylene	µg/kg		850 J(EHT,FD)			490 J(EHT,FD)			3900 J(EHT)	
TICs	µg/kg	4–Hydroxy–4–Methyl–2–Pentanone[a]	4000 B,J,N	(RT 5.30)	4–Hydroxy–4–Methyl–2–Pentanone[a]	2700 B,J,N	(RT 5.30)	4–Hydroxy–4–Methyl–2–Pentanone[a]	4300 B,J,N	(RT 5.32)
		1–Heptadecene[b]	650 J,N	(RT 21.02)	1–Fluoro–Decane[b]	130 J,N	(RT 21.02)	2–Methyl–Anthracene[e]	170 J,N	(RT 24.02)
		Unknown[d]	190 J	(RT 24.27)	1–Hexadecanol[c]	96 J,N	(RT 23.57)	3–Methyl–Phenanthrene[e]	250 J,N	(RT 24.10)
		Unknown[d]	500 J	(RT 24.42)	Unknown[d]	140 J	(RT 24.37)	Unknown[d]	440 J	(RT 24.32)
		9–Hexadecenoic Acid[f]	140 J,N	(RT 24.50)	Hexadecanoic Acid[b]	280 J,N	(RT 24.64)	Unknown[d]	310 J	(RT 24.42)
		Hexadecanoic Acid[b]	630 J,N	(RT 24.69)	Unknown[d]	72 J	(RT 24.95)	Hexadecanoic Acid[b]	260 J,N	(RT 24.70)
		Unknown[d]	190 J	(RT 24.99)	Unknown[d]	150 J	(RT 26.04)	Unknown[d]	350 J	(RT 25.02)
		Unknown[d]	100 J	(RT 26.04)	Unknown[d]	95 J	(RT 30.94)	Unknown[d]	1900 J	(RT 26.11)
		Unknown[d]	150 J	(RT 30.04)	Unknown[d]	320 J	(RT 32.22)	11H–Benzo[A]Fluorene[e]	350 J,N	(RT 28.06)
		Octacosane[b]	880 J,N	(RT 32.24)	Unknown[d]	370 J	(RT 32.32)	Unknown[d]	310 J	(RT 28.21)
		Unknown[d]	600 J	(RT 32.34)	Unknown[d]	320 J	(RT 32.37)	1–Methyl–Pyrene[e]	230 J,N	(RT 28.27)
		Unknown[d]	840 J	(RT 32.39)	7–Hexyl–Eicosane[b]	840 J,N	(RT 32.47)	3,4–Dihydrocyclopenta(Cd)Pyr[e]	210 J,N	(RT 31.14)
		Unknown[d]	1800 J	(RT 32.51)	Tetratetracontane[b]	480 J,N	(RT 32.61)	Unknown[d]	250 J	(RT 32.37)
		Unknown[d]	1100 J	(RT 32.62)	Octacosane[b]	660 J,N	(RT 32.64)	Unknown[d]	640 J	(RT 32.52)
		Unknown[d]	1700 J	(RT 32.69)	Unknown[d]	460 J	(RT 32.72)	Unknown[d]	380 J	(RT 32.66)
		Unknown[d]	620 J	(RT 32.89)	Unknown[d]	290 J	(RT 32.87)	Octacosane[b]	430 J,N	(RT 32.72)
		Unknown[d]	9800 J	(RT 33.12)	Unknown[d]	3200 J	(RT 33.09)	Unknown[d]	340 J	(RT 32.79)
		Pentatriacontane[b]	3500 J,N	(RT 33.34)	Unknown[d]	1000 J	(RT 33.31)	7–Hexyl–Eicosane[b]	1000 J,N	(RT 33.16)
		Unknown[d]	14000 J	(RT 33.71)	Pentatriacontane[b]	2900 J,N	(RT 33.66)	Pentatriacontane[b]	270 J,N	(RT 33.74)
		Benzo[J]Fluoranthene[e]	1100 J,N	(RT 34.77)	Benzo[J]Fluoranthene[e]	620 J,N	(RT 34.74)	Benzo[J]Fluoranthene[e]	560 J,N	(RT 35.07)
		Unknown[d]	1400 J	(RT 35.19)	Unknown[d]	710 J	(RT 35.16)	Unknown[d]	760 J	(RT 35.29)
TIC Total	µg/kg		43890 (21)			15833 (21)			13710 (21)	

Table 3-35. Data Summary Table: Sediment – Site 5 – Ramp Drainage Ditch, 178th Tactical Fighter Group, Springfield ANGB, Springfield, Ohio (Continued)

SAIC ID Number		SD5-4DL	SD5-4RE	SD5-5
Laboratory ID Number		89653DL	89653RE	89654
Collection Date		5-6-92	5-6-92	5-6-92
Collection Depth (ft)		0.0-0.5	0.0-0.5	0.0-0.5
Associated Field QC Sample		SP-TB SD5-ER N/A SD5-FB	SP-TB SD5-ER N/A SD5-FB	SP-TB SD5-ER N/A SD5-FB
Parameter	Units			
TOTAL PETROLEUM HYDROCARBONS (SW 8015M)				
Diesel Fuel	mg/kg	NA	NA	44 J(EHT)
Heavy Oil	mg/kg	NA	NA	320 J(EHT)
PRIORITY POLLUTANT METALS				
AA METALS				
Antimony (SW 3050/7041)	mg/kg	NA	NA	0.39 J(N)
Arsenic (SW 3050/7060)	mg/kg	NA	NA	9.1
Lead (SW 3050/7421)	mg/kg	NA	NA	14.4 J(FD)
Mercury (SW 3050/7471)	mg/kg	NA	NA	0.05 U
Thallium (SW 3050/7841)	mg/kg	NA	NA	0.2 B
ICP METALS (SW 3050/6010)				
Beryllium	mg/kg	NA	NA	0.46 B
Cadmium	mg/kg	NA	NA	0.34 J(N)
Chromium	mg/kg	NA	NA	15.1 J(E,FD)
Copper	mg/kg	NA	NA	18.2
Nickel	mg/kg	NA	NA	17.4
Zinc	mg/kg	NA	NA	64.8 J(N,E)
VOLATILE ORGANICS (SW 8240 [A])				
	μg/kg	NA	ND	ND
SEMIVOLATILE ORGANIC (SW 8270 [B])				
Naphthalene	μg/kg	5700 UJ(EHT)	NA	360 UJ(EHT)
2-Methylnaphthalene	μg/kg	5700 UJ(EHT)	NA	360 UJ(EHT)
Acenaphthene	μg/kg	5700 UJ(EHT)	NA	360 UJ(EHT)
Dibenzofuran	μg/kg	5700 UJ(EHT)	NA	360 UJ(EHT)
Fluorene	μg/kg	5700 UJ(EHT)	NA	360 UJ(EHT)
Phenanthrene	μg/kg	5200 J(EHT)	NA	360 UJ(EHT)
Anthracene	μg/kg	730 J(EHT)	NA	360 UJ(EHT)
Carbazole	μg/kg	5700 UJ(EHT)	NA	360 UJ(EHT)
Fluoranthene	μg/kg	11000 J(EHT)	NA	360 UJ(EHT)
Pyrene	μg/kg	13000 J(EHT)	NA	60 J(EHT)
Benzo(a)anthracene	μg/kg	3800 J(EHT)	NA	53 J(EHT)
Chrysene	μg/kg	5100 J(EHT)	NA	360 UJ(EHT)
bis(2-Ethylhexyl)phthalate	μg/kg	5700 UJ(MB,EHT)	NA	39 J(EHT)
di-N-Octyl phthalate	μg/kg	5700 UJ(EHT)	NA	360 UJ(MB,EHT)
Benzo(b)fluoranthene	μg/kg	7500 J(EHT)	NA	360 UJ(EHT)
Benzo(k)fluoranthene	μg/kg	2100 J(EHT)	NA	69 J(EHT)
Benzo(a)pyrene	μg/kg	4700 J(EHT)	NA	360 UJ(EHT)
Indeno(1,2,3-c,d)pyrene	μg/kg	5900 J(EHT)	NA	42 J(EHT)
Dibenzo(a,h)anthracene	μg/kg	5700 UJ(EHT)	NA	360 UJ(EHT)
Benzo(g,h,i)perylene	μg/kg	6500 J(EHT)	NA	360 UJ(EHT)
TICs	μg/kg	4-Hydroxy-4-Methyl-2-Pentanone^{a} 5900 B,J,N (RT 4.97)	NA	4-Hydroxy-4-Methyl-2-Pentanone^{a} 2900 B,J,N (RT 5.30)
		Unknown^{d} 2800 J (RT 25.72)		Heptadecane, 2,6,10,14-Tetra^{b} 120 J,N (RT 28.74)
		11H-Benzo[A]Fluorene^{a} 1700 J,N (RT 27.62)		Octacosane^{b} 88 J,N (RT 29.86)
		1-Methyl-Pyrene^{a} 2800 J,N (RT 27.84)		Unknown^{d} 98 J (RT 30.92)
		Benzo[B]Naphtho[1,2-D]Thioph^{a} 880 J,N (RT 29.56)		Unknown^{d} 100 J (RT 31.99)
		Unknown^{d} 1000 J (RT 29.67)		Unknown^{d} 270 J (RT 33.02)
		Unknown^{d} 1200 J (RT 32.02)		Unknown^{d} 130 J (RT 34.07)
		Unknown^{d} 1300 J (RT 32.06)		Pentatriacontane^{b} 550 J,N (RT 35.14)
		Unknown^{d} 2700 J (RT 32.16)		Unknown^{d} 350 J (RT 37.44)
		Unknown^{d} 1700 J (RT 32.31)		Unknown^{d} 200 J (RT 38.77)
		Unknown^{d} 2500 J (RT 32.34)		
		Unknown^{d} 1300 J (RT 32.44)		
		Unknown^{d} 12000 J (RT 32.79)		
		Unknown^{d} 3800 J (RT 33.01)		
		Benzo[E]Pyrene^{a} 1800 J,N (RT 33.94)		
		Unknown^{d} 820 J (RT 34.06)		
		Benzo[J]Fluoranthene^{a} 5200 J,N (RT 34.46)		
		Unknown^{d} 3000 J (RT 34.92)		
		Unknown^{d} 4100 J (RT 37.37)		
TIC Total	μg/kg	56500 (19)	NA	4806 (10)

Table 3-35. Data Summary Table: Sediment – Site 5 – Ramp Drainage Ditch, 178th Tactical Fighter Group, Springfield ANGB, Springfield, Ohio (Continued)

Validation note: All descriptive data qualifiers applied to the reported values by the laboratory are reported in parentheses.
Each data point has been assessed to determine whether the value is considered usable (i.e., no qualifier), usable but estimated (i.e., "J"), or not usable (i.e., "R"). All usability qualifiers are followed by the applicable laboratory or field QC qualifier, presented in parentheses and defined below. Usability qualifiers were not applied to values qualified by the laboratory, but were not considered to have been adversely impacted by the applicable laboratory QC result (e.g., duplicated and matrix spike analysis).
A – samples were analyzed for VOCs using SW 8240, laboratory analyses followed methods outlined in the March 1990 CLP SOW for organic analyses
B – samples were analyzed for SVOCs using SW 3550/8270, laboratory analysis followed method details outlined in the March 1990 CLP SOW for organic analyses
NA – not analyzed
ND – not detected
N/A – not applicable
RT – retention time in minutes
TICs–tentatively identified compounds, total concentration is listed and the total number of tentatively identified compounds is inside the parenthases
Data Validation Qualifiers
J – associated numerical value is the approximate concentration
U – compound/element was included in analysis, but was not detected
UJ – reported quantitation limit is approximate and may or may not represent the actual quantitation necessary to accurately and precisely measure the analyte
Explanatory Data Validation Qualifiers
EHT – extraction holding time outside control limits
FD – field duplicate relative percent differences (RPDs) outside control limits
MB – compound/element was also detected in the associated laboratory method blank
EPA–defined CLP SOW Laboratory Qualifiers
B(metals) – the reported value is estimated because it is greater than the Instrument Detection Limit (IDL), but less than the Contract Required Detection Limit(CRDL)
B(organics) – compound was also detected in the associated laboratory method blank
E(metals) – the reported value is estimated due to the presence of interference
N – spiked sample recovery outside of control limits
N(TICs) – presumptive evidence of a compound
* – duplicate sample analysis outside of control limits
SAIC TIC Evaluation Categories
[a] – laboratory and extraction artifacts
[b] – petroleum or petroleum degradation products
[c] – other
[d] – unknown
[e] – polycyclic aromatic hydrocarbons
[f] – naturally occuring organic compounds

Table 3—36. Onsite Gas Chromatography Results for Soil at Site 5 – Ramp Drainage Ditch, 178th Tactical Fighter Group, Springfield ANGB, Springfield, Ohio

			Analytical Parameters ($\mu g/kg$)									
Soil Boring	Sample Number	Depth (feet BLS)	TVO	TCA	CCl_4	TCE	PCE	BEN	TOL	ETZ	XYL	Comments
SB5–1	SB5–1–01	5.0–7.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	Drainage ditch wet due to prior rain. Sample sent to lab 8/17/92.
	SB5–1–02	7.0–9.0	170	ND	ND	ND	ND	ND	ND	ND	ND	
	SB5–1–03	11.0–13.0	130	ND	ND	ND	ND	ND	ND	ND	ND	
	SB5–1–07	25.0–27.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	Saturated interval (soil/water interface). Sample sent to lab 8/17/92.
SB5–2	SB5–2–01	5.0–7.0	1500	ND	ND	ND	ND	ND	ND	ND	ND	Gravel recovered initially; paused to verify water and sewer lines. Sample sent to lab 8/18/92.
	SB5–2–04	31.0–32.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	Saturated interval (soil/water interface).
SB5–3	SB5–3–01	0.5–2.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	Sample sent to lab 8/18/92.
	SB5–3–02	26.5–28.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	Saturated interval (soil/water interface). Replicate GC taken. Sample sent to lab 8/18/92.
	SB5–3–02D	26.5–28.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	
SB5–4	SB5–4–01	0.5–2.5	100	ND	ND	ND	ND	ND	ND	ND	ND	Replicate GC and replicate samples taken. Sample and replicate sent to lab 8/18/92.
	SB5–4–01D	0.5–2.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	
	SB5–4–02	28.5–30.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	Saturated interval (soil/water interface). Sample sent to lab 8/18/92.

Table 3-37. Data Summary Table: Soil – Site 5 – Ramp Drainage Ditch, 178th Tactical Fighter Group, Springfield ANGB, Springfield, Ohio

SAIC ID Number			SB5-1-1			SB5-1-7			SB5-1-7RE	
Laboratory ID Number			94674			94675			94675RE	
Collection Date			8-17-92			8-17-92			8-17-92	
Collection Depth (ft)			5.0-7.0			25.0-27.0			25.0-27.0	
Associated Field QC Sample			TB-4 EB5-1 FB5-1 SD5-FB			TB-4 EB5-1 FB5-1 SD5-FB			TB-4 EB5-1 FB5-1 SD5-FB	
Parameter	Units									
TOTAL PETROLEUM HYDROCARBONS (SW 8015M)										
Diesel Fuel	mg/kg		8			48			NA	
Heavy Oil	mg/kg		5			13			NA	
PRIORITY POLLUTANT METALS										
AA METALS										
Antimony (SW 3050/7041)	mg/kg		0.32 J(N,W,r)			0.21 J(N,W,r)			NA	
Arsenic (SW 3050/7060)	mg/kg		6.7 J(N)			9 J(N)			NA	
Lead (SW 3050/7421)	mg/kg		8.2			6.7			NA	
Thallium (SW 3050/7841)	mg/kg		0.21 J(W)			0.21 J(W)			NA	
ICP METALS (SW 3050/6010)										
Beryllium	mg/kg		0.29 B			0.2 B			NA	
Cadmium	mg/kg		0.18 U			0.31 U(MB)			NA	
Chromium	mg/kg		7.4			5.7			NA	
Copper	mg/kg		13.3			16.4			NA	
Nickel	mg/kg		12			18.4			NA	
Silver	mg/kg		1.9 U(MB)			1.7 U(MB)			NA	
Zinc	mg/kg		45.6 J(E)			124 J(E)			NA	
VOLATILE ORGANICS (SW 8240 [A])										
Acetone	µg/kg		12 U			34			NA	
Toluene	µg/kg		12 U			11 UJ(IS)			NA	
Ethylbenzene	µg/kg		12 U			11 UJ(IS)			NA	
Xylene (total)	µg/kg		12 U			11 UJ(IS)			NA	
TICs	µg/kg	Dimethoxy-Methane [b]	14 J,N	(RT 5.86)		0 (0)			NA	
TIC Total	µg/kg		14 (1)			0 (0)			NA	
SEMIVOLATILE ORGANICS (SW 8270 [B])										
Fluoranthene	µg/kg		42 J			360 U			360 U	
bis(2-Ethylhexyl)phthalate	µg/kg		370 U			360 U			360 U	
TICs	µg/kg	4-Hydroxy-4-Methyl-2-Pentanone [a]	12000 J,N,A	(RT 4.15)	3,6-Dimethyl-Decane [b]	320 J,N	(RT 13.75)	Tetradecane [b]	350 J,N	(RT 15.25)
		Nonanamide [c]	220 B,J,N	(RT 23.12)	Tetradecane [b]	370 J,N	(RT 15.47)	Unknown [d]	230 J	(RT 16.25)
		Unknown [d]	240 J	(RT 25.37)	Unknown [d]	240 J	(RT 16.47)	2,7,10-Trimethyl-Dodecane [b]	450 J,N	(RT 16.87)
		Dodecanamide [c]	370 B,J,N	(RT 25.61)	2,7,10-Trimethyl-Dodecane [b]	460 J,N	(RT 17.09)	Hexadecane [b]	570 J,N	(RT 18.39)
		Unknown [d]	5400 J	(RT 27.71)	Hexadecane [b]	540 J,N	(RT 18.62)	Unknown [d]	320 J	(RT 19.10)
		Unknown [d]	53 J	(RT 27.89)	Unknown [d]	360 J	(RT 19.32)	Unknown [d]	460 J	(RT 19.84)
		Unknown [d]	55 J	(RT 27.92)	Heptadecane [b]	450 J,N	(RT 20.05)	2,6-Dimethyl-Heptadecane [b]	430 J,N	(RT 19.92)
		Unknown [d]	63 J	(RT 28.96)	Hexadecane, 2,6,10-Trimethyl [b]	530 J,N	(RT 20.14)	Octadecane [b]	330 J,N	(RT 21.20)
		Octacosane [b]	110 J,N	(RT 30.92)	Octadecane [b]	360 J,N	(RT 21.44)	Unknown [d]	310 J	(RT 21.32)
		Unknown [d]	1500 J	(RT 31.81)	Unknown [d]	340 J	(RT 21.55)	Unknown [d]	530 J	(RT 22.50)
		Unknown [d]	52 J	(RT 32.19)	Unknown [d]	450 J	(RT 22.74)	Eicosane [b]	330 J,N	(RT 23.75)
		Unknown [d]	120 J	(RT 34.66)	Eicosane [b]	380 J,N	(RT 24.00)	Unknown [d]	240 J	(RT 24.95)
		Unknown [d]	270 J	(RT 35.97)	Heptadecane, 2,6,10,15-Tetra [b]	260 J,N	(RT 25.19)	Docosane [b]	240 J,N	(RT 26.11)
		Unknown [d]	96 J	(RT 36.22)	Docosane [b]	290 J,N	(RT 26.36)	Unknown [d]	240 J	(RT 27.21)
					Unknown [d]	280 J	(RT 27.44)	Unknown [d]	1400 J	(RT 27.99)
					Unknown [d]	1700 J	(RT 28.26)	Tetracosane [b]	170 J,N	(RT 28.27)
					7-Hexyl-Eicosane [b]	250 J,N	(RT 28.52)	Pentacosane [b]	190 J,N	(RT 29.29)
					Pentacosane [b]	220 J,N	(RT 29.54)	Octacosane [b]	160 J,N	(RT 31.26)
					Hexacosane [b]	170 J,N	(RT 30.52)	Unknown [d]	1200 J	(RT 32.11)
					Unknown [d]	1000 J	(RT 32.37)	Unknown [d]	140 J	(RT 33.12)
TIC Total	µg/kg		20549 (14)			8970 (20)			8290 (20)	

Table 3–37. Data Summary Table: Soil – Site 5 – Ramp Drainage Ditch, 178th Tactical Fighter Group, Springfield ANGB, Springfield, Ohio (Continued)

SAIC ID Number Laboratory ID Number Collection Date Collection Depth (ft) Associated Field QC Sample Parameter	Units	SB5–2–1 94801 8–18–92 5.0–7.0 TB–5 EB5–1 FB5–1 SD5–FB	SB5–2–2 94802 8–18–92 24.0–26.0 TB–5 EB5–1 FB5–1 SD5–FB	SB5–3–1 94803 8–18–92 0.5–2.0 TB–5 EB5–1 FB5–1 SD5–FB
TOTAL PETROLEUM HYDROCARBONS (SW 8015M)				
Diesel Fuel	mg/kg	42	79	<2
Heavy Oil	mg/kg	18	34	12
PRIORITY POLLUTANT METALS				
AA METALS				
Antimony (SW 3050/7041)	mg/kg	0.23 UJ(N)	0.22 J(N)	0.17 UJ(N)
Arsenic (SW 3050/7060)	mg/kg	9.1 J(*)	11.9 J(*)	9.7 J(*)
Lead (SW 3050/7421)	mg/kg	9.2 *	9.4 *	17.2 *
Thallium (SW 3050/7841)	mg/kg	0.42 J(N)	0.42 J(N)	0.36 J(N)
ICP METALS (SW 3050/6010)				
Beryllium	mg/kg	0.46 B	0.21 B	0.53
Cadmium	mg/kg	0.24 U	0.22 U	0.18 U
Chromium	mg/kg	10.8 J(N)	4.7 J(N)	12.5 J(N)
Copper	mg/kg	18	29.7	18.7
Nickel	mg/kg	17.3	46.5	20
Silver	mg/kg	1.6	2.9	1.5
Zinc	mg/kg	53.5 J(E)	37.5 J(E)	60.1 J(E)
VOLATILE ORGANICS (SW 8240 [A])				
Acetone	μg/kg	16	12	11 U
Toluene	μg/kg	12 U	12 U	11 U
Ethylbenzene	μg/kg	12 U	12 U	11 U
Xylene (total)	μg/kg	12 U	12 U	11 U
TICs	μg/kg	0 (0)	0 (0)	0 (0)
TIC Total	μg/kg	0 (0)	0 (0)	0 (0)
SEMIVOLATILE ORGANICS (SW 8270 [B])				
Fluoranthene	μg/kg	340 U	340 U	350 U
bis(2–Ethylhexyl)phthalate	μg/kg	59 J	340 U	350 U
TICs	μg/kg	4–Hydroxy–4–Methyl–2–Pentanone[a] 3500 B,J,N,A (RT 4.55)	4–Hydroxy–4–Methyl–2–Pentanone[a] 2700 B,J,N,A (RT 4.63)	4–Hydroxy–4–Methyl–2–Pentanone[a] 5000 B,J,N,A (RT 4.67)
		Unknown[d] 59 J (RT 32.11)	2–Methyl–Nonane[b] 120 J,N (RT 9.99)	9–Hexadecenoic Acid[f] 100 J,N (RT 23.75)
		Unknown[d] 220 J (RT 37.79)	4,7–Dimethyl–Undecane[b] 200 J,N (RT 11.99)	Hexadecanoic Acid[f] 98 J,N (RT 23.89)
			2,6–Dimethyl–Undecane[b] 150 J,N (RT 12.22)	Unknown[d] 67 J (RT 27.92)
			Unknown[d] 430 J (RT 13.85)	Unknown[d] 120 J (RT 29.04)
			Unknown[d] 440 J (RT 15.60)	Unknown[d] 100 J (RT 30.12)
			2,3,7–Trimethyl–Decane[b] 220 J,N (RT 16.60)	Unknown[d] 96 J (RT 31.19)
			Unknown[d] 350 J (RT 17.27)	Unknown[d] 210 J (RT 32.24)
			Hexadecane[b] 310 J,N (RT 18.84)	Unknown[d] 220 J (RT 33.32)
			5–Propyl–Tridecane[b] 170 J,N (RT 19.52)	Unknown[d] 81 J (RT 33.72)
			Unknown[d] 460 J (RT 20.32)	Unknown[d] 350 J (RT 34.44)
			2,6–Dimethyl–Heptadecane[b] 310 J,N (RT 20.37)	Unknown[d] 440 J (RT 36.89)
			Unknown[d] 290 J (RT 21.74)	Unknown[d] 170 J (RT 37.61)
			Unknown[d] 180 J (RT 21.82)	
			Unknown[d] 350 J (RT 23.09)	
			Iron, Tricarbonyl[N–(Phenyl–[b] 230 J,N (RT 24.37)	
			Unknown[d] 150 J (RT 25.61)	
			Docosane[b] 300 J,N (RT 26.79)	
			Unknown[d] 340 J (RT 27.94)	
			Unknown[d] 230 J (RT 29.06)	
			Pentacosane[b] 240 J,N (RT 30.12)	
TIC Total	μg/kg	3779 (3)	8170 (21)	7052 (13)

Table 3-37. Data Summary Table: Soil – Site 5 – Ramp Drainage Ditch, 178th Tactical Fighter Group, Springfield ANGB, Springfield, Ohio (Continued)

Parameter	Units			
SAIC ID Number		SB5-3-2	SB5-4-1	SB5-4-1R
Laboratory ID Number		94804	94805	94806
Collection Date		8-18-92	8-18-92	8-18-92
Collection Depth (ft)		26.5-28.5	0.5-2.5	0.5-2.5
Associated Field QC Sample		TB-5 EB5-1 FB5-1 SD5-FB	TB-5 EB5-1 FB5-1 SD5-FB	TB-5 EB5-1 FB5-1 SD5-FB
TOTAL PETROLEUM HYDROCARBONS (SW 8015M)				
Diesel Fuel	mg/kg	65	2	4
Heavy Oil	mg/kg	27	11	13
PRIORITY POLLUTANT METALS				
AA METALS				
Antimony (SW 3050/7041)	mg/kg	0.18 UJ(N)	0.16 UJ(N)	0.16 J(N)
Arsenic (SW 3050/7060)	mg/kg	6.4 J(*)	8.7 J(*)	10.4 J(*)
Lead (SW 3050/7421)	mg/kg	9.1 S*	9.1 *	10.5 S*
Thallium (SW 3050/7841)	mg/kg	0.31 J(N)	0.34 J(N)	0.23 J(N)
ICP METALS (SW 3050/6010)				
Beryllium	mg/kg	0.23 B	0.29 B	0.33 B
Cadmium	mg/kg	0.24 B	0.17 U	0.17 U
Chromium	mg/kg	6 J(N)	7.3 J(N)	7.4 J(N)
Copper	mg/kg	15.2	13.8	17.1
Nickel	mg/kg	11.6	15.5	16
Silver	mg/kg	1.5	1.6	1.8
Zinc	mg/kg	41 J(E)	43.8 J(E)	46.8 J(E)
VOLATILE ORGANICS (SW 8240 [A])				
Acetone	μg/kg	12 U	11 U	11 U
Toluene	μg/kg	12 U	10 J	14
Ethylbenzene	μg/kg	12 U	7 J	11 U
Xylene (total)	μg/kg	12 U	8 JX	11 U
TICs	μg/kg	0 (0)	0 (0)	0 (0)
TIC Total	μg/kg	0 (0)	0 (0)	0 (0)
SEMIVOLATILE ORGANICS (SW 8270 [B])				
Fluoranthene	μg/kg	340 U	340 U	370 U
bis(2-Ethylhexyl)phthalate	μg/kg	340 U	35 J	370 U
TICs	μg/kg	4-Hydroxy-4-Methyl-2-Pentanone[a] 4000 B,J,N,A (RT 4.65)	4-Hydroxy-4-Methyl-2-Pentanone[a] 4100 B,J,N,A (RT 4.65)	4-Hydroxy-4-Methyl-2-Pentanone[a] 7400 B,J,N,A (RT 4.68)
		2-Methyl-Nonane[b] 130 J,N (RT 11.99)	Hexadecanoic Acid[f] 140 J,N (RT 23.89)	Unknown[d] 90 J (RT 29.99)
		Unknown[d] 310 J (RT 13.85)	Unknown[d] 170 J (RT 32.24)	Unknown[d] 190 J (RT 32.11)
		Tetradecane[b] 290 J,N (RT 15.60)	Unknown[d] 87 J (RT 33.31)	Unknown[d] 120 J (RT 33.16)
		2,3,7-Trimethyl-Decane[b] 160 J,N (RT 16.60)	Unknown[d] 110 J (RT 33.37)	1,4-Hexadiene, 3,3,5-Trimeth[e] 120 J,N (RT 33.24)
		Unknown[d] 330 J (RT 17.27)	Unknown[d] 370 J (RT 34.44)	Unknown[d] 280 J (RT 34.29)
		Hexadecane[b] 320 J,N (RT 18.84)	Unknown[d] 440 J (RT 36.86)	Unknown[d] 280 J (RT 36.69)
		5-Propyl-Tridecane[b] 190 J,N (RT 19.52)		
		Heptadecane[b] 490 J,N (RT 20.32)		
		2,6-Dimethyl-Heptadecane[b] 320 J,N (RT 20.37)		
		Unknown[d] 320 J (RT 21.74)		
		Unknown[d] 190 J (RT 21.82)		
		Unknown[d] 370 J (RT 23.09)		
		Unknown[d] 230 J (RT 24.37)		
		Unknown[d] 160 J (RT 25.61)		
		Docosane[b] 340 J,N (RT 26.79)		
		Unknown[d] 330 J (RT 27.94)		
		Unknown[d] 300 J (RT 29.06)		
		Pentacosane[b] 240 J,N (RT 30.12)		
		Octacosane[b] 190 J,N (RT 31.19)		
		Unknown[d] 330 J (RT 32.26)		
TIC Total	μg/kg	9540 (21)	5417 (7)	8480 (7)

Table 3–37. Data Summary Table: Soil – Site 5 – Ramp Drainage Ditch 178th Tactical Fighter Group, Springfield ANGB, Springfield, Ohio (Continued)

SAIC ID Number			SB5–4–2	
Laboratory ID Number			94807	
Collection Date			8–18–92	
Collection Depth (ft)			28.5–30.5	
Associated Field QC Sample			TB–5 EB5–1 FB5–1 SD5–FB	
Parameter	Units			
TOTAL PETROLEUM HYDROCARBONS (SW 8015M)				
Diesel Fuel	mg/kg		36	
Heavy Oil	mg/kg		13	
PRIORITY POLLUTANT METALS				
AA METALS				
Antimony (SW 3050/7041)	mg/kg		0.2 J(N)	
Arsenic (SW 3050/7060)	mg/kg		4.4 J(*)	
Lead (SW 3050/7421)	mg/kg		7.6 S*	
Thallium (SW 3050/7841)	mg/kg		0.2 UJ(N)	
ICP METALS (SW 3050/6010)				
Beryllium	mg/kg		0.19 B	
Cadmium	mg/kg		0.21 U	
Chromium	mg/kg		8.7 J(N)	
Copper	mg/kg		10.7	
Nickel	mg/kg		11.5	
Silver	mg/kg		1.5	
Zinc	mg/kg		35 J(E)	
VOLATILE ORGANICS (SW 8240 [A])				
Acetone	μg/kg		18	
Toluene	μg/kg		11 U	
Ethylbenzene	μg/kg		11 U	
Xylene (total)	μg/kg		11 U	
TICs	μg/kg		0 (0)	
TIC Total	μg/kg		0 (0)	
SEMIVOLATILE ORGANICS (SW 8270 [B])				
Fluoranthene	μg/kg		350 U	
bis(2–Ethylhexyl)phthalate	μg/kg		350 U	
TICs	μg/kg	4–Hydroxy–4–Methyl–2–Pentanone[a]	3200 B,J,N,A	(RT 4.63)
		2–Methyl–Nonane[b]	77 J,N	(RT 11.97)
		Unknown[d]	130 J	(RT 13.84)
		Unknown[d]	130 J	(RT 15.60)
		2,3,7–Trimethyl–Decane[b]	86 J,N	(RT 16.59)
		Unknown[d]	150 J	(RT 17.25)
		Hexadecane[b]	140 J,N	(RT 18.82)
		2,7,10–Trimethyl–Dodecane[b]	82 J,N	(RT 19.50)
		Heptadecane[b]	200 J,N	(RT 20.30)
		2,6–Dimethyl–Heptadecane[b]	160 J,N	(RT 20.35)
		Unknown[d]	140 J	(RT 21.72)
		Unknown[d]	86 J	(RT 21.80)
		Unknown[d]	170 J	(RT 23.07)
		Unknown[d]	110 J	(RT 24.37)
		Unknown[d]	86 J	(RT 25.61)
		Unknown[d]	130 J	(RT 26.79)
		Unknown[d]	150 J	(RT 27.94)
		Unknown[d]	180 J	(RT 29.04)
		Unknown[d]	140 J	(RT 30.12)
		Unknown[d]	110 J	(RT 31.19)
		Unknown[d]	210 J	(RT 32.26)
TIC Total	μg/kg		5867 (21)	

Table 3–37. Data Summary Table: Soil – Site 5 – Ramp Drainage Ditch, 178th Tactical Fighter Group, Springfield ANGB, Springfield, Ohio (Continued)

Validation note: All descriptive data qualifiers applied to the reported values by the laboratory are reported in parentheses. Each data point has been assessed to determine whether the value is considered usable (i.e., no qualifier), usable but estimated (i.e., "J"), or not usable (i.e., "R"). All usability qualifiers are followed by the applicable laboratory or field QC qualifier, presented in parentheses and defined below. Usability qualifiers were not applied to values qualified by the laboratory, but were not considered to have been adversely impacted by the applicable laboratory QC result (e.g., duplicated and matrix spike analysis).

A – samples were analyzed for VOCs using SW 8240, laboratory analyses followed methods outlined in the March 1990 CLP SOW for organic analyses
B – samples were analyzed for SVOCs using SW 3550/8270, laboratory analysis followed method details outlined in the March 1990 CLP SOW for organic analyses
NA – not analyzed
RT – retention time in minutes
TICs–tentatively identified compounds, total concentration is listed and the total number of tentatively identified compounds is inside the parenthases

Data Validation Qualifiers

J – associated numerical value is the approximate concentration
U – compound/element was included in analysis, but was not detected
UJ – reported quantitation limit is approximate and may or may not represent the actual quantitation necessary to accurately and precisely measure the analyte

Explanatory Data Validation Qualifiers

IS – internal standard outside control limits
MB – compound/element was also detected in the associated laboratory method blank
r – correlation coefficient for the calibration curve is less than 0.995

EPA–defined CLP SOW Laboratory Qualifiers

A(TICs) – suspects ALDOL–condensation product
B(metals) – the reported value is estimated because it is greater than the Instrument Detection Limit (IDL), but less than the Contract Required Detection Limit(CRDL)
B(organics) – compound was also detected in the associated laboratory method blank
E(metals) – the reported value is estimated due to the presence of interference
N – spiked sample recovery outside of control limits
N(TICs) – presumptive evidence of a compound
S – the reported value was determined by the Method of Standard Additions (MSA)
W – post–digestion spike for Graphite Furnace Atomic Absorption (GFAA) analysis is out of control limits (85–115%), while sample absorbance is less than 50% of the spike absorbance
X – compound is present, but does not meet CLP criteria
* – duplicate sample analysis outside of control limits

SAIC TIC Evaluation Categories

^{a} – laboratory and extraction artifacts
^{b} – petroleum or petroleum degradation products
^{c} – other
^{d} – unknown
^{f} – naturally occuring organic compounds

Table 3-38. Comparison of Site 5, Ramp Drainage Ditch, Results with Background Upper Tolerance Limits: Soil 178th Tactical Fighter Group, Springfield ANGB, Springfield, Ohio

Parameter	Units	Proportion of Results Greater than Detection Limit	Minimum Detected Result	Mean Detected Result	Maximum Detected Result	Upper Tolerance Limit	Proportion of Results Greater than Upper Tolerance Limit
Diesel Fuel	mg/kg	2 / 2	8	25	42	37.00	1 / 2
Heavy Oil	mg/kg	2 / 2	5	11.5	18	160.00	0 / 2
INORGANICS							
Antimony	mg/kg	1 / 2	0.32	0.2175	0.32	0.21	1 / 2
Arsenic	mg/kg	2 / 2	6.7	7.9	9.1	11.30	0 / 2
Beryllium	mg/kg	2 / 2	0.29	0.375	0.46	0.55	0 / 2
Chromium (III)	mg/kg	2 / 2	7.4	9.1	10.8	121.00	0 / 2
Copper	mg/kg	2 / 2	13.3	15.65	18	48.70	0 / 2
Lead	mg/kg	2 / 2	8.2	8.7	9.2	126.00	0 / 2
Nickel	mg/kg	2 / 2	12	14.65	17.3	61.50	0 / 2
Silver	mg/kg	1 / 2	1.6	1.275	1.6	5.30	0 / 2
Thallium	mg/kg	2 / 2	0.21	0.315	0.42	0.40	1 / 2
Zinc	mg/kg	2 / 2	45.6	49.55	53.5	343.00	0 / 2
ORGANICS							
Fluoranthene	mg/kg	1 / 2	0.042	0.106	0.042	0.44	0 / 2

Samples SB5-1-1 and SB5-2-1 were used in the comparison to background samples.

Table 3-39. Comparison of Site 5, Ramp Drainage Ditch, Results with Background Upper Tolerance Limits: Sediment 178th Tactical Fighter Group, Springfield ANGB, Springfield, Ohio

Parameter	Units	Proportion of Results Greater than Detection Limit	Minimum Detected Result	Mean Detected Result	Maximum Detected Result	Upper Tolerance Limit	Proportion of Results Greater than Upper Tolerance Limit
Diesel Fuel	mg/kg	5 / 5	36	139.4	400	37.00	4 / 5
Heavy Oil	mg/kg	4 / 5	1	133.4	320	160.00	2 / 5
INORGANICS							
Antimony	mg/kg	5 / 5	0.39	0.51	0.77	0.21	5 / 5
Arsenic	mg/kg	5 / 5	7.2	8.35	9.5	11.30	0 / 5
Beryllium	mg/kg	5 / 5	0.315	0.445	0.5	0.55	0 / 5
Cadmium	mg/kg	5 / 5	0.34	7.778	21	1.50	4 / 5
Chromium (III)	mg/kg	5 / 5	15.1	66.1	126	121.00	2 / 5
Copper	mg/kg	5 / 5	15.85	29.01	48.6	48.70	0 / 5
Lead	mg/kg	5 / 5	14.4	125.5	268	126.00	2 / 5
Mercury	mg/kg	2 / 5	0.09	0.055	0.1	0.50	0 / 5
Nickel	mg/kg	5 / 5	10.3	17.6	22.3	61.50	0 / 5
Thallium	mg/kg	5 / 5	0.165	0.205	0.25	0.40	0 / 5
Zinc	mg/kg	5 / 5	64.8	251.6	643	343.00	1 / 5
ORGANICS							
Anthracene	mg/kg	4 / 5	0.11	0.511	1.4	0.12	4 / 5
Benzo(a)anthracene	mg/kg	4 / 5	0.525	4.209	16	0.21	4 / 5
Benzo(a)pyrene	mg/kg	5 / 5	0.042	4.62	17	0.22	4 / 5
Benzo(b)fluoranthene	mg/kg	5 / 5	0.069	7.537	28	0.37	4 / 5
Benzo(g,h,i)perylene	mg/kg	4 / 5	0.67	4.244	13	0.20	4 / 5
Benzo(k)fluoranthene	mg/kg	4 / 5	0.41	2.634	10	0.13	5 / 5
Carbazole	mg/kg	4 / 5	0.059	0.3678	1.2	0.11	4 / 5
Chrysene	mg/kg	5 / 5	0.039	4.536	16	0.25	4 / 5
Fluoranthene	mg/kg	5 / 5	0.06	7.669	24	0.44	4 / 5
Indeno(1,2,3-cd)pyrene	mg/kg	4 / 5	0.71	5.124	18	0.23	4 / 5
Phenanthrene	mg/kg	4 / 5	0.79	3.111	8.2	0.27	4 / 5
Pyrene	mg/kg	5 / 5	0.053	9.341	30	0.44	4 / 5

Samples SD5-1, SD5-2, SD5-3, SD5-4, and SD5-5 were used in the comparison to background samples.

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4. CONTAMINANT FATE AND TRANSPORT

The purpose of a site investigation (SI) is not only to verify the presence of contaminants, but also to evaluate contaminant behavior; a fate and transport assessment integrates climatic, geotechnical, and physico-chemical properties to determine how contaminants will behave after release to the environment. Section 3 described the geologic and hydrogeologic setting, background/ambient sampling results, and chemical results from the sites under investigation. This assessment serves as an adjunct to the discussions in Section 3 by incorporating physico-chemical properties with measured results to verify the conclusions about contaminant migration from areas of suspected release.

This section presents a discussion of the fate and transport mechanisms of site-related contaminants introduced into the environment. Section 4.1 outlines the potential mechanisms and processes that affect the fate and transport of inorganic chemicals and organic compounds at the sites. Section 4.2 discusses the fate and transport of the detected chemicals at each of the sites.

4.1 MECHANISMS AND PROCESSES AFFECTING THE FATE AND TRANSPORT OF ELEMENTS AND ORGANIC COMPOUNDS AT SPRINGFIELD ANGB

The pathways for migration of inorganic contaminants released to the environment are easily understood; however, it is important to understand how several phenomena influence subsurface migration. At ambient temperatures, metals may disperse from the site bound to fugitive dust particles; move through surface water or groundwater as dissolved salts; or if in solid form, be carried along with flowing waters. Dissolved inorganic contaminants may percolate through the soil column, possibly reaching groundwater and migrating through saturated soil from the site. Contaminant transport mechanisms may be complicated by interactions and reactions, especially in the subsurface. These interactions and reactions include metal speciation, solubility and dissolution, complexation, adsorption and surface chemistry, ion-exchange reactions, and reduction-oxidation potentials in soil.

Several additional factors must be considered when evaluating organic contaminant transport and reactivity. Organic compounds are affected by several major processes: partitioning, hydrolysis, co-solvation and ionization, biodegradation, and volatilization and dissolution. The following sections describe the interactions/reactions of inorganic and organic contaminants detected during the SI at Springfield Air National Guard Base (ANGB).

4.1.1 Partitioning

Inorganic chemicals released to unsaturated soil will most commonly be adsorbed onto soil particles or dissolved in soil moisture. Adsorption, surface complexation, and ion-exchange reactions are similar sorption mechanisms for inorganic contaminants. While adsorption is the most important process governing transport, it is also less evolved and understood than the other mechanisms. Functional groups on reactive surface sites attract metal ions through van der Waals forces and other similar inter-molecular attractive forces. Ion-exchange reactions are similar to surface complexation reactions, except that electrostatic or Coulombic forces are responsible for binding trace metal ions to mineral surface sites (i.e., ionic attraction versus weaker inter-molecular van der Waals attraction).

Sorption processes are less complicated for organic contaminants. Sorption of organic contaminants to soil matter is sometimes considered an equilibrium-partitioning process between the aqueous and nonaqueous phases (i.e., hydrophobic soil matter). A measure of an organic contaminant's affinity for hydrophobic soil matter is the log octanol/water partition coefficient (log K_{ow}). The log K_{ow} is an experimentally derived, log transformed ratio of the concentration of the chemical in the octanol phase to the concentration of the chemical in the immiscible aqueous phase. Log octanol/water partition coefficients are measures of the likelihood of a chemical to adsorb to organic matter. Lyman et al. (1982) suggest that low log K_{ow} values (e.g., less than 1) are hydrophilic (i.e., highly soluble with little affinity to sorb to organic material). Lyman et al. (1982) also suggest that chemicals with high log K_{ow} values (e.g., greater than 4) should be considered hydrophobic (i.e., low solubilities and high tendencies to bind to organic material). Note that other measures exist to estimate sorption potential for organic contaminants to soil (e.g., the partition coefficient, Kp, and the partition coefficient normalized for the organic carbon content of soil, K_{oc}), which are based on similar principals to the K_{ow} or log K_{ow}.

Several estimation equations are used to predict the extent of absorption potential mitigating the movement of an organic contaminant; in general, these equations correlate the adsorption or distribution coefficient with an organic chemical's water solubility. One such equation, based on the retardation factor (Dragun 1988), was used to estimate the mobility of the organic chemicals detected during the SI. A list of the organic compounds detected at the Base and their corresponding migration rates are shown in Table 4-1 along with the equation utilized in their calculation.

4.1.2 Solubility

Solubility is a measure of the ability of a given chemical to dissolve completely in a solvent (usually water). Highly water-soluble compounds are generally composed of polar molecules and tend to spread rapidly in the environment. Soil and soil-water reduction/oxidation potential (i.e., pH and Eh), along with the form of the metal (i.e., metal species) and complexation reactions, influence the solubilities of inorganic contaminants. Geochemical equilibrium models, which illustrate predominant dissolved species or minerals of the elements in aqueous systems, are depicted on Eh-pH diagrams. These diagrams may be used to estimate the conditions under which elements are either soluble or exist as a solid (i.e., precipitate or complex). Most metals may exist with different oxidation states and solubility is directly related to the oxidation state of various metals, especially at different pHs or Ehs (i.e., reduction/oxidation potentials). For example, iron (III) precipitates (becomes insoluble) in slightly acidic to alkaline solutions, while iron (II) is very soluble. Metal ions also may react with inorganic or organic ligands to form new, soluble species called complexes.

Many of the organic compounds detected during the SI may be classified as either dense, nonaqueous-phase liquids (DNAPLs) or light, nonaqueous-phase liquids (LNAPLs). The behavior of these groups of organic compounds in groundwater is considerably different, and consequently, migration rates from the site are different. In general, DNAPLs in soil and groundwater tend to migrate downward until they encounter a confining layer, while LNAPLs

Table 4–1. Migration Rates of Organic Compounds Detected in Soil and Sediment 178th Tactical Fighter Group, Springfield ANGB, Springfield, Ohio

Compound	V_c – Migration Rate (inches/year)	Compound	V_c – Migration Rate (inches/year)
Acenaphthene	1.84E–01	Fluoranthene	2.23E–02
Acetone	2.28E+03	Fluorene	2.18E–02
Anthracene	6.06E–02	Indeno(1,2,3–cd)pyrene	8.00E–04
Benzene	1.31E+01	Isophorone	2.75E+01
Benzo(a)anthracene	4.24E–03	2–Methylnaphthalene	9.98E–02
Benzo(a)pyrene	1.54E–04	4–Methyl–2–pentanone	1.38E+02
Benzo(b)fluoranthene	1.54E–03	Naphthalene	9.03E–01
Benzo(g,h,i)perylene	5.30E–04	N–Nitroso–di–N–propylamine	8.29E+01
Benzo(k)fluoranthene	1.54E–03	di–N–Octylphthalate	8.68E–07
bis(2–Ethylhexyl)phthalate	4.24E–07	Pentachlorophenol	9.43E–01
2–Butanone	6.90E+02	Phenanthrene	6.06E–02
Carbazole	Not available	Pyrene	2.23E–02
Carbon Disulfide	3.54E+00	Toluene	2.83E+00
Chrysene	4.24E–03	Trichloroethene	2.57E+01
Dibenzofuran	1.04E–01	Xylenes	3.54E+00
Ethylbenzene	7.71E–01		

Migration rates were calculated using the following equation: $V_c = V_{sw}(WC + b\,K_d)^{-1}$ (Dragun 1988): where V_{sw} is the volume of water percolating through the unsaturated zone (7.2 inches/year), WC is the soil–water content (80%), b is the soil bulk density (1.5 g/mL), and K_d is the chemical–specific distribution coefficient ($K_{oc} \times f_{oc}$). Organic carbon partition coefficients (Dragun 1988 and Montgomery 1991) were normalized to the assumed carbon content of the soil.

tend to float on the groundwater surface. Organic compounds can be transported by groundwater in aqueous or nonaqueous phases or in a gaseous phase in the vadose zone by diffusion and dispersion. The dissolved chemicals will be transported in the approximate direction of groundwater flow and will travel at a rate somewhat less than the rate of groundwater movement. Nonaqueous phase liquids are generally more persistent, and small amounts can affect large volumes of water. As nonaqueous phase liquids move through geologic media, they can displace air and water, effectively lowering the permeability of the media. This reduction in permeability is dependent on the porosity and nature of the geologic media, the nature of the compounds, and the concentrations or volumes of the compounds.

4.1.3 Volatilization

Most fuels have volatile constituents, including JP-4, which makes volatilization an important transport mechanism for this investigation. Volatile constituents are at equilibrium between partitioning to the soil or soil moisture and soil pore gases. The vapors can migrate upward through the unsaturated zone to ground surface and volatilize into the atmosphere. As vapors are removed and new air passes through the pore spaces of the affected zone, additional compounds will partition from the liquid to the vapor phase to maintain equilibrium. Unless interrupted by natural or manmade external conditions, this process allows continued vapor emissions.

Henry's Law constants, H_c, are a measure of the tendency of a chemical to escape from a mixture. H_c is defined as the ratio of the partial pressure of a chemical (i.e., the concentration of pollutant) divided by the mole fraction of the gas in a dilute solution. Some generalizations between volatilization rates from water and H_c are presented below (Lyman et al. 1982):

- $H < 10^{-7}$ atm • m^{3} • mol^{-1} — the substance is less volatile than water, and its concentration will increase as water evaporates; it is essentially nonvolatile
- $10^{-7} < H < 10^{-5}$ atm • m^{3} • mol^{-1} — the substance slowly volatilizes; the rate is controlled by slow molecular movement (diffusion) through the air
- $10^{-5} < H < 10^{-3}$ atm • m^{3} • mol^{-1} — volatilization begins to become a significant transfer mechanism; this range includes some polycyclic aromatic hydrocarbons (PAHs) and halogenated aromatics

- $H > 10^{-3}$ atm • m^3 • mol^{-1} — substances may be released in significant quantities; resistance from the water film (i.e., solubility and diffusion rate in water) is the rate controlling process.

4.1.4 Degradation

Contaminant persistence is a function of physical, chemical, and biological processes that affect the chemical as it moves through air, soil, and water. These processes include photolysis, hydrolysis, bioaccumulation, and biotransformation or biodegradation. Simple inorganic contaminants may undergo chemical species transformation (i.e., change the charge state, such as Cr^{+6} to Cr^{+3}) after being released to the environment (see discussion in Section 4.2.1 for more details). Organometallic compounds can undergo a variety of chemical reactions that may transform one compound into another, change the state of the compound, or cause a compound to combine with other chemicals; however, the metallic portion of the organometallic compounds will only change oxidation states With the exception of changing oxidation states or possibly exchanging metallic species, inorganic contaminants are much more stable than organic contaminants. Hydrolysis, photolysis, and biodegradation are the processes and reactions of greatest importance in regard to degrading organic contaminants.

Hydrolysis is a nucleophilic substitution reaction of a dissolved organic compound with water or a hydroxide ion. Because water is plentiful in most soils, acting both as a solvent and a nucleophile, hydrolysis is a very important reaction. In this reaction, a functional group is exchanged from the organic molecule with a hydroxyl functional group from the water. One important example of this reaction is the hydrolysis of chlorinated compounds, which often yields an alcohol or alkene. This reaction is particularly significant because chlorinated compounds are not readily biodegraded.

Photolysis is the degradation of dissolved compounds by light. Light is absorbed by the compound, which results in a chemical reaction involving molecular rearrangement, dissociation, or oxidation of the energized molecules. Indirect photolysis occurs when an organic compound reacts with other previously energized molecules, rather than directly with solar radiation. Generally, compounds in the subsurface are not significantly affected by photolysis until released into the atmosphere.

Biodegradation is the breakdown of organic compounds through biological processes. An excellent example of biodegradation is the reduction of chlorinated organic compounds, which may be consumed by aerobic (i.e., oxygen utilizing) and anaerobic (i.e., nonoxygen utilizing) bacteria as food sources. The sequential degradation of tetrachloroethylene to trichloroethylene, 1,1,1-trichloroethane, 1,1-dichloroethene, 1,1-dichloroethane, cis- and trans-1,2-dichloroethylene, 1,2-dichloroethane, vinyl chloride, and finally chloroethane is illustrated in Dragun (1988). Vinyl chloride accumulates and, when measured, indicates the possibility that chlorinated solvents have been released to the environment.

4.2 TRANSPORT AND FATE

This section discusses the transport and fate of chemicals detected during laboratory analysis for each site, as listed in Tables 4-2 through 4-6. Brief descriptions of the types of chemicals detected in the sampled media are provided first, followed by descriptions of pathways of transport and the fate of the chemicals in the environment.

4.2.1 Site Descriptions

The following subsections briefly describe the chemicals detected and the matrix in which they were detected at Sites 1 through 5.

4.2.1.1 Site 1 - Fire Training Area No. 1 (FTA-1)

Figure 4-1 illustrates the potential routes for chemical migration from Site 1 - Fire Training Area No. 1 (FTA-1). Because fire training activities were conducted at Site 1, flammable materials and combustion byproducts were suspected. Contaminant migration possibly could have occurred through volatilization, fugitive dust dispersion, infiltration of chemicals into the vadose zone and groundwater, and transport by surface water runoff. However, data indicate that contaminants are not migrating from the site.

Site 1 encompasses the initial FTA, which was abandoned in 1963. The following chemicals were detected during SI activities. In soil, total petroleum hydrocarbons (TPH), toluene, three semivolatile organic compounds (SVOCs) (i.e., 2-methylnapthalene, phenanthrene,

Table 4-2. Metals and Organic Compounds Detected at Site 1 - Fire Training Area 1

	Sample Matrix	
Compound	Soil	Groundwater
Metals		
Antimony	D	D
Arsenic	D	D
Beryllium	D	D
Cadmium		
Chromium	D	D
Copper	D	D
Lead	D	D
Mercury		
Nickel	D	D
Selenium	D	D
Silver		
Thallium	D	
Zinc	D	D
Volatile Organic Compounds		
Toluene	D	
Semivolatile Organic Compounds		
2-Methylnapthalene	D	
Phthalate Esters		
Bis(2-ethylhexyl)phthalate	D	
Polynuclear Aromatic Compounds		
<u>Low PAHs</u>:		
Phenanthrene	D	

D	-	Detected compound
Low PAH	-	Low molecular weight polynuclear aromatic compounds
High PAH	-	High molecular weight polynuclear aromatic compounds

Table 4-3. Metals and Organic Compounds Detected at Site 2 - Fire Training Area 2

	Sample Matrix		
Compound	Sediment	Soil	Groundwater
Metals			
Antimony	D	D	D
Arsenic	D	D	D
Beryllium	D	D	D
Cadmium	D	D	
Chromium	D	D	D
Copper	D	D	D
Lead	D	D	D
Mercury	D		D
Nickel	D	D	D
Selenium	D	D	D
Silver		D	D
Thallium	D	D	
Zinc	D	D	D
Volatile Organic Compounds			
Acetone	D	D	
2-Butanone	D	D	
Benzene		D	
Carbon disulfide	D	D	
Ethylbenzene		D	
Xylene		D	
4-Methyl-2-pentanone		D	

D - Detected compound
Low PAH - Low molecular weight polynuclear aromatic compounds
High PAH - High molecular weight polynuclear aromatic compounds

Table 4-3. Metals and Organic Compounds Detected at Site 2 - Fire Training Area 2 (continued)

	Sample Matrix		
Compound	Sediment	Soil	Groundwater
Semivolatile Organic Compounds			
Carbazole	D		
Isophorone		D	
2-Methylnapthalene		D	
Naphthalene		D	
Pentachlorophenol		D	
Tetrachloroethene			D
Phalate Esters:			
bis(2-Ethylhexyl)phthalate	D	D	
Polynuclear Aromatic Compounds			
Low PAHs:			
Anthracene	D		
Fluoranthene	D	D	
Phenanthrene	D	D	
High PAHs:			
Benzo(a)anthracene	D		
Benzo(a)pyrene	D		
Benzo(b)fluoranthene	D		
Benzo(k)fluoranthene	D		
Benzo(g,h,i)perylene	D		
Chrysene	D		
Indeno(1,2,3-c,d)pyrene	D		
Pyrene	D	D	

D - Detected compound
Low PAH - Low molecular weight polynuclear aromatic compounds
High PAH - High molecular weight polynuclear aromatic compounds

Table 4-4. Metals and Organic Compounds Detected at Site 3 - Leach Field

Compound	Soil	Groundwater
Metals		
Antimony	D	D
Arsenic	D	D
Beryllium	D	D
Cadmium	D	D
Chromium	D	D
Copper	D	D
Lead	D	D
Mercury	D	
Nickel	D	D
Selenium	D	D
Silver	D	D
Thallium	D	
Zinc	D	D
Volatile Organic Compounds		
Acetone	D	
Carbon Disulfide	D	
1,2-Dichloroethene		D
Ethylbenzene	D	
N-nitroso-di-N-propylamine	D	
Toluene	D	
Trichloroethene		D
Xylene	D	
Semivolatile Organic Compounds		
Carbazole	D	
2-Methylnapthalene	D	

D	-	Detected compound
Low PAH	-	Low molecular weight polynuclear aromatic compounds
High PAH	-	High molecular weight polynuclear aromatic compounds

Table 4-4. Metals and Organic Compounds Detected at Site 3 - Leach Field (continued)

Compound	Soil	Groundwater
Phthalate Esters		
bis(2-Ethylhexyl)phthalate	D	
Polynuclear Aromatic Compounds		
Low PAHs:		
Acenaphthene	D	
Anthracene	D	
di-N-Octylphthalate	D	
Fluorene	D	
Fluoranthrene	D	
Phenanthrene	D	
High PAHs:		
Benzo(a)anthracene	D	
Benzo(a)pyrene	D	
Benzo(b)fluoranthene	D	
Benzo(g,h,i)perylene	D	
Benzo(k)fluoranthene	D	
Chrysene	D	
Indeno(1,2,3,c,d)pyrene	D	
Pyrene	D	

D - Detected compound
Low PAH - Low molecular weight polynuclear aromatic compounds
High PAH - High molecular weight polynuclear aromatic compounds

Table 4-5. Metals and Organic Compounds Detected at Site 4 - POL Area

	Sample Matrix	
Compound	Soil	Groundwater
Metals		
Antimony		D
Arsenic		D
Beryllium	D	D
Cadmium	D	D
Chromium	D	D
Copper	D	D
Lead	D	D
Mercury		D
Nickel	D	D
Selenium		D
Silver		D
Thallium		D
Zinc	D	D
Volatile Organic Compounds		
Benzene		D
1,2-Dichloroethene		D
Toluene	D	
Trichloroethene	D	D

Note: No SVOC analysis performed at Site 4.

D - Detected compound
Low PAH - Low molecular weight polynuclear aromatic compounds
High PAH - High molecular weight polynuclear aromatic compounds

Table 4-6. Metals and Organic Compounds Detected at Site 5 - Ramp Drainage Ditch

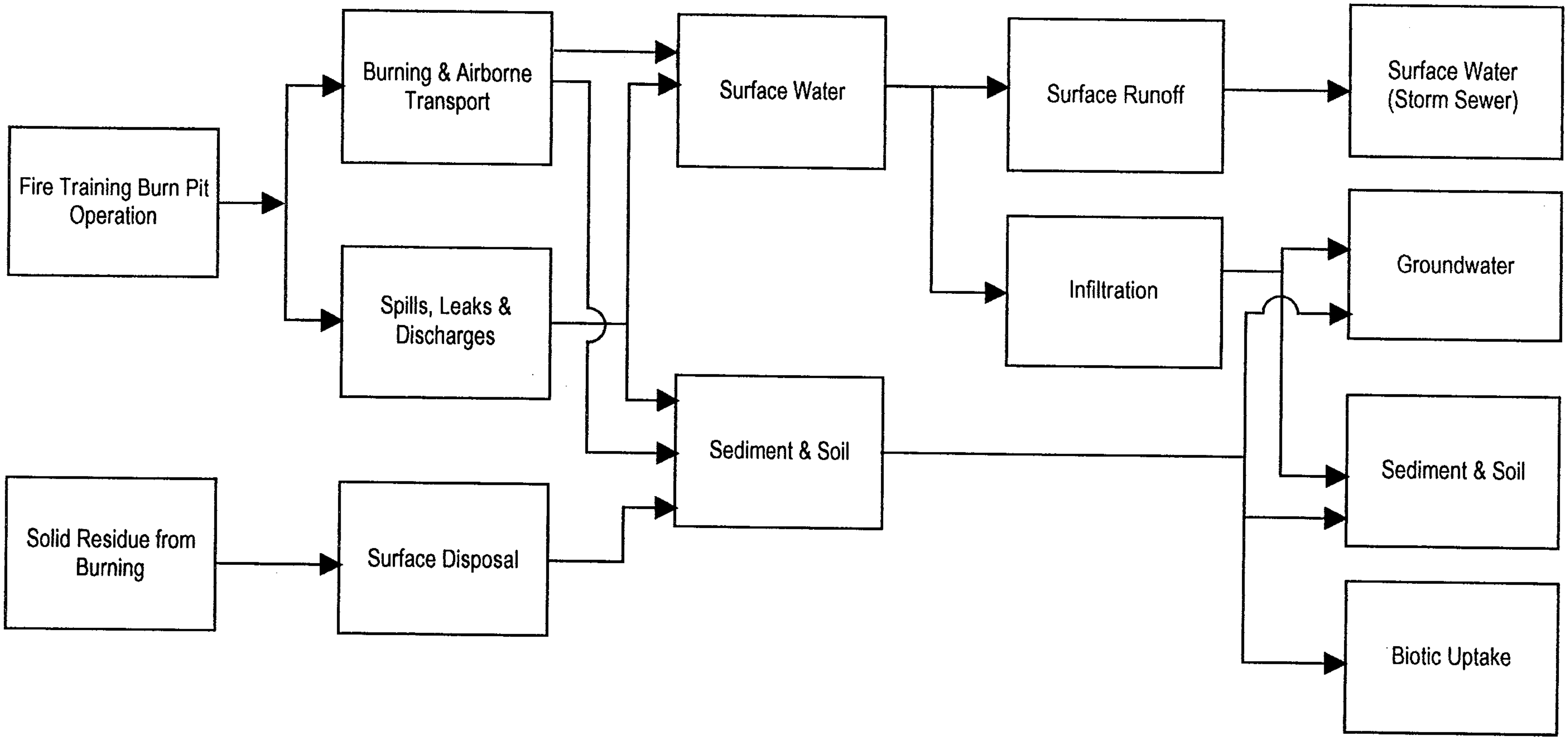
	Sample Matrix	
Compound	Sediment	Soil
Metals		
Antimony		D
Arsenic	D	D
Beryllium	D	D
Cadmium	D	D
Chromium	D	D
Copper	D	D
Lead	D	D
Mercury	D	
Nickel	D	D
Selenium		
Silver		D
Thallium	D	D
Zinc	D	D
Volatile Organic Compounds		
Acetone		D
Toluene		D
Ethylbenzene		D
Xylene		D
Semivolatile Organic Compounds		
Carbazole	D	
Naphthalene	D	
2-Methylnapthalene	D	
Dibenzofuran	D	

D - Detected compound
Low PAH - Low molecular weight polynuclear aromatic compounds
High PAH - High molecular weight polynuclear aromatic compounds

Table 4-6. Metals and Organic Compounds Detected at Site 5 - Ramp Drainage Ditch (continued)

	Sample Matrix	
Compound	Sediment	Soil
Phthalate Esters		
bis(2-Ethylhexyl)phthalate	D	D
di-N-Octylphthalate	D	
Low PAHs:		
Acenaphthene	D	
Anthracene	D	
Fluorene	D	
Fluoranthrene	D	D
Phenanthrene	D	
High PAHs:		
Benzo(a)anthracene	D	
Benzo(a)pyrene	D	
Benzo(b)fluoranthene	D	
Benzo(g,h,i)perylene	D	
Benzo(k)fluoranthene	D	
Chrysene	D	
Dibenzo(a,h)anthracene	D	
Indeno(1,2,3,c,d)pyrene	D	
Pyrene	D	

D - Detected compound
Low PAH - Low molecular weight polynuclear aromatic compounds
High PAH - High molecular weight polynuclear aromatic compounds



SAIC

Site 1 or 2 - Fire Training Areas, Potential Routes of Chemical Migration

Springfield ANGB, Springfield, Ohio

and bis[2-ethylhexyl]phthalate) and seven metals (i.e., arsenic, beryllium, chromium, copper, lead, nickel, and zinc) were detected. In groundwater, antimony, selenium, and chromium were detected. Table 4-2 lists the chemicals that were detected during the SI at Site 1.

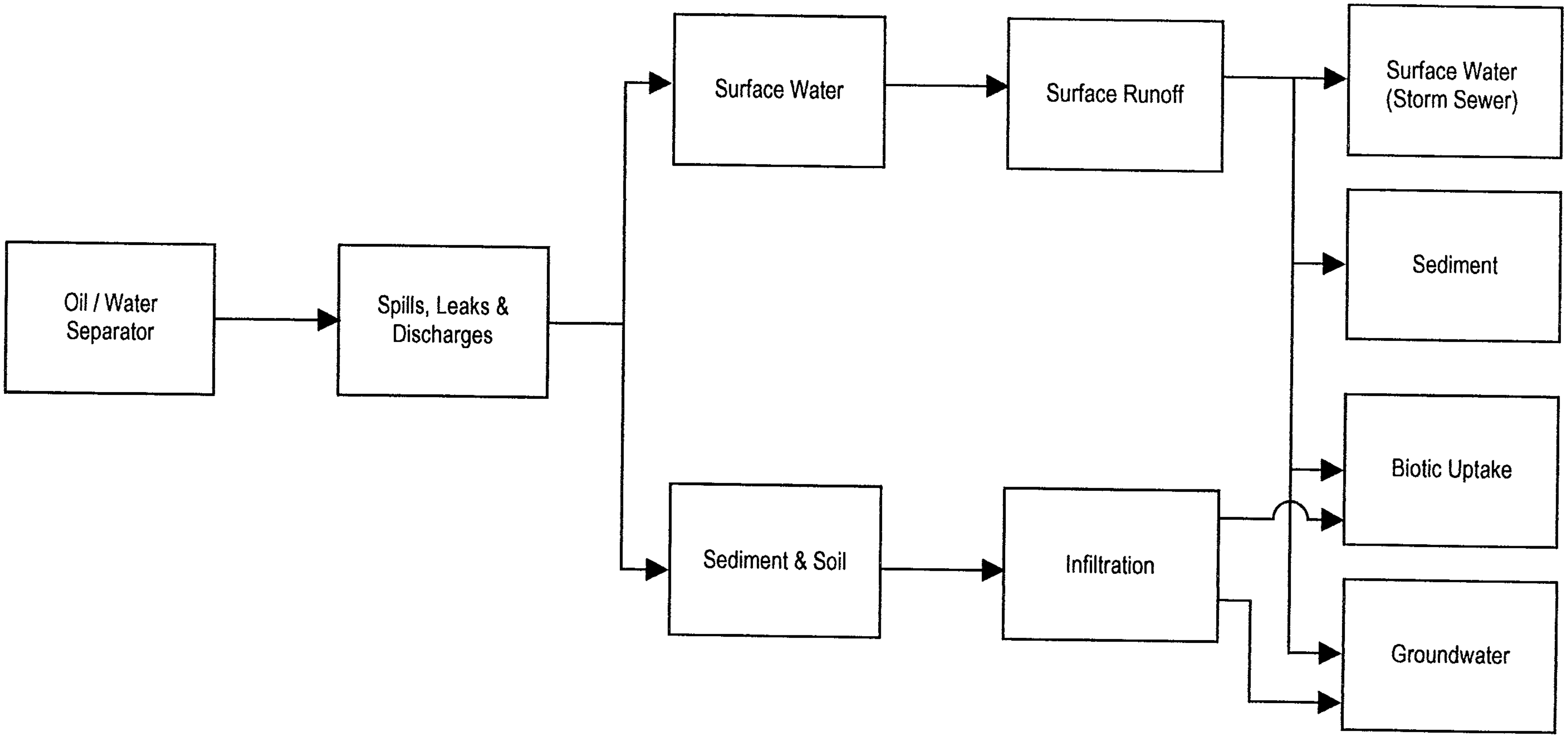
4.2.1.2 Site 2 - Fire Training Area No. 2 (FTA-2)

The potential migration routes for contaminants from Site 2 - Fire Training Area No. 2 (FTA-2) are the same as those outlined for Site 1 and are depicted in Figure 4-1. Site 2 includes the second FTA utilized on Base and the present day fire training facilities. In addition, the site includes a drainage swale, which skirts the site area along the south and western border. Fire training activities were formerly conducted at Site 2, very similar to Site 1, and therefore, flammable materials and their combustion byproducts were encountered in various environmental media at the site. Again, the primary migration pathway for contaminants from the site should include transport by surface water runoff and downward percolation through the unsaturated soil column. In addition, the use of large volumes of water, associated with the present day training activities, may increase the potential for downward chemical migration. Chemicals detected during the SI include TPH, metals, volatile organic compounds (VOCs), and SVOCs, which are listed in Table 4-3.

4.2.1.3 Site 3 - Leach Field (LCH)

The routes for chemical migration at Site 3 - Leach Field are depicted in Figure 4-2. Site 3 encompasses the leach field and outfall site, which was operated from 1950 to 1980. During this time, this system incorporated oil/water separators (OWSs) at various locations around the Base (see Section 1.4.2.3). The OWS effluent from these areas flowed through the sanitary sewer system, which drained into a septic tank and into the leach field. Types of wastes disposed of at this site include waste oil, solvents, battery acid, photographic chemicals, ethylene glycol, cleaners, degreasers, and fuel.

The primary route for contaminant migration from the site includes the infiltration and percolation of surface water through the vadose zone and into the groundwater. Chemicals detected at the site are listed in Table 4-4.



Site 3 - Leach Field,
Potential Routes of Chemical Migration

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4.2.1.4 Site 4 - POL Storage Area

Figure 4-3 outlines the potential contaminant migration pathways for the POL Storage Area. Site 4 consists of a fuel spill of approximately 1,000 gallons of JP-4 fuel, which occurred in 1972 during a refueling accident. The primary transport mechanism of concern for contaminants released at this site is infiltration through the vadose zone and transportation into surface waters. Volatilization of the spilled fuel also is an important transport pathway. Chemicals detected during the SI at Site 4 are shown in Table 4-5.

4.2.1.5 Site 5 - Ramp Drainage Ditch (RDD)

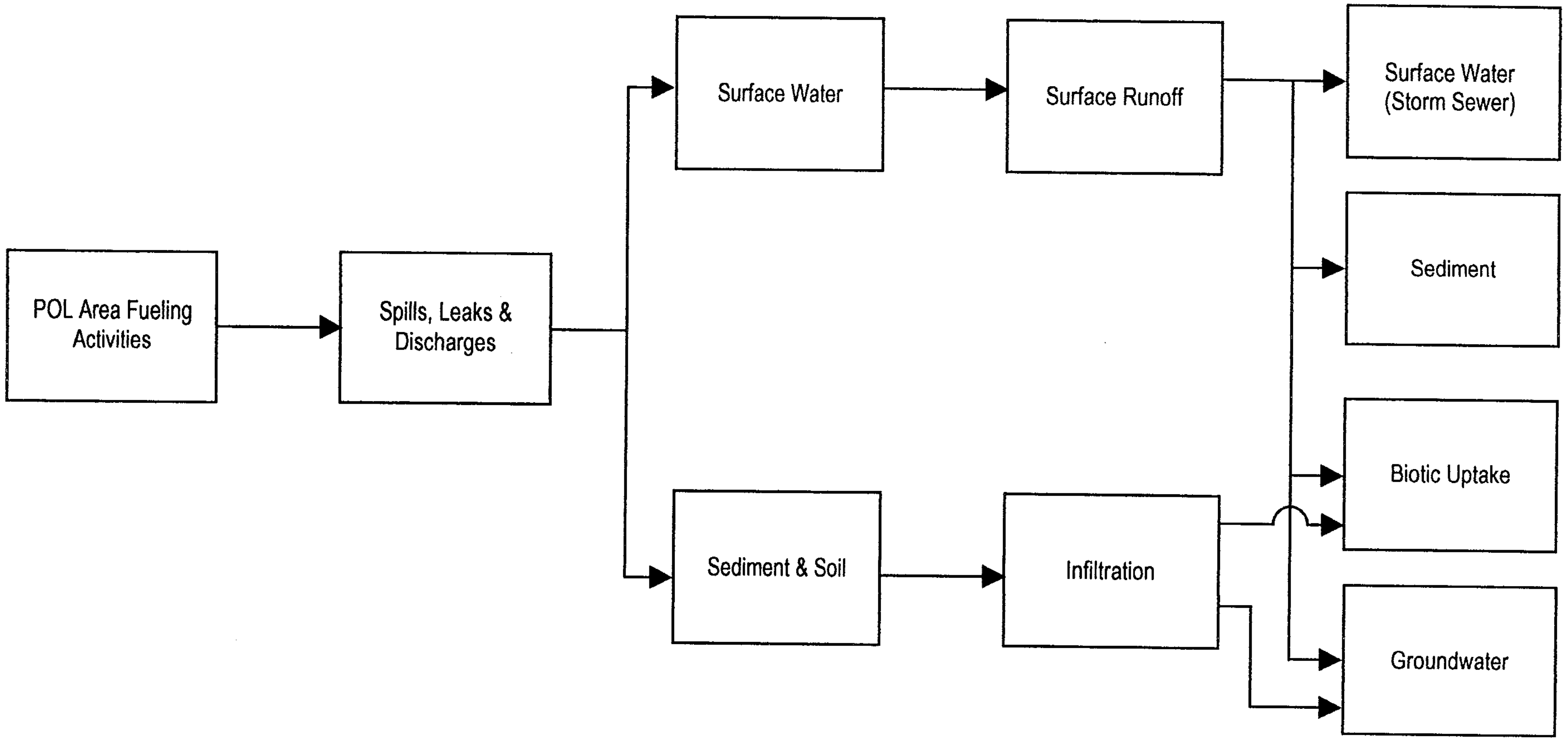
The potential routes for chemical migration at Site 5 Ramp Drainage Ditch are depicted in Figure 4-4. The primary release mechanism is from the accidental discharge to the apron ditches (including washing of residue from the parking apron into the ditches), spills and leaks, surface runoff, and infiltration and percolation of chemicals in the vadose zone. Chemicals detected during the SI at Site 5 are shown in Table 4-6.

4.2.2 Chemical Transport and Fate

The following paragraphs provide both general and site-specific information on the transport and fate of the primary chemicals of potential concern detected in samples collected during the SI.

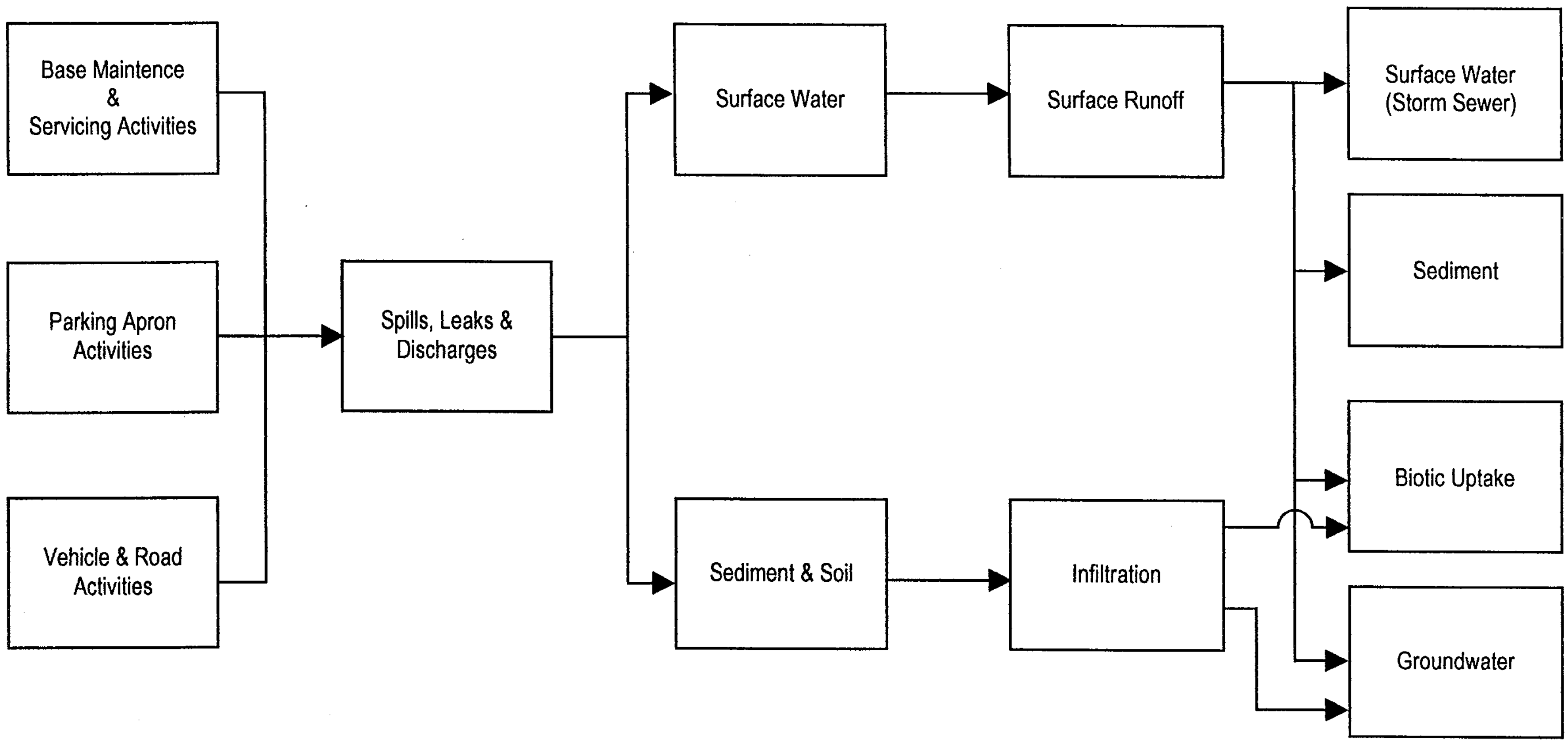
- **Inorganic Contaminants (Metals)**

  Typically, inorganic contaminants will be transported in the dissolved phase through the soil column. Slightly lower pHs (and Ehs) also may mobilize some inorganic species. Constituents dissolved in infiltrating water may be transported into subsurface aquifers. If sufficient quantities of these compounds are released, they also may migrate through the vadose zone as a free liquid and enter groundwater. It is believed, however, that inorganic contaminants are principally bound to soil particles because most inorganic contaminants measured in groundwater samples were not detected after filtration. Also, geologic formations with smaller particle sizes (i.e., silt and clay materials) appear to act as a repository for inorganic contaminants. These smaller soil particles are more readily transportable to the subsurface aquifer although the inorganic species may not be soluble. Insoluble inorganic species will also move through the vadose zone suspended in water. This



Site 4 - POL Storage Area, Potential Routes of Chemical Migration

Springfield ANGB, Springfield, Ohio



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Site 5 - Ramp Drainage Ditch,
Potential Routes of Chemical Migration

Springfield ANGB, Springfield, Ohio

Figure: 4-4 | Project: 01-0827-03-0200-005

will transport the insoluble metals to the groundwater. The contaminants adsorbed to particulates or suspended in the water are measurable in unfiltered groundwater samples and measurable at lower concentrations or not detected in filtered groundwater samples. In general, the migration rate of metals in vadose zone soil is not expected to be significant. Because of interactions with the atmosphere, this is a very oxidizing regime (e.g., converting metal sulfides to sulfates). The following transport mechanisms are important for metals in the vadose zone. The more soluble species may be expected to move downward toward the water table due to percolation. Insoluble or precipitated metal species are not expected to migrate in unsaturated soil. These solid forms may move in the unsaturated zone, depending on the local hydrologic conditions.

Antimony—Antimony has a relatively high solubility in water, and therefore, is generally very mobile in the environment. However, pH, Eh and sorptive interactions also influence its mobility. The presence of antimony in different environmental media is not expected to be related to site activities.

Antimony was detected in surface soil, subsurface soil, and groundwater at many locations throughout the Base. Detected groundwater concentrations for the compound were consistently higher than those detected in the soils. The detected concentrations, both in soil and groundwater, appear to differ from levels measured in background.

Arsenic—The high mobility of arsenic in the environment is clearly indicated by the results of this SI, which indicate its presence in all media sampled. Arsenic was detected at numerous locations throughout the Base in surface and subsurface soil and groundwater.

The results of statistical analyses (Sections 3.5 through 3.9) indicate that arsenic concentrations in site soil samples were similar to background concentrations (i.e., arsenic appears to be naturally occurring in soil). Statistical comparisons of arsenic concentrations in unfiltered groundwater samples collected from Sites 2, 3, and 4 were inconclusive; some of the measured concentrations exceeded the background upper tolerance intervals. It is believed that because arsenic was detected in unfiltered groundwater samples above background but not detected in the filtered sample at concentrations above background, and detected in soil samples at levels similar to background, the concentrations of arsenic in the groundwater are most likely naturally occurring and not site related.

Beryllium—Beryllium has a very low aqueous solubility and is probably precipitated or adsorbed onto solids after introduction to the aqueous environment. No data were found on the adsorption of beryllium; however, due to its geochemical similarity to aluminum, one would expect that at low pH, beryllium would tend to be adsorbed onto clay mineral surfaces, while at high pH, it should be complexed with an insoluble ligand. Beryllium should be present in particulate (sorbed or precipitated) rather than in dissolved form in most natural environments.

Beryllium was detected in sediment, soil, and groundwater at numerous locations throughout the Base. Concentrations were measured in the groundwater at Sites 2 and 4 that exceed Safe Drinking Water Act (SDWA) maximum contaminant levels

(MCLs). However, neither the source of the metal nor the mechanism for transport has been clearly defined during the SI.

Cadmium—Compared to the other heavy metals, cadmium is more mobile in the aquatic environment and may be transported in solution as either hydrated cations or as organic or inorganic complexes. Although sorption processes affect cadmium to a lesser extent than most of the other heavy metal pollutants, sorption by mineral surfaces, hydrous metal oxides, and organic materials probably removes more cadmium from solution than does precipitation. Laboratory results suggest that in the transport of cadmium in the saturated zone, suspended solids of high organic content play a dominant role (Gardiner 1974).

The distribution of measured cadmium concentrations suggests that the metal is most prevalent in the surface soils and surface sediment throughout the Base. The presence of cadmium in surface soil and sediment does not appear to be related to site activities; except possibly at Site 5 sediments where levels exceed background. It does not appear to be migrating downward in the soil column because it was either not detected or at low concentrations in soil and groundwater samples.

Chromium—Chromium exists in two oxidation states in the soil environment: trivalent Cr^{+3} and hexavalent Cr^{+6}. The hexavalent species is quite soluble, existing in solution as a complex anion, and is not sorbed to any significant degree by clays. Trivalent chromium reacts with the aqueous hydroxide ion to form the insoluble chromium hydroxide ($Cr(OH)^3$). Precipitation of this material is thought to be the dominant fate of chromium in natural waters.

Chromium was detected in Base sediment, soil, and groundwater samples. Except in Site 2 groundwater samples, concentrations in site samples did not exceed the background upper tolerance limits; chromium is not considered to be site related, with the possible exception of Site 2 groundwater. Levels were detected in unfiltered groundwater at Sites 2 and 4 at levels greater that the MCLs.

Copper—The fate of copper in the environment is dependent on one of the following processes: complex formation, especially with humic substances; or, sorption to hydrous metal oxides, clays, and organic material. The fate of copper is highly dependent on variables such as pH, Eh, and concentration of organic materials and adsorbents.

At the Base, copper was detected at all of the sites and background locations in all environmental media sampled. Copper measured in soils appears to be naturally occurring (see Sections 3.5 through 3.9). Consequently, the presence of copper in background soils and groundwater samples, and the absence of copper in unfiltered groundwater samples, reinforces the premise that groundwater does not appear to be influenced by activities at any of the sites.

Lead—Sorption processes are effective in reducing the concentration of soluble lead in natural waters. The tendency for lead to form complexes with naturally occurring organic materials in soil increases its adsorptive affinity for clays and other mineral surfaces.

The distribution of detected lead concentrations suggests that lead movement through soils is mitigated by sorption and possible movement of soluble ions in the groundwater. Lead in soil and sediment are comparable to background. Levels in groundwater are indistinguishable from background except at Site 2; it is significant that lead was not detected in filtered groundwater samples. Because the levels in soil and sediment appear to be naturally occurring and lead was only detected in unfiltered groundwater samples at the investigation sites, lead in groundwater does not appear to be site related.

Mercury—The major fate process removing mercury from natural water systems is adsorption to particulate surfaces or possible precipitation. The overwhelming majority of dissolved mercury is removed in this manner within a relatively short time, usually in the immediate vicinity of the source. The primary locations where mercury was detected is in the drainage ditches. Comparisons to the levels in background samples suggests that mercury is naturally occurring.

Nickel—Nickel appears to be a relatively mobile heavy metal. Sorption and precipitation do not appear to be as important as with other heavy metals. Nickel has an affinity for organic materials, hydrous iron, and manganese oxides.

Nickel was detected at numerous locations throughout the Base. Results indicate that nickel is present in moderate to high levels in groundwater; the MCL for nickel was exceeded at Sites 2, 3, and 4. Soil and groundwater concentrations did not exceed the background upper tolerance limits; therefore, nickel does not appear to be site related.

Selenium—In general, selenium chemical species are very soluble in water, but selenium also has a sorptive affinity for hydrous metal oxides, clays, and organic materials. However, neither the source of the metal nor the mechanism for transport has been clearly defined during the SI. Selenium levels are indistinguishable from background levels and do not appear to be site related.

Silver—Silver was detected in surface soil, subsurface soil, and groundwater at Sites 2 and 3 and in soil at Site 5. Except for soil concentrations at Site 3 and unfiltered groundwater concentrations at Sites 3 and 4, measured concentrations did not exceed the background upper tolerance limits for soil or groundwater. Silver also appears to be bound to suspended particulate matter; silver was not detected in filtered groundwater samples. The presence of silver at levels greater than background at Site 3 may be attributed to the disposal of battery acid and photochemical processing wastes in the former leach field.

Thallium—Thallium can be removed from solution by adsorption onto clay minerals. Detected values were observed throughout the Base at levels indistinguishable from background.

Zinc—Zinc complexes are soluble in neutral and acidic solutions, so that zinc is readily transported in most natural waters. Note that zinc is one of the most mobile and ubiquitous of the heavy metals. Although zinc is readily soluble, sorption to clay minerals, hydrous oxides, and organic matter is a mechanism that significantly mitigates offsite transport.

Zinc was detected in all media at all of the sites at levels similar to those measured at background locations.

- **Total Petroleum Hydrocarbons**

Although volatile aromatic hydrocarbons and PAHs are present in fuels and oils, aliphatic hydrocarbons are the major constituents of petroleum substances. Petroleum products such as gasoline also contain lighter hydrocarbons, including benzene, toluene, ethylbenzene, and xylene (BTEX) compounds; heavier fuels (e.g., diesel); and oils (e.g., motor oil, fuel oil).

Petroleum hydrocarbons are nonpolar and insoluble in water and many other polar solvents; therefore, they are relatively unreactive compared to other organic compounds. Furthermore, petroleum compounds have high log K_{ow} values and will partition to soils high in organic carbon content. Less partitioning will occur for soils lower in organic matter content (e.g., some clays or sandy soil). Because of high log K_{ow} values and low water solubilities, it is unlikely that these contaminants will migrate through the soil column.

Site 1—TPH were detected in all three soil borings at Site 1. Although TPH were detected in the surface soil samples, the greatest concentrations were detected at greater depths, 20.5 to 22.0 feet below land surface (BLS), and similar concentrations were measured in all three borings.

This pattern indicates that many of the petroleum hydrocarbons have leached through the vadose zone by gravitation and carried by infiltration and percolation to groundwater.

The absence of TPH in the groundwater suggests the downward migration is not a significant concern. Upon reaching the groundwater surface, TPH will tend to float on the water surface (i.e., LNAPLs) where they may dissolve in the water, sorb to soil particles, or both. Some of the contaminants not sorbed to the soil may move with the groundwater flow. TPH are degraded naturally by microorganisms or weathered in soil, which is the likely fate for these chemicals at this location. The absence of TPH in the groundwater and the elevated TPH concentrations in the gray clay encountered at Site 1 indicate that the clay also may be acting to impede migration of the TPH and act as a point of accumulation.

Site 2—TPH concentrations ranged from not detected to 830 mg/kg in soil samples. These were confined to the immediate vicinity of the burn pit; much lower concentrations were measured at greater distance from the burn pit. The results indicate that TPH are not spreading horizontally in the soil and that they are migrating vertically in soil only near the release (TPH were detected up to 0.5 mg/L in two groundwater samples).

Site 3—At Site 3, TPH levels were greatest at depths between 6 and 9 feet BLS at soil borings SB3-2, SB3-4, and SB3-5. The source of TPH in shallower samples is unknown, since the soil has been emplaced after the abandonment of the leach field. The results suggest that the wastes deposited at the site have remained sorbed to soils; however, slightly elevated TPH values at a greater depths of 13 to 18 feet BLS in soil boring SB3-5 may indicate that migration may be occurring at that location.

Site 4—TPH were detected in surface and subsurface soil samples well below the levels determined by the Ohio Division of the State Fire Marshall, Bureau of Underground Storage Tank (UST) Regulations (ODOC 1992) for TPH as gasoline and "other than gasoline." Samples collected from greater depths indicate that TPH is not migrating vertically in the soils.

Site 5—Levels of TPH much less than guidance levels for UST sites were detected in the subsurface soils at Site 5. Elevated levels of TPH were detected in the sediment samples collected from the drainage ditch. These results may indicate that the majority of the TPH has partitioned to the soils high in organic content located in the ditch. However, the presence of TPH at greater depths suggest that vertical migration through the vadose zone has occurred.

- **Aromatic Hydrocarbons**

Measured concentrations of aromatic hydrocarbons at the sites are statistically different from background. The presence of these contaminants is probably related to site activities where measured.

Benzene—Benzene is a moderately volatile organic chemical. The low chemical reactivity of benzene is related to the stability of the aromatic ring. Benzene in excess of its water solubility would float on the water's surface. The major environmental fate process is volatilization of benzene from soil to the atmosphere. Sorption to soils occurs under conditions of constant exposure (K_{ow} = 135, EPA 1985); however, the limited data suggest sorption is a less important fate process than volatilization. Benzene is considered moderately mobile in soils.

Benzene was detected in Site 2 soil and in groundwater at Site 4. At Site 2, two surface soil samples collected from SB-2 and SB-3 had detected concentrations of benzene. Furthermore, two subsurface soil samples collected from 7 to 9.5 feet BLS had measured concentrations of benzene. These benzene concentrations in the surface and shallow subsurface soil indicate that a shallow localized area around the mock airplane has been contaminated by fire training activities; however, no benzene was detected in the groundwater, suggesting that benzene migration is localized to the unsaturated zone soil.

Ethylbenzene—Although ethylbenzene is naturally occurring, most ethylbenzene in the environment is the result of human activities. Like other volatile aromatic hydrocarbons, the primary transport mechanism of ethylbenzene from contaminated soil is volatilization. The amount of volatilization will be controlled by the degree of soil sorption. Less volatilization will result from soil higher in organic matter content because of the high low K_{ow} (K_{ow} = 3.15, EPA 1979). The tendency of ethylbenzene to partition to soil also will immobilize this compound in contaminated soil and slow the infiltration to groundwater.

Ethylbenzene was detected in the soils at Sites 2, 3, and 5. The ethylbenzene results at Site 2 are very similar to those displayed by benzene. Surface and shallow subsurface detection of ethylbenzene in SB2-2 and SB2-3 and that ethylbenzene was not detected in groundwater suggests that downward migration is localized to the unsaturated soil.

Ethylbenzene was detected in Site 3 soil borings SB3-4 and SB3-5 at depths of 6 to 9 feet BLS. Detection of ethylbenzene at this depth can be attributed to the presence of residual leach field waste. The general absence of ethylbenzene in the subsurface soil, below 9 feet, and the groundwater suggests that the movement of this compound may have been immobilized, as discussed above.

At Site 5, ethylbenzene was detected in one surface soil sample at soil boring SB5-4. The absence of ethylbenzene in subsurface soil indicates that the contaminants are limited to the surface soils.

Toluene—Volatilization is the major fate process for toluene. The compound is relatively insoluble and less dense than water; however, it does sorb to soils significantly (log K_{ow} = 2.69, EPA 1979).

Toluene was detected in the soils at Sites 1, 3, 4, and 5. At Site 1, toluene was detected in the surface soil boring SB1-1 and in the subsurface of soil boring SB1-3. No clearly defined source is apparent from the results.

Toluene also was detected in the surface and subsurface soils at Site 3. No source for toluene has been identified for surface soil contamination; however, the detection of the toluene in soil boring SB3-5 can be attributed to the residual leach field waste deposited at that location.

The presence of toluene in Site 5 soil is similar to the discussion of ethylbenzene and benzene discussed above.

Xylene—Volatilization from soil is again the most important transport mechanism, and biodegradation appears to be the most important environmental fate mechanism for xylene isomers. Soil sorption will slow volatilization, especially in soils with higher organic matter content (log K_{ow} = 3, EPA 1985). Biodegradation studies reveal soil-groundwater residence times in naturally occurring systems for all isomers range from 11 to 37 days (Dragun 1988).

Xylene was detected in the soil at Sites 2, 3, and 5. The results are similar to those of ethylbenzene; therefore, no further discussion has been included.

- **Chlorinated Solvents**

Trichloroethene (TCE)—The most important environmental transport process for TCE is volatilization. Volatilization is not decreased by soil sorption (K_{ow} = 195 calculated from log K_{ow}, EPA 1985). Downward migration is also an important transport mechanism because TCE does not bind well to soil and is slightly soluble in water; because of these conditions, it will rapidly move through the unsaturated soil to groundwater. The estimated half life in a soil-groundwater system based on field observations is 300 days (Dragun 1988).

TCE was detected in the groundwater at Site 3. Site history indicates that this site may be a potential source. However, the reported concentrations were much lower than the MCL. TCE also was detected in the soil and groundwater at Site 4. 1,2-Dichloroethene also was detected in the groundwater at Sites 3 and 4. The presence of these compounds at Site 4 is not understood because these solvents are not components of JP-4. An upgradient area may be the source of these solvents migrating into the area of Site 4.

The drainage pattern at the time of the spill at Site 4 indicates that downstream migration is probably in a southwest direction from the Base. However, the groundwater at the site has been shown to flow to the northeast. For this reason, the detected chlorinated solvents are not believed to be related to the events associated with the spill. In addition, these solvents are not components of JP-4.

- **Polycyclic Aromatic Hydrocarbons**

PAHs are a class of compounds consisting of substituted and unsubstituted polycyclic and heterocyclic aromatic rings formed because of incomplete combustion of organic compounds with insufficient oxygen (EPA 1980). PAHs are also naturally found in petroleum products (i.e., tars, asphalts, and to a lesser extent crude oils) with similar properties. Table 4-7 lists the PAHs detected during the SI and presents a summary of PAH derivatives and their common usages. The presence of these compounds in the environment can be attributed to natural or anthropogenic activities. Forest fires and volcanic activity are natural sources of PAHs, and anthropogenic sources include combustion of coal and fuel-related products (including automobile exhaust). Most of the PAHs at the sites were detected at levels greater that background and appear to be site related, especially in samples collected near the burn pit at Site 2. Since PAHs have similar physical and chemical properties, they are evaluated as a class of compounds here.

PAHs are primarily airborne contaminants from incomplete combustion of fuels and wood products; they can bind to airborne particulates or exist as a vapor. Because of their release to the atmosphere, these compounds can be transported great distances from the release site by winds. Compounds are then deposited into surface water or soils. PAH surface water contamination can volatilize, photodegrade, oxidize, biodegrade, or bind to particulates (settling to bottom as sediment). In soils, PAHs can volatilize, biodegrade, or percolate to groundwater. These compounds are not very soluble in groundwater, yet PAH contamination can spread vertically within an aquifer.

PAHs are fairly insoluble (34.4 mg/L for naphthalene to 5×10^{-4} mg/L for dibenzo[a,h]anthracene) in water. Because of their low aqueous solubility, these compounds persist in the environment and inhibit rates of hydrolysis, photolysis, and oxidation.

Table 4-7. PAH Derivatives and Uses

Chemical	Derivation	Use
Acenaphthene	From coal tar	Insecticide, fungicide, plastics
Anthracene	By salting out from crude anthracene oil	Dyes, alizarin, phenanthrene, carbazole, anthraquinone, calico printing, a component of smoke screens
Benzo(a)anthracene	Formed during the incomplete burning of coal, oil, and gas	Research chemical; however, it is no longer produced commercially in the U.S.
Benzo(b)fluoranthene	Formed during the incomplete burning of coal, oil, and gas	Research chemical; however, there is no commercial production of this compound
Benzo(k)fluoranthene	Formed during the incomplete burning of coal, oil, and gas	There is no commercial use of this compound
Benzo(g,h,i)perylene	Formed during the incomplete burning of coal, oil, and gas	There is no commercial production or known use of this compound
Benzo(a)pyrene	Coal tar pitch volatiles are products of the distillation of bituminous coal and contain polynuclear aromatic hydrocarbons	Research chemical; however, it is no longer used commercially in the U.S.
Chrysene	Distillation of coal tar	Organic synthesis
Dibenzo(a,h)anthracene	Not found	Research chemical; however, it is no longer produced commercially in the U.S.
Fluoranthene	From coal tar or petroleum	Constituent of coal tar and petroleum derived asphalt used as lining material to protect interior of steel and ductile-iron potable water pipes and storage tanks
Fluorene	By reduction of diphenylene ketone with zinc, from coal tar	Resinous products, dyestuffs
Indeno(1,2,3-cd)pyrene	A semireinforcing carbon black made in 1964 and atypical of furnace blacks was extracted with triple distributed benzene for 24 hours followed by separation of polynuclear aromatic hydrocarbons	Research chemical; however, it is no longer used commercially in the U.S.
Naphthalene	(a) From coal-tar oils boiling between 200 to 250°C (middle oil) by crystallization and distillation (b) From petroleum fractions after various catalytic processing operations	Moth repellant, fungicide, smokeless powder, cutting fluid, lubricant, synthetic resins, synthetic tanning, preservative, textile chemicals, emulsion breakers, scintillation counters, and antiseptics
Phenanthrene	Factional distillation of high-boiling coal-tar oils with subsequent recrystallization from alcohol	Dyestuffs, explosives, synthesis of drugs, biochemical research, manufacturing phenanthrenequinone
Pyrene	From coal tar	Biochemical research

Henry's Law constants for PAHs for the chemicals detected at the Base vary from 5.07 x 10^{-13} for indeno(1,2,3-cd)pyrene to 1.1 x 10^{-3} atm • m^3 • mol^{-1} for fluorene. Some of the lighter molecular weight PAHs are potentially volatile and the heavier molecular weight compounds are non- or semivolatile. Although some PAHs are slightly volatile, volatilization is not considered to be a significant transport process for most PAHs. The low solubility and hydrophobicity of PAHs are conditions that impede the ability of these chemicals to infiltrate groundwater.

Soils higher in organic content (i.e., upper horizon of Sites 2, 3, and 5) will show the greater affinity to PAHs. The log K_{ow} values for PAHs detected at the Base range from 3.37 for naphthalene to 7.66 for indeno(1,2,3-c,d)pyrene.

Although the predominant fate of many PAHs is sorption to sediments, low molecular weight PAHs (LPAHs) are more likely to dissolve or volatilize than high molecular weight PAHs (HPAHs). The likely sources of both LPAH and HPAH compounds at the Base are fire training activities, POL storage area activities, leach field residue, runway/flightline activities and vehicle emissions.

Phenanthrene was the only PAH detected at Site 1, Fire Training Area 1. The compound is a LPAH and was detected in the surface soil of SB1-1 and in the subsurface soil of SB1-2. The limited number of detections in the soil and the absence of PAH in groundwater suggests that only low levels of PAH exist at the site and that these compounds are not migrating far from the source.

At Site 2, Fire Training Area 2, both LPAHs and HPAHs were detected. The source is probably fuels and oils burned during fire training exercises, as suggested by the distribution of compounds detected in surface and subsurface soil around the burn pad. The presence of PAHs in the drainage ditch sediments indicates that they probably are being transported by water associated with fire training activities. However, the absence of these compounds in the groundwater suggests that they are not migrating far from the source area.

Multiple compounds, both LPAHs and HPAHs were detected in the soil at the Leach Field, Site 3. However, the overwhelming majority of the detections were associated with the residual leach field material and the overlying lithology. The distribution of detected compounds and the absence of PAHs in the groundwater suggests that the compounds are remaining close to their original location.

At Site 5, Ramp Drainage Ditch, five LPAHs and nine HPAHs were detected in the sediment and surface soil. All of these PAHs were detected in the sediment associated with the ditch; however only one PAH was detected in the soil samples collected close to the ditch. These detections indicate that the majority of compounds are sorbing to the organic material associated with the ditch and are not migrating into the vadose environment.

5. BASELINE HUMAN HEALTH RISK ASSESSMENT

5.1 INTRODUCTION

A baseline human health risk assessment has been conducted evaluating exposure to chemicals present at, or released from, waste sites at Springfield Air National Guard Base (ANGB). The purpose of the risk assessment is to evaluate potential risks to human health and to support the determination of the need for site remediation. Risk assessment is a tool in selecting appropriate remedial alternatives, and one of the components that may be required to reach a remedial decision. The baseline risk assessment focuses on potential noncancer and cancer health effects from long-term, low-level exposures to site-related contaminants.

The baseline risk assessment is part of the site investigation (SI) at Springfield ANGB, and is based upon results of samples collected in 1992 and 1993. This assessment focuses only on the following areas of concern:

- Site 2 - Fire Training Area No. 2
- Site 3 - Leach Field and Outfall
- Site 5 - Ramp Drainage Ditch.

Descriptions of these sites and information concerning their history are presented in Section 1.4. Risk assessment was not conducted for Sites 1 and 4. At Site 1, contamination was not detected at levels significant to warrant risk assessment. As discussed in Section 3.5, contaminants detected in soils at Site 1 are indistinguishable from background levels detected on the Base and no site-related contaminants were detected in groundwater 50 feet downgradient from the burn pit. At Site 4, trichloroethylene was detected in soils and groundwater. This is not related to the JP-4 spill. Before a risk assessment can be conducted for this site, further sampling is needed to further characterize the source and extent of the trichloroethylene contamination.

The baseline risk assessment is organized according to the U.S. Environmental Protection Agency's (EPA's) Risk Assessment Guidance for Superfund (RAGS), which specifies four steps (EPA 1989a):

- Step 1—Data Collection and Evaluation (Section 5.2)
    - Gather and analyze relevant site data
    - Identify chemicals of potential concern
- Step 2—Exposure Assessment (Section 5.3)
    - Analyze contaminant releases
    - Identify exposed populations
    - Identify potential exposure pathways for current and future land uses
    - Estimate exposure concentrations for pathways
    - Estimate contaminant intakes for pathways
- Step 3—Toxicity Assessment (Section 5.4)
    - Collect qualitative and quantitative toxicity information
    - Determine appropriate toxicity values
- Step 4—Risk Characterization (Section 5.5)
    - Characterize potential for adverse health effects to occur
        - Estimate cancer risks
        - Estimate noncancer hazard quotients
    - Evaluate uncertainty
    - Summarize risk information.

5.2 DATA COLLECTION AND EVALUATION

The first step in the risk assessment process is to obtain and evaluate all available data on contaminants present in the environmental media at Sites 2, 3, and 5. This section of the risk assessment focuses on the following elements: (1) overview of the sample collection program and data quality assessment as it relates to the human health risk assessment, (2) summary of methods and selection of chemicals of potential concern, and (3) data aggregation to support the calculation of the exposure point concentrations (the concentrations of chemical contaminants at the point of contact with the receptor). Section 5.3 provides information on calculating the exposure point concentrations.

The sampling program for Sites 2, 3, and 5 at Springfield ANGB was conducted in the spring and fall of 1992 and in the spring of 1993. The program included the collection of samples from soils and groundwater. Both unfiltered and filtered groundwater samples are available for these sites. The risk assessment primarily uses unfiltered groundwater samples, but also uses filtered samples to assess the significance of chemicals detected in unfiltered groundwater samples. In particular, the filtered versus unfiltered comparison provides information regarding the extent to which unfiltered groundwater samples from a monitoring well may be used to represent samples from a hypothetical drinking water supply well. Section 2 presents the methods and rationale for the sampling program. Results of the sample analyses are presented in Sections 3.3 through 3.9.

The sampling program called for the collection of sediment and surface water samples in the drainage swale near Site 2 and in the Ramp Drainage Ditch (Site 5). However, at the time the sampling activities were being conducted, no standing water was present in either the ditch or swale. Therefore, at Sites 2 and 5, sediment samples with the designation "SD" are considered soils.

Analytical data collected at Springfield ANGB have undergone quality assurance/quality control (QA/QC) evaluation using the Hazardous Waste Remedial Actions Program (HAZWRAP) Level C (i.e., EPA Level III) for soil and groundwater samples; QC requirements described in *Requirements for Quality Control of Analytical Data* (DOE/HWP-65/R1, July 1990); and the guidelines and specifications described in the Quality Assurance Projects Plans (QAPPs) submitted as part of the project work plans prepared by Science Applications International Corporation (SAIC).

5.2.1 Selection of Chemicals of Potential Concern

In some cases, it may be impractical to quantitatively evaluate all chemicals identified in environmental media (due to limitations in computer capability, etc.). In such cases, a subset of chemicals may be identified as chemicals of potential concern for quantitative evaluation in the risk assessment. However, reducing the number of chemicals evaluated in the risk assessment is specified as optional by EPA and does not improve the quality or accuracy of the risk assessment. Therefore, in this risk assessment, all chemicals detected in a medium were carried through the risk assessment for that medium. Screening processes that would further reduce the number of chemicals to be evaluated were not performed. This is the method preferred by EPA (EPA 1989a), as noted in the following quote:

> If conducting a risk assessment on a large number of chemicals is feasible (e.g., because of adequate computer capability), then the procedures presented in this section [i.e., for reducing the number of chemicals of potential concern] should not be used. Rather, the most important chemicals ... identified after the risk assessment could be presented in the main text of the report, and the remaining chemicals could be presented in the appendices.

5.2.1.1 Chemicals in Soils

As mentioned previously, all chemicals positively identified in soil samples (from 0 to 10 feet below land surface [BLS]) have been incorporated into the risk assessment. These chemicals are presented along with summary statistics in Appendix H, Tables H-1 through H-7. Background sampling locations were selected as site-specific points of comparison and represent conditions that may be expected to exist at each site in the absence of site-related activities. Inorganic chemicals are often naturally occurring, and although organics may also be naturally occurring, they are generally assumed to originate from human activity. Note that EPA does not recommend eliminating chemicals from the risk assessment based upon their presence in background samples (EPA 1989a).

5.2.1.2 Chemicals in Groundwater

Two primary water-bearing units are located beneath Springfield ANGB: a shallow aquifer that is affected by surficial hydrologic conditions, and a deeper bedrock aquifer that acts independently of surface conditions. The Base is currently supplied by the city of Springfield, which obtains its water from 10 wells drilled into the bedrock aquifer in the northern part of the city. Groundwater from the shallow aquifer is not used as a source of drinking water by Base personnel. This is largely due to the low productivity of this aquifer (see discussion in Section 4). All groundwater samples collected for this SI were taken from the shallow aquifer, as this is the only aquifer that might be affected by disposal practices on the Base.

As with soils, all chemicals positively detected in groundwater were carried through the risk assessment (see Appendix H, Table H-1 through H-7). In addition, the significance of chemicals in groundwater was evaluated by means of comparison with ARARs. This comparison is presented in Sections 3.5 through 3.9. Samples from upgradient wells were collected for groundwater and provide an important means of comparison with contaminant levels believed to be site related.

5.2.2 Data Aggregation and Summary Statistics

Once the environmental monitoring data have undergone QA/QC evaluation and chemicals of potential concern are selected, they are manipulated for the purposes of risk assessment. The data must be aggregated and statistical calculations performed to derive a meaningful estimate of the exposure point concentrations.

Data aggregation refers to the manner in which sample data are combined in order to calculate statistics and estimate risk. Data aggregation must focus on key receptors at potential risk of exposure and the land use area and circumstances under which exposure is most likely to occur. The concept of the "exposure unit" is therefore introduced as a basis for the assessment of exposure and may be thought of as the geographic area within which a receptor would realistically be expected to spatially and temporally aggregate exposure to contaminants.

At Springfield ANGB, data have been aggregated in two ways: according to site (i.e., treating each site as a separate exposure unit) and according to depth. Aggregating all data within a site was performed because the sites are under the same land use and are small enough that a receptor would be likely to average exposures across an entire site.

Data also were aggregated according to depth. In this risk assessment, soils were divided into surface and subsurface categories to enhance evaluation of current and future exposure to the receptors. Due to different sampling conditions, surface and subsurface soil classifications were not consistent for all of the sites under investigation. Surface soils were designated in the following manner:

- Site 2: 0 to 0.5 feet BLS (at the soil sampling locations, the top one-half foot consisted of gravel, rendering it impossible to collect true surface soil samples; therefore, sediment samples collected from 0 to 0.5 feet BLS were used to characterize exposures to surface soils in the risk assessment)
- Site 3: 0.5 to 2.5 feet BLS (due to a surface grass layer, the Site 3 shallow soil samples were collected at the following intervals: 0.5 to 1.5 feet BLS, 0.5 to 2 feet BLS, and 0.5 to 2.5 feet BLS; because of the various and overlapping sample depths, all of these samples were designated as surface soils for Site 3)
- Site 5: 0 to 0.5 feet BLS.

Subsurface soils were designated as follows:

- Site 2: 0.5 to 10 feet BLS
- Site 3: 2.5 to 10 feet BLS
- Site 5: 0.5 to 10 feet BLS.

Soil borings deeper than 10 feet are generally below typical construction zone soils and contact is unlikely.

Compiling separate shallow and deeper soil depth data sets allows increased resolution regarding the extent of the observed contamination, and is intended to provide a rational basis for focusing cleanup efforts, if required.

Next, summary statistics were prepared for each chemical in each medium and exposure unit (i.e., each site). The summary statistics calculated for the baseline risk assessment are presented in Appendix H, Tables H-1 through H-7. These statistics are based upon the combined 1992 and 1993 sampling sets, and include frequency of detection, minimum and maximum concentrations of chemicals in the environment, minimum and maximum detection limits, and the arithmetic mean concentrations of chemicals. The mean concentrations have been expressed as the arithmetic mean and the upper confidence limit on the arithmetic mean of the untransformed sample data for every site evaluated (EPA 1992d). "Not detected" results were treated as one-half the limit of detection and included in the calculations of the mean values.

5.3 EXPOSURE ASSESSMENT

This section evaluates the potential for human exposure to contaminants at the sites under investigation. The exposure assessment, in conjunction with the subsequent toxicity assessment, supports the characterization of potential risks to human health. The exposure assessment consists of the following principal components:

- Evaluation of contaminant transport
- Identification and characterization of exposure pathways
- Identification of populations at risk of exposure
- Discussion of assumptions used in deriving estimates of intake or dose.

To quantify exposure (and subsequent dose), exposure scenarios have been developed along with quantitative exposure parameter estimates. These exposure parameters include, for example, exposure frequency (i.e., how often a person may visit the site) and contact rate (i.e., how much soil may be ingested on a day of exposure). Although uncertainty in the results of the risk assessment may be tied to the exposure assumptions, the methods used in this section follow the most current EPA guidance on exposure and risk assessment (EPA 1989a,b and 1992d).

Because of the difficulty associated with realistically quantifying exposure, risk assessment has been conducted using two estimates: "most likely exposure" (MLE) values (i.e., an average or representative value) and "reasonable maximum exposure" (RME) values (i.e., an upper-bound conservative estimate). EPA defines the RME estimate as "the maximum exposure that is reasonably expected to occur at a site" (EPA 1989a). MLE and RME estimates were developed for environmental concentrations, as well as for input variables used in the exposure assessment equations used to estimate chronic intake or dose.

5.3.1 Land Use

Both current and future land use must be considered in the baseline risk assessment (EPA 1989a). It is important to note that Springfield ANGB is one of the bases designated for closure in the future. As a result, future land use of the Base is somewhat uncertain. However, Springfield ANGB is a tenant organization located within the boundaries of the Springfield Municipal Airport and is designated in public records as within Zone I-1 (heavy industry). Because of its proximity to the Springfield Municipal Airport, it is likely that future land use will be restrictive and will exclude residential or agricultural use.

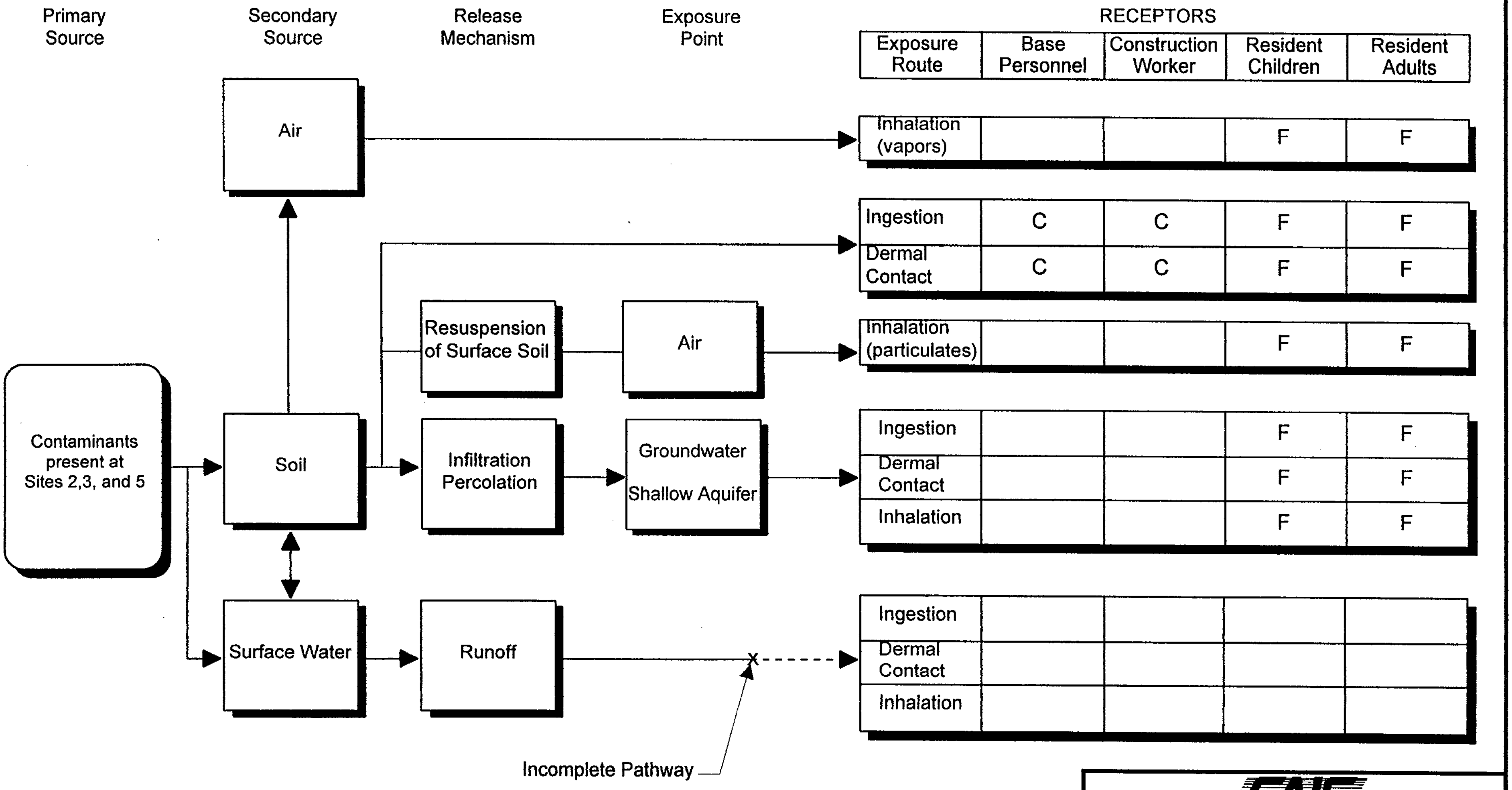
Even if Springfield ANGB does not remain under Ohio Air National Guard (OANG) management, land use would be primarily determined by the Springfield-Beckley Municipal Airport Authority. The Springfield Municipal Airport is a controlled and fenced facility and the general public does not have free access to this property. However, given the fact that there are residences adjacent to the Base and that the Base will most likely be closed in the future, future residential development of the property has been evaluated in the risk assessment.

5.3.2 Characterization of the Exposure Setting: Conceptual Site Model

The exposure assessment may be qualitatively summarized as a conceptual site model, as presented in Figure 5-1. A conceptual site model has been prepared to characterize the transport of a chemical from the source of release to receptors at potential risk of exposure. Following EPA guidance, the conceptual site model identifies the sources and types of environmental release and links these with receptor locations and activity patterns to determine the important pathways of human exposure (EPA 1989a).

A single conceptual site model has been prepared for Sites 2, 3, and 5. Based on the available site-specific data and discussions with Base personnel, the transport and exposure pathways for Sites 2, 3, and 5 are similar (except no groundwater for Site 5) and may be represented by a single model. As shown in Figure 5-1, contaminants at the waste sites may act as potential sources of chemicals migrating into surface water and soils beneath the site. Once in soils, further chemical transport may occur via runoff, infiltration or percolation, or entrainment of particulates or volatile emissions into the atmosphere.

Conceptual Site Model : Sites 2,3, and 5



RECEPTORS

Exposure Route	Base Personnel	Construction Worker	Resident Children	Resident Adults
Inhalation (vapors)			F	F
Ingestion	C	C	F	F
Dermal Contact	C	C	F	F
Inhalation (particulates)			F	F
Ingestion			F	F
Dermal Contact			F	F
Inhalation			F	F
Ingestion				
Dermal Contact				
Inhalation				

C - Pathway evaluated under current land use
F - Pathway evaluated under future land use

Sites 2, 3, and 5
Conceptual Site Model

Springfield ANGB, Springfield Ohio

Figure: 5-1
Project: 01-0827-03-0200-005

Under current land use, Base personnel (such as maintenance workers) and construction workers are the most likely receptor groups at potential risk of exposure to chemicals. As there is no current use of groundwater from the shallow aquifer, exposures have been evaluated only for ingestion and dermal contact with soils. Inhalation exposure estimates for suspended soil or sediment particulates (dust) originating from the waste sites are likely to overstate exposures under current land use, since Sites 3 and 5 are infrequently visited by Base personnel, and all three sites are well vegetated or graveled. Therefore, these exposures have not been evaluated. Volatile emissions from soils are not of great concern, since the low levels of observed volatile organic contamination result in very low emission rates, and because the exposure points are all outdoors where vapor concentrations rapidly disperse due to atmospheric dilution. Therefore, volatile emissions from soils are evaluated only under the more conservative future land use scenario.

Under future residential development, resident adults and children are the most likely receptor groups at risk of exposure. The exposure pathways of principal concern for these receptors are inadvertent ingestion and dermal exposure to soils and groundwater (i.e., direct contact), inhalation of volatiles in groundwater, inhalation of suspended soil particulates, and inhalation of volatile emissions from the soil. Exposures to groundwater from the shallow unconsolidated aquifer are evaluated in the risk assessment under future land use. However, it is unlikely that the shallow aquifer will be used as a source of drinking water in the future. Productivity in this aquifer is low. Even before converting to city water, the Base drinking water was supplied by two local wells completed in the bedrock aquifer. Currently, the Base is supplied by the city of Springfield, which obtains its water from 10 wells drilled into he bedrock aquifer in the northern part of the city. Local receptors also do not use the unconsolidated aquifer for potable water (Ohio Department of Natural Resources 1995). In the future, it is likely that local receptors and the Base will continue to be supplied by the city of Springfield.

Exposure to surface water is an incomplete pathway. The drainage swales or ditches that exist on the Base retain liquid only during intermittent periods of rainfall, eliminating the possibility of chronic exposure. During the times sampling was conducted, no surface water was present in the swales or ditches so no surface water samples were collected.

5.3.3 Exposure Point Concentrations

Exposure point concentrations are the concentrations of chemicals reportedly available to human receptors at the point of contact. Exposure point concentrations for the risk estimates are developed from appropriate sample data, which were aggregated on a site-by-site basis, as discussed in Section 5.2.2. From this sample data, summary statistics were generated for each chemical in each medium (see Appendix H).

The exposure point concentrations for this baseline risk assessment are the arithmetic averages, which were calculated as part of the summary statistics. For each chemical, two concentrations were calculated: an MLE exposure point concentration, and an RME exposure point concentration. The MLE exposure point concentration is the arithmetic mean; the RME exposure point concentration is the 95 percent upper confidence limit (UCL) on the arithmetic mean. EPA recommends the latter because the uncertainty associated with any estimate of exposure concentration warrants a conservative approach that will err on the side of health protection.

The 95 percent UCL estimates are statistically conservative and protective of health. EPA guidance also notes that environmental concentrations are "best expressed as an estimate of the arithmetic mean regardless of the distribution of the data" (EPA 1992d). The 95 percent UCL was calculated using the formula presented below (EPA 1992e):

$$UCL = \bar{x} + t\left(\frac{s}{\sqrt{n}}\right)$$

where:

$\bar{x}$ = Arithmetic mean or average of the untransformed data

s = Standard deviation

t = Student-t statistic (one-tailed test)

n = Number of samples.

The 95th percent high-end estimate on the arithmetic mean (UCL) generally falls above the arithmetic average and below the maximum observed sample data value. Risk estimates based upon the exposure point concentrations for the RME characterize high-end risks to human health. If the sample set is small, or if considerable variability in measured concentrations exists, the arithmetic mean and/or the UCL of the arithmetic mean may exceed the maximum value observed at the site. Under these circumstances, EPA recommends substituting the maximum observed concentration for use in the baseline risk assessment.

Use of the arithmetic mean and the UCL of the mean (or maximum) for concentrations and for MLE and RME parameters (see Section 5.3.4) is intended to provide a range of estimates of the potential risks to human health. A range of estimates is preferable, since single point estimates tend to falsely convey more certainty than is appropriate, and thus do not reflect the inherent uncertainty of the risk assessment.

For all Base personnel exposures, only surface soil data were used. Therefore, within each area, the 95 percent UCL was calculated using only samples taken from the interval designated as surface soil. For the construction worker and adult and child resident exposures, both surface and subsurface soils (down to 10 feet) were taken into account. During construction activities (e.g., excavation, such as construction of foundations or basements), workers may be exposed to subsurface soils. In addition, during excavation, soils that were 10 feet BLS may be inadvertently brought to the surface and spread around the residence area. In this manner, adults and children in a future residential scenario also may be exposed to what are currently subsurface soils. Instead of averaging all values from both soil horizons (i.e., surface and subsurface) into a single value, summary statistics were calculated separately for the two horizons. Then, the highest value of the two was selected as the exposure point concentration for construction workers and residents. In the majority of the cases, the highest concentration was found in the surface soils. The latter is a more conservative method that does not bias the exposure point concentrations too low due to lower contaminant concentrations in one of the soil horizons.

Exposure point concentrations used in the baseline risk assessment are presented as summary statistics in Appendix H, Tables H-1 through H-7.

5.3.4 Exposure Equations and Assumptions

This section presents the exposure equations and assumptions used in deriving intake estimates for use in risk assessment. The following exposure pathways are considered:

- Ingestion and dermal contact with soils by Base personnel
- Ingestion and dermal contact with soils by construction workers
- Ingestion and dermal contact with soils, inhalation of volatile emissions from soils, and inhalation of suspended particulates by resident adults and children
- Ingestion, dermal contact, and inhalation of volatiles from groundwater by resident children and adults.

The use of the intake equations presented in this section is in accordance with methods presented by EPA in RAGS (EPA 1989a). Two sets of exposure assumptions are used, one representing average exposures (MLE) and the other representing high-end RMEs. The exposure assumptions used in this assessment are presented in Table 5-1. All chemicals are assumed not to transform or degrade over the period of exposure.

The oral and inhalation intakes calculated are expressed as the amount of chemical at the exchange boundary (e.g., skin, lungs, intestine) that is available for absorption. These intakes are not equivalent to the absorbed dose (the amount of chemical actually absorbed into the blood stream). Dermal doses are estimates of absorbed dose, however, and this discrepancy is a source of uncertainty when comparing or combining dermal doses with intakes from other exposure routes.

5.3.4.1 Exposure to Soils

Soil ingestion exposures have been evaluated for Base personnel and construction workers in the current occupational scenario, and for resident adults and children in the future residential scenario. Intakes for soil ingestion are estimated by means of the following equation:

Table 5-1. Exposure Assumptions
178th Tactical Fighter Group, Springfield ANGB, Springfield, Ohio

ROUTE PARAMETER	UNITS	CURRENT LAND USE								FUTURE LAND USE							
		Base Personnel				Construction Workers				Children				Adults			
		RME		MLE		RME		MLE		RME		MLE		RME		MLE	
General																	
Body weight	kg	70	a	70	a	70	a	70	a	15	a	15	a	70	a	70	a
Exposure duration (except soil ing.)	years	25	a	25	a	2	h	2	h	6	a	6	a	30	b	9	b
Averaging time-noncancer (except soil ing.)	days	9125	c	9125	c	730	c	730	c	2190	c	2190	c	10950	c	3285	c
Averaging time - cancer	days	25550	b	25550	b	25550	b	25550	b	25550	b	25550	b	25550	b	25550	b
Soil Ingestion																	
Ingestion rate	mg/day	100	e	50	a	480	i	200	j	200	a	200	a	100	a	100	a
Exposure frequency	days/year	100	e	50	d	250	a	250	a	350	a	275	l	350	a	275	l
Units conversion	kg/mg	1.00E-06	-	1.00E-06	-	1.00E-06	-	1.00E-06	-	1.00E-06	-	1.00E-06	-	1.00E-06	-	1.00E-06	-
Exposure duration	years	25	a	25	a	2	h	2	h	6	a	6	a	24	a	9	b
Averaging time - noncancer	days	9125	c	9125	c	730	c	730	c	2190	c	2190	c	8760	c	3285	c
Soil Dermal Contact																	
Skin surface area available	cm^2/day	5800	c	5000	c	5800	c	5000	c	2010	c	1750	c	5800	c	5000	c
Soil-to-skin adherence factor	days/year	1	c	0.2	c	1	c	0.2	c	1	c	0.2	c	1	c	0.2	c
Dermal absorption factor (inorganics)	none	0.001	f	0.001	f	0.001	f	0.001	f	0.001	f	0.001	f	0.001	f	0.001	f
Dermal absorption factor (organics)	none	0.01	f	0.01	f	0.01	f	0.01	f	0.01	f	0.01	f	0.01	f	0.01	f
Exposure frequency	days/year	100	e	50	d	250	a	250	a	350	a	275	l	350	a	275	l
Units conversion	kg/mg	1.00E-06	-	1.00E-06	-	1.00E-06	-	1.00E-06	-	1.00E-06	-	1.00E-06	-	1.00E-06	-	1.00E-06	-
Fugitive Dust Inhalation																	
Inhalation rate	m^3/day	NA	-	NA	-	NA	-	NA	-	20	a	20	a	20	a	20	a
Particulate emission factor	m^3/kg	NA	-	NA	-	NA	-	NA	-	4.63E+09	g	4.63E+09	g	4.63E+09	g	4.63E+09	g
Exposure frequency	days/year	NA	-	NA	-	NA	-	NA	-	350	a	275	l	350	a	275	l
Inhalation of Volatiles (from soils)																	
Inhalation rate	m^3/day	NA	-	NA	-	NA	-	NA	-	20	a	20	a	20	a	20	a
Volatilization factor	m^3/kg	NA	-	NA	-	NA	-	NA	-	chemical specific				chemical specific			
Exposure frequency	days/year	NA	-	NA	-	NA	-	NA	-	350	a	275	l	350	a	275	l

Table 5-1. Exposure Assumptions (continued)
178th Tactical Fighter Group, Springfield ANGB, Springfield, Ohio

ROUTE PARAMETER	UNITS	CURRENT LAND USE								FUTURE LAND USE							
		Base Personnel				Construction Workers				Children				Adults			
		RME		MLE		RME		MLE		RME		MLE		RME		MLE	
Groundwater Ingestion																	
Ingestion rate	L/day	NA	-	NA	-	NA	-	NA	-	1	k	1	k	2	b	1.4	b
Exposure frequency	days/year	NA	-	NA	-	NA	-	NA	-	350	a	275	l	350	a	275	l
Groundwater Dermal Contact																	
Skin surface area available	cm^2/day	NA	-	NA	-	NA	-	NA	-	8000	c	7000	c	20000	c	20000	c
Permeability coefficient	cm/hour	NA	-	NA	-	NA	-	NA	-	chemical specific				chemical specific			
Exposure time	hour/day	NA	-	NA	-	NA	-	NA	-	0.17	b	0.12	b	0.17	b	0.12	b
Exposure frequency	days/year	NA	-	NA	-	NA	-	NA	-	350	a	275	l	350	a	275	l
Units conversion	L/cm^3	NA	-	NA	-	NA	-	NA	-	1.00E-03	-	1.00E-03	-	1.00E-03	-	1.00E-03	-
Groundwater Inhalation																	
Inhalation Rate	m^3/hour	NA	-	NA	-	NA	-	NA	-	0.6	b	0.6	b	0.6	b	0.6	b
Volatilization Factor	m^3/kg	NA	-	NA	-	NA	-	NA	-	0.5	g	0.5	g	0.5	g	0.5	g
Exposure time	hour/day	NA	-	NA	-	NA	-	NA	-	0.17	b	0.12	b	0.17	b	0.12	b
Exposure frequency	days/year	NA	-	NA	-	NA	-	NA	-	350	a	275	l	350	a	275	l

NA - Pathway not evaluated

a. EPA 1991a, Human Health Evaluation Manual, Supplemental Guidance: Standard Default Exposure Factors

b. EPA 1989a, Risk Assessment Guidance for Superfund, Part A

c. EPA 1992a, Dermal Exposure Assessment; total body surface areas are taken from pp. 8-10 and 8-12 of EPA 1992a, using the 50th and 95th percentiles as the MLE and RME; for skin surface area available during soil contact, assumes 25% of total body surface area is exposed

d. Site-specific value based on professional judgment and information from OANG personnel

e. As a reasonable high end estimate, assumed a value two times the average (typical) reported for the site

f. EPA 1992b, RAF recommended by EPA Region IV

g. EPA 1991b, Risk Assessment Guidance for Superfund, Part B

h. Assumes a two year full-time project with excavation

i. Hawley 1985

j. Elevated due to excavation

k. EPA 1989b, Exposure Factors Handbook

l. EPA 1991f, EPA Region X guidance

$$Intake\ (mg/kg\text{-}day) = \frac{CS \times IR \times CF \times FI \times EF \times ED}{BW \times AT}$$

where:

CS = Chemical concentration in soil (mg/kg)
IR = Ingestion rate (mg/day)
CF = Conversion factor (10^{-6} kg/mg)
FI = Fraction ingested from contaminated source (1.0) (unitless)
EF = Exposure frequency (days/year)
ED = Exposure duration (years)
BW = Body weight (kg)
AT = Averaging time for non-cancer effects (days)
Averaging time for cancer effects (days).

Soil ingestion rates for children and adults were taken from EPA's Human Health Evaluation Manual, Supplemental Guidance: Standard Default Exposure Factors (EPA 1991a). For Base personnel, a rate of 100 mg/day was used as the RME estimate and 50 mg/day was used as the MLE estimate (the latter is the rate recommended for commercial/industrial scenarios in EPA 1991a). For construction workers, ingestion rates are assumed to be elevated. A rate of 480 mg/day (Hawley 1985) was used for the RME of an adult working outdoors, and 200 mg/day was used as the MLE estimate.

Exposure frequencies for residents also are taken from EPA 1991a for the RME and EPA 1991f (EPA Region X guidance) for the MLE. Exposure durations are from EPA 1991a for children and adults. For Base personnel, exposure frequency is assumed to be the greatest at Site 2, the fire training area. Based on information obtained from Springfield ANGB staff, it was decided that plausible MLE and RME estimates would be 50 and 100 days, respectively. This corresponds to 1 or 2 days per week for 50 weeks in each year. Although exposure at Sites 3 and 5 are expected to be less, the same exposure frequency has been used as a conservative measure. Exposures are assumed to occur over a 25-year period for Base personnel (i.e., an exposure duration of 25 years) (EPA 1991a). For the construction worker, activities are assumed to occur full-time (250 days per year) over a 2-year period.

Body weights (BW) used in this assessment (70 kg for adults, Base personnel, and construction workers, and 15 kg for children) are the average body weights of the receptor over the exposure period. Since cancer effects accumulate over a lifetime and noncancer effects do not, averaging times (AT) are different for carcinogenic and noncarcinogenic exposures. For the latter, intakes are averaged over the period of exposure. AT values are therefore determined by multiplying the exposure duration by 365 days per year. For carcinogens, the averaging time is based on a 70-year lifetime, and is therefore, 25,550 days, regardless of the exposure duration.

Dermal exposure is assumed to occur simultaneously with inadvertent ingestion exposure during maintenance or training activities. Soil dermal penetration exposures also have been evaluated for Base personnel and construction workers, and for adults and children living in a residential area.

$$Absorbed\ Dose\ (mg/kg\text{-}day) = \frac{CS \times CF \times SA \times AF \times ABS \times EF \times ED}{BW \times AT}$$

where:

CS = Chemical concentration in soil (mg/kg)

CF = Conversion factor (10^{-6} kg/mg)

SA = Skin surface area available for contact (cm^2/day)

AF = Soil to skin adherence factor (mg/cm^2)

ABS = Inorganics - absorption fraction for inorganics = 0.001
Organics - absorption fraction for organics = 0.01

EF = Exposure frequency (days/year)

ED = Exposure duration (years)

BW = Body weight (kg)

AT = Averaging time for non-cancer effects (days)
Averaging time for cancer effects (days).

The skin surface area available for soil contact assumes that 25 percent of the total body surface area is exposed. The total body surface areas are taken from pages 8 through 10 and 8 through 12 of EPA 1992a, using the 50th and 95th percentiles as the MLE and RME, respectively. Skin surface areas for adults and children were calculated from EPA's *Dermal Exposure Assessment* manual (EPA 1992a). Base personnel and construction workers are assumed to be adults. Soil to skin adherence factors also were taken from EPA 1992a.

Dermal absorption values of 0.001 (0.1%) for inorganic chemicals and 0.01 (1%) for organic chemicals were used based on EPA Region IV guidance (EPA 1992b). These values are relative absorption factors that convert intake (applied dose) to absorbed dose (i.e., the amount of chemical absorbed into the blood stream). Values for exposure frequency and duration, body weight, and averaging time are the same as those used in the soil ingestion pathway.

Intake of fugitive dust via inhalation has been evaluated for children and adults in the future residential scenario. Intakes are calculated as follows:

$$Intake\ (mg/kg\text{-}day) = \frac{CS \times IR \times EF \times ED}{PEF \times BW \times AT}$$

where:

CS = Chemical concentration in soil (mg/kg)
IR = Inhalation rate (m^3/day)
EF = Exposure frequency (days/year)
ED = Exposure duration (years)
PEF = Particulate emission factor (4.63 x 10^9 m^3/kg, EPA default value)
BW = Body weight (kg)
AT = Averaging time for noncancer effects (days)
Averaging time for cancer effects (days).

Inhalation rates were set at 20 m^3 per day for both adults and children for both MLE and RME. Guidance for adults is presented in EPA 1991a. Inhalation rates for children were set equal to adult rates because of their often elevated level of activity.

In the above equation, a particulate emission factor (PEF) is used. This factor relates the concentration of the contaminant in soil to the concentration of respirable particles in the air from fugitive dust emissions. These emissions result from wind erosion. The default value of 4.63×10^9 m^3/kg was taken from RAGS, Volume I, Part B (EPA 1991b) and represents a surface with unlimited erosion potential. Values for exposure frequency and duration, body weight, and averaging time are the same as those used in the soil ingestion pathway.

Inhalation of volatile emissions from soils has been evaluated for residents under future land use according to guidance presented in RAGS, Volume I, Part B (EPA 1991b). Daily intakes are estimated by means of the following equation:

$$Intake\ (mg/kg\text{-}day) = \frac{CS \times IR \times EF \times ED}{VF \times BW \times AT}$$

where:

CS = Chemical concentration in soil (mg/kg)
IR = Inhalation rate (m^3/day)
EF = Exposure frequency (days/year)
ED = Exposure duration (years)
VF = Volatilization factor (m^3/kg)
BW = Body weight (kg)
AT = Averaging time for noncancer effects (days)
Averaging time for cancer effects (days).

The soil-to-air volatilization factor is described in EPA 1991b. It is calculated using both chemical-specific values (e.g., Henry's Law constant) and site-specific values (e.g., area of contamination). The volatilization factors used in this risk assessment are presented in

Appendix H, Table H-91 through H-94. Values for all other parameters are the same as those used in the fugitive dust inhalation pathway.

5.3.4.2 Exposure to Groundwater

In the future residential scenario, adults and children are assumed to be exposed to contaminated groundwater. As mentioned previously, these exposures are highly unlikely due to the low productivity of the shallow aquifer and because it is unlikely that the Base will be developed for residential or agricultural uses. Intake estimates for groundwater ingestion are calculated as follows:

$$Intake\ (mg/kg\text{-}day) = \frac{CW \times IR \times EF \times ED}{BW \times AT}$$

where:

CW = Chemical concentration in water (mg/L)
IR = Ingestion rate (L/day)
EF = Exposure frequency (days/year)
ED = Exposure duration (years)
BW = Body weight (kg)
AT = Averaging time for non-cancer effects (days)
Averaging time for cancer effects (days).

Groundwater exposures were evaluated only for future residents. Groundwater exposures were analyzed by assuming that a hypothetical primary (sole-source) drinking water supply well would exist at each area. Although the groundwater exposures are theoretical, they are still useful for developing a measure of significance of the observed contamination. Primary exposure occurs from ingestion of the drinking water. The ingestion rate for adults is 2 liters per day for the RME estimate and 1.4 liters per day for the MLE estimate (EPA 1989a). For children, a value of 1 L/day was used for both the RME and the MLE values (EPA 1989b). The exposure frequency and duration are the same as those used in the soil pathways under future residential land use.

The intake of chemicals in groundwater via dermal contact is calculated as follows:

$$Absorbed\ Dose\ (mg/kg\text{-}day) = \frac{CW \times SA \times PC \times ET \times EF \times ED \times CF}{BW \times AT}$$

where:

CW = Chemical concentration in water (mg/L)
SA = Skin surface area available for contact (cm^2)
PC = Chemical-specific dermal permeability constant (cm/hr)
ET = Exposure time (hours/day)
EF = Exposure frequency (days/year)
ED = Exposure duration (years)
CF = Conversion factor (1 liter/1,000 cm^3)
BW = Body weight (kg)
AT = Averaging time for non-cancer effects (days)
Averaging time for cancer effects (days).

The skin surface area available for contact for adults was taken as 20,000 cm^2 for both the RME and MLE estimates (EPA 1992a). For children, the surface area available was estimated at 8,000 cm^2 for the RME and 7,000 cm^2 for the MLE. This is based on the 95th and 50th percentile total body surface areas for children aged 2 to 6 years in the *Dermal Exposure Assessment* manual (EPA 1992a).

Dermal permeability constants for each substance are presented in Table 5-2 and were taken directly from EPA's *Dermal Exposure Assessment* manual (EPA 1992a). The permeability constants in these tables were measured values, or were experimentally derived from the K_{ow} for each substance. In cases where no permeability constant was available for a particular substance, the dermal permeability constant for water was substituted as a default. This assumption is intended as a reasonable default, since the water-borne contaminants are present as highly dilute, aqueous solutions. The exposure times for adults and children were set at 7 minutes per day (MLE) and 12 minutes per day (RME) for the dermal contact and volatile inhalation pathways (EPA 1989a).

Table 5-2. Dermal Permeability Constants
178th Tactical Fighter Group, Springfield ANGB, Springfield, Ohio

SUBSTANCE	KP (cm/hr)
Inorganics	
KP_INORG (default)	1.0E-03
Antimony	1.0E-03
Arsenic	1.0E-03
Beryllium	1.0E-03
Cadmium (water)	1.0E-03
Chromium (III)	2.0E-03
Copper	1.0E-03
Lead	4.0E-06
Mercury	1.0E-03
Nickel	1.0E-04
Silver	1.0E-03
Thallium	1.0E-03
Zinc	6.0E-04
Organics	
KP_ORG (default; water)	1.5E-03
1,2-Dichloroethylene	1.6E-02
2-Methylnaphthalene	1.5E-03
Acetone	1.5E-03
Benzene	1.1E-01
Benzo(a)anthracene	4.6E+01
Benzo(a)pyrene	1.2E+00
Benzo(b)fluoranthene	1.2E+00
Benzo(g,h,i)perylene	1.5E-03
Benzo(k)fluoranthene	1.2E+00
Carbon Disulfide	2.4E-02
Chrysene	8.1E-01
Di-n-octyl phthalate	1.5E-03
Ethylbenzene	7.4E-02
Fluoranthene	3.6E-01
Fluorene	1.5E-03
Indeno(1,2,3-cd)pyrene	1.9E+00
Naphthalene	6.9E-02
Pentachlorophenol	6.5E-01
Phenanthrene	2.7E-01
Pyrene	1.5E-03
Tetrachloroethylene	4.8E-02
Trichloroethylene	2.0E-01
Xylenes	8.0E-02

Source: EPA 1992a

In addition, inhalation exposures could occur during showering (or bathing). Hot water temperatures and the spraying action of the shower nozzle could result in releases of volatile constituents from groundwater, particularly in a closed room, which receptors may inhale. This pathway is applicable only to volatile organic compounds (VOCs) with relatively low molecular weights. The equation is as follows:

$$Intake\ (mg/kg\text{-}day) = \frac{CW \times IR \times K \times ET \times EF \times ED}{BW \times AT}$$

where:

CW = Chemical concentration in water (mg/L)
IR = Inhalation rate (m^3/hour)
K = Volatilization factor (0.5 L/m^3, EPA default value)
ET = Exposure time (hours/day)
EF = Exposure frequency (days/year)
ED = Exposure duration (years)
BW = Body weight (kg)
AT = Averaging time for non-cancer effects (days)
Averaging time for cancer effects (days).

The inhalation rate of 0.6 m^3/hour was taken from RAGS, Volume I, Part A (EPA 1989a). A default volatilization factor of 0.5 L/m^3 was developed by EPA (1991b) to estimate the average concentration of the volatilized contaminant in air from the concentration of a contaminant in household water. This is applicable only to chemicals with a Henry's Law constant of greater than 1×10^{-5} atm • m^3/mole and a molecular weight of less than 200 g/mole.

5.4 TOXICITY ASSESSMENT

The objectives of the toxicity assessment are to evaluate the inherent toxicity of the compounds under investigation, and to identify and select toxicological measures for use in evaluating the significance of the exposure. In the development of these toxicological measures, available dose-response data are reviewed on the adverse effects to human and nonhuman receptors.

The baseline risk assessment has adopted two basic approaches to evaluating noncancer and cancer health effects to humans resulting from exposure to chemical contaminants. The methods are recommended by EPA, and reflect a fundamental difference in proposed mechanism of toxic action. In assessing the potential for noncancer health effects, EPA assumes the existence of a threshold below which there are no adverse toxic effects. An example of a toxicologic threshold is when a repair process must be overwhelmed before adverse effects present themselves. In contrast, a "nonthreshold" exposure to a carcinogen always carries some risk of adverse effect. For example, an extremely low level of exposure to a carcinogen may result in chromosomal or enzyme changes leading to cellular proliferation associated with cancer.

EPA derives and publishes reference doses (RfDs) and reference concentrations (RfCs) for use in evaluating adverse noncarcinogenic effects. These are estimates (with uncertainty spanning an order of magnitude or greater) of daily human exposures, including sensitive subpopulations, that may go without appreciable deleterious effects during a lifetime (EPA 1989a). EPA derives RfDs and RfCs based on estimates of the no-observable-adverse-effect level (NOAEL) or lowest-observable-adverse-effect level (LOAEL) in humans or test animals. The assessment of the potential for noncarcinogenic effects (i.e., the use of RfDs and RfCs in risk assessment) is based on the assumption of a threshold below which adverse health effects are not anticipated to occur.

Carcinogenesis, however, is generally thought to be a phenomenon for which the presumption of threshold effects is inappropriate (EPA 1989a). EPA does not therefore estimate an effects threshold for this class of chemicals. EPA uses a two-part evaluation in which the subject chemical is first assigned a weight-of-evidence classification, and then a cancer potency (slope factor) is calculated.

The cancer potency factor is a plausible high-end estimate of the slope of the dose-response curve in the low dose range. It is interpreted as the probability of a cancer response per unit intake of a chemical over a lifetime. In risk assessment, the cancer slope (potency) factor is used to estimate the excess lifetime probability of a carcinogenic effect occurring in exposed receptors.

The weight-of-evidence classification evaluates the evidence that a given chemical is a carcinogen to humans and animals. These ratings are as follows:

- A: Human carcinogen
- B1: Probable human carcinogen - limited human data are available

  B2: Probable human carcinogen - sufficient data in animals, and inadequate or no evidence in humans
- C: Possible human carcinogen
- D: Not classifiable as to human carcinogenicity.

EPA develops cancer slope factors for carcinogens that have been rated A, B1, B2, and for many that have been rated class C. The units of the cancer slope factor are in units of inverse dose, or $(\mathrm{mg/kg/day})^{-1}$.

For the assessment of human health risk of exposure to chemicals at Springfield ANGB, the following toxicity values are of principal importance:

- RfDs for oral exposure-acceptable intake values for chronic exposure (noncarcinogenic effects)
- RfCs for inhalation exposure-acceptable intake values for chronic exposure (noncarcinogenic effects)
- Carcinogenic slope factors for oral exposure
- Carcinogenic slope factors for the inhalation route.

The primary sources of information for these data is the EPA Integrated Risk Information System (IRIS) data base (EPA 1994a). IRIS is a computer-housed catalog of EPA risk assessment and risk management information for chemical substances. Data in the IRIS system are regularly reviewed and updated monthly. If toxicity measures are not available on IRIS, EPA recommends use of the EPA Office of Research and Development (ORD) Health Effects Assessment Summary Tables (HEAST) (EPA 1993a) as the second current source of information.

Table 5-3 summarizes the toxicity values used in the human health risk assessment. Priority is given to the values obtained from the IRIS data base as they have been verified by the EPA RfD/RfC Work Group or the Carcinogen Risk Assessment Verification Endeavor (CRAVE) Work Group.

In instances where toxicity information is unavailable, another approach has been taken to evaluate the toxic effects of a chemical or groups of chemicals. The following information was unavailable for this risk assessment:

- Toxicity values for the dermal pathway
- Verified reference dose for lead
- Reference doses or cancer slope factors for many polycyclic aromatic hydrocarbons (PAHs).

Dermal Toxicity Values—Toxicity values are available only for the oral and inhalation pathways. EPA has not published toxicity values for evaluating the dermal contact pathway.

In the *Dermal Exposure Assessment* manual (EPA 1992a), EPA states:

> . . . if estimates of the gastrointestinal absorption fraction are available for the compound of interest in the appropriate vehicle, then the oral dose-response factor, unadjusted for absorption, can be converted to an absorbed dose basis . . . Lacking this information, the oral factor should be used as is [for evaluating dermal uptake] accompanied by a strong statement emphasizing the uncertainty involved.

The adjustment of the oral toxicity measure requires sufficient data from the principal laboratory studies on oral absorption efficiency in the species of which the toxicity measures are based. Since researching studies of gastrointestinal absorption estimates is beyond the scope of

Table 5-3. Toxicity Values for Waste Site Evaluation
178th Tactical Fighter Group, Springfield ANGB, Springfield, Ohio

	NONCARCINOGENIC												
COMPOUND	Effects Oral Route (mg/kg/day) RfD-S(a)	Effects Oral Route (mg/kg/day) RfD-C(a)	Uncertainty Factor Oral Route (subchronic)	Uncertainty Factor Oral Route (chronic)	Source (Oral)	Effects Inhalation Route (mg/m3) RfC-S(b)	Effects Inhalation Route (mg/m3) RfC-C(b)	Effects Inhalation Route (mg/kg/day) RfC-S(b)	Effects Inhalation Route (mg/kg/day) RfC-C(b)	Uncertainty Factor Inhal. Route (subchronic)	Uncertainty Factor Inhal. Route (chronic)	Source (Inhal.)	Noncarcinogenic Target Organ and Critical Effect
INORGANICS													
Antimony	4.00E-04	4.00E-04	1000	1000	d,c	--	--	--	--	--	--	--	whole body, blood; inc. mortality
Arsenic	3.00E-04	3.00E-04	3	3	d,c	--	--	--	--	--	--	--	skin; keratosis, hyperpigmentation
Beryllium	5.00E-03	5.00E-03	100	100	d,c	--	--	--	--	--	--	--	no observed effects
Cadmium (food)	--	1.00E-03	--	10	c	--	--	--	--	--	--	--	kidney; proteinuria
Cadmium (water)	--	5.00E-04	--	10	c	--	--	--	--	--	--	--	kidney; proteinuria
Chromium (III)	1.00E+00	1.00E+00	1000	100	d,c	--	--	--	--	--	--	m	no observed effects
Copper	3.70E-02	3.70E-02	--	--	d,j	--	--	--	--	--	--	--	Gastrointestinal system; irritation
Lead	--	--	--	--	f	--	--	--	--	--	--	--	CNS, blood
Mercury	3.00E-04	3.00E-04	1000	1000	d	3.00E-04	3.00E-04	8.57E-05	8.57E-05	30	30	m,d	oral-CNS; neurotoxicity. inhal.-kidney effects
Nickel	2.00E-02	2.00E-02	300	300	d,c,k	--	--	--	--	--	--	--	dec. body and organ weight
Selenium	5.00E-03	5.00E-03	3	3	d,c	--	--	--	--	--	--	--	whole body; clinical selenosis
Silver	5.00E-03	5.00E-03	3	3	d,c	--	--	--	--	--	--	--	skin; argyria
Thallium	8.00E-04	8.00E-05	300	3000	d,c	--	--	--	--	--	--	--	liver, blood; inc. sgot and serum LDH
Zinc	3.00E-01	3.00E-01	3	3	d,c,k	--	--	--	--	--	--	--	blood; anemia

* - values are for thallium (I) carbonate, thallium (I) chloride, and thallium (I) sulfate

Table 5-3. Toxicity Values for Waste Site Evaluation
178th Tactical Fighter Group, Springfield ANGB, Springfield, Ohio (continued)

	NONCARCINOGENIC													
COMPOUND	Effects Oral Route (mg/kg/day) RfD-S(a)	RfD-C(a)	Uncertainty Factor Oral Route (subchronic)	Uncertainty Factor Oral Route (chronic)	Source (Oral)	Effects Inhalation Route (mg/m3) RfC-S(b)	RfC-C(b)	Effects Inhalation Route (mg/kg/day) RfC-S(b)	RfC-C(b)	Uncertainty Factor Inhal. Route (subchronic)	Uncertainty Factor Inhal. Route (chronic)	Source (Inhal.)	Noncarcinogenic Target Organ and Critical Effect
ORGANICS													
Acenaphthene	6.00E-01	6.00E-02	300	3000	d,c	--	--	--	--	--	--	--	liver; hepatotoxicity
Acenaphthylene	3.00E-01	3.00E-02	--	--	h	--	--	--	--	--	--	--	--
Acetone	1.00E+00	1.00E-01	100	1000	d,c	--	--	--	--	--	--	--	inc. liver, kidney weights, nephrotoxicity
Anthracene	3.00E+00	3.00E-01	300	3000	d,c	--	--	--	--	--	--	--	no observed effects
Benzene	--	4.00E-04	--	--	l	--	--	--	--	--	--	m	--
Benzo(a)anthracene	3.00E-01	3.00E-02	--	--	h	--	--	--	--	--	--	--	--
Benzo(a)pyrene	3.00E-01	3.00E-02	--	--	h	--	--	--	--	--	--	--	--
Benzo(b)fluoranthene	3.00E-01	3.00E-02	--	--	h,m	--	--	--	--	--	--	--	--
Benzo(g,h,i)perylene	3.00E-01	3.00E-02	--	--	h	--	--	--	--	--	--	--	--
Benzo(k)fluoranthene	3.00E-01	3.00E-02	--	--	h	--	--	--	--	--	--	--	--
2-Butanone	2.00E+00	6.00E-01	1000	3000	d,c	1.00E+00	1.00E+00	2.86E-01	2.86E-01	3000	1000	d,c	oral and inhal. - dec. fetal birth weight
Carbazole	--	--	--	--	--	--	--	--	--	--	--	--	--
Carbon Disulfide	1.00E-01	1.00E-01	100	100	d,c	1.00E-02	1.00E-02	2.86E-03	2.86E-03	1000	1000	d	oral and inhal.-fetus; toxicity
Chrysene	3.00E-01	3.00E-02	--	--	h	--	--	--	--	--	--	--	--
Dibenzo(a,h)anthracene	3.00E-01	3.00E-02	--	--	h	--	--	--	--	--	--	--	--
Dibenzofuran	--	--	--	--	--	--	--	--	--	--	--	--	--
1,2-Dichloroethylene	9.00E-03	9.00E-03	1000	1000	d	--	--	--	--	--	--	--	liver; hepatic lesions
Di-n-octyl phthalate	2.00E-02	2.00E-02	1000	1000	d	--	--	--	--	--	--	--	kidney, liver; inc. weight, inc. sgot and sgpt activity
Ethylbenzene	--	1.00E-01	--	1000	m,c	--	1.00E+00	--	2.86E-01	--	300	m,c	oral-liver, kidney toxicity. inhal.-developmental toxicity
Fluoranthene	4.00E-01	4.00E-02	300	3000	d,c	--	--	--	--	--	--	--	kidney, liver, blood; inc. weight, hematological changes
Fluorene	4.00E-01	4.00E-02	300	3000	d,c	--	--	--	--	--	--	--	erythrocytes; dec. counts
Indeno(1,2,3-cd)pyrene	3.00E-01	3.00E-02	--	--	h	--	--	--	--	--	--	--	--
Isophorone	2.00E+00	2.00E-01	100	1000	d,c	--	--	--	--	--	--	--	kidney; lesions
2-Methylnaphthalene	3.00E-01	3.00E-02	300	--	h	--	--	--	--	--	--	--	skin effects
4-Methyl-2-pentanone	8.00E-01	8.00E-02	300	3000	d	8.00E-01	8.00E-02	2.29E-01	2.29E-02	100	1000	d	oral and inhal.-liver, kidney effects
Naphthalene	--	--	--	--	m	--	--	--	--	--	--	--	dec. body weight
N-nitroso-di-n-propylamine	--	--	--	--	--	--	--	--	--	--	--	--	--
Pentachlorophenol	3.00E-02	3.00E-02	100	100	d,c	--	--	--	--	--	--	--	liver, adrenal effects, fetotoxicity
Phenanthrene	3.00E-01	3.00E-02	--	--	h	--	--	--	--	--	--	--	--
Pyrene	3.00E-01	3.00E-02	300	3000	d,c	--	--	--	--	--	--	--	kidney; red. weight, renal tubular pathology
Tetrachloroethylene	1.00E-01	1.00E-02	100	1000	d,c	--	--	--	--	--	--	--	liver; hepatotoxicity
Toluene	2.00E+00	2.00E-01	100	1000	d,c	--	4.00E-01	--	1.14E-01	--	300	m,c	oral-liver, kidney altered wts. inhal.-neurological effects
Trichloroethylene	--	--	--	--	--	--	--	--	--	--	--	--	--
Xylenes	--	2.00E+00	--	100	m,c,g	--	--	--	--	--	--	--	CNS hyperactivity; dec. body weight

Table 5-3. Toxicity Values for Waste Site Evaluation (continued)
178th Tactical Fighter Group, Springfield ANGB, Springfield, Ohio

	CARCINOGENIC							
COMPOUND	Cancer Slope Factor (CSF): Oral Route (mg/kg/day)-1	WOE	Unit Risk Factor Oral Route (ug/l)-1	Source (Oral)	Cancer Slope Factor (CSF): Inhalation Route (mg/kg/day)-1	Unit Risk Factor Inhalation Route (ug/m3)-1		Source (Inhal.)
INORGANICS								
Antimony	--	--	--	--	--	--	--	--
Arsenic	1.75E+00	[A]	5.00E-05	c,e	5.00E+01	4.30E-03	[A]	d,c
Beryllium	4.30E+00	[B2]	1.20E-04	c	8.40E+00	2.40E-03	[B2]	d,c
Cadmium (food)	--	--	--	--	6.10E+00	1.80E-03	[B1]	d,c
Cadmium (water)	--	--	--	--	6.10E+00	1.80E-03	[B1]	d,c
Chromium (III)	--	--	--	--	--	--	--	--
Copper	--	[D]	--	c	--	--	--	--
Lead	--	[B2]	--	c	--	--	--	--
Mercury	--	[D]	--	c	--	--	--	--
Nickel	--	--	--	--	--	--	--	--
Selenium	--	[D]	--	c	--	--	--	--
Silver	--	[D]	--	c	--	--	--	--
Thallium	--	[D]	--	c	--	--	--	--
Zinc	--	[D]	--	c	--	--	--	--

* - values are for thallium (I) carbonat

Table 5-3. Toxicity Values for Waste Site Evaluation (continued)
178th Tactical Fighter Group, Springfield ANGB, Springfield, Ohio

COMPOUND	CARCINOGENIC Cancer Slope Factor (CSF): Oral Route (mg/kg/day)-1	WOE	Unit Risk Factor Oral Route (ug/l)-1	Source (Oral)	Cancer Slope Factor (CSF): Inhalation Route (mg/kg/day)-1	Unit Risk Factor Inhalation Route (ug/m3)-1		Source (Inhal.)
ORGANICS								
Acenaphthene	--	--	--	--	--	--	--	--
Acenaphthylene	--	[D]	--	c	--	--	--	--
Acetone	--	[D]	--	c	--	--	--	--
Anthracene	--	[D]	--	c	--	--	--	--
Benzene	2.90E-02	[A]	8.30E-07	c	2.90E-02	8.30E-06	[A]	d,c
Benzo(a)anthracene	7.30E-01	[B2]	--	i	--	--	--	--
Benzo(a)pyrene	7.30E+00	[B2]	2.10E-04	c	--	--	--	--
Benzo(b)fluoranthene	7.30E-01	[B2]	--	i	--	--	--	--
Benzo(g,h,i)perylene	--	[D]	--	c	--	--	--	--
Benzo(k)fluoranthene	7.30E-01	[B2]	--	i	--	--	--	--
2-Butanone	--	[D]	--	c	--	--	--	--
Carbazole	2.00E-02	[B2]	5.70E-07	c	--	--	--	--
Carbon Disulfide	--	--	--	--	--	--	--	--
Chrysene	7.30E-02	[B2]	--	i	--	--	--	--
Dibenzo(a,h)anthracene	7.30E+00	[B2]	--	i	--	--	--	--
Dibenzofuran	--	[D]	--	c	--	--	--	--
1,2-Dichloroethylene	--	--	--	--	--	--	--	--
Di-n-octyl phthalate	--	--	--	--	--	--	--	--
Ethylbenzene	--	[D]	--	c	--	--	--	--
Fluoranthene	--	[D]	--	c	--	--	--	--
Fluorene	--	[D]	--	c	--	--	--	--
Indeno(1,2,3-cd)pyrene	7.30E-01	[B2]	--	i	--	--	--	--
Isophorone	9.50E-04	[C]	2.70E-08	c	--	--	--	--
2-Methylnaphthalene	--	--	--	--	--	--	--	--
4-Methyl-2-pentanone	--	--	--	--	--	--	--	--
Naphthalene	--	[D]	--	c	--	--	--	--
N-nitroso-di-n-propylamine	7.00E+00	[B2]	2.00E-04	c	--	--	--	--
Pentachlorophenol	1.20E-01	[B2]	3.00E-06	c	--	--	--	--
Phenanthrene	--	[D]	--	c	--	--	--	--
Pyrene	--	[D]	--	c	--	--	--	--
Tetrachloroethylene	--	--	--	--	--	--	--	--
Toluene	--	[D]	--	c	--	--	--	--
Trichloroethylene	--	--	--	--	--	--	--	--
Xylenes	--	[D]	--	c	--	--	--	--

Table 5-3. Toxicity Values for Waste Site Evaluation
178th Tactical Fighter Group, Springfield ANGB, Springfield, Ohio (continued)

	NONCARCINOGENIC												
	Effects Oral Route (mg/kg/day)		Uncertainty Factor Oral Route	Uncertainty Factor Oral Route		Effects Inhalation Route (mg/m3)		Effects Inhalation Route (mg/kg/day)		Uncertainty Factor Inhal. Route	Uncertainty Factor Inhal. Route		Noncarcinogenic
COMPOUND	RfD-S(a)	RfD-C(a)	(subchronic)	(chronic)	Source (Oral)	RfC-S(b)	RfC-C(b)	RfC-S(b)	RfC-C(b)	(subchronic)	(chronic)	Source (Inhal.)	Target Organ and Critical Effect

a. RfD-S: Reference dose for subchronic exposure, oral route. RfD-C: Reference dose for chronic (long-term) exposure, oral route.

b. RfC-S: Reference concentration for subchronic (short-term) exposure, inhalation route. RfC-C: Reference concentration for chronic (long-term) exposure, inhalation route. Inhalation RfCs have been converted to inhalation RfDs by multiplying by 20m u3 /day and dividing by 70 kg.

c. EPA IRIS Data Base (June 1994).

d. USEPA ORD Health Effects Assessment Summary Tables (HEAST) FY 1993 Annual (March 1993) and Supplements No. 1 and No. 2 (July 1993 and November 1993).

e. The oral unit risk for arsenic has been proposed by EPA. The oral slope factor was calculated from the unit risk by assuming an ingestion of 2 liters of water per day by a 70 kg adult.

f. EPA has not developed a reference dose for lead. EPA recommends use of the lead biokinetic model to estimate blood lead levels for the purposes of risk assessment.

g. Toxicity measures presented are for mixed xylenes.

h. In the absence of toxicity data, the RfDs for pyrene have been adopted for this compound.

i. The cancer slope factor for this compound has been estimated by multiplying the cancer slope factor for benzo(a)pyrene by a toxicity equivalence factor (USEPA 1993b).

j. The EPA Office of Drinking Water MCL of 1.3 mg/L has been converted to intake estimate of 3.7E-02 mg/kg-day by assuming ingestion of 2 liters of water/day by a 70 kg adult.

k. Values are for metals in the form of soluble salts.

l. The RfD for chronic exposure to a 70 kg adult was derived from the EPA ADI of 0.025 mg/day. Drinking Water Criteria Document for Benzene (USEPA 1985, EPA Office of Drinking Water).

m. For subchronic information regarding these chemicals (and chronic information regarding napthalene [RfD]), HEAST instructs the user to contact the Superfund Health Risk Technical Support Center.

RELATIVE POTENCY OF PAHs

PAH	Relative Potency (a)
Benzo(a)pyrene	1.000
Benzo(a)anthracene	0.100
Benzo(b)fluoranthene	0.100
Benzo(k)fluoranthene	0.100
Chrysene	0.010
Dibenzo(a,h)anthracene	1.000
Indeno(1,2,3-cd)pyrene	0.100

a. USEPA Region IV, Interim Guidance, February 11, 1992 this risk assessment, the oral toxicity values have been used to estimate risk, as recommended by EPA. It should be noted that because this approach uses cross-route absorption efficiencies and toxicologic mechanisms that may not be directly comparable, this evaluation is a source of additional uncertainty.

Lead—Lead does not have a verified RfD. Therefore, lead exposures have been analyzed by estimating blood lead levels using EPA's uptake/biokinetic computer program, LEAD 0.6 (EPA 1991d). The approach using the lead uptake model and the corresponding results are presented in Section 5.5.

PAHs—Many PAHs do not have published RfDs for noncancer effects or slope factors for carcinogenic effects. In order to evaluate these effects, PAHs exhibiting noncancer effects were assigned an RfD equivalent to that of pyrene (EPA 1992b).

Two approaches to risk assessment may be adopted for PAHs exhibiting carcinogenic effects. The first approach is to assume that the cancer slope factor for all carcinogenic PAHs is equivalent to that of benzo(a)pyrene, which is the only PAH for which an Agency-verified slope factor exists. This method is very conservative, in that benzo(a)pyrene has a greater cancer potency than the other carcinogenic PAHs. This also means that the cancer risk posed by PAHs will be intentionally overestimated.

The second approach is also conservative, but is a more realistic, scientifically based refinement over the first approach. Using this approach, relative potency factors have been applied to the detected carcinogenic PAHs, relating their cancer potencies to the cancer slope factor of benzo(a)pyrene, which is 7.3 $(mg/kg\text{-}day)^{-1}$. For these substances, the relative cancer potency factors are fractional multipliers used to yield substance-specific oral cancer potency factors that are generally somewhat less than that of benzo(a)pyrene. The relative cancer potency factors are presented in Table 5-4 and have been integrated into the toxicity table (Table 5-3) and risk calculations.

Table 5-4. Relative Potency Factors for Carcinogenic PAHs

Chemical	Relative Potency Factor
Benzo(a)pyrene	1.00
Benzo(a)anthracene	0.10
Benzo(b)fluoranthene	0.10
Benzo(k)fluoranthene	0.10
Chrysene	0.01
Dibenzo(a,h)anthracene	1.00
Indeno(1,2,3-cd)pyrene	0.10

Source: EPA 1992b

EPA recommends caution when conducting a quantitative evaluation of carcinogenic PAHs for the dermal contact route, until appropriate toxicity values become available. Because compounds such as benzo(a)pyrene cause skin cancer at the point of application, it is imprecise to use the oral slope factor to evaluate these risks (EPA 1992a). However, the alternative is to remove dermal PAH exposures from the quantitative risk assessment. As an added conservative measure, carcinogenic PAHs for the dermal contact route were included in the quantitative risk estimates and evaluated using the oral slope factors. Although this approach is uncertain, the direction of the introduced bias is toward overestimating risk when compared to exclusion from the quantitative estimates.

Samples collected at Springfield ANGB were not analyzed for hexavalent chromium. Since hexavalent chromium is not associated with activity occurring at the sites under investigation, it has been assumed that all chromium is present as trivalent chromium (Cr^{+3}).

5.5 RISK CHARACTERIZATION

This section presents the risk characterization for Springfield ANGB. Section 5.5.1 presents an overview of risk characterization methods used in this assessment. Section 5.5.2 presents the results of risk characterization for each site and includes an evaluation of background concentrations. Section 5.5.3 evaluates the uncertainties associated with the risk estimates.

5.5.1 Risk Characterization Methods

Risk characterization integrates the exposure and toxicity assessments by comparing estimates of intake or dose with appropriate toxicity values. This in turn provides an indication of the potential for adverse effects to exposed receptors. The objective of the baseline risk characterization is to determine if exposure to chemicals associated with the sites poses risks that exceed EPA target levels for human health or adverse ecological effects. The results of the risk assessment may thus support the determination of need for site remediation.

5.5.1.1 General EPA Methods for Risk Assessment

This risk characterization presents a separate evaluation of noncarcinogenic and carcinogenic effects. The assessment distinguishes cancer from noncancer effects because organisms typically respond differently following exposure to carcinogenic or noncarcinogenic agents. The risk characterization evaluates adverse noncarcinogenic effects in terms of hazard quotients (HQs) for individual chemicals, and hazard indices (HIs) for noncancer health effects following exposure to multiple chemicals or across multiple exposure pathways.

The cancer risks are probabilistic estimates of the excess (incremental) lifetime cancer risk (ELCR) of cancer for an individual that are specifically attributable to exposure to site-related chemicals. The cancer risk estimates are determined by multiplying the route-specific intake or dose estimates by cancer slope factors. The terms *excess* and *incremental* imply risk above and beyond that not originating at the site. It does not mean that site-related health effects have been excluded; in fact, all risks related to the observed contamination at the sites are included. The cancer risk estimates in this assessment are incremental risks associated with long-term exposure to carcinogens, for as much as decades of contact with contaminated environmental media. Given the no threshold assumption for carcinogenesis adopted by EPA, every exposure to a carcinogen is assumed to carry an increased risk of cancer.

The procedure for calculating risk associated with exposure to carcinogenic compounds has been established by EPA (EPA 1989a,c; EPA 1991c). A nonthreshold, dose-response model is used to calculate a cancer slope (potency) factor (which mathematically is the slope of the dose-response curve) for each chemical. To derive an estimate of risk, the cancer slope factor (CSF - defined below) is then multiplied by the estimated chronic daily dose experienced by the exposed individual:

$$\text{Risk} = \text{CDI} \times \text{CSF}$$

where:

Risk = High-end estimate of the excess lifetime cancer risk to an individual (unitless probability)

CDI = Chronic daily dose averaged over a 70-year period (mg/kg body weight/day)

CSF = 95 percent high-end estimate of the slope of the dose-response curve (mg/kg body weight/day)$^{-1}$.

The CSF is used to convert estimates of daily intake or dose averaged over a lifetime, to incremental excess risk of an individual developing cancer. EPA notes that use of this equation assumes that the dose-response relationship is linear in the low-dose portion of the multistage model dose-response curve. Given this assumption, the slope factor is a constant and risk is directly proportional to intake.

In evaluating risk of exposure to more than one carcinogen, the risk measure for each compound may be summed (in the absence of information on antagonistic or synergistic effects) to provide an overall estimate of total carcinogenic risk (EPA 1989a).

$$\text{Risk}_T = \sum_{i=1}^{n} \text{Risk}_i$$

where:

Risk_T = The combined excess lifetime cancer risk across chemical carcinogens

Risk_i = The risk estimate for the ith chemical of n chemicals under evaluation.

This is conducted for each source of environmental release, associated exposure pathway, and receptor group at risk of exposure. Population risks are derived by multiplying the overall risk level (summed for all subject chemicals) by the number of people exposed. This would yield a measure of the additional incidence of developing cancer (i.e., additional number of new cases) in the exposed population over a lifetime (i.e., 70 years) of exposure.

The traditionally accepted practice of evaluating exposure to noncarcinogenic compounds has been to experimentally determine a NOAEL and to divide this by a safety factor to establish an acceptable human dose, for example, acceptable daily intake or RfD. The RfD is then compared to the average daily dose experienced by the exposed population to obtain a measure of concern for adverse noncarcinogenic effects:

$$HQ = \frac{\text{Dose}}{\text{RfD}}$$

where:

HQ = Hazard Quotient: potential for adverse noncarcinogenic effects

Dose = Average daily dose for subchronic or chronic exposure (mg/kg body weight/day)

RfD = Acceptable intake for subchronic or chronic exposure (mg/kg body weight/day).

Dose and the RfD are expressed in the same units and are based upon common exposure periods (i.e., chronic, subchronic, or shorter-term). If HQ is > 1, there may be potential for adverse noncarcinogenic effects at the given exposure/dose level. Guidelines for evaluating exposure to mixtures of noncarcinogens is presented by EPA (1989a). Essentially, this involves summing the HQ (ratio of daily dose/RfD) for all chemicals under evaluation. If the sum of these ratios is > 1, there is the potential for adverse noncarcinogenic effects. Under these circumstances, EPA recommends segregating the compounds into groups of like or common toxicological effects, and re-evaluating the potential for manifestation of the various adverse health effects identified.

5.5.1.2 EPA Risk Characterization Method for Lead

Recent toxicologic evidence indicates significant adverse health effects are apparent in children at relatively low levels of exposure to lead. Health effects associated with low-level lead exposures include reproductive effects, neurological effects, and learning disorders. At the present time, toxicologic studies indicate that there may be no threshold of exposure below which adverse effects do not occur. Given the uncertainty surrounding an acceptable exposure below which there would be no adverse effects for lead, EPA has recently withdrawn the RfD for lead. In response to these recent developments, the Centers for Disease Control (CDC) have established a guideline for acceptable blood lead levels in children of 10 micrograms of lead per deciliter of blood (lowered recently from 25 μg/dl).

Direct monitoring of blood lead levels in exposed populations are not available for the waste sites at Springfield ANGB. Therefore, the risk characterization for lead is based on an alternative method using a biokinetic model developed by EPA for this purpose.

The model, LEAD 0.6 (EPA 1991d), has been developed by EPA to estimate blood lead levels in children based upon uptake originating from various sources in the environment. The LEAD 0.6 model includes default exposure parameters, which may be reasonably used in the absence of site-specific data. The model was designed to accept either default or site-specific inputs, and model input parameters were adjusted to be consistent with the exposure parameters used for chemicals other than lead. In evaluating lead in soils, only exposure parameters were adjusted in the LEAD 0.6 model. No adjustment was made to the default absorption methodology used in the model.

5.5.1.3 Interpreting the Risk Estimates

EPA guidelines for interpreting noncarcinogenic and carcinogenic effects have been adopted in the baseline risk assessment. EPA has established target risk levels for use in determining the need for site remediation. For carcinogenic effects, the total excess lifetime cancer risk to the individual of exposure to all contaminants should not exceed the target range of 10^{-6} to 10^{-4}. Cancer risks less than 10^{-6} are not typically considered a concern. Although the 10^{-6} risk level is identified by EPA as a "point of departure" in evaluating the results of risk assessment, the revised National Contingency Plan (NCP) clearly indicates that the 10^{-4} level is the upper bound of the target cancer risk range (EPA 1991c).

For noncarcinogenic effects, EPA specifies that cleanup should be based on targeted levels of exposure as determined by the EPA RfDs, taking into account the effects of multiple contaminants and multiple exposure pathways at the site. If the HQ (ratio of daily intake or dose over the RfD) is $>$ 1, there may be excessive noncarcinogenic effects at the given exposure/dose level. For multiple noncarcinogens, the HQs for all of the chemicals under evaluation are summed. If this sum is $>$ 1, there may be excessive noncarcinogenic health effects to mixtures of chemicals.

In the special case of lead exposures, the appropriate target is defined as a maximum of 5 percent of the exposed population exceeding the CDC blood lead cutoff. This is based on EPA guidance concerning an acceptable point of reference (EPA 1991e):

> We recommend a model projection benchmark of either 95 percent of the sensitive population having blood lead levels below 10 μg/dl or a 95 percent probability of an individual having a blood lead level below 10 μg/dl.

The target for lead exposures is thus defined as a maximum of 5 percent of the exposed population exceeding the CDC blood lead cutoff.

5.5.1.4 Methods for Evaluating Background Soil Concentrations and Upgradient Groundwater Concentrations

Soil samples from each site have been evaluated relative to background concentrations using a two-step process. In the first step, risk assessment has been conducted using background soil concentrations. These results are compared to the results of risk assessment using data from the sites under investigation.

The second method is a statistical comparison of site contamination versus background soil levels using a tolerance interval approach. In order to evaluate the significance of individual inorganic analytes, concentrations for each analyte at a given site have been compared to the upper tolerance limit on the distribution of the background soil samples. The upper tolerance limit is an upper confidence limit for a given percentile of the background data set. For this comparison, the 90th percentile and the 95 percent confidence coefficient was used. In other words, the upper tolerance limit is the concentration below which 90 percent of the sample data fall, with 95 percent certainty. The upper limit of the tolerance interval was estimated for the background data set using a nonparametric method (Washington State 1992). A nonparametric method was chosen because a goodness-of-fit test determined that the data were not normally or lognormally distributed. The tolerance interval comparison to sample data provides evidence that inorganic chemicals found within the tolerance interval may or may not be site-related soil contaminants, and whether or not they may be naturally occurring substances.

The tolerance interval comparison conducted for Springfield ANGB determines the number of site soil samples (for a detected analyte) that exceed the upper limit of the tolerance interval. This number is reported as a proportion (i.e., the number of soil samples exceeding the background tolerance interval over the total number of soil samples for a given analyte). If site sample concentrations exceed the upper tolerance limit for a chemical, that chemical may be concluded to be statistically different from background (i.e., site-related). Site samples within the tolerance interval (below the upper tolerance limit) are concluded to be indistinguishable from background concentrations (i.e., not site-related contaminants). A complete description of the methodology of the background comparison is presented in Section 3.3. The results of the comparison are presented in Sections 3.5 through 3.9. The risk assessment focuses primarily on those chemicals that are responsible for risks that are within or above EPA targets.

For groundwater, concentrations in site samples have been evaluated relative to upgradient groundwater concentrations in the same manner as for soils. Risk assessment was conducted using the concentrations from upgradient wells and a tolerance interval comparison was made.

5.5.2 Risk Characterization Results

The following subsections present the risk characterization results for Sites 2, 3, and 5. Results for each site are discussed separately. Note that only RME risk estimates are presented in the body of the report. The more detailed characterization tables are presented in Appendix H. In Tables 5-5 through 5-7, a risk characterization summary is provided for each site. As an additional point of comparison, Table 5-8 presents hypothetical risk estimates for background soils and upgradient groundwater. Each table presents quantitative results of the risk assessment and a letter designator interpreting the estimates in light of EPA targets. In the summary tables, risk estimates that are below the noncancer HI of 1 and the cancer target risk range are indicated with a "B." "E" designates risk exceeding the EPA target cancer risk range or hazard index. Cancer risk estimates within the EPA target cancer risk range are designated with a "W."

The results of the lead analysis also are included in the following discussion. Table 5-9 presents the results of the EPA LEAD 0.6 biokinetic model for background as well as Sites 2, 3, and 5. For this analysis, the RME (UCL) exposure point concentration for lead in soil was used to calculate blood lead levels in children. Further information is included in Appendix H, Figures H-1 through H-10, which presents detailed output from the model. This output includes the parameters used in each run, and numerical and graphical results. Table 5-9 shows the percentile of children exceeding the 10 μg/dl blood lead concentration cutoff guideline.

As currently developed, the LEAD 0.6 model is designed for analysis of exposures to children, not adults. As an additional point of comparison, the soil lead exposure point concentrations at each site may be compared to recent EPA soil cleanup guidelines for lead (EPA 1994b). The soil lead guidelines establish a screening level of 400 mg/kg total lead in soil as protective of residential populations. The greatest concentration of lead in soils (268 mg/kg at Site 5) does not exceed the screening level.

5.5.2.1 Site 2 - Fire Training Area No. 2 (FTA-2)

Soils

Noncancer Health Effects—As shown in Table 5-5, all noncancer risk estimates for Site 2 are acceptable. HIs are all below 1.0 for Base personnel (HI = 0.03), construction workers (HI = 0.3), adults (HI = 0.09), and children (HI = 0.78) in both current and future

Table 5-5. Risk Estimate Summary - RME Risks
Site 2 - Fire Training Area 2
178th Tactical Fighter Group, Springfield ANGB, Springfield, Ohio

CURRENT - OCCUPATIONAL

MEDIA	ROUTE	BASE PERSONNEL				CONSTRUCTION WORKER			
		Noncancer		Cancer		Noncancer		Cancer	
Soil	Ingestion	2.3E-02	B	9.7E-06	W	2.8E-01	B	9.3E-06	W
	Dermal	1.7E-03	B	3.6E-06	W	4.7E-03	B	7.1E-07	B
Soil Total	**Combined**	**2.5E-02**	B	**1.3E-05**	W	**2.9E-01**	B	**1.0E-05**	W

TOTAL	**2.5E-02**	B	**1.3E-05**	W	**2.9E-01**	B	**1.0E-05**	W

FUTURE - RESIDENTIAL

MEDIA	ROUTE	CHILDREN				ADULTS			
		Noncancer		Cancer		Noncancer		Cancer	
Soil	Ingestion	7.7E-01	B	7.6E-05	W	8.3E-02	B	3.3E-05	W
	Inhalation	2.9E-07	B	1.8E-08	B	6.2E-08	B	1.9E-08	B
	Dermal	1.1E-02	B	4.9E-06	W	6.6E-03	B	1.5E-05	W
Soil Total	**Combined**	**7.8E-01**	B	**8.1E-05**	W	**8.9E-02**	B	**4.8E-05**	W

MEDIA	ROUTE	CHILDREN				ADULTS			
		Noncancer		Cancer		Noncancer		Cancer	
Air (vapors) Total	**Inhalation**	**6.8E-04**	B	**1.6E-07**	B	**1.5E-04**	B	**1.7E-07**	B

MEDIA	ROUTE	CHILDREN				ADULTS			
		Noncancer		Cancer		Noncancer		Cancer	
Groundwater	Ingestion	2.1E+01	E	9.9E-04	E	8.8E+00	E	2.1E-03	E
	Inhalation	--	--	--	--	--	--	--	--
	Dermal	2.5E-02	B	1.5E-05	W	1.4E-02	B	8.3E-06	W
GW Total	**Combined**	**2.1E+01**	E	**1.0E-03**	E	**8.9E+00**	E	**2.1E-03**	E

MEDIA	ROUTE	CHILDREN				ADULTS			
		Noncancer		Cancer		Noncancer		Cancer	
Filtered Groundwater	Ingestion	7.0E-01	B	2.0E-05	W	3.0E-01	B	4.3E-05	W
	Inhalation	--	--	--	--	--	--	--	--
	Dermal	9.3E-04	B	3.1E-07	B	5.0E-04	B	1.7E-07	B
FGW Total	**Combined**	**7.0E-01**	B	**2.0E-05**	W	**3.0E-01**	B	**4.3E-05**	W

TOTAL *	**2.1E+01**	E	**1.1E-03**	E	**8.9E+00**	E	**2.2E-03**	E

"B" - Below EPA human noncancer health effects target (HI < 1) or cancer risk (ELCR < 1 x 10-6)
"W" - Within EPA target cancer risk range (ELCR <= 1 x 10-4 and >= 1 x 10-6)
"E" - Exceeds EPA human noncancer health effects target (HI > 1) or cancer risks (ELCR > 1 x 10E-4)
* - TOTAL does not include risks from filtered groundwater
-- No results are available for this route because detected chemicals do not easily volatilize and/or have no EPA-approved toxicity values

Table 5-6. Risk Estimate Summary - RME Risks
Site 3 - Leach Field
178th Tactical Fighter Group, Springfield ANGB, Springfield, Ohio

CURRENT - OCCUPATIONAL

MEDIA	ROUTE	BASE PERSONNEL				CONSTRUCTION WORKER			
		Noncancer		Cancer		Noncancer		Cancer	
Soil	Ingestion	1.6E-02	B	4.0E-06	W	2.2E-01	B	3.9E-06	W
	Dermal	1.0E-03	B	8.3E-07	B	2.8E-03	B	1.7E-07	B
Soil Total	**Combined**	**1.7E-02**	B	**4.8E-06**	W	**2.2E-01**	B	**4.0E-06**	W

TOTAL	**1.7E-02**	B	**4.8E-06**	W	**2.2E-01**	B	**4.0E-06**	W

FUTURE - RESIDENTIAL

MEDIA	ROUTE	CHILDREN				ADULTS			
		Noncancer		Cancer		Noncancer		Cancer	
Soil	Ingestion	5.9E-01	B	3.1E-05	W	6.3E-02	B	1.3E-05	W
	Inhalation	3.9E-07	B	1.3E-08	B	8.3E-08	B	1.4E-08	B
	Dermal	6.3E-03	B	1.1E-06	W	3.9E-03	B	3.5E-06	W
Soil Total	**Combined**	**6.0E-01**	B	**3.3E-05**	W	**6.7E-02**	B	**1.7E-05**	W

MEDIA	ROUTE	CHILDREN				ADULTS			
		Noncancer		Cancer		Noncancer		Cancer	
Air (vapors) Total	**Inhalation**	**1.9E-04**	B	--	--	**4.1E-05**	B	--	--

MEDIA	ROUTE	CHILDREN				ADULTS			
		Noncancer		Cancer		Noncancer		Cancer	
Groundwater	Ingestion	1.2E+01	E	5.1E-04	E	5.0E+00	E	1.1E-03	E
	Inhalation	--	--	--	--	--	--	--	--
	Dermal	1.5E-02	B	2.0E-07	B	8.0E-03	B	5.3E-07	B
GW Total	**Combined**	**1.2E+01**	E	**5.1E-04**	E	**5.0E+00**	E	**1.1E-03**	E

TOTAL	**1.2E+01**	E	**5.4E-04**	E	**5.1E+00**	E	**1.1E-03**	E

"B" - Below EPA human noncancer health effects target (HI < 1) or cancer risk (ELCR < 1 x 10-6)
"W" - Within EPA target cancer risk range (ELCR <= 1 x 10-4 and >= 1 x 10-6)
"E" - Exceeds EPA human noncancer health effects target (HI > 1) or cancer risks (ELCR > 1 x 10E-4)
-- No results are available for this route because detected chemicals do not easily volatilize and/or have no EPA-approved toxicity values

Table 5-7. Risk Estimate Summary - RME Risks
Site 5 - Ramp Drainage Ditch
178th Tactical Fighter Group, Springfield ANGB, Springfield, Ohio

CURRENT - OCCUPATIONAL

MEDIA	ROUTE	BASE PERSONNEL				CONSTRUCTION WORKER			
		Noncancer		Cancer		Noncancer		Cancer	
Soil	Ingestion	2.3E-02	B	2.2E-05	W	2.9E-01	B	2.1E-05	W
	Dermal	2.2E-03	B	1.2E-05	W	5.7E-03	B	2.3E-06	W
Soil Total	**Combined**	**2.6E-02**	B	**3.4E-05**	W	**3.0E-01**	B	**2.4E-05**	W

TOTAL	**2.6E-02**	B	**3.4E-05**	W	**3.0E-01**	B	**2.4E-05**	W

FUTURE - RESIDENTIAL

MEDIA	ROUTE	CHILDREN				ADULTS			
		Noncancer		Cancer		Noncancer		Cancer	
Soil	Ingestion	8.0E-01	B	1.8E-04	E	8.5E-02	B	7.5E-05	W
	Inhalation	2.9E-07	B	1.3E-08	B	6.2E-08	B	1.4E-08	B
	Dermal	1.3E-02	B	1.6E-05	W	8.0E-03	B	4.9E-05	W
Soil Total	**Combined**	**8.1E-01**	B	**1.9E-04**	E	**9.3E-02**	B	**1.2E-04**	E

MEDIA	ROUTE	CHILDREN				ADULTS			
		Noncancer		Cancer		Noncancer		Cancer	
Air (vapors) Total	**Inhalation**	--	--	--	--	--	--	--	--

TOTAL	**8.1E-01**	B	**1.9E-04**	E	**9.3E-02**	B	**1.2E-04**	E

"B" - Below EPA human noncancer health effects target (HI < 1) or cancer risk (ELCR < 1 x 10-6)
"W" - Within EPA target cancer risk range (ELCR <= 1 x 10-4 and >= 1 x 10-6)
"E" - Exceeds EPA human noncancer health effects target (HI > 1) or cancer risks (ELCR > 1 x 10E-4)
-- No results are available for this route because detected chemicals do not easily volatilize and/or have no EPA-approved toxicity values

Table 5-8. Risk Estimate Summary - RME Risks
Background
178th Tactical Fighter Group, Springfield ANGB, Springfield, Ohio

CURRENT - OCCUPATIONAL

MEDIA	ROUTE	BASE PERSONNEL				CONSTRUCTION WORKER			
		Noncancer		Cancer		Noncancer		Cancer	
Soil	Ingestion	1.7E-02	B	3.1E-06	W	2.1E-01	B	3.0E-06	W
	Dermal	1.0E-03	B	3.4E-07	B	2.6E-03	B	6.8E-08	B
Soil Total	**Combined**	**1.8E-02**	B	**3.4E-06**	W	**2.1E-01**	B	**3.0E-06**	W

TOTAL	**1.8E-02**	B	**3.4E-06**	W	**2.1E-01**	B	**3.0E-06**	W

FUTURE - RESIDENTIAL

MEDIA	ROUTE	CHILDREN				ADULTS			
		Noncancer		Cancer		Noncancer		Cancer	
Soil	Ingestion	5.7E-01	B	2.4E-05	W	6.1E-02	B	1.0E-05	W
	Inhalation	8.8E-07	B	1.2E-08	B	1.9E-07	B	1.3E-08	B
	Dermal	5.8E-03	B	4.6E-07	B	3.6E-03	B	1.4E-06	W
Soil Total	**Combined**	**5.8E-01**	B	**2.5E-05**	W	**6.5E-02**	B	**1.2E-05**	W

MEDIA	ROUTE	CHILDREN				ADULTS			
		Noncancer		Cancer		Noncancer		Cancer	
Air (vapors) Total	**Inhalation**	**3.4E-05**	B	--	--	**7.4E-06**	B	--	--

MEDIA	ROUTE	CHILDREN				ADULTS			
		Noncancer		Cancer		Noncancer		Cancer	
Groundwater	Ingestion	3.7E+00	E	1.8E-04	E	1.6E+00	E	3.9E-04	E
	Inhalation	--	--	--	--	--	--	--	--
	Dermal	4.3E-03	B	2.4E-07	B	2.3E-03	B	6.4E-07	B
GW Total	**Combined**	**3.7E+00**	E	**1.8E-04**	E	**1.6E+00**	E	**3.9E-04**	E

MEDIA	ROUTE	CHILDREN				ADULTS			
		Noncancer		Cancer		Noncancer		Cancer	
Filtered Groundwater	Ingestion	3.0E-01	B	--	--	1.3E-01	B	--	--
	Inhalation	--	--	--	--	--	--	--	--
	Dermal	4.0E-04	B	--	--	2.2E-04	B	--	--
FGW Total	**Combined**	**3.0E-01**	B	--	--	**1.3E-01**	B	--	--

TOTAL	**4.3E+00**	E	**2.1E-04**	E	**1.6E+00**	E	**4.0E-04**	E

"B" - Below EPA human noncancer health effects target (HI < 1) or cancer risk (ELCR < 1 x 10-6)
"W" - Within EPA target cancer risk range (ELCR <= 1 x 10-4 and >= 1 x 10-6)
"E" - Exceeds EPA human noncancer health effects target (HI > 1) or cancer risks (ELCR > 1 x 10E-4)
-- No results are available for this route because detected chemicals do not easily volatilize and/or have no EPA-approved toxicity values

Table 5-9. LEAD 0.6 Uptake/Biokinetic Model Assumptions[b] and Results
178th Tactical Fighter Group, Springfield ANGB, Springfield, Ohio

	Site 2	Site 3	Site 5	Background (total) [a]	Background (dissolved) [a]
Lead Concentration in Soil (mg/kg)	72.59	47.4	255.9	70.45	70.45
Lead Concentration in Groundwater (μg/L)	197	62.4	[b]	65.2	5.7
Lead Concentration in Air (μg/m^3)	1.57×10^{-5}	1.02×10^{-5}	5.29×10^{-5}	1.52×10^{-5}	1.52×10^{-5}
Geometric Mean of the Projected Blood Lead Level (μg Pb/dL blood)	18.42	6.71	4.25	7.13	2.21
Sensitive Age Group (months)	72 to 84	72 to 84	36 to 48	72 to 84	36 to 48
Percentile Exceeding 10 μg Pb/dL blood Lead Level	**94.61**	**11.84**	**0.68**	**15.47**	**0.00**

[a] Total and dissolved lead concentrations in groundwater were used for the analysis of background samples.

[b] Monitoring data and default LEAD 0.6 intake assumptions were used in the model, with the following exceptions:

- the particulate emission factor, in conjunction with measured lead concentrations in soil, was used to calculate airborne lead concentrations (10^{-7} to 10^{-9} μg/m3) in place of the default setting (0.200 μg/m^3), and
- since no groundwater samples were collected from Site 5, the default lead concentration in drinking water, 4 μg/L, was used.
- the concentrations of lead in soil and groundwater are the exposure point concentrations (RME) presented in Tables H-1 through H-7 in Appendix H; because monitoring data are not available for concentrations in house dust, the soil concentration also was used for the concentration in house dust.

land use scenarios. This indicates that no adverse noncarcinogenic effects are anticipated for the defined exposures to these receptors.

Cancer Risks—Table 5-5 also presents the summed cancer risks for soil exposures. Each of these risks fall within the defined EPA target cancer risk range (10^{-6} to 10^{-4}). The highest soil cancer risks are for children and adults ingesting soil in a hypothetical future residential land use scenario (8 x 10^{-5} and 5 x 10^{-5}, respectively). For all receptors, ingestion risks are due mainly from exposure to arsenic and benzo(a)pyrene (responsible for 80% of the ingestion risk). Dermal contact risks are due mainly from exposure to benzo(a)pyrene (responsible for 65% of the dermal contact risk).

Groundwater

Noncancer Health Effects—At Site 2, noncancer HIs for unfiltered groundwater exceed the EPA target of 1.0 for both adults and children. In both cases, the risks are due almost entirely to the ingestion route, with HIs of 21 and 9 for the child and adult, respectively. For the child, the HI of 21 is due mainly to arsenic (responsible for 81% of the HI); however, copper and nickel are also responsible for HIs greater than one. For the adult, only arsenic has an HI greater than one. Noncancer HIs for filtered groundwater are one to two orders of magnitude lower than those for unfiltered groundwater and are below the EPA target HI at 0.7 for the child and 0.3 for the adult.

Cancer Risks—Cancer risks from exposure to unfiltered groundwater are above the upper limit of the target cancer risk range, at 1 x 10^{-3} for the child and 2 x 10^{-3} for the adult. The ingestion route is responsible for these elevated risks (dermal contact risks fall within the target risk range for unfiltered groundwater). In all cases, arsenic and beryllium are the only contributors, with arsenic responsible for 76 percent of the ingestion and dermal contact risk. As with the noncancer HIs, risks for filtered groundwater are one to two orders of magnitude lower than those for unfiltered groundwater and fall within the EPA target cancer risk range at 2 x 10^{-5} for the child and 4 x 10^{-5} for the adult. Because beryllium was not detected in filtered groundwater, the filtered groundwater cancer risks are due entirely to arsenic.

Air

Noncancer health effects from inhalation of volatile emissions fall well below the noncancer HI of one. Cancer risks fall below the EPA target risk range.

Lead Effects

Table 5-9 indicates that exposures to lead in soils and groundwater at Site 2 exceed the CDC blood lead reference concentration (upper limit of 10 μg/dl). The geometric mean blood lead concentration of the most sensitive age group (72 to 84 months) is 18.42 μg/dl, with 95 percent exceeding the limit. The concentration of lead in the unfiltered groundwater is mainly responsible for these high levels. This is corroborated by the fact that at Site 5, using a lead concentration in soils that is three to four times greater than at Site 2 and the default lead concentration in drinking water (4 μg/L), did not yield a blood lead level that exceeded the CDC guideline. It is important to recognize that lead was not detected in filtered groundwater samples at Site 2. If the lead model were run using Site 2 lead concentrations in soil and the default lead concentration in drinking water, blood lead levels would not be elevated above the guideline set by CDC.

Comparisons to Background

Tolerance Interval for Soils—Tables 3-20 and 3-21 in Section 3.6 present a detailed tolerance interval comparison of Site 2 soils to background. For the shallow soil data set, the pertinent substances (those with an HI greater than one and a cancer risk greater than 1 x 10^{-6}) and the respective proportion of site samples exceeding the upper tolerance limit for background include arsenic (1/6), beryllium (1/6), benzo(a)anthracene (4/6), benzo(a)pyrene (3/6), benzo(b)fluoranthene (3/6), benzo(k)fluoranthene (6/6), and indeno(1,2,3-cd)pyrene (3/6). (Note that the shallow soil samples were classified as sediments, but no standing water was present in the swales and ditches at the time of sampling.) For the deeper (to 10 feet) soils, the substances include arsenic (0/8) and beryllium (0/8), indicating that neither exceed background levels. Based upon these results, PAHs primarily appear to exceed background levels for soils.

Tolerance Interval for Groundwater—Table 3-22 in Section 3.6 presents the comparison for Site 2 groundwater samples and the upper tolerance limit for the upgradient results. The pertinent substances and the respective proportion of samples exceeding the upper tolerance limit include arsenic (1/3), beryllium (1/3), copper (2/3), and nickel (1/3). Based on these results, the levels of inorganics detected in Site 2 groundwater may be site related.

Risk Assessment Results—Risk assessment was conducted for current and future land use scenarios using background concentrations in soils and upgradient groundwater concentrations. In background, noncancer and cancer risks for soils fall within or below EPA targets. However, both cancer and noncancer risks for unfiltered groundwater are above EPA targets in upgradient wells. This is predominantly due to arsenic, which is responsible for 69 percent of the noncancer HI and 63 percent of the cancer risk. The remaining cancer risk is attributable to beryllium. With filtered groundwater, hazard indices drop below the EPA target HI of one.

At Site 2, risks are higher than those calculated for the background, but are within an order of magnitude of the background risks. As with the upgradient wells, arsenic and beryllium are entirely responsible for the groundwater cancer risk and arsenic is primarily responsible (81%) for the groundwater noncancer HI.

5.5.2.2 Site 3 - Leach Field (LCH)

Soils

Noncancer Health Effects—As shown in Table 5-6, all noncancer risk estimates for Site 3 are acceptable. HIs are all below 1.0 for Base personnel (HI = 0.02), construction workers (HI = 0.2), adults (HI = 0.07), and children (HI = 0.6) in both current and future land use scenarios. These results are similar to those for Site 2 and indicate that no adverse noncarcinogenic effects are anticipated for the defined exposures to these receptors.

Cancer Risks—At Site 3, the soil cancer risks fall within the defined EPA target cancer risk range. The highest cancer risks are for children and adults ingesting soil, at 3×10^{-5} and 2×10^{-5}, respectively. For all receptors, ingestion and dermal contact cancer risks are due mainly from exposure to arsenic (responsible for 82% of the ingestion risk) and benzo(a)pyrene (responsible for 17% of the ingestion and 65% of the dermal contact risk).

Groundwater

Noncancer Health Effects—At Site 3, noncancer HIs for unfiltered groundwater exceed the EPA target of 1.0 for both adults and children. In both cases, the risks are due almost entirely to the ingestion route, with HIs of 12 and 5 for the child and adult, respectively. For both receptors, the ingestion HI is due mainly to arsenic (responsible for 86% of the HI), which was the only chemical with an HI greater than one. Dissolved metals were not detected in Site 3 filtered groundwater; therefore, no risks are assumed to exist from exposure to filtered groundwater at Site 3.

Cancer Risks—Cancer risks from exposure to unfiltered groundwater are above the upper limit of the target cancer risk range, at 5×10^{-4} for the child and 1×10^{-3} for the adult. The ingestion route is responsible for these elevated risks (dermal contact risks fall below the target risk range). In all cases, arsenic and beryllium are the only contributors, with arsenic responsible for 88 percent of the ingestion risk and 98 percent of the dermal contact risk. Dissolved metals were not detected in Site 3 filtered groundwater; therefore, no risks are assumed to exist from exposure to filtered groundwater at Site 3.

Air

Noncancer health effects from inhalation of volatile emissions fall below the EPA target HI of one. Cancer risks for this route were not evaluated because the detected chemicals do not easily volatilize or do not have EPA-approved toxicity values.

Lead Effects

Table 5-9 indicates that exposures to lead in soils and groundwater at Site 3 exceed the CDC blood lead reference concentration (upper limit of 10 μg/dl). The geometric mean blood lead concentration of the most sensitive age group (72 to 84 months) is 6.71 μg/dl, with 12 percent exceeding the limit. The concentration of lead in the unfiltered groundwater is mainly responsible for these high levels. It is important to recognize that lead was not detected in filtered groundwater samples at Site 3. If the lead model were run using Site 3 lead concentrations in soil and the default lead concentration in drinking water, blood lead levels would not be elevated above the guideline set by CDC.

Comparisons to Background

Tolerance Interval for Soils—Table 3-27 in Section 3.7 presents a detailed tolerance interval comparison of Site 3 soils to background. The pertinent substances (those with an HI greater than one and a cancer risk greater than 1 x 10^{-6}) and the respective proportion of samples exceeding the upper tolerance limit for background include arsenic (1/8), beryllium (0/8), and benzo(a)pyrene (3/8). Based upon these results, concentrations of organic compounds exceed backgound levels and appear to be site related.

Tolerance Interval for Groundwater—As shown in Table 3-28, concentrations of chemicals detected in groundwater do not differ significantly from concentrations in upgradient wells. The pertinent substances and the respective proportion of samples exceeding the upper tolerance limit include arsenic (1/3), and beryllium (0/3).

Risk Assessment Results—Comparison of risk assessment results at Site 3 to background risks indicates that Site 3 risks are indistinguishable from background. Risks at Site 3 are nearly identical to those in background, with Site 3 risks slightly higher than background risks in all cases but one. Those showing the greatest disparity are within a factor of four of the background risks, which may be accountable to natural variability in soils. Arsenic and beryllium in groundwater are responsible for noncancer HIs and cancer risks above EPA targets.

In background, cancer risks for soils fall within the target cancer risk range. In upgradient wells, both cancer and noncancer risks for unfiltered groundwater are above EPA targets. This is predominantly due to arsenic, which is responsible for 69 percent of the noncancer HI and 63 percent of the cancer risk. The remaining cancer risk is attributable to beryllium. Using filtered groundwater concentrations, hazard indices drop below the EPA target HI of one.

5.5.2.3 Site 5 - Ramp Drainage Ditch (RDD)

Soils

Noncancer Health Effects—At Site 5, all noncancer risk estimates are acceptable. HIs are all below 1.0 for Base personnel (HI = 0.03), construction workers (HI = 0.3), adults (HI = 0.09), and children (HI = 0.8) in both current and future land use scenarios.

Cancer Risks—Under current land use, the soil cancer risks fall within the defined EPA target cancer risk range for Base personnel and construction workers. The highest cancer risks are due to soil ingestion (2×10^{-5} for both Base personnel and construction workers), with benzo(a)pyrene responsible for over 50 percent of the risk. Dermal contact risks are also largely due to benzo(a)pyrene.

In the future residential scenario, cancer risks for children and adults slightly exceed the upper limit of the target cancer risk range, at 1.9×10^{-4} and 1.2×10^{-4}, respectively. Again, the ingestion route is responsible for the majority of the risk with benzo(a)pyrene responsible for 52 percent, dibenzo(a,h)anthracene - 14 percent, arsenic - 10 percent, and benzo(b)fluoranthene - 9 percent. For the dermal contact pathway, benzo(a)pyrene is responsible for 58 percent of the risk.

Groundwater

An evaluation of groundwater risks at Site 5 has not been conducted because groundwater samples were not collected at this site. The Ramp Drainage Ditch was selected only for soil sampling because the source of contamination was expected to be runoff from the parking apron. The highest levels of contamination were expected to be in the surface or shallow subsurface soils. In addition, the type of contamination was expected to be long chain hydrocarbons and metals. The data confirmed these assumptions and the depth of the organic contamination was determined from the deep soil boring (5-10 feet BLS). Based on the results of soil sampling, groundwater sampling was not considered necessary.

Air

Noncancer and cancer risks for this route were not evaluated because the detected chemicals do not easily volatilize or do not have EPA-approved toxicity values.

Lead Effects

Table 5-9 indicates that exposures to lead in soils at Site 5 are below the EPA target. Exposures to the most sensitive population (ages 36 to 48 months) are projected to result in an geometric mean blood lead concentration of 4.25 μg/dl with 0.68 percent exceeding the 10 μg/dl upper limit. Because no groundwater samples were collected at Site 5, the model was run using the default lead concentration in drinking water of 4 μg/L.

Comparisons to Background

Tolerance Interval for Soils—Tables 3-39 and 3-40 in Section 3.9 present a detailed tolerance interval comparison of Site 5 soils to background. For the shallow soil data set, the pertinent substances and the respective proportion of samples exceeding the upper tolerance limit include arsenic (0/5), beryllium (0/5), benzo(a)anthracene (4/5), benzo(a)pyrene (4/5), benzo(b)fluoranthene (4/5), benzo(k)fluoranthene (5/5), and indeno(1,2,3-cd)pyrene (4/5). For the deeper (to 10 feet) soils, the substances include arsenic (0/2) and beryllium (0/2). Based upon these results, only PAHs appear to exceed background levels and the remaining substance levels at Site 5 do not appear to significantly differ from background levels.

Risk Assessment Results—Risk assessment was conducted for current and future land use using background concentrations in soils. Risks at Site 5 are higher than those calculated for the background, but are within an order of magnitude of the background risks. In background, both noncancer and cancer risks for soils fall within the EPA target cancer risk range or below the noncancer target HI.

5.5.3 Evaluation of Uncertainty

In the following section, an evaluation is presented of the sources of uncertainty in the baseline human health risk assessment for Springfield ANGB and the relative influence of these sources on the results of the evaluation. It is essential to recognize the uncertainty inherent in risk assessment. Uncertainty is inherent in the selection of key input parameters and in every step of the risk assessment process. Risk assessment of waste sites must not be viewed as yielding single value, invariant results. Rather, the results of risk assessment are estimates that span a range of possible values, and which may be understood only in light of the assumptions and methods used in the evaluation.

The results of the risk assessment are presented in terms of the potential for adverse effects based upon a number of conservative assumptions. The tendency to be conservative is an effort to err toward protecting health. Uncertainty can be found at all phases in the risk assessment: in the analytical data, the exposure assessment, the toxicity information, and the risk characterization.

Uncertainty in the Analytical Data

Uncertainty will always surround estimates of environmental concentrations at waste sites. The objective is to understand, minimize, and quantify this uncertainty in risk assessment. Given the objective of protecting human health and the environment, it is prudent to design the SI program to minimize the number of conclusions based on underestimates of risk (e.g., concluding there is no significant difference between background and site concentrations, when in fact site concentrations are higher).

The uncertainty associated with the statistical analysis is moderate, with no apparent direction to the bias. This means that the statistics may either overestimate or underestimate the actual exposures. The exposure point concentrations were based on normal statistics. These assumptions could introduce uncertainty, but should not be seriously affected by slight deviations from normality. Using normal statistics may result in imprecise estimates if the true distribution is not normal or lognormal. Such practices are, however, strongly recommended by EPA (EPA 1992c and 1992d).

At Springfield ANGB, background levels have been established using data from locations on the Base (as opposed to using regional background levels, for example). Using Base background levels allows one to distinguish between contaminant levels resulting from everyday Base practices from those resulting from activities at Sites 1 through 5. Using background levels outside the Base would most likely produce different results (e.g., PAH levels might be expected to be higher on Base than off Base).

Exposure Assessment Uncertainty

Exposure assessment may introduce considerable uncertainty in the risk assessment process. Uncertainty in all elements of the exposure assessment are brought together and compounded in the estimate of intake or dose. The professional judgment of the risk assessor becomes particularly important, and the risk assessor must examine and interpret a diversity of information, including: the nature, extent, and magnitude of contamination; transport of chemicals in the environment; identification of exposure routes; identification of receptor groups currently at risk and potentially at risk in the future; and activity patterns of receptors and receptor groups.

Different types of uncertainty have been identified in the exposure assessment (EPA 1992d):

- Scenario Uncertainty: missing or incomplete information needed to define the exposure scenario or pathway
- Parameter Uncertainty: inadequate information to quantify an exposure variable or parameter.

Scenario uncertainty arises when pathways were not included in, or were eliminated from, the assessment. In this risk assessment, a hypothetical future residential land use scenario was assumed in which children and adults would be exposed to surface and subsurface soils and groundwater from the shallow aquifer. Because of zoning restrictions and proximity to the Springfield-Beckley Municipal Airport, future residential development of the land is unlikely. In addition, risks associated with human exposure to groundwater from the shallow aquifer are highly uncertain. This groundwater is not currently used by the Base, and future use is unlikely because of the low productivity of this aquifer. The exposure and risk estimates provided herein are highly conservative and add substantial uncertainty to the analysis.

Many of the exposure parameters used in the risk assessment are default values recommended by EPA. These default parameters, which are generally conservative, do not necessarily reflect actual behavior and have been used in the absence of site-specific information. In addition, assumptions regarding the future land uses are highly speculative. In attempting to predict future exposures, assumptions must be made concerning contaminant fate and transport, future site activities, and receptor behavior. In particular, it was assumed that contaminant concentrations will be the same in the future as at present, and that the contaminants themselves are immobile. The uncertainty associated with the exposure assumptions used in the risk assessment is moderate, and most likely overestimates the actual risks.

Each of these parameters is commonly treated as a single point estimate. None of these parameters, however, is truly a single value. Instead, a range of values or distribution would more accurately represent these parameters. Defining a range of values for any given parameter is actually a measure of variability in the risk assessment. Quantitative uncertainty analysis allows one to measure this variability, but is difficult because of the quantity and quality of data available, or the commitment of time and resources. Although conducting a quantitative uncertainty analysis is beyond the scope of this risk assessment, it does focus on two point estimates (MLE and RME) rather than one, in an effort to define a range of reasonable risks.

Uncertainties Related to Toxicity Information

Although EPA provides toxicity values that are point estimates, a significant amount of uncertainty may surround these point estimates. Identification of the sources of this uncertainty enables the risk assessor to establish the degree of confidence associated with the toxicity measures.

Uncertainty is inherent within the toxicity assessment and is primarily due to differences in study design, species, sex, routes of exposure, or dose-response relationships. A major source of uncertainty involves using toxicity values based on experimental studies that substantially differ from typical human exposure scenarios. The derivation of the toxicity values must take into account such differences as 1) using dose-response information from animal studies to predict effects in humans, 2) using dose-response information from high-dose studies to predict adverse health effects from low doses, 3) using data from short-term studies to predict chronic effects, and 4) extrapolating from specific populations to general populations.

The cancer slope factors in particular are based on studies that may differ greatly from realistic situations. Experimental cancer bioassays typically expose animals to very high levels of chemicals (i.e., the maximum tolerated dose) for their entire lifetime. After the appropriate studies have been identified, the slope factor is calculated as the upper 95th percent confidence limit of the slope of the dose-response curve. This introduces conservatism into the risk assessment.

The derivation of reference doses generally involves the use of animal studies. Uncertainty factors ranging from 1 to 10,000 are incorporated into the reference dose to provide an extra level of public health protection. The factors used depend on the type of study from which the value has been derived (e.g., animal or human, chronic or acute). The scientific basis for this practice is somewhat uncertain. In general, high uncertainty factors are meant to bias the results conservatively so that the reference dose will not result in adverse health effects.

Oral toxicity values have been used to evaluate dermal exposures, since dermal toxicity values are unavailable. In the absence of estimates of gastrointestinal absorption, this approach is recommended by EPA (1992a). This introduces uncertainty because risks associated with dermal contact effects cannot be estimated using oral toxicity data. Since research on this topic is limited, it is difficult to predict the bias of the uncertainty. Further uncertainty is introduced by the fact that dermal dose estimates are actually measuring absorbed dose versus the administered dose for the oral pathway.

There are many chemicals for which no toxicity value exists and for which little information is available. Therefore, a quantitative risk estimate cannot be calculated for these chemicals. For example, many chemicals are not evaluated for the inhalation pathway because of limited inhalation-based toxicological information.

Cancer and noncancer risks are summed in the risk characterization process (separately for carcinogens and noncarcinogens) to estimate potential risks associated with the simultaneous exposure to multiple chemicals. In the case of carcinogens, this gives carcinogens with a class B or class C weight-of-evidence the same weight as carcinogens with a class A weight-of-evidence. It also equally weights slope factors derived from animal data with those derived from human data. Uncertainties in the combined risks are also compounded because RfDs and cancer slope factors do not have equal accuracy or levels of confidence and are not based on the same severity of effect.

Toxicity values are not available for all of the carcinogenic PAHs. However, values have been assigned to several carcinogenic PAHs based upon toxicity equivalence factors (which relate the carcinogenicity of each PAH to the carcinogenicity of benzo(a)pyrene). This approach, although currently under review by EPA, is based on scientific studies, and is thought to be more realistic than the alternative method of assuming that all carcinogenic PAHs have a potency factor equal to that of benzo(a)pyrene.

As shown in Table 5-3, arsenic is a Class A human carcinogen, which is the most certain carcinogen classification. The oral unit risk (and resulting cancer slope factor) was based on studies of human *dermal* cancers occurring in populations *ingesting* drinking water with high levels of arsenic. EPA recommends that risk managers recognize the large uncertainties associated with the cancer slope factor for arsenic. This is reflected in the following quote:

> . . . in reaching risk management decisions in a specific situation, risk managers must recognize and consider the quantities and uncertainties of risk estimates. The uncertainties associated with ingested inorganic arsenic are such that estimates could be modified *downwards* as much as an order of magnitude, relative to risk estimates associated with most other carcinogens. (EPA 1993)

Uncertainties in Risk Characterization

Uncertainties in any phase of the risk analysis are reflected in the risk estimates. Some uncertainty is associated with the summation of risks and HQs for multiple chemical contaminants. As stated in RAGS (EPA 1992e), "The assumption of dose additivity ignores possible synergisms or antagonisms among chemicals, and assumes similarity in mechanisms of action and metabolism." However, summing risks and HQs for multiple substances in this risk assessment provides a conservative estimate.

Table 5-10 summarizes the principal sources of uncertainty in the baseline human health risk assessment. In keeping with EPA guidance (EPA 1989a), the table is a qualitative (order of magnitude) assessment incorporating simple relative influences of principal sources of uncertainty on the overall results of risk assessment.

Groundwater Risk Uncertainty

The following discussion focuses on the potential uncertainties associated with using monitoring well data to represent a hypothetical drinking water supply well. Risk estimates for the groundwater pathway focus primarily on the chemical levels reported for unfiltered groundwater samples. Additional filtered groundwater sample data are also available for the sites under investigation.

Comparison of unfiltered and filtered groundwater samples provides information regarding whether chemical contaminants are present in dissolved form or as suspended (and filterable) particulates. The concern in this comparison centers on the understanding that in a monitoring well that is only occasionally purged and sampled, the particulate levels may be somewhat greater than if the well were frequently pumped (as would be the case for a residential drinking water supply well). The demand for water and the concurrent pumping action would serve to develop the well to a greater extent than a monitoring well, thus lowering particulate levels.

Note that the primary focus of the risk analysis is based on unfiltered samples, since a hypothetical drinking water supply well may or may not be filtered. Rather, the comparison of

Table 5-10. Qualitative uncertainty estimates
178th Tactical Fighter Group, Springfield ANGB, Springfield, Ohio

Assumptions	Effect on risk estimates		
	Potential for overestimating risk	Potential for underestimating risk	Potential for over or underestimating risk
Environmental sampling/analysis			
Sufficient number of samples obtained			M
Precision and accuracy of chemical analysis		L	
Statistical analysis			M
Exposure assumptions			
Likelihood of exposure scenarios occurring	M		
Contact, uptake, and absorption rates are representative of exposed populations	L to M		
Assumption that chemicals do not transform or degrade over time	L		
Toxicity assessment			
Use of EPA-verified cancer slope factor for arsenic	M		
Use of EPA-verified RfDs and cancer slope factors (besides arsenic)			M
Quantitative evaluation not performed for chemicals having no EPA-verified toxicity values		M	
Dermal exposure risks are estimated using oral RfDs			M
Use of equivalency factor for PAHs	L		
Risk characterization			
Likelihood that receptors under evaluation are actually at risk	M		
Assumption of additivity of toxic effects			M

L = Low
M = Medium

unfiltered versus filtered results provides an indication that the chemicals are adsorbed to particulates (not dissolved) and may thus overrepresent the exposures expected in a more realistic drinking water scenario. In overrepresenting exposures, the bias in the uncertainty will contribute to overestimation of risk. Although the magnitude of the uncertainty is not precisely stated, it is largely related to the magnitude of the difference in the unfiltered and filtered chemical concentrations. In cases where this difference is large, the uncertainty surrounding this issue will be reflected in the risk estimates as a correspondingly large bias toward overestimation.

5.6 SUMMARY AND CONCLUSIONS

The human health baseline risk assessment for Springfield ANGB has been conducted at Sites 2 (Fire Training Area No. 2), 3 (Leach Field), and 5 (Ramp Drainage Ditch). The risk assessment is intended to evaluate risks to human health and to support the determination of the need for site remediation. The assessment examines the potential for adverse noncarcinogenic and carcinogenic effects following long-term exposure to site-related contaminants.

Both current and future land use have been considered in the risk assessment. Under current land use, soil exposures to Base personnel and construction workers have been evaluated. Under future land use, soil, groundwater, and air exposures to resident adults and children have been evaluated. The results of the baseline risk assessment may be summarized as follows:

- Sites 2, 3, and 5 at Springfield ANGB are located within Zone I-1 (heavy industry). Based upon this fact and the proximity of the Base to the Springfield-Beckley Municipal Airport, it is unlikely that future land use will involve residential or other exposures to the general public.
- Currently, groundwater from the shallow aquifer is not being used as a source of drinking water. In the future, it is unlikely that this groundwater will be used for drinking water due to the low productivity of the shallow aquifer.
- Under current land use, all health risks fall within or below EPA targets.
- Under future residential land use, health risks above EPA targets exist for both children and adults due to the presence of chemical carcinogens in soils at Site 5, and due to the presence of chemicals (carcinogens and noncarcinogens) in *unfiltered* groundwater at Sites 2 and 3 (groundwater samples were not collected at Site 5). All other risks under future land use were below or within EPA targets.

- At Site 2, risks from exposure to *filtered* groundwater fell below or within EPA targets. At Site 3, dissolved metals were not detected in filtered groundwater.
- Health effects related to lead exposures for children are above the EPA target at Sites 2 and 3, and below the EPA target at Site 5. The higher concentrations of lead in unfiltered groundwater, as opposed to the concentrations in soils, are primarily responsible for blood lead levels above the target. Note that lead was not detected in filtered groundwater samples at Sites 2 and 3. If site-specific soil concentrations were used along with default drinking water concentrations, blood lead levels in children would not exceed the EPA target.
- A tolerance interval approach was used to statistically compare soil concentrations of pertinent chemicals (those with hazard quotients greater than one and cancer risks greater than 1×10^{-6}) with background data. The results of this analysis indicate that PAHs exceed background levels at Sites 2, 3, and 5, appearing to be site related. In addition, the levels of inorganics detected in Site 2 groundwater may be site related.
- As an additional comparison against background, risk assessment was conducted using background concentrations. Both site and background soil risks were below EPA targets, except for PAHs at Site 5. For groundwater, noncancer and cancer risks were above EPA targets for both site and background. This is predominantly due to arsenic and beryllium.

It is important to recognize the uncertainty inherent in the risk assessment process. The results have been presented as ranges, which are better indicators of the distributions of potential outcomes than are single point estimates. Such distributions reflect the range of possible values of component variables (e.g., the range of values for exposure factors and toxicity factors). As conducted, the baseline risk assessment yields average and upper-bound estimates of the potential for adverse health effects. Given the conservative approach to the risk assessment, it is very unlikely that the potential risks to human health have been underestimated.

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6. SUMMARY OF CONCLUSIONS AND RECOMMENDATIONS

A site investigation (SI) has been conducted under the U.S. Department of Defense (DOD) Installation Restoration Program (IRP) at Springfield Air National Guard Base (ANGB). The objectives of the SI were to:

- Determine the chemical nature and magnitude of identified chemical contaminants
- Evaluate the potential for contaminant release and migration
- Compare site-related contaminant concentrations with applicable or relevant and appropriate requirements (ARARs) and conduct a human health risk assessment
- Prepare recommendations for broader investigative activities (RIs) to determine the magnitude and extent of contamination, if necessary
- Evaluate the need for immediate response actions
- Support no further action decisions and the completion of decision documents.

The five sites that were investigated are:

- Site 1 - Fire Training Area No. 1 (FTA-1)
- Site 2 - Fire Training Area No. 2 (FTA-2)
- Site 3 - Leach Field (LCH-3)
- Site 4 - POL Area (POL)
- Site 5 - Ramp Drainage Ditch (RDD).

Site 6 - Mess Hall Underground Storage Tank Oil Spill (MHUST) was identified during the preliminary assessment (PA), but was not investigated under this program. Research into the Mess Hall UST spill revealed that there was such a small amount of oil spilled (less than 10 gallons) that no field sampling was considered necessary. The only planned activity is to develop a decision document to eliminate this site from further investigation under the IRP.

6.1 SUMMARY AND CONCLUSIONS

Field investigation and data analysis activities were conducted at the five sites at Springfield ANGB to meet the objectives of the SI. Data collection activities included aerial photograph review, soil organic vapor (SOV) surveys, onsite gas chromatography (GC) screening, drilling and sampling of soil borings, installing piezometers, installing and sampling groundwater monitoring wells, surface soil and sediment sampling, and aquifer testing. Data analysis activities included geologic and hydrogeologic data evaluation, chemical data analyses, validation and evaluation, and a baseline human health risk assessment on Sites 2, 3, and 5. All aspects of the program from planning through the evaluation and assessment phases were conducted under a stringent quality assurance/quality control (QA/QC) program.

6.1.1 Geology and Hydrogeology

Soils encountered during SI activities were unconsolidated glacial sediments predominantly composed of silts and clays. Bedrock was not encountered during drilling; however, the Niagaran Limestone formation is reportedly at about 40 feet below land surface (BLS). Partially confining strata was encountered throughout the Base just above the shallow aquifer with the exception of Site 4, which had saturated conditions above the confining strata.

Groundwater was encountered in the glacial sediments at each site. Groundwater flow direction was determined to be north-northeast to northeast across the Base with hydraulic conductivities in the aquifer material varying from 10^{-2} to 10^{-5} cm/sec. Permeability of the confining strata was determined to be about 10^{-8} cm/sec.

6.1.2 Quality Assurance/Quality Control (QA/QC)

A detailed QA/QC program was instituted throughout the SI program to ensure that collected samples were representative of the sites under investigation and that analytical procedures adequately describe the characteristics and concentrations of compounds in the samples. A review of these procedures and the control data indicate that the data quality objectives (DQOs) for precision, accuracy, representativeness, comparability, and completeness (PARCC) have been met. Instances were identified where circumstances were beyond the control of field personnel or where compounds were found within the field or laboratory blank samples. These instances are attributable to the sample collection activities, decontamination procedures, transport, storage, and/or analysis. These compounds are not indicative of site-related contamination, and their presence does not adversely affect the usefulness of the environmental data.

6.1.3 Site 1 - Fire Training Area No. 1 Summary of Results and Conclusions

The location of FTA-1 was identified through the review of aerial photographs, conducting interviews with Base personnel, and conducting an SOV survey. Results of these activities were used to locate three soil borings. The borings were located and sampled within the area accurately identified as the burn pit. Sampling and analysis indicated that total petroleum hydrocarbons (TPH), toluene, and semivolatile organic compounds (SVOCs) were detected in the soils. This sampling is considered to represent the area of potentially highest concentrations of contamination. Although detected, the soil contaminants concentrations were generally consistent with background levels and did not exceed regulatory criteria. Because of the lack of contamination above background criteria, the soils are not considered to be a source of contamination at Site 1 - FTA-1.

The tentatively identified compounds (TICs) in the soils were primarily unknown compounds; however, the TIC that comprised the largest concentrations was an aldol condensation product, which is an artifact of the analytical procedure and not the environment. It is suspected that several of the other unknown SVOC TICs also are analytical artifacts. This further supports the conclusion that the identified contaminants are not adversely impacting the environment.

Using the groundwater elevations and flow directions measured from the piezometers, a monitoring well was installed downgradient from the site, but within a radius that would detect contamination migrating in groundwater. TPH, VOCs, or SVOCs were not detected in groundwater samples. The metals detected in the groundwater were within background concentrations. In one groundwater sample, nickel slightly exceeded its ARAR. Lead also exceeded its ARAR; however, EPA's biokinetic uptake model for lead was used to determine that lead concentrations in groundwater do not pose a risk to residential children. Therefore, the groundwater at Site 1 is not considered to be problematic.

6.1.4 *Site 2 - Fire Training Area No. 2 Summary of Results and Conclusions*

Aerial photographs, interviews with Base personnel, and a SOV survey were used to locate five soil borings within the burn pit of Fire Training Area No. 2. Data collected during the field investigation indicated that fuel-related compounds, including TPH and PAHs, were present in the soil throughout the sampled interval. Although benzene, toluene, ethylbenzene, and xylene (BTEX) compounds were present in the upper 9.5 feet of soil, TPH are the only compound that exceeded the Ohio Division of State Fire Marshall action levels. Petroleum hydrocarbons are present below 9.5 feet, but at lower concentrations and tend to diminish with depth until reaching the dense clay layer approximately 25 feet below land surface (BLS). Slightly greater concentrations of petroleum hydrocarbons and PAHs at this level are interpreted as an accumulation of contaminants above the dense clay. Although contaminants have migrated between 9.5 feet and the water table, the relatively slow permeability (10^{-8} cm/sec) of the silts and clays underlying the site have restricted the vertical migration.

Site history, aerial photograph review, SOV survey, piezometers, and onsite soil screening results were used to locate two groundwater monitoring wells downgradient from the Site 2 burn pit. Sampling and analysis of these monitoring wells showed that the groundwater beneath the site is not a pathway for contaminant migration. The only compounds detected were metals and trace amounts of diesel fuel in the unfiltered samples. These results are not considered representative of the groundwater quality because of the very fine material in the saturated interval. Instead, the results are a measure of the contaminant concentrations of the fine particles in suspension. Analysis of filtered groundwater indicated no organic compounds present and inorganic compounds within ranges measured in the background wells.

Analysis of samples collected from the drainage ditch indicate the TPH and SVOC values in sediments may be the result of nonsite-related contamination. The concentrations of contaminants did not show a trend that would indicate Site 2 to be the source. Sources of this contamination may include the paved access road north of the site, a trash burning area southwest of FTA-2, or runoff from the runway east of the site. None of the detected contaminants exceeded any established regulatory criteria and are considered typical of drainage in an industrial area.

To further determine the potential for adverse impacts from the detected contaminants, all compounds detected were evaluated by conducting a human health risk assessment. Conclusions of the risk assessment are summarized in Section 6.2.

6.1.5 Site 3 - Leach Field Summary of Results and Conclusions

Site 3 - Leach Field was located using a scaled engineering drawing of the leach field, aerial photographs, and conducting an SOV survey, which indicated the areas of maximum potential contamination. Five soil borings were located within the leach field at the points of maximum SOV concentrations. One monitoring well was located downgradient from the site, but close enough to ensure that samples from the well would detect contaminant migration.

Soil contaminants (i.e., TPH, VOCs, and SVOCs) detected at Site 3 were shown to be limited to the upper 12 feet of soil. Contaminant distribution indicates a potential for two zones or sources of contamination. The upper 2 to 3 feet shows SVOC and SVOC TIC contamination. Since this material was placed after use of the leach field had stopped, these contaminants are not considered to be site related. The concentrations of these contaminants are not greater than levels of concern, and therefore, are not adversely impacting the environment. Contaminants detected between 6 and 10 feet BLS (i.e., TPH, acetone, xylenes, toluene, and VOC TICs) are related to activities associated with the leach field. The highest concentrations of these compounds were detected in samples collected from the gravel filter bed. Petroleum hydrocarbons were detected within the soil interval associated with the leach field filter bed (approximately 6 to 9 feet BLS) at concentrations that exceed regulatory criteria.

Analysis of unfiltered groundwater detected arsenic, beryllium, chromium, lead, and nickel above Federal and/or Ohio maximum contaminant levels (MCLs). These concentrations are considered to be associated with solids suspended in groundwater and are not appropriate for comparison to drinking water ARARs. Groundwater analyses for dissolved inorganic compounds did not detect contaminants. No VOCs, VOC TICs, or SVOCs were detected in groundwater samples.

All detected chemicals were evaluated by conducting a human health risk assessment to further evaluate the potential impact of Site 3. The conclusions of the baseline risk assessment are summarized in Section 6.2.

6.1.6 Site 4 - POL Storage Area Summary of Results and Conclusions

The analytical results obtained from the SI conducted at Site 4 show the presence of TPH in the soils; however, all concentrations were less than the regulatory criteria. The soil TPH contamination appears to be concentrated in one area and confined by fine-grained sediments. The VOC and SVOC TICs identified in soil at the site are petroleum related, but also are limited aerially. No metals were detected above background levels in the soils. No other petroleum-related contamination is present in the soils or groundwater at this site. It was not considered necessary to perform a baseline risk assessment for Site 4 - POL Storage Area because the contamination associated with the reported fuel spill was determined to be less than levels of concern and limited to a small localized area. However, two chlorinated hydrocarbons (i.e., trichloroethene and 1,2-dichloroethene) were detected in soil and groundwater.

Trichloroethene (TCE) was detected in one soil sample collected from Site 4 at a concentration of 9 μg/kg. The groundwater at Site 4 contains concentrations of 1,2-dichloroethene and TCE above the MCL for these compounds. Although an extensive research was conducted (i.e., ANG personnel interviews, standard operating procedures [SOPs] review, records reviews), the source of VOCs at Site 4 in the soils and groundwater are yet unknown.

6.1.7 Site 5 - Ramp Drainage Ditch Summary of Results and Conclusions

The SI activities conducted at Site 5 showed the presence of both heavy oil and diesel fuel TPH in the soils. This contamination is considered to be limited to the surface because organic compounds were not detected above background or regulatory levels deeper than 0.5 feet BLS. VOCs and SVOCs also were detected in the soils, but are not considered problematic due to the type and level of contamination identified. Metals, including copper, nickel, and zinc, were present at concentrations above the background levels. TPH, SVOCs, and metals were detected at elevated levels in all sediment samples analyzed and indicate that contamination is present in the sediments and has resulted from runoff from the aircraft parking area and adjacent roads. In summary, metals contamination of the soils and sediment contamination consisting of TPH, SVOCs, and metals are concerns at Site 5.

To further evaluate the potential impact of these contaminants, a baseline human health risk assessment was conducted for contaminants detected at Site 5. The conclusions of the risk assessment are presented in Section 6.2.

6.2 SUMMARY AND CONCLUSIONS OF THE BASELINE HUMAN HEALTH RISK ASSESSMENT

The human health baseline risk assessment for Springfield ANGB has been conducted at Site 2 - FTA-2, Site 3 - Leach Field, and Site 5 - Ramp Drainage Ditch. The risk assessment is intended to evaluate risks to human health and to support the determination of the need for site remediation. The assessment examines the potential for adverse noncarcinogenic and carcinogenic effects following long-term exposure to site-related contaminants.

Both current and future land use have been considered in the risk assessment. Under current land use, soil exposures to Base personnel and construction workers have been evaluated. Under future land use, soil and groundwater exposures to resident adults and children have been evaluated. Given the conservative approach to the risk assessment, it is very unlikely that the potential risks to human health have been underestimated.

The results of the baseline risk assessment may be summarized as follows:

- Sites 2, 3, and 5 at Springfield ANGB are located within Zone I-1 (heavy industry). Based upon this fact and the proximity of the Base to the Springfield-Beckley Municipal Airport, it is unlikely that future land use will ever involve residential or other exposures to the general public.
- Currently, groundwater from the shallow aquifer is not being used as a source of drinking water. In the future, it is very unlikely that this groundwater will be used for drinking water due to the low productivity of the shallow aquifer.
- Under current land use, all health risks fall within or below U.S. Environmental Protection Agency (EPA) targets.

- Under future residential land use, health risks above EPA targets exist for both children and adults due to the presence of chemical carcinogens in soils at Site 5, and due to the presence of chemicals (carcinogens and noncarcinogens) in *unfiltered* groundwater at Sites 2 and 3 (groundwater samples were not collected at Site 5). Groundwater at Site 5 is not expected to be adversely affected, since all contamination is limited to the upper 5 feet of the soil column. All other risks under future land use were below or within EPA targets.
- At Site 2, risks from exposure to *filtered* groundwater fell below or within EPA targets. At Site 3, dissolved metals were not detected in filtered groundwater.
- Health effects related to lead exposures for children are above the EPA target at Sites 2 and 3, and below the EPA target at Site 5. The higher concentrations of lead in unfiltered groundwater, as opposed to the concentrations in soils, are primarily responsible for blood lead levels above the target. Note that lead was not detected in filtered groundwater samples at Sites 2 and 3. If site-specific soil concentrations were used along with default drinking water concentrations, blood lead levels in children would not exceed the EPA target.
- A tolerance interval approach was used to statistically compare soil concentrations of pertinent chemicals (those with hazard quotients greater than one and cancer risks greater than 1×10^{-6}) with background data. The results of this analysis indicate that chemical concentrations detected at Site 3 are indistinguishable from background. At Sites 2 and 5, convincing statistical evidence exists that PAHs exceed background levels, appearing to be site related.

6.3 RECOMMENDATIONS

It is recommended that no further investigation, removal action, or remediation activities be conducted on the soils or groundwater at Site 1. This recommendation is based on the accurate location of the site and the determination that no site-related contamination exists.

Further action is recommended at Site 2 prior to use of the site for other than the current fire training activities. Soil containing contaminants at greater than regulatory criteria within the upper 9.5 feet should be evaluated for removal or remediation. Additional periodic groundwater sampling will confirm that contaminants are not migrating to groundwater from the burn pit area. No further action is recommended for sediments located at Site 2. This is based on the assessment that contaminants detected are not site related and that transport of sediment contaminants by surface water is sporadic and does not represent a complete exposure pathway.

No further action is recommended at Site 3 based on current use of the site. Petroleum hydrocarbon concentrations that exceed regulatory criteria are confined to the former leach field filter bed from approximately 6 to 9 feet BLS and have not migrated significantly since operations ceased in 1980. If future uses involve construction and excavation at the site, the former leach field filter bed material should be disposed of in accordance with regulatory guidelines.

No site-related actions are recommended for Site 4 because the absence of site-related contamination was confirmed. It is recommended that further action be taken to identify the source and extent of VOCs detected in groundwater and soil upslope from the spill area at Site 4.

Remediation of surface soils and sediment at Site 5 is not recommended under its current use. Future uses are also likely to be heavy industrial because the area is zoned I-1. If removal is necessary due to rezoning to residential, the vertical extent of contamination should be more precisely identified (between 0.5 and 5 feet BLS) to optimize remediation.

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