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FINAL REMEDIAL INVESTIGATION AT OPERABLE UNIT 7 (OU 7) SITE 16 VOLUME 1 OF 2 CHAPTERS 1 THROUGH 7 AND APPENDICES A THROUGH E NAS CECIL FIELD FL
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REMEDIAL INVESTIGATION
OPERABLE UNIT 7

NAVAL AIR STATION CECIL FIELD
JACKSONVILLE, FLORIDA

VOLUME I: CHAPTER 1.0 THROUGH 7.0
APPENDIX A THROUGH E

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REMEDIAL INVESTIGATION
OPERABLE UNIT 7

NAVAL AIR STATION CECIL FIELD
JACKSONVILLE, FLORIDA

Unit Identification Code No. N60200

Contract No. N62467-89-D-0317/090

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July 1995

This document that describes the Remedial Investigation of Operable Unit 7, Naval Air Station Cecil Field, Jacksonville, Florida, has been prepared under the direction of a Florida-Registered Professional Geologist. The work and professional opinions rendered in this report were conducted or developed in accordance with commonly accepted procedures consistent with applicable standards of practice.

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Date: 7-31-95

CERTIFICATION OF TECHNICAL
DATA CONFORMITY (MAY 1987)

The Contractor, ABB Environmental Services, Inc., hereby certifies that, to the best of its knowledge and belief, the technical data delivered herewith under Contract No. N62467-89-D-0317/090 are complete and accurate and comply with all requirements of this contract.

Date: July 19, 1995

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FOREWORD

The Department of the Navy developed the Installation Restoration (IR) program to locate, identify, and remediate environmental contamination from the past disposal of hazardous materials at Navy and Marine Corps installations. The Navy IR program follows the Department of Defense Environmental Restoration Program mandated by the Superfund Amendments and Reauthorization Act of 1986 to address waste sites that may pose a threat to human health or the environment.

The IR program consists of Preliminary Assessment and Site Inspection, Remedial Investigation and Feasibility Study (RI/FS), and Remedial Design and Remedial Action at sites where chemicals were possibly disposed. The Preliminary Assessment and Site Inspection identifies the presence of pollutants. The RI/FS analyzes the nature and extent of contamination and determines the optimum remedial solution. The Remedial Design and Remedial Action complete the implementation of the solution.

Previous investigations have determined that Naval Air Station (NAS) Cecil Field has 18 waste sites that may pose a threat to human health or the environment. Therefore, an RI/FS will be performed to address the extent, magnitude, and impact of possible contamination at these waste sites.

This Remedial Investigation report for Operable Unit 7 summarizes the field program completed at Site 16 and presents the findings and conclusions reached during the investigation.

Questions regarding this report should be addressed to the Commanding Officer, Code OOB, P.O. Box 111, NAS Cecil Field, Jacksonville, Florida 32215-0111.

EXECUTIVE SUMMARY

ABB Environmental Services, Inc., has been contracted by the Southern Division, Naval Facilities Engineering Command to complete a Remedial Investigation (RI) and Feasibility Study (FS) for the Aircraft Intermediate Maintenance Department (AIMD) seepage pit, holding tank, and affected area at Naval Air Station (NAS) Cecil Field. NAS Cecil Field is located in western Duval County, Florida, approximately 14 miles west of Jacksonville, Florida. The objectives of the RI (initiated in 1992) were (1) to characterize the nature and extent of contamination associated with Operable Unit (OU) 7 and (2) to gather sufficient data to complete the Baseline Risk Assessment (BRA) and FS of remedial alternatives. This document contains only the RI; the BRA and the FS have been completed under separate cover. A summary of the BRA is provided in Chapter 6.0.

The AIMD seepage pit, holding tank, and affected area have been designated as Site 16, OU 7. The seepage pit and holding tank are located west of the north-south jet runways and 60 feet north of Building 313. From 1959 until 1980, greases, rusts, scale, solvents, and paint wastes generated during a machine and engine parts cleaning process, along with glass beads and blasting grit from the airframes blasting shop, were disposed at OU 7. Liquid waste generated from operations conducted within Building 313 were pumped from a sump to the holding tank, which acted as a surge tank for the adjacent seepage pit. The construction of the seepage pit allowed for seepage of wastes directly into the subsurface soil and groundwater.

Accumulated glass beads and blasting grit caused the system to malfunction. In the late 1960's, a 4-inch vitrified clay discharge pipe was installed in the seepage pit to allow drainage to the NAS Cecil Field storm sewer system. This stormwater drainage system eventually discharges to a series of drainage ditches (approximately 2,800 feet east of the seepage pit) that flow into Sal Taylor Creek (approximately 5,000 feet east of the seepage pit).

Use of the seepage pit was discontinued in 1980. From 1980 until 1989 the holding tank was used for 90-day storage of hazardous waste. In 1989, piping leading from the building to a bead separator (operated from 1982 until 1989) and from the building to the 4,000-gallon holding tank was disconnected and plugged from within the building. In addition, all liquids in the holding tank were pumped out and transported to an offsite treatment, storage, and disposal (TSD) facility for treatment.

In March 1994, the holding tank, seepage pit, and glass bead separator were excavated during an Interim Remedial Action (IRA) and removed from the site on May 17, 1994. Soil contaminated with trichloroethene (TCE) at concentrations above the action level of 1 milligram per kilogram (mg/kg) was excavated to the top of the water table and disposed offsite at a hazardous waste landfill. The area was backfilled with clean fill and restored to original grade (ABB-ES, 1994).

Because the invert of the former seepage pit was below the water table, contaminants were discharged directly to the groundwater creating a mound that spread the contaminants radially in the soil and groundwater. With the exception of TCE and cobalt, none of these contaminants was observed to have migrated from the source area in the 35 years since the discharge to the seepage pit began.

The highest groundwater concentrations of TCE were detected in a temporary groundwater sampling probe (an Aquaprobe™) at the source area. The highest of these detections was 1,500,000 micrograms per liter ($\mu g/\ell$) in the 28 to 32 feet below land surface (bls) interval. Based on the USEPA Batch Model it is estimated to take approximately 20 years for the natural flow of groundwater to reduce the TCE concentration at this location to 5 $\mu g/\ell$.

The leading edge of the TCE contaminated groundwater plume has migrated approximately 1,000 feet downgradient of the source in the 35 years since the discharge to the seepage pit began, roughly 300 feet farther than would be expected based on the estimated groundwater seepage velocity of 21 feet per year. This observation is interpreted to be the result of longitudinal dispersion. The projected path of the TCE plume is to the southeast, ultimately discharging into a drainage ditch and wetlands (in approximately 105 years) that are, in turn, drained by Sal Taylor Creek. A storm sewer draining a part of the industrial area south of OU 7, including the area west of Building 313, crosses the migrating plume and may represent a preferential pathway for a part of the plume.

A BRA was completed at OU 7 to characterize the risks associated with exposures to site-related contaminants for human health and ecological receptors (ABB-ES, 1995a).

The only human health risk identified was an incremental lifetime cancer risk of 3 in 1,000 and a non-cancer risk (Hazard Index [HI]) of 50, based on the assumption that a potable water supply well may be installed in the contaminant plume. The major contaminant contributing cancer risk is 1,1-dichloroethene, a breakdown product of TCE. Major contributors to the HI are 1,2-dichloroethene, 1,1-dichloroethene, TCE, antimony, and thallium.

Assays conducted in the drainage ditches indicated reduced macroinvertebrate communities, possibly the result of total recoverable petroleum hydrocarbons (TRPH) not associated with OU 7. Terrestrial wildlife exposed to surface water and sediment in the drainage ditches were assessed and no risks were identified. However, risks associated with exposures to bis(2-ethylhexyl)phthalate, aluminum, iron, and zinc are possible for aquatic receptors if groundwater discharges to the wetlands with the maximum contaminant concentrations currently observed.

Conclusions regarding the physical characteristics of the OU 7 study area and the contaminants detected in surface water, sediment, surface soil, subsurface soil, and groundwater include the following.

- Sufficient information was collected in the field or compiled from historical records to identify and assess human and ecological risks, extent and nature of contamination, and remedial alternatives.

- Contaminant distribution from the seepage pit is well defined in surface and subsurface soil at OU 7 and contaminants do not pose a risk to human or ecological receptors.

- Wastes disposed in the former seepage pit have contaminated underlying groundwater at OU 7 sufficiently to pose a health risk if groundwater is used as a future drinking water supply.

- There are no unacceptable human health risks associated with the drainage ditch surface water or sediment.

- OU 7 is located in a highly industrialized area and is expected to remain industrialized after base closure. The site is served by potable water and utilities.

- Assuming the maximum concentrations detected in groundwater are unaffected by dispersion and other processes, risks are possible for aquatic receptors as groundwater migrates and discharges to the wetlands east of the runways. No such risks are estimated for discharge to Sal Taylor Creek.

- Measured risks to certain types of macroinvertebrates in the drainage ditches east of the runways are interpreted to be related to the TRPH (from sources other than OU 7) in the sediment.

- Based on assumptions that did not consider contaminant degradation on losses along the flowpath from the seepage pit to the wetlands, contaminated groundwater is estimated to begin discharging in about 105 years and may reach a maximum TCE concentration of 730 $\mu g/\ell$ in approximately 195 years (assuming a continuing source).

- Contaminants detected in the shallow soil (0 to 2 feet bls) are interpreted to be related to surface activity rather than the former underground waste disposal operations.

- Several risk-related groundwater contaminants are not believed to be associated with the source area at OU 7 because they appear to enter the OU 7 area from the underlying intermediate aquifer or in a deeper part of the surficial aquifer. These contaminants include: bis(2-ethylhexyl)-phthalate, antimony, and zinc.

Based on the evaluation of data gathered during the OU 7 RI, the following data limitations were identified.

- Contaminants in surface water and sediment in the drainage ditches east of the north to south runways may not all be attributable to OU 7 operations and existing soil and groundwater contamination in the source area. Based on the nature of the contaminants (i.e., petroleum-related contaminants and inorganics) several other industrial activities (i.e., former and current runway and hangar operations) appear to be the major contaminant contributors (e.g., TRPH) to ecological risks identified in surface water and sediment.

Based on the evaluation of data gathered during the OU 7 RI, the following data gaps were identified.

- Extent and magnitude of contaminated groundwater entering the storm sewer, if any, have not been quantified.

- The distribution of TCE in vadose and phreatic soil on the west side of Building 313 is not fully defined.

None of these data gaps prevented the development and selection of a remedial action for OU 7.

Based on the evaluation of data gathered during the OU 7 RI, the following recommendations are presented.

- Assuming use of the surficial aquifer as a potable water source, a program should be instituted to prevent risks associated with OU 7 contaminants identified in the groundwater.

- An investigation of the storm sewer network should be conducted to identify sources of contamination present in the drainage ditches that discharge to Sal Taylor Creek.

- An assessment of contamination in soil and groundwater west of Building 313 should be included as part of any subsequent remedial activity.

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GLOSSARY

ABB-ES	ABB Environmental Services, Inc.
AIMD	Aircraft Intermediate Maintenance Department
AQUIRE	Aquatic Information Retrieval
ASTM	American Society for Testing and Materials
AWQC	Ambient Water Quality Criteria
bls	below land surface
BRA	Baseline Risk Assessment
BRAC	Base Realignment and Closure
CDM	Camp, Dresser, and McKee
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
cis-DCE	cis-1,2-dichloroethene
CLP	Contract Laboratory Program
COD	chemical oxygen demand
CPCs	chemicals of potential concern
CRDL	contract required detection limit
CSF	cancer slope factor
DDD	dichlorodiphenyldichloroethane
DDE	dichlorodiphenyldichloroethene
DDT	dichlorodiphenyltrichloroethane
DERP	Defense Environmental Restoration Program
DNAPL	dense nonaqueous phase liquids
°F	degrees Fahrenheit
1,1-DCA	1,1-dichloroethane
1,1-DCE	1,1-dichloroethene
1,2-DCE	1,2-dichloroethene
EA	EA Engineering, Science, and Technology
EBS	Environmental Baseline Survey
ECD	electron capture detectors
ECPC	ecological chemicals of potential concern
ELCR	excess lifetime cancer risk
EM	electromagnetic
ER-L	Effects Range-Low
ER_M	Effects Range-Medium
ERA	Ecological Risk Assessment
FAC	Florida Administrative Code
FDEP	Florida Department of Environmental Protection
FDER	Florida Department of Environmental Regulation
FFA	Federal Facility Agreement
FFS	Focused Feasibility Study
FID	flame ionization detector
FS	Feasibility Study
ft/day	feet per day
ft/ft	feet per foot
ft/yr	feet per year

ft^2	square feet
ft^3	cubic feet
ft^3/day	cubic feet per day
ft^2/day	square feet per day
ft^3/sec	cubic feet per second
GC	gas chromatograph
gpm	gallons per minute
GPR	ground penetrating radar
GPS	global positioning system
HHCPC	human health chemical of potential concern
HHRA	human health risk assessment
HI	hazard index
HQ	hazard quotient
HSA	hollow stem auger
IAS	Initial Assessment Study
IR	Installation Restoration
IRA	Interim Remedial Action
IROD	Interim Record of Decision
IZS	intermediate zone of the surficial system
K	hydraulic conductivity
LZS	lower zone of the surficial system
MAG	magnetometer
MCL	maximum contaminant level
MEK	methyl ethyl ketone
mg/kg	milligrams per kilogram
mg/kg-day	milligrams per kilogram per day
mg/ℓ	milligrams per liter
MR	mud-rotary
msl	mean sea level
μg/kg	micrograms per kilogram
μg/ℓ	micrograms per liter
NA	not applicable
NACIP	Naval Assessment and Control of Installation Pollutants
NAPL	nonaqueous phase liquids
NAS	Naval Air Station
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
ND	not detected
NDI	Non-Destructive Inspection
NE	northeast
NEESA	Naval Energy and Environmental Support Activity
NFD	Naval Fuel Depot
NGVD	National Geodetic Vertical Datum of 1929
NOAA	National Oceanic and Atmospheric Administration
NPL	National Priority List

NS	not searched
NSF	National Sanitation Foundation
NTU	Nephelometric Turbidity Units
NW	northwest
ODEX	reverse circulation
OLF	Outlying Landing Field
OU	Operable Unit
OVA	organic vapor analyzer
PARCC	precision, accuracy, representativeness, completeness, and comparability
PAH	polynuclear aromatic hydrocarbon
PCB	polychlorinated biphenyl
PCE	tetrachloroethene
PDE	potential dietary exposure
PID	photoionization detector
PSC	Potential Source of Contamination
PVC	polyvinyl chloride
RCRA	Resource Conservation and Recovery Act
RDL	reported detection limit
RfD	reference dose
RFI	RCRA Facility Investigation
RI	Remedial Investigation
RI/FS	Remedial Investigation and Feasibility Study
RTV	reference toxicity value
SAP	Sampling and Analysis Plan
SARA	Superfund Amendments and Reauthorization Act
SE	southeast
SOUTHNAV-FACENGCOM	Southern Division, Naval Facilities Engineering Command
SVOC	semivolatile organic compounds
SW	southwest
TAL	target analyte list
TCA	trichloroethane
TCE	trichloroethene
TCL	target compound list
TMSS	Technical Memorandum for Supplemental Sampling
TOC	total organic carbon
TOH	total organic halogen
TOX	toxicity
TPH	total petroleum hydrocarbon
TRPH	total recoverable petroleum hydrocarbon
TSD	treatment, storage, and disposal
USC	U.S. Code
USDA	U.S. Department of Agriculture
USEPA	U.S. Environmental Protection Agency

USFWS	U.S. Fish and Wildlife Services
USGS	U.S. Geological Survey
UZH	upper zone of the Hawthorn Group
UZS	upper zone of the surficial system
VFR	Visual Flight Rules
VOCs	volatile organic compounds
WSW	west to southwest
Zn	zinc

1.0 INTRODUCTION

ABB Environmental Services, Inc. (ABB-ES), has been contracted by the Department of the Navy, Southern Division, Naval Facilities Engineering Command (SOUTHNAVFACENGCOM), to conduct a Remedial Investigation and Feasibility Study (RI/FS) for Operable Unit (OU) 7 located at Naval Air Station (NAS) Cecil Field in Jacksonville, Florida (Figure 1-1). OU 7 (Figure 1-2) consists of Site 16, Aircraft Intermediate Maintenance Department (AIMD) seepage pit, associated structures (Figure 1-3) (but not including Building 313), and adjacent areas affected by these facilities. The RI/FS is being conducted under contract number N62467-89-D-0317/090. This report addresses the results and conclusions of the Remedial Investigation (RI), including a summary of the human health and ecological baseline risk assessment (Chapter 6.0). The Baseline Risk Assessment (BRA) is reported separately (ABB-ES, 1995a).

1.1 PURPOSE OF REPORT. This report documents the results of the RI field investigation addressing OU 7 at NAS Cecil Field. Information gathered during this RI and during previous studies has facilitated a comprehensive evaluation of both the physical characteristics and environmental contamination at OU 7. The physical and chemical database for OU 7 will be used to support the OU 7 BRA and FS (ABB-ES, 1995b). The BRA and FS for OU 7 are reported separately from this RI.

The goals of the RI/FS are to assess the extent, magnitude, and impact of contamination at OU 7, to qualitatively and quantitatively assess the current and possible future risks posed to human health and the environment, and to develop appropriate remedial actions if a threat to human health and/or the environment is anticipated based on assumed exposure to contaminants detected.

The objectives of the NAS Cecil Field RI/FS investigation at OU 7 include the following:

1. assess the nature and extent of contamination in site soil, groundwater, surface water, and sediment in the drainage ditches east of the runways;

2. gather sufficient information to complete the human health and ecological risk assessments; and

3. collect sufficient data to complete an FS of remedial alternatives.

The RI/FS is being performed in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980 and the Superfund Amendments and Reauthorization Act (SARA) of 1986, which established a series of programs for the cleanup of hazardous waste disposal and spill sites nationwide. One of those programs, the Defense Environmental Restoration Program (DERP), is codified in SARA Section 211 (10 U.S. Code [USC] 2701). The Navy's Installation Restoration (IR) program is a component of the DERP.

1.2 SITE BACKGROUND. The mission of NAS Cecil Field (the facility) and available background information for the facility and OU 7 are presented in this section. A general description of NAS Cecil Field is given in Subsection 1.2.1. Subsection

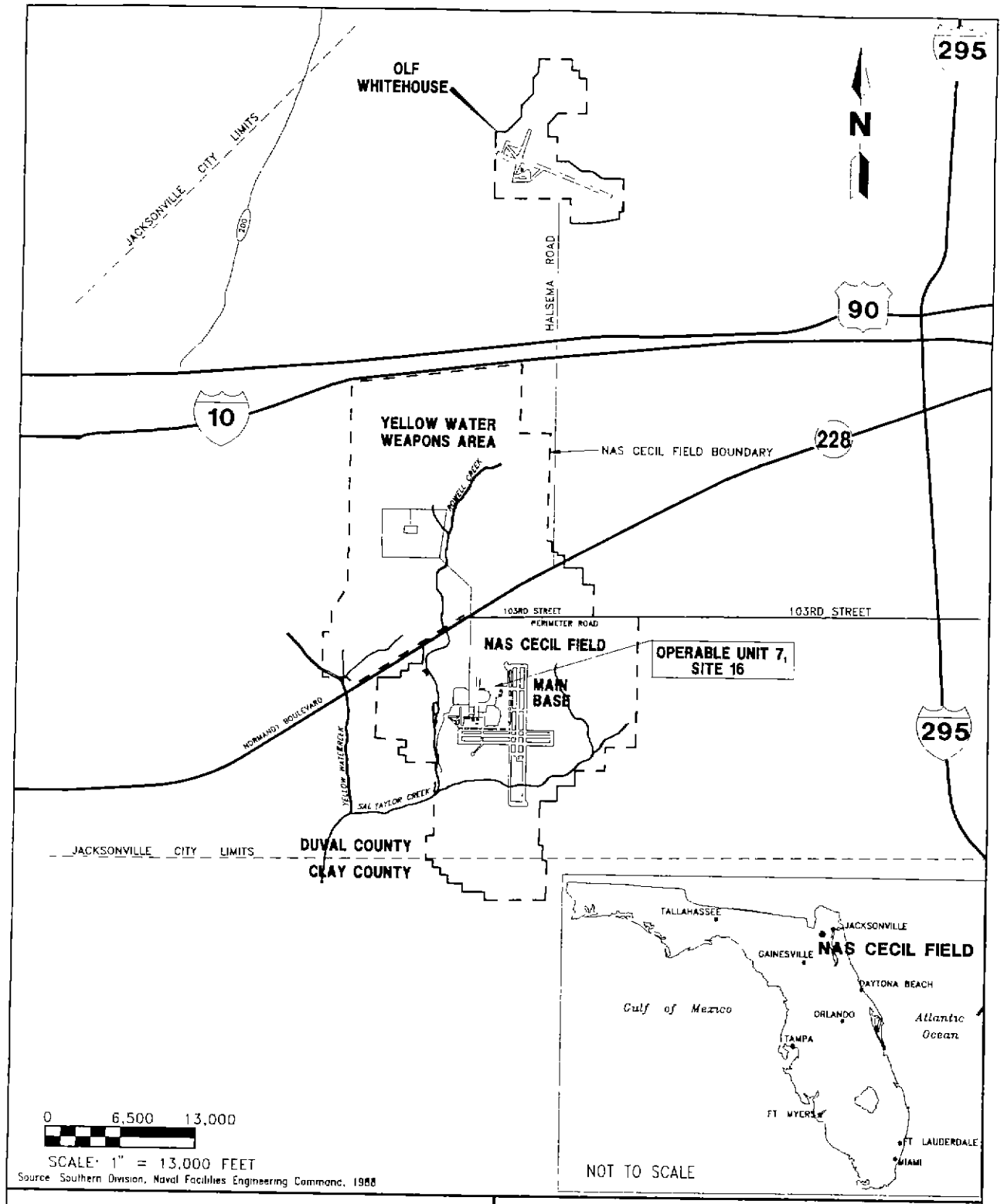


FIGURE 1-1
GENERAL LOCATION MAP

REMEDIAL INVESTIGATION, OPERABLE UNIT 7

NAS CECIL FIELD
JACKSONVILLE, FLORIDA

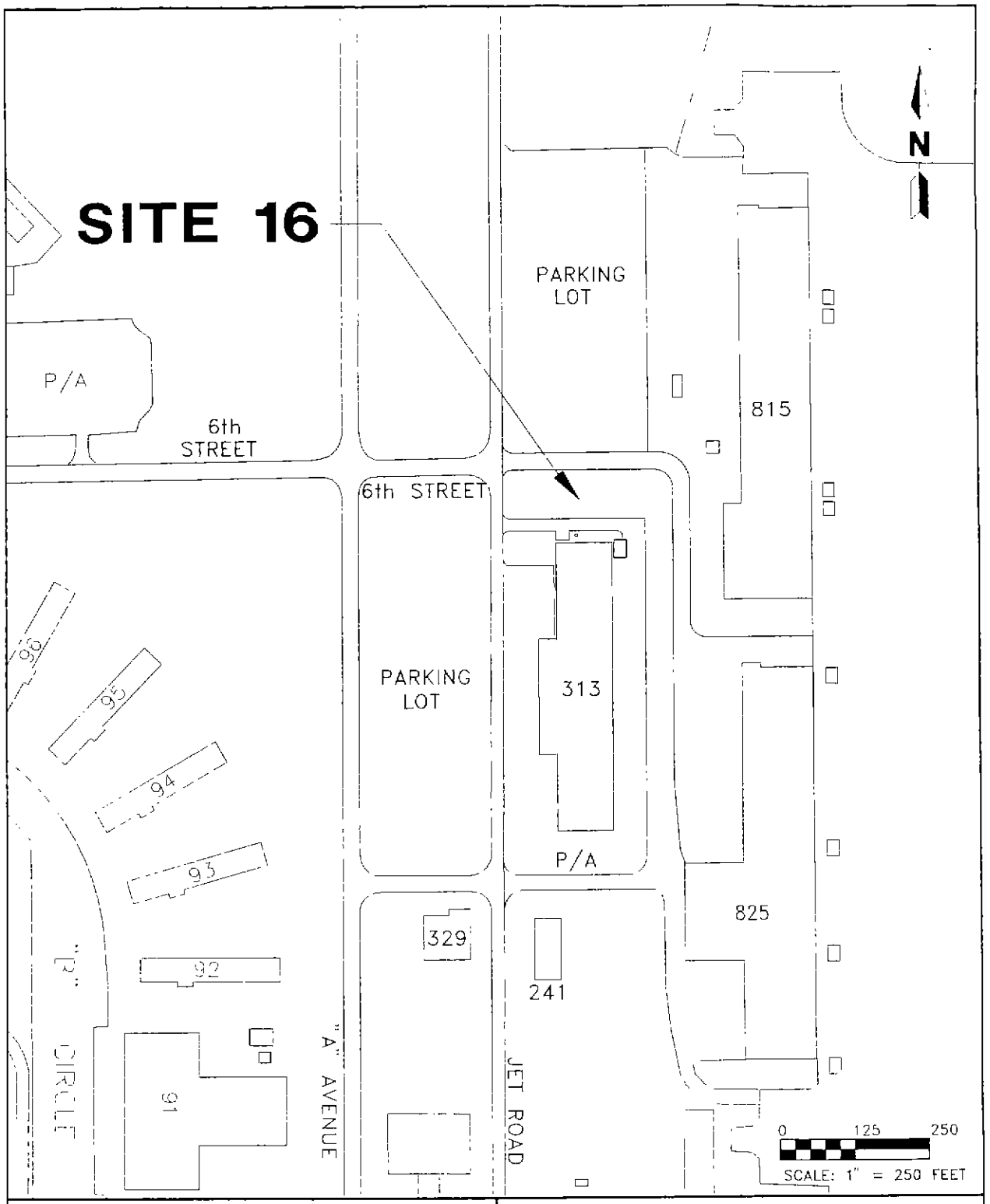
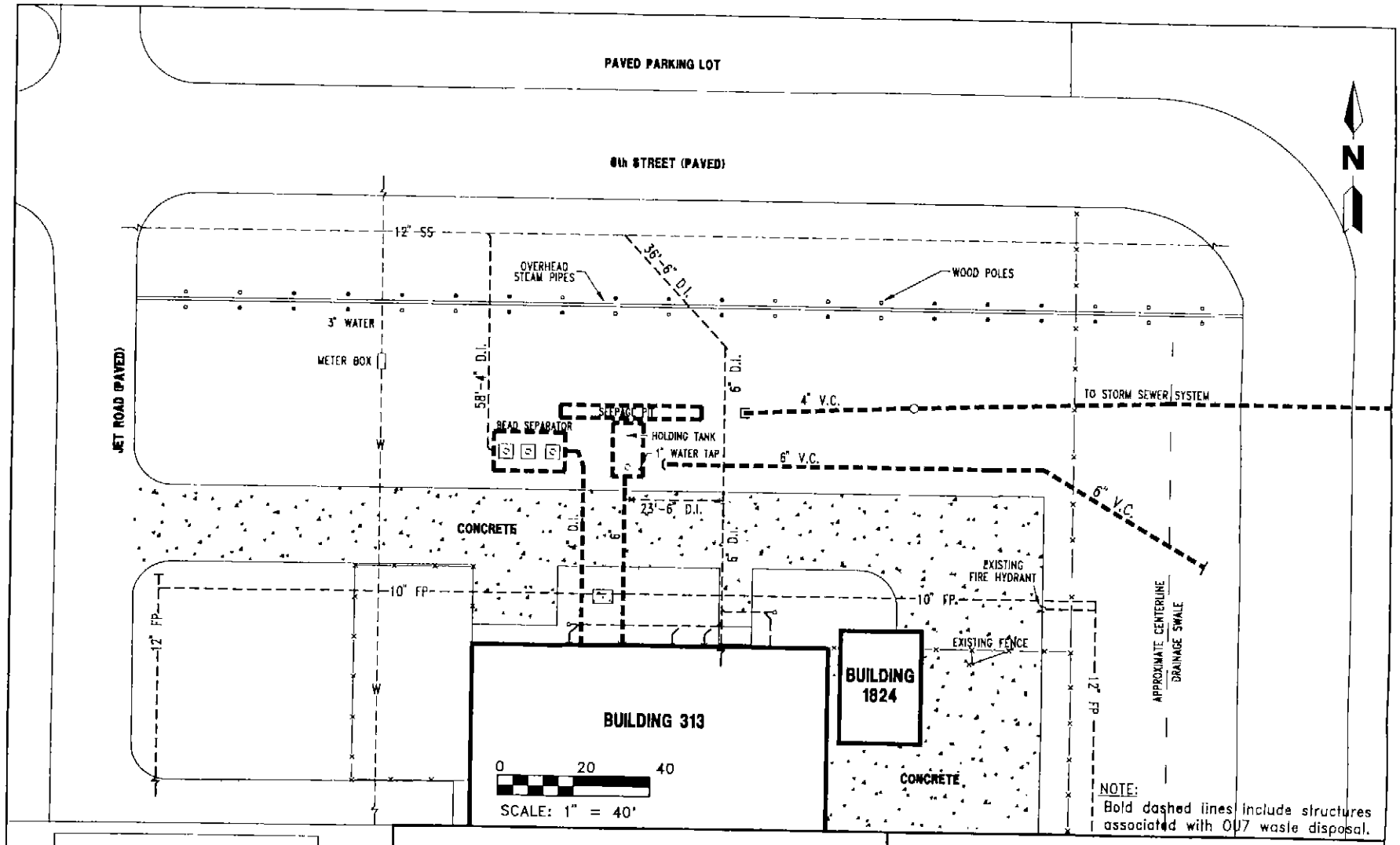


FIGURE 1-2
SITE LOCATION MAP

REMEDIAL INVESTIGATION, OPERABLE UNIT 7

NAS CECIL FIELD
JACKSONVILLE, FLORIDA



LEGEND

—D.I.—	D.I.	Ductile iron
—V.C.—	V.C.	Vitrified clay
—W—	W	Water main
—SS—	SS	Sanitary sewer
—FP—	FP	Fire main pipe

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FIGURE 1-3
OPERABLE UNIT 7, SITE 16, AIRCRAFT INTERMEDIATE MAINTENANCE DEPARTMENT SEEPAGE PIT AREA (BEFORE REMOVAL)

REMEDIAL INVESTIGATION, OPERABLE UNIT 7

NAS CECIL FIELD
JACKSONVILLE, FLORIDA

1.2.2 summarizes available historical information for the facility and OU 7. Subsection 1.2.3 provides a remedial review and status of NAS Cecil Field.

1.2.1 Facility Description The official mission of NAS Cecil Field is to provide facilities, services, and material support for the operation and maintenance of naval weapons, aircraft, and other units of the operating forces as designated by the Chief of Naval Operations. Some of the tasks required to accomplish this mission include: (1) operation of fuel storage facilities, (2) provision of facilities and performance of organizational level aircraft maintenance, (3) provision of facilities and performance of intermediate level aircraft maintenance, and (4) maintenance and operation of an engine repair facility and test cells for designated turbo-jet engines.

NAS Cecil Field is comprised of 11 departments, each with special assistants and staff offices. The facility is also host to more than 40 tenant commands (SOUTHNAVFACENGCOM, 1989). NAS Cecil Field supports a work force of approximately 11,000 civilian and military personnel and can accommodate approximately 3,500 residents in base quarters and housing.

1.2.1.1 **Facility Land Use** NAS Cecil Field occupies more than 31,000 acres and can be divided into four distinct areas: the main base (NAS Cecil Field), which occupies 9,516 acres; the Yellow Water Weapons Department, which occupies 8,091 acres; Outlying Landing Field (OLF) Whitehouse, which occupies 2,587 acres; and the 11,072-acre Land Target Complex Detachment Astor. The main facility, the Yellow Water Weapons Department, and OLF Whitehouse are shown on Figure 1-1. Land Target Complex Detachment Astor is located 120 miles south of the main base.

The main facility of NAS Cecil Field is located in southwestern Duval County, Florida, and is within the Jacksonville city limits. Land west and north of the base is characterized as rural and is predominantly forested. Cary State Forest is 5 miles to the northwest. The rural community of Whitehouse is nearly adjacent to OLF Whitehouse, and the rural community of Halsema is approximately 1.8 miles to the south of OLF Whitehouse. The main facility consists of intersecting north-south and east-west runways bracketing the flightline and support facilities. These facilities occupy approximately 1,000 acres in the northwest quadrant of NAS Cecil Field. The remaining acreage of the main base is mostly undeveloped (SOUTHNAVFACENGCOM, 1989).

1.2.1.2 **Adjacent Land Use** The greatest population density is approximately 14 miles to the northeast in downtown Jacksonville. Land surrounding NAS Cecil Field is used primarily as forestry with some light agriculture and ranching. Small communities and scattered dwellings associated with these activities are located in the vicinity. A small residential area on Nathan Hale Road, which abuts the NAS Cecil Field property to the west, is an example of these rural communities. The closest incorporated municipality is the town of Baldwin, which is centered approximately 6.4 miles to the northwest of the main facility entrance.

To the east, the rural surroundings grade into a suburban fringe bordering the major east-west roadways. Low intensity commercial use, such as convenience stores and low density residential areas, characterize the land use in this eastern area. Herlong Airport lies approximately 4.5 miles east of NAS Cecil Field along State Road 228. The region becomes more urbanized as the city of Jacksonville is approached. A development called Villages of Argyle, consisting

of seven separate villages or communities, is located to the southeast of NAS Cecil Field. To the east, a golf course and residential area border the main base (SOUTHNAVFACENGCOM, 1989).

1.2.2 Site Description OU 7 consists of Site 16, the AIMD seepage pit, associated piping from Building 313, and adjacent areas affected by these facilities. OU 7 is located west of and adjacent to the north-south jet runways on NAS Cecil Field. The AIMD seepage pit is located 60 feet north of Building 313. Currently, the Jet Engine Maintenance Shop and Non-Destructive Inspection (NDI) Laboratory are located in Building 313. A map of the vicinity of OU 7 is provided on Figure 1-3.

OU 7 is vegetated with grass that is mowed regularly. The general area adjacent to OU 7 is relatively flat and is covered with asphalt and concrete. The immediate area is crisscrossed with several utilities (Figure 1-3), including a water line, overhead steam line, fire water main, a sanitary sewer main, and storm sewers (both active and abandoned). There are no inlets to the storm sewer system in the immediate vicinity of OU 7 (ABB-ES, 1992). In 1988 and during the site visits conducted by ABB-ES in 1993, the ground surface exhibited no evidence (staining or absence of vegetation) of adverse effects from previous waste activities at the site.

Surface water flow from OU 7 is typically toward the adjacent paved roads and parking lots. To the east, an unlined grass drainage swale may receive some runoff and carry it toward a catch basin. The runoff from the paved roads and parking lots in the vicinity of OU 7 ultimately flows to the NAS Cecil Field stormwater sewer system (Harding Lawson Associates, 1988).

1.2.3 Remedial Review and Status The first environmental study for the investigation of waste handling and/or disposal sites at NAS Cecil Field was completed between 1983 and 1985 by Geraghty & Miller, Inc.. This study was followed by an Initial Assessment Study (IAS) completed by Envirodyne Engineers in 1985. The IAS was completed under the Navy Assessment and Control of Installation Pollutants (NACIP) program, which was the precursor to the Navy's present Installation Restoration (IR) program. In 1988, a Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI) was completed by Harding Lawson Associates. The RFI acted on the recommendations of the IAS. OU 7 was included in the IAS and the RFI.

NAS Cecil Field was placed on the National Priority List (NPL) by the U.S. Environmental Protection Agency (USEPA) and the Office of Management and Budget in December 1989. A Federal Facility Agreement (FFA) for NAS Cecil Field was signed by the Florida Department of Environmental Protection (FDEP, formerly the Florida Department of Environmental Regulation [FDER]), USEPA, and the Navy in 1990. Following the listing of NAS Cecil Field on the NPL and the signing of the FFA, remedial response activities at the facility have been completed under CERCLA authority.

NAS Cecil Field has several locations where hazardous wastes may have been handled, spilled, or buried. The individual locations are currently referred to as potential sources of contamination (PSCs). The name "site" is applied to PSCs that are currently under investigation at NAS Cecil Field as part of the IR program. At the time of the facility's listing on the NPL, 18 PSCs had been identified. A study completed in 1988 (by Harding Lawson Associates) identified

another PSC (PSC 19). Remedial response activities are currently underway at Sites 1, 2, 3, 5, 7, 8, 10, 11, 14, 15, 16, and 17. Field investigation plans are currently being prepared for the investigation of PSCs 4, 6, 9, 12, 18, and 19.

In 1993 NAS Cecil Field was selected for closure by the Base Realignment and Closure (BRAC) Commission. An Environmental Baseline Survey (EBS) was completed as the first step in the closure process. The EBS identifies parcels of land for sale, lease, or investigation depending on the condition of the parcel. OU 7 was designated in the November 1994 EBS as yellow (release of hazardous substances has occurred, and remedial actions are underway, but all required remedial actions have not yet been taken).

1.2.4 History of OU 7 From 1959 until 1980, greases, rusts, scale, and paint wastes generated during a machine and engine parts cleaning process, along with glass beads and blasting grit from the airframes blasting shop, were disposed at OU 7. Most wastes were discharged to the seepage pit area north of Building 313, but some were reportedly dumped on the ground on the east side of the building. Based on operations occurring within Building 313 during this time, waste components disposed may have included: sodium cyanide, trichloroethene (TCE), creosol, phenol, methylene chloride, and oil (Harding Lawson Associates, 1988).

Liquid waste generated from operations conducted within Building 313 drained toward a floor sump located at the north end of the building (Figure 1-3). This sump was connected via vitrified clay piping to a 4,100-gallon underground concrete holding tank located north of the building. The holding tank acted as a surge tank for the adjacent seepage pit. The holding tank contained a sump equipped with a sump pump and was constructed so that wastes could be pumped from the sump into either the seepage pit located north of the holding tank or the NAS Cecil Field storm sewer system (via 6-inch vitrified clay piping). The seepage pit was constructed with concrete blocks on top of a concrete slab and measured approximately 40 feet long by 3 feet wide by 10 feet deep. One-half-inch gaps were left between the vertical intersections of the concrete blocks and no mortar was used within these gaps. The construction of the seepage pit allowed for seepage of wastes directly into the subsurface soil and groundwater. The date of the installation of this system is unknown; however, the tank is believed to have been installed concurrently with the seepage pit (C. Vargas & Associates, Ltd., 1981).

Glass beads and blasting grit from sandblasting operations within Building 313 were allowed to enter the system through the sump in the building. Subsequently, glass beads accumulated within the tank and seepage pit and caused the system to malfunction. In the late 1960's, a 4-inch vitrified clay discharge pipe was installed in the seepage pit to allow drainage to the NAS Cecil Field storm sewer system. The discharge pipe was installed approximately 3 feet above the base of the seepage pit. This pipe was installed so that when the level of wastewater within the seepage pit reached the level of the discharge pipe, the wastewater would overflow to the storm sewer system. The storm sewer that received discharge directly from the holding tank eventually discharges to a series of open ditches, east of the north-south runways, that empty into Sal Taylor Creek (Harding Lawson Associates, 1988). The distance from OU 7 to Sal Taylor Creek is approximately 5,000 feet.

Use of the seepage pit was discontinued in 1980 and piping leading from the tank to the seepage pit was removed and the tank's outlet to the seepage pit was plugged. As shown on Figure 1-3, piping from the tank to the storm sewer system was partially removed and plugged, and the piping leading from the seepage pit to the storm sewer system was also plugged. The length of pipe removed before plugging is unknown; soil was left in place during pipe removal and plugging activities. During these activities, the top 4 feet of soil in the seepage pit were removed and backfilled with clean sand. Concurrently, a bead separator, for gravity settling of glass beads from the wastewater, was installed to the west of this system. This separator was connected to another sump located within the building via ductile iron piping. Discharge from the bead separator was connected to the NAS Cecil Field sanitary sewer system via 4-inch ductile iron piping (C. Vargas & Associates, LTD, 1981). Wastewater discharge from Building 313 continued after the installation of the bead separator.

From 1980 until 1989, the holding tank was used for 90-day storage of hazardous waste. This activity was permitted under the facility's RCRA hazardous waste storage permit number 8016-122017. This permit was granted in 1987 by the USEPA and the FDEP (SOUTHNAVFACENGCOM, 1993). The tank reportedly received first floor washing water from the NDI Laboratory's metal cleaning area.

The use of the bead separator continued from 1982 until 1989. Renovation of the north end of Building 313 in 1989 included the abandonment of this system. All piping leading from the building to the bead separator and from the building to the 4,000-gallon holding tank was disconnected and plugged from within the building. In addition, all liquids in the holding tank were pumped out and transported to an offsite treatment, storage, and disposal (TSD) facility for treatment (ABB-ES, 1993a).

In March 1993, NAS Cecil Field obtained a modification to permit number 8016-122017. This modification (permit number 8016-211406) stipulated that the 4,100-gallon holding tank must be closed in accordance with RCRA by June 4, 1994. As part of an Interim Remedial Action (IRA), the NDI holding tank was excavated on May 11, 1994, and removed from the site on May 17, 1994. In addition, the seepage pit and glass bead separator were also removed. Associated piping was either removed entirely or partially removed, cut at appropriate locations, and plugged with grout. Approximately 1,578 tons of soil contaminated with TCE at concentrations above the IRA action level of 1 milligram per kilogram (mg/kg) were excavated and disposed offsite at a hazardous waste landfill. The area was backfilled with clean fill and restored to original conditions (ABB-ES, 1994a). Details of the IRA can be found in the NDI holding tank closure certification and report (ABB-ES, 1994a).

A Focused Feasibility Study (FFS) (ABB-ES, 1993) was prepared prior to the implementation of the IRA to provide remedial action objectives and remedial alternatives. Following the FFS a Proposed Plan (ABB-ES, 1993b) was prepared and a public meeting was conducted to present the preferred remedial alternative. The selected remedy was documented in the Interim Record of Decision (IROD) (ABB-ES, 1994b) dated March 1994.

1.2.5 Previous Investigations Investigation of the AIMD seepage pit and adjacent area at OU 7 began in 1985. Each of the investigations completed is discussed in this section in chronological order. Findings, conclusions, and

recommendations from these previous investigations are presented and summarized in Appendix A and Table 1-1.

1.2.5.1 **Initial Assessment Study (IAS)** The IAS (Envirodyne Engineers, 1985) was completed to identify hazardous waste sites at NAS Cecil Field warranting further investigation and was accomplished through a records search of historical data, aerial photographs, field inspections, and personnel interviews. No intrusive field investigations were conducted. Eighteen sites were identified during the IAS, including Site 16 (OU 7), the AIMD Seepage Pit Area. The information collected during the IAS led to the initiation of RFI field activities at OU 7 (Envirodyne Engineers, 1985).

1.2.5.2 **Resource Conservation and Recovery Act (RCRA) Facility Investigation** The RFI (Harding Lawson Associates, 1988) included a magnetometer survey, the installation of three monitoring wells with subsequent sampling and analysis of groundwater, sampling and analysis of one sediment sample, and collection of water level measurements in all monitoring wells. The monitoring well and sediment sampling locations are shown on Figure 1-4. Evaluation of magnetometer survey results (obtained using the Scintrex-Integrated Geophysical System with a magnetometer and very low frequency sensors) showed the location of anticipated anomalies corresponding to some of the actual subsurface features (buried tank and buried utilities), as well as an unexpected anomaly to the east of the seepage pit, most likely representing disturbance to natural soil but reported as possibly representing contaminant migration from the seepage pit into the soil.

Analytical results from unfiltered groundwater samples collected during the RFI indicated the presence of 1,2 trans-dichloroethylene (380 micrograms per liter [$\mu g/\ell$]), TCE (400 $\mu g/\ell$), chromium (74 $\mu g/\ell$), and lead (175 $\mu g/\ell$). Analytical results from the sediment sample collected from the ground surface above the underground discharge pipe connecting the seepage pit to the storm sewer system indicated that the sediment contained 19 mg/kg of lead. The direction of groundwater flow estimated from the three groundwater level measurements was to the south.

Based on the results of the RFI, a Corrective Action Study Plan was recommended to further investigate the lateral and vertical extent of the hazardous constituents found at the site.

1.2.5.3 **1991-92 Remedial Investigation Activities** RI activities conducted by ABB-ES during fall 1991 and spring 1992 included: a ground penetrating radar (GPR) survey to identify areas of excavation, utilities, and other subsurface anomalies; a piezocone (direct push technology) survey to investigate subsurface lithology and to collect subsurface soil and groundwater samples; groundwater sample headspace screening for volatile organic compounds (VOCs); surface soil sampling; subsurface soil sampling; monitoring well installation and collection and analyses of groundwater samples; hydraulic conductivity testing; and collection of water level measurements from monitoring wells.

The results of these investigations, as summarized in the *Technical Memorandum for Supplemental Sampling at Operable Units 1, 2, and 7* (TMSS) (ABB-ES, 1992a), are summarized below for OU 7.

<u>GPR Survey</u>. The GPR survey was conducted on October 10, 1991, to locate areas of disturbed soil and underground piping and/or utility networks. An area of

Table 1-1
Findings and Conclusions from Previous Investigations

Remedial Investigation
Operable Unit 7, NAS Cecil Field
Jacksonville, Florida

Previous Study	Tasks Completed	Results of Sampling	Recommendations
Initial Assessment Study (IAS) (Envirodyne Engineers, 1985)	1. Records search 2. Onsite survey 3. Confirmation study ranking 4. Site ranking 5 Confirmation study recommendations	No sampling conducted	1. Install three surficial monitoring wells to detect contaminant migration from the seepage pit. 2. Collect samples from the three groundwater monitoring wells on a quarterly basis for 1 year. 3. Collect a sediment sample from the drainageway that received discharge from the seepage pit. 4. Analyze the groundwater and sediment samples by GC and FID scan with capillary column for MEK, TCE, toluene, phenol, methylene chloride, and cresol; COD; TOC; TOX; cadmium, chromium, silver, lead, cyanide; oil and grease; specific conductance; and pH.
RCRA Facility Investigation (RFI) (Harding Lawson Associates, 1988)	1. Site reconnaissance 2. Geophysical survey 3 Installed three new groundwater monitoring wells. 4. Collected three groundwater samples 5 Collected one surface sediment sample.	1. Groundwater results a trichloroethene (TCE): 400 micrograms per liter ($\mu g/\ell$) b 1,2-trans-dichloroethylene: 380 $\mu g/\ell$ c. chromium: 74 $\mu g/\ell$ d. lead: 175 $\mu g/\ell$	1. Corrective Action Study to further investigate the lateral and vertical extent and concentrations of the hazardous constituents found at the site.
Remedial Investigation and Feasibility Study for OUs 1, 2, and 7 (ABB-ES, 1991)	1. Ground penetrating radar (GPR) survey. 2. Piezocone survey 3. Groundwater headspace screening 4. Surface soil sampling 5. Subsurface soil sampling and monitoring well installation. 6. Groundwater sampling 7. Hydraulic conductivity testing and water level elevation determination.	1. The GPR survey was not successful in delineating the seepage pit, underground piping, and underground utility network. 2. Low concentrations of TCE, TCA, and PCE were detected in the four groundwater headspace screening samples collected. 3 The one piezocone probe, installed to 48 feet, indicated fine- to silty fine-grained sand with lenses of cemented sand to hardpan. 4. Analysis of five surface soil samples indicated the presence of toluene, xylene, and PAHs.	1. Conduct EM and MAG geophysical survey to determine the location of buried piping and utility networks. 2. Collect and analyze four surface soil samples to support RA and FS. 3. Collect and screen soil and groundwater samples from a minimum of 15 locations to determine the horizontal and vertical extent of contamination at the site 4 Install three borings with continuous split-spoon sampling to a depth of approximately 120 feet bls to determine site-specific lithology. Install four borings to identify the presence of DNAPL based on the results of the screening (see 3).

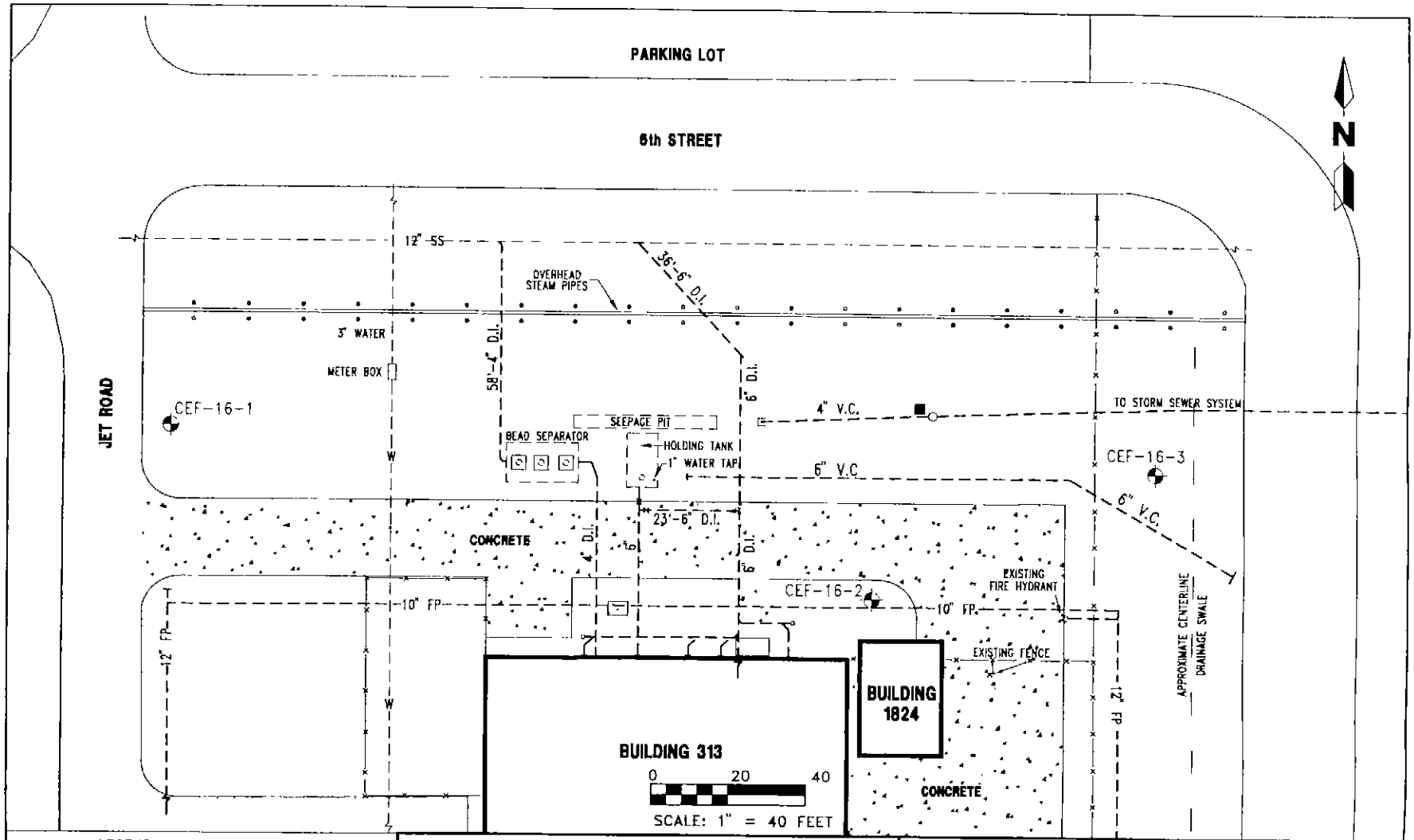
See notes at end of table.

Table 1-1 (Continued)
Findings and Conclusions from Previous Investigations

Remedial Investigation
Operable Unit 7, NAS Cecil Field
Jacksonville, Florida

Previous Study	Tasks Completed	Results of Sampling	Recommendations
Remedial Investigation and Feasibility Study for OUs 1, 2, and 7 (ABB-ES, 1991) (Continued)		5 Analysis of 16 subsurface soil samples from five borings detected the presence of acetone, 1,2-DCE, TCE, naphthalene, 2-methylnaphthalene, 2-methylphenol, 4-methylphenol, and bis(2-ethylhexyl)phthalate 6. Analysis of groundwater samples from seven new monitoring wells detected 1,1-DCE, 1,1-DCA, 1,2-DCE, 1,1,1-TCA, TCE, naphthalene, 2-methylphenol, and 2,4-dimethylphenol. 7. The hydraulic conductivities estimated from the slug tests were: 2.7-4.6 ft/day for three LZS wells, 1 0 ft/day for one LZS well, and 28 ft/day for one UZH well. 8. Results of water level measurements indicate a groundwater flow direction to the southeast in the UZS.	5. Install eight borings to characterize and delineate soil contamination at the site. Collect two soil samples from each boring for laboratory analyses Also collect soil samples from select borings for geotechnical analyses. 6. Install a 10 monitoring wells to complete characterization and delineation of site contamination.

Notes: GC = gas chromatograph.
FID = flame ionization detector.
MEK = methyl ethyl ketone.
TCE = trichloroethene.
COD = chemical oxygen demand.
TOC = total organic carbon.
TOX = toxicity.
RCRA = Resource Conservation and Recovery Act.
OU = Operable Unit.
ABB-ES = ABB Environmental Services, Inc.
TCA = trichloroethane.
PCE = tetrachloroethene.
PAH = polynuclear aromatic hydrocarbons
EM = electromagnetic.
MAG = magnetometer
RA = Risk Assessment.
FS = Feasibility Study.
bls = below land surface.
DNAPL = dense nonaqueous phase liquid.
1,2-DCE = 1,2-dichloroethene.
1,1-DCE = 1,1-dichloroethene.
1,1-DCA = 1,1-dichloroethane.
1,1,1-TCA = 1,1,1-trichloroethane.
ft/day = feet per day.
LZS = lower zone surficial.
UZH = upper zone Hawthorn.
UZS = upper zone surficial.



LEGEND

- Groundwater monitoring well
- Sediment sample location
- D.I. Ductile iron
- V C Vitrified clay
- W Water main
- SS Sanitary sewer
- FP Fire main pipe

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FIGURE 1-4
RCRA FACILITY INVESTIGATION (1987)
MONITORING WELL AND SEDIMENT SAMPLING LOCATIONS

REMEDIAL INVESTIGATION, OPERABLE UNIT 7

NAS CECIL FIELD
JACKSONVILLE, FLORIDA

disturbed soil was identified in the vicinity of the holding tank, seepage pit, and bead separator. Delineation of the seepage pit, underground piping, and underground utility network was not successful.

Piezocone Survey. A piezocone survey was conducted on October 18, 1991, to collect lithologic information on subsurface soil in the vicinity of OU 7 (Figure 1-5). Fine-grained to silty sand with occasional lenses of cemented sand was detected at OU 7 to a depth of approximately 48 feet below land surface (bls).

Groundwater Headspace Screening. Groundwater screening was conducted on October 18, 1991 (Figure 1-5), using onsite gas chromatographs (GCs) equipped with electron capture detectors (ECDs) and flame ionization detectors (FIDs) to identify VOCs, specifically chlorinated aliphatics and aromatic organics. TCE and 1,1,1,-trichloroethane (TCA) were detected, but their concentrations in groundwater were not quantified.

Surface Soil Sampling. Surface soil samples were collected for analysis of target compound list (TCL) organics and target analyte list (TAL) inorganics on April 29, 1992 (Figure 1-5). Analytical results from this effort are summarized in Appendix A. The results of the organic fraction analyses indicated the presence of VOCs and several semivolatile organic compounds (SVOCs) characteristic of solvents, plasticizers, and petroleum.

Subsurface Soil Sampling and Monitoring Well Installation. Subsurface soil samples were collected for analysis of TCL organics on December 3, 1991 (Figure 1-5). Seven borings were completed and monitoring wells were installed at each boring. Three samples were selected for analysis from two borings and two samples were selected for analysis from each of the remaining five borings. Evaluation of the analytical results, which are summarized in Appendix A, indicated the presence of VOCs and SVOCs characteristic of solvents and petroleum products and inorganics typical of natural soils. Chromium and lead were detected at concentrations about 2 times higher than background subsurface soil.

Groundwater Sampling. Groundwater samples were collected for analysis of TCL organics, TAL inorganics, and total petroleum hydrocarbons (TPH) on November 11, 1991 (Figure 1-5). Evaluation of analytical results, which are summarized in Appendix A, indicates the presence of VOCs characteristic of solvents, particularly 1,1,1-TCA and TCE-related degradation products.

Hydraulic Conductivity Testing and Water Level Elevation Determination. Slug tests were conducted in all new wells installed at the site on December 16, 1991. The hydraulic conductivity for monitoring wells screened in the upper part of the surficial aquifer ranged from 2.68 feet per day (ft/day) to 4.61 ft/day compared to 1.01 ft/day for the lower part of the surficial aquifer. Hydraulic conductivity for the intermediate aquifer averaged 27.87 ft/day. Water level measurements were taken on November 19, 1991, and again on April 29, 1992. The depth to water averaged 6.81 feet bls, which corresponds to an elevation of 72.02 feet above mean sea level (msl). The depth to groundwater varies seasonally.

Several data needs were identified after the 1991 OU 7 RI. These consisted primarily of data needed to further assess the nature and extent of soil and groundwater contamination. Recommendations to fill the data needs were presented in the TMSS.

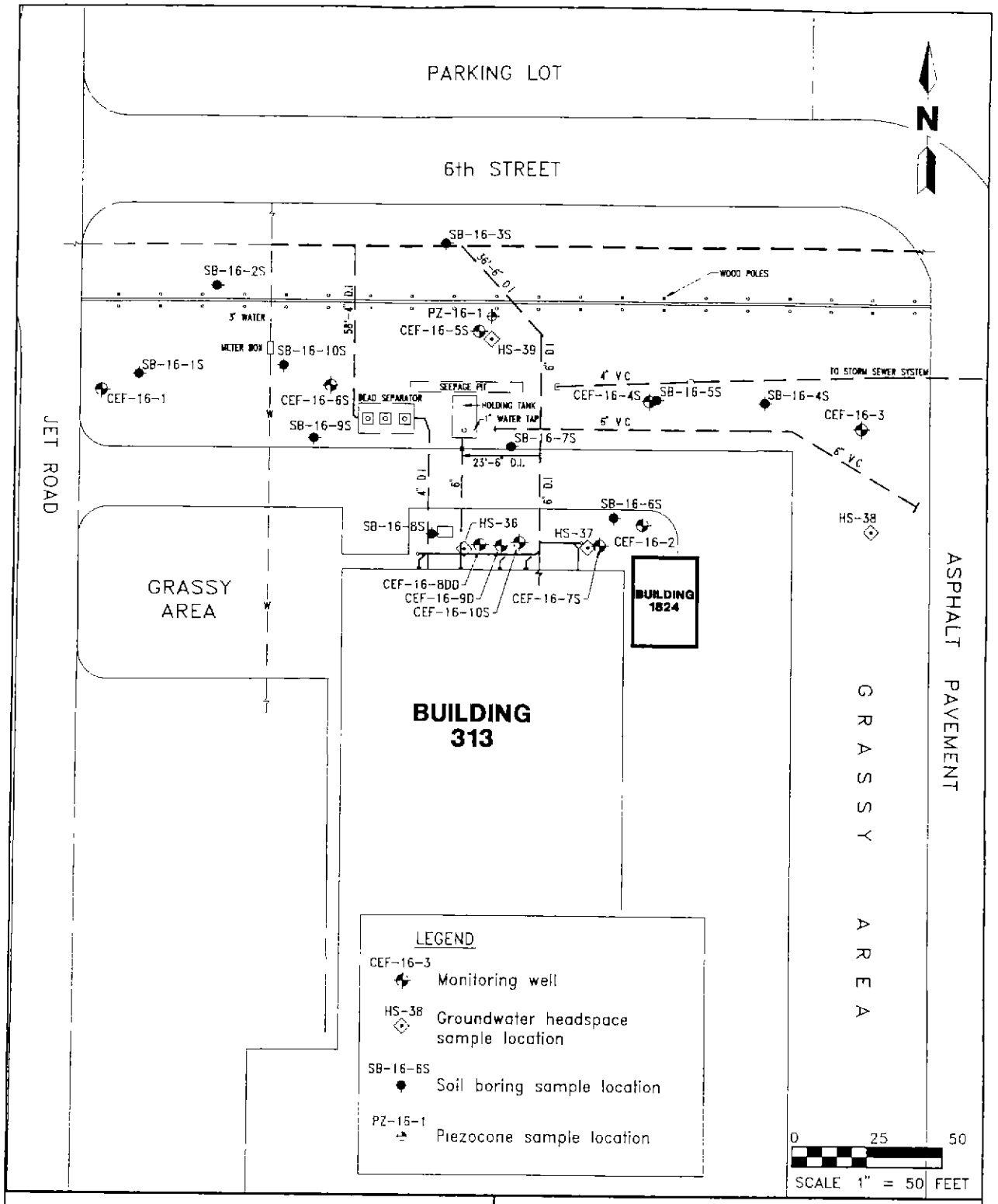

FIGURE 1-5
MONITORING WELL, SOIL BORING, PIEZOCONE, AND GROUNDWATER HEADSPACE SCREENING LOCATIONS, 1991

REMEDIAL INVESTIGATION, OPERABLE UNIT 7

NAS CECIL FIELD
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1.3 CONCEPTUAL UNDERSTANDING BASED ON SITE HISTORY AND PREVIOUS INVESTIGATIONS. This section presents the conceptual understanding of site conditions prior to RI field activities. Based on the historical information collected, waste liquids (primarily spent solvents and TCE contaminated wash water) resulting from paint preparation and parts cleaning operations are anticipated to have discharged from Building 313 to the holding tank, and more recently the bead separator, providing gravity separation of wastes. Drainage from the holding tank went to the seepage pit that drained directly to the underlying vadose and phreatic zone soil and groundwater from approximately 1959 to 1980, a period of 21 years. The addition of these wastewaters to the groundwater would be expected to create a localized mounding effect. The mounding is believed to have had the potential to spread the contaminants radially (horizontally and vertically) from the source. When the discharge ceased, the mound would have subsided, leaving contamination in what is now the vadose zone soil (soil above the water table). After the initial spreading caused by the mounding, the contaminants would migrate with the flow of groundwater. Any contaminants remaining within the initial mound area in vadose and phreatic soil (soil below the water table) would serve as a continuing source of groundwater contamination. Based on the groundwater flow direction and rate estimated from the 1991-92 RI activities data, the dissolved contaminants in the shallow groundwater (UZS) are expected to have migrated approximately 800 feet to the southeast of the source area in the 35 years since the discharge began.

Based on the estimated flow direction, and topographic and surface drainage features, the UZS would be expected to eventually discharge to the wetlands east of the north-south runways and north of the east-west runways and Sal Taylor Creek, which drains these wetlands. There are several stormwater sewers and a buried former drainage ditch in the vicinity of OU 7 that drain to the east. The extent to which these subsurface features influence groundwater or contaminant migration is unknown.

1.4 REPORT ORGANIZATION. The NAS Cecil Field OU 7 RI report consists of seven chapters and has been prepared in accordance with *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA* (USEPA, 1988a). Chapter 1.0 contains a description and history of the sites. Site characterization activities and field programs completed for OU 7 are described in Chapter 2.0. This chapter focuses on the sampling locations selected, analyses completed, and the rationale for sampling collection.

Chapter 3.0 provides descriptions of the physical characteristics of the study area, such as surface and subsurface features, geology, hydrogeology, hydrology, etc. The findings of various media (groundwater, surface water, sediment, and soil) sampling and chemical analyses at OU 7 are addressed in Chapter 4.0. This chapter integrates the analytical results with the findings of subsurface and hydrogeologic investigations to describe the nature and extent of contamination present at OU 7. In an effort to reduce some of the bulk of Chapter 4.0, tables presenting a summary of detections have been replaced by tables showing frequency of detection and minimum and maximum concentrations for each medium. Where appropriate, organic and inorganic detections have been presented on figures. The complete analytical data set is in Appendix M.

Contaminant fate and transport are discussed in Chapter 5.0. Chapter 6.0 presents a summary of the BRA. Summary and conclusions of the RI at OU 7 are presented in Chapter 7.0. References are presented at the end of the report. Appendices are included in a separate bound volume.

2.0 STUDY AREA INVESTIGATION

Presented in Chapter 2.0 is a discussion of the study area investigation, which was conducted to quantify, confirm, and adjust as needed the conceptual understanding of the site conditions. Subsection 1.2.3, in the previous chapter, presents the findings and conclusions from previous investigations. The data collection efforts completed during the 1993-94 RI activities for OU 7 are presented in this chapter.

The 1993-94 RI activities were conducted in accordance with the approach proposed in the TMSS. The supplemental investigative activities outlined in the TMSS for OU 7 consisted of a screening program for soil and groundwater and a confirmatory sampling program. Estimates of the number of wells, soil borings, and surface soil samples were proposed in the TMSS, with well and sampling locations identified (in consultation among the FDEP, USEPA, and the Navy) following completion of the screening program.

Confirmatory soil and groundwater sampling locations and rationale for OU 7 were documented in the following memoranda, which are presented in Appendix B:

- monitoring well placement at OU 7, dated April 13, 1994; and
- surface and subsurface soil sampling locations at OU 7, dated July 8, 1994

The 1993-94 RI field activities at OU 7 consisted of:

- site reconnaissance;
- sampling and chemical analyses of surface water, sediment, surface and subsurface soil;
- monitoring well installation;
- groundwater sampling and chemical analyses;
- hydraulic conductivity testing;
- water level elevation measurements; and
- biological testing.

2.1 SURFACE FEATURES. Investigations completed to characterize existing surface features at the site included land surveying and site reconnaissance.

Land surveying of all sampling stations at OU 7 was completed during the 1993-94 RI activities. During the survey, which used the global positioning system (GPS) and conventional laser surveying techniques, several monuments were established at NAS Cecil Field, including one at OU 7, to facilitate future surveying efforts. An elevation and location survey was performed to locate all sampling points including monitoring wells, soil borings, and surface soil samples at OU 7. Each land surface elevation and the top of monitoring well casing elevation at OU 7 were surveyed vertically to a minimum degree of accuracy of 0.01 foot based on

the National Geodetic Vertical Datum (NGVD) of 1929. Sampling stations were located to the nearest 0.1 foot and referenced to the Florida State Plane Coordinate System (North American Datum, 1983-90). Monitoring wells installed during previous investigations were resurveyed. Information on storm sewer locations and invert elevations was obtained, and visual inspection and dry weather water sampling and analysis were conducted for selected catch basins and outfalls.

2.2 CONTAMINANT SOURCE INVESTIGATIONS. Information on the sources for materials discharged to the seepage pit at OU 7 was evaluated during the preparation of the IAS (Envirodyne Engineers, 1985) and the RFI (Harding Lawson Associates, 1988). Subsection 1.2.3 summarized the findings and conclusions of the IAS and RFI. Contaminant source investigations completed during this RI/FS investigation included review of site operational history, site reconnaissance, and soil and groundwater investigations. Details of these investigations are presented later in Chapters 2.0 and 3.0, and the results of the investigations are presented in Chapter 4.0.

2.3 SURFACE WATER AND SEDIMENT INVESTIGATIONS. The purpose of the surface water and sediment investigation was to assess potential contaminant migration through groundwater-surface water interaction, surface water runoff, and soil erosion from OU 7. This information is used in developing an understanding of site conditions as well as to support human health and ecological risk assessment.

Surface water and sediment samples (STC-1, STC-3, and STC-4) were collected on June 22, 1993, from three locations in the drainage ditches east of the runways and on June 29, 1993, from one location (STC-R1) upstream of the drainage ditches in Sal Taylor Creek (Figure 2-1). Due to expiration of holding times, these locations were resampled on August 18, 1993, and analyzed for select parameters. These ditches receive stormwater drainage from the runway area and much of the developed area west of the runways (including OU 7) and carry the stormwater to Sal Taylor Creek.

These sample locations were selected because they potentially receive drainage from OU 7; however, they also receive drainage from the areas north, east, south, and west of OU 7. Because much of the area around OU 7 is paved (runways, roadways, aprons, and parking lots) and is active with aircraft, vehicles, and maintenance activities, the stormwater runoff from the area would be expected to contain petroleum-based constituents (fuels, lubricants, etc.). The sampling location in the northernmost ditch (STC-1) could show evidence of past releases from the sump pump discharges from the seepage pit of the holding tank. Sampling location STC-3 could show evidence of contaminated groundwater finding a preferential flow path along the storm sewers.

Surface water samples were collected by facing upstream and directly immersing the bottle, taking care to avoid stirring up sediment. Sediment samples were collected by using a gravity corer to obtain sediment from the streambed at a depth of approximately 0 to 1 foot. VOC jars were filled with sample material from the end of the gravity corer. The remaining sample containers were filled with homogenized sediment. Sediment cores were gathered from the sample area and mixed in a stainless-steel bucket to obtain sufficient sediment volume to fill the remaining sample containers. The gravity corer, stainless-steel spoons, and stainless-steel bucket were decontaminated prior to use and between each sample

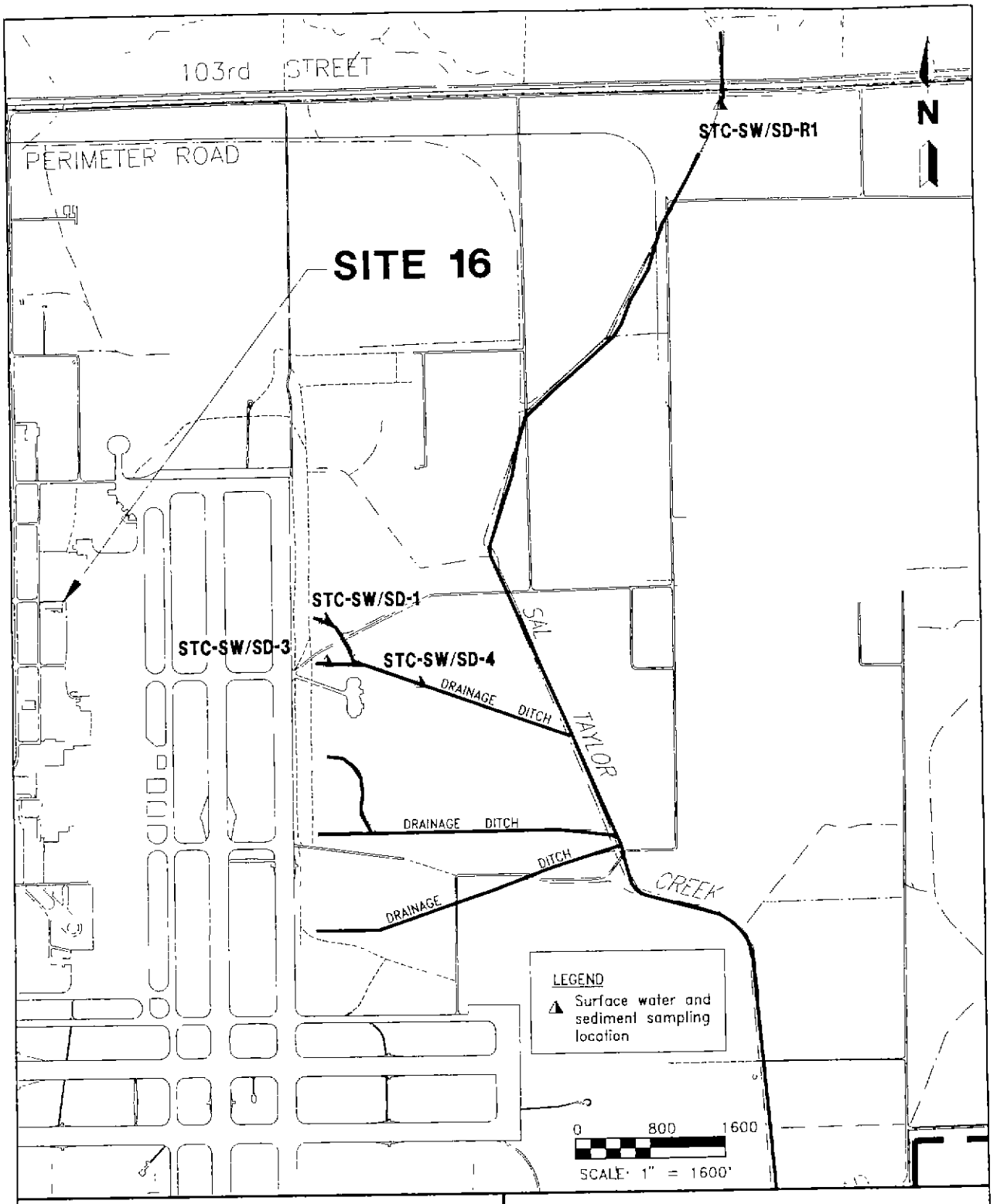


FIGURE 2-1
SURFACE WATER AND SEDIMENT SAMPLING LOCATIONS

REMEDIAL INVESTIGATION, OPERABLE UNIT 7

NAS CECIL FIELD
JACKSONVILLE, FLORIDA

location. The date, time, and location of the samples were logged by field personnel.

Field measurements of surface water pH, temperature, depth, specific conductance, and dissolved oxygen were recorded at each sample location. The results of these measurements are presented in the BRA (ABB-ES, 1995). Surface water and sediment samples were analyzed for TCL organics and TAL inorganics. Detection limits lower than the contract required detection limits (CRDL) were used for selected metals during the surface water and sediment analytical program. The metals and their corresponding lowered detection limit are: beryllium, 0.2 $\mu g/\ell$; cadmium, 0.2 $\mu g/\ell$; and silver, 0.1 $\mu g/\ell$.

Total organic carbon (TOC) analyses were completed for all sediment samples. TPH analyses were completed on samples from selected sediment sampling locations. Wet chemistry analyses were performed on the surface water samples, which included hardness and nutrients analyses, for evaluating possible effects on the aquatic system. Hexavalent chromium analysis was performed on select surface water and sediment samples to evaluate whether this more toxic form of chromium was present. Samples were analyzed in accordance with Naval Energy and Environmental Support Activity (NEESA) Level D quality control (QC) (NEESA, 1988), comparable to USEPA Level IV. The results of the surface water and sediment sampling conducted in the vicinity of OU 7 are presented in Chapter 4.0.

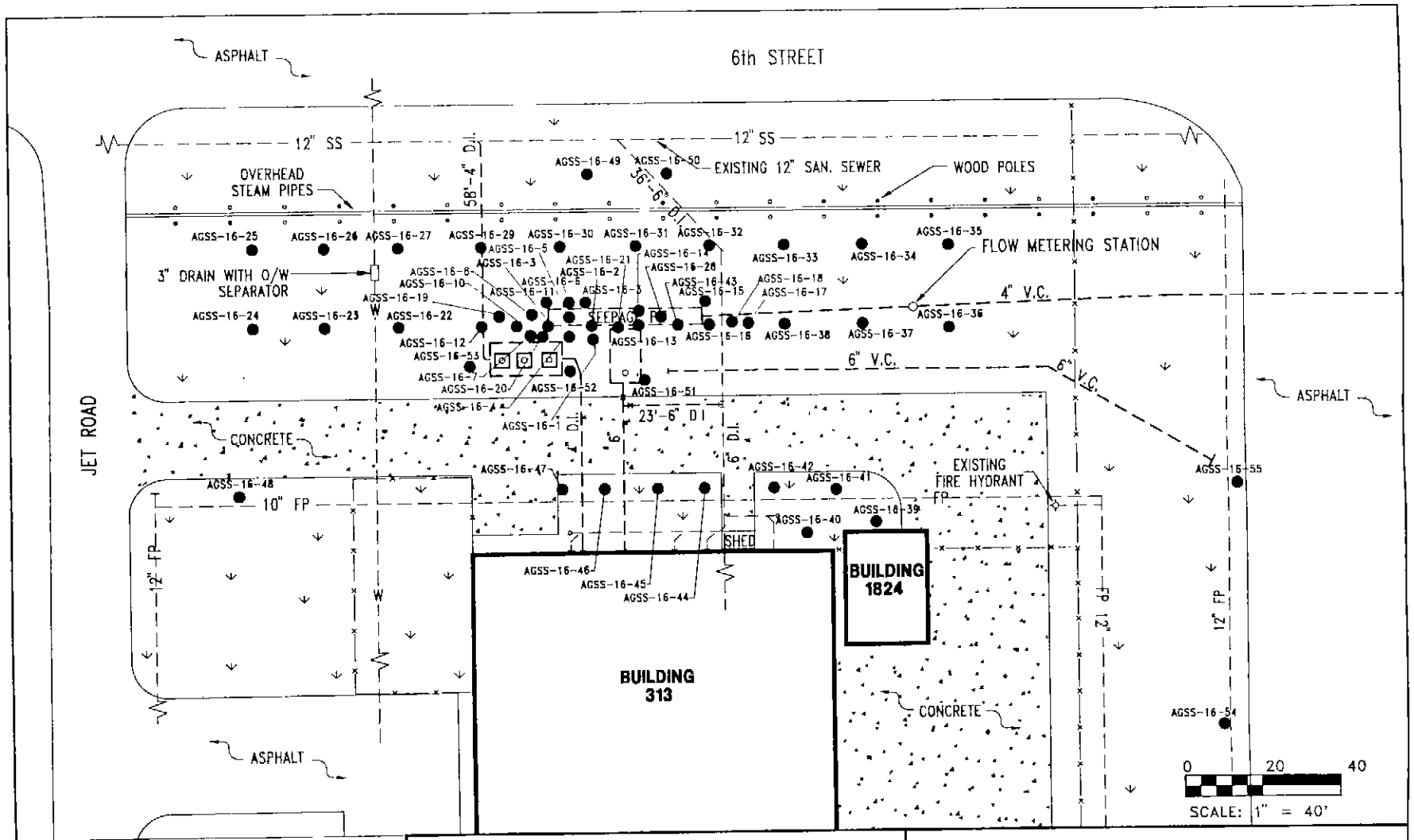
2.4 SOIL INVESTIGATIONS

Soil investigations were conducted to characterize the nature and extent of contamination identified to be present by the previous investigations. This was accomplished by conducting a screening program, using onsite laboratory analysis, followed by confirmatory sampling and analysis at Level IV quality control.

2.4.1 Soil Screening

The soil screening program was implemented at OU 7 to delineate the horizontal and vertical extent of soil contamination. The screening program was comprised of two series of sample location designations, AGSS and GS. The AGSS series was conducted in March 1993 as part of an accelerated effort to delineate the contamination detected in the unsaturated soil in the area of the seepage pit, north of Building 313. The GS series was conducted in conjunction with the Aquaprobe™ groundwater screening (see Subsection 2.7.1) in December 1993 and January 1994, and covered the seepage pit as well as the area to the west, south, and southeast of OU 7. The locations of the AGSS and GS series samples are presented on Figures 2-2 and 2-3, respectively. The soil boring logs are presented in Appendix C. The AGSS borings were advanced by hollow stem auger (HSA) method with continuous split-spoon samples collected. The GS borings were also installed by HSA and samples were collected continuously to the water table.

The soil samples at each location were screened to the water table with a photoionization detector (PID) or flame ionization detector (FID). Two soil samples from each boring (sometimes three from AGSS borings) were submitted for onsite USEPA modified Method 8010/8020 analysis based upon the following criteria: the soil samples were selected based upon elevated PID or FID readings, visible evidence of contamination, or, in the case that neither above-mentioned method is conclusive, a sample selected by the field geologist from the mid-depth of the borehole. The results of the soil screening program are presented in Appendix D and discussed in Chapter 4.0.



LEGEND

- D.I. Ductile iron
- V.C. Vitrified clay
- FP Fire main pipe
- ● Site screening sample location

CECIL\CE-AGSS\NP\03-17-95

FIGURE 2-2
SOIL SCREENING LOCATIONS (AGSS SERIES)

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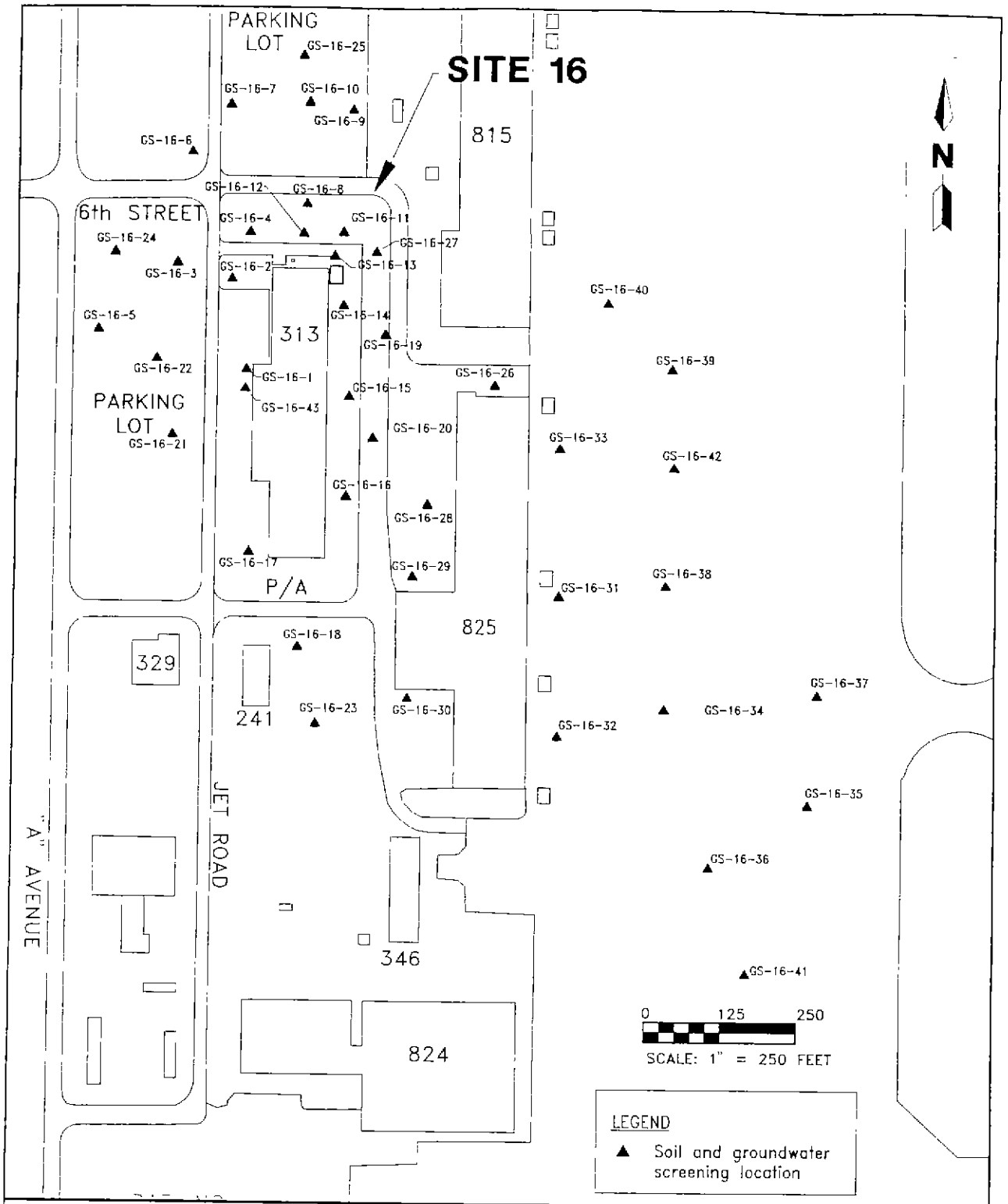

FIGURE 2-3
SOIL AND GROUNDWATER SCREENING LOCATIONS (GS SERIES)

REMEDIAL INVESTIGATION, OPERABLE UNIT 7

NAS CECIL FIELD
JACKSONVILLE, FLORIDA

2.4.2 Post-Excavation Soil Sampling In May 1994, an IRA was conducted at the seepage pit area to remove unsaturated soil with concentrations of TCE above 1 mg/kg. The excavated soil was staged on the grassy strip of Site 16 north of the overhead steam pipes and south of 6th Street. Soil samples were collected from the excavated area for analysis. The area of excavation and the sample locations are depicted on Figure 2-4. The samples were submitted for onsite USEPA modified Method 8010/8020 analysis. The analytical results of the post excavation soil samples are presented in Appendix D and discussed in Chapter 4.0.

2.4.3 Confirmatory Soil Sampling To confirm the nature and extent of soil contamination detected at the seepage pit area, surface and subsurface soil sampling and analysis were conducted. Surface soil was sampled at 10 locations on August 12, 1994, and soil borings were advanced at 12 locations from August 13 to 16, 1994. The sampling locations were selected based on the results of the screening and post-excavation analytical results. These surface and subsurface soil sampling locations are presented on Figures 2-5 and 2-6, respectively. The rationale for the collection of confirmatory surface and subsurface soil sampling is documented in a July 8, 1994, memorandum (Appendix B).

The surface soil samples were collected from depths of 0 to 1 foot bls and submitted for Contract Laboratory Program (CLP) analysis of TCL organics, TAL inorganics, and TPH. Two subsurface soil samples were collected from each boring. One sample was collected immediately above the water table. The depth of the second sample was selected based upon elevated organic vapor analyzer (OVA) readings, visible evidence of contamination, or, in the case that neither above-mentioned method was conclusive, a sample was selected by the field geologist from mid-depth of the borehole. These samples were analyzed according to CLP procedures for TCL organics, TAL inorganics, TPH, and TOC at USEPA Level IV QC requirements. The results of the confirmatory soil sampling are discussed in Chapter 4.0.

Two geotechnical samples were collected from the vadose zone at Site 16 and submitted for analysis of soil moisture content (American Society for Testing and Materials [ASTM] D-2216), Atterberg limits (ASTM D-4318), cation exchange capacity (SW9081), bulk density (ASTM E12-70), and grain-size analysis (ASTM D-421 and 422) (ASTM, 1994). The results of the geotechnical analyses are presented in Appendix E.

2.5 GROUNDWATER INVESTIGATIONS. The groundwater investigations were conducted to characterize the nature and extent of contamination at OU 7. This was accomplished by conducting a screening program followed by confirmatory sampling.

2.5.1 Groundwater Screening Groundwater screening samples were collected between December 1993 and January 1994 from 42 locations at OU 7 using the Aquaprobe™ system. These locations are depicted as the GS series soil screening locations shown on Figure 2-3.

The Aquaprobe™ consists of: (1) a stainless-steel drive point, (2) a 4-foot screened section made of 10 slot, wound stainless steel, (3) a retractable outer casing that seats against the drive point and encloses the screen until the time of sample collection, and (4) a screw-joint riser pipe, fitted with o-rings, which is attached to the outer casing. *In situ* groundwater sample collection using the Aquaprobe™ is accomplished by augering (using HSA) down to 4 to 5 feet above the

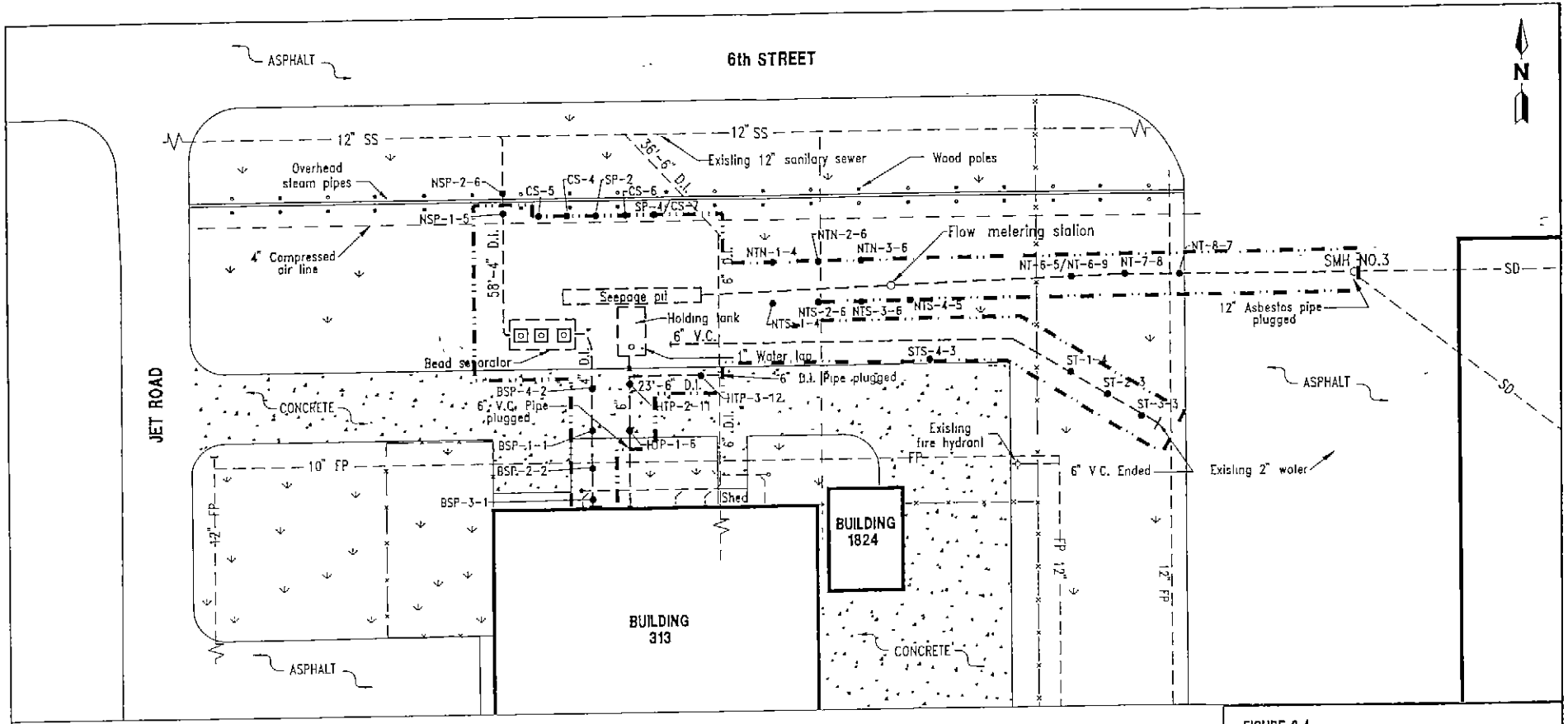

FIGURE 2-4
POST EXCAVATION SOIL SAMPLING LOCATIONS

NOTE:
The last digit of the sample number indicates the depth from which the sample was collected in feet below original land surface except for CS and SP samples.

LEGEND
Limits of structure and pipe removal and soil excavation
NTN1-4 Post excavation soil sampling location

0 15 30
SCALE: 1" = 30

REMEDIAL INVESTIGATION, OPERABLE UNIT 7
NAS CECIL FIELD
JACKSONVILLE, FLORIDA

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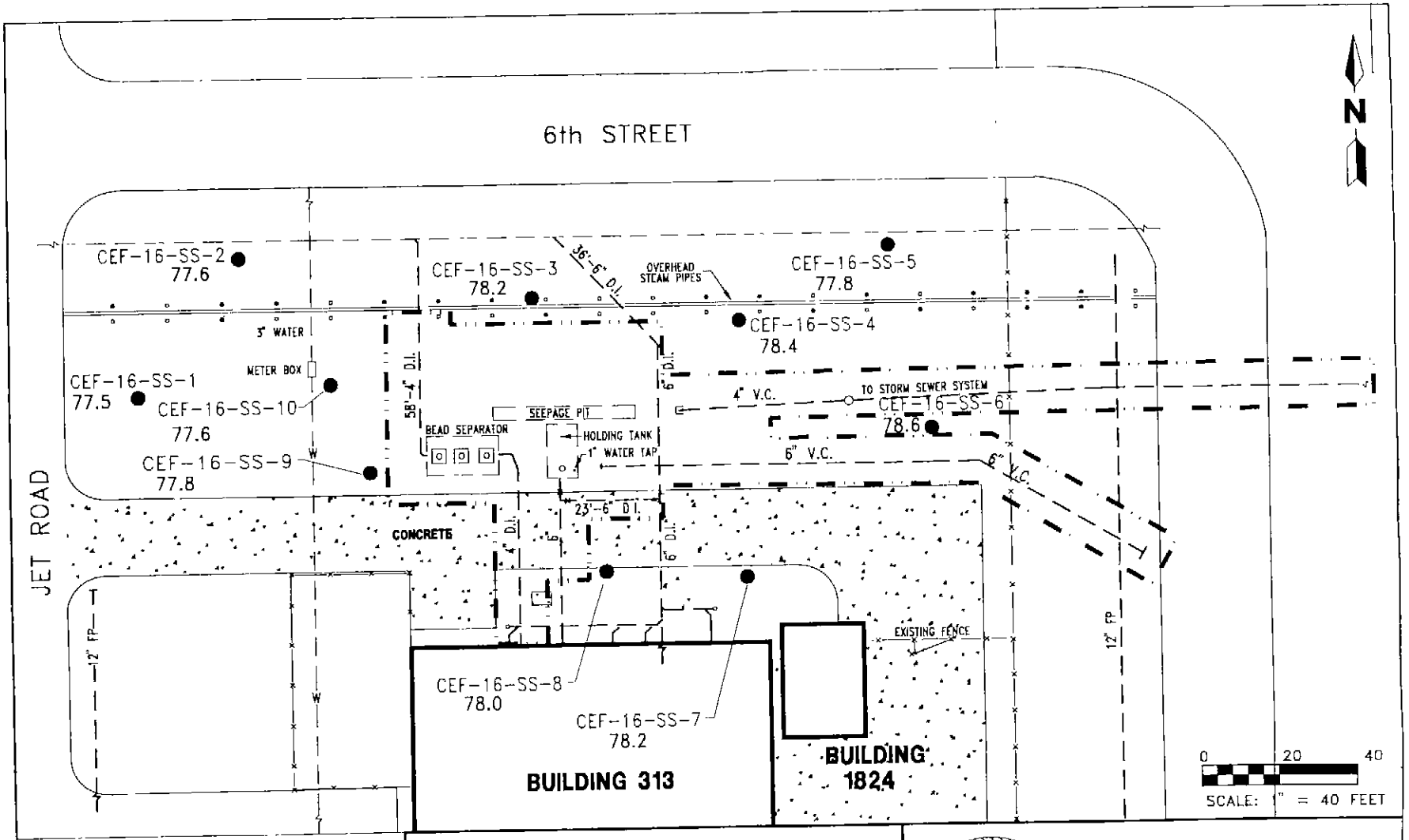

LEGEND

- ● Surface soil sample
- Excavation boundary
- 77.8 Land surface elevation in feet (NGVD), National Geodetic Vertical Datum of 1929

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FIGURE 2-5
COMFIRMATORY SURFACE SOIL SAMPLING LOCATIONS

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JACKSONVILLE, FLORIDA

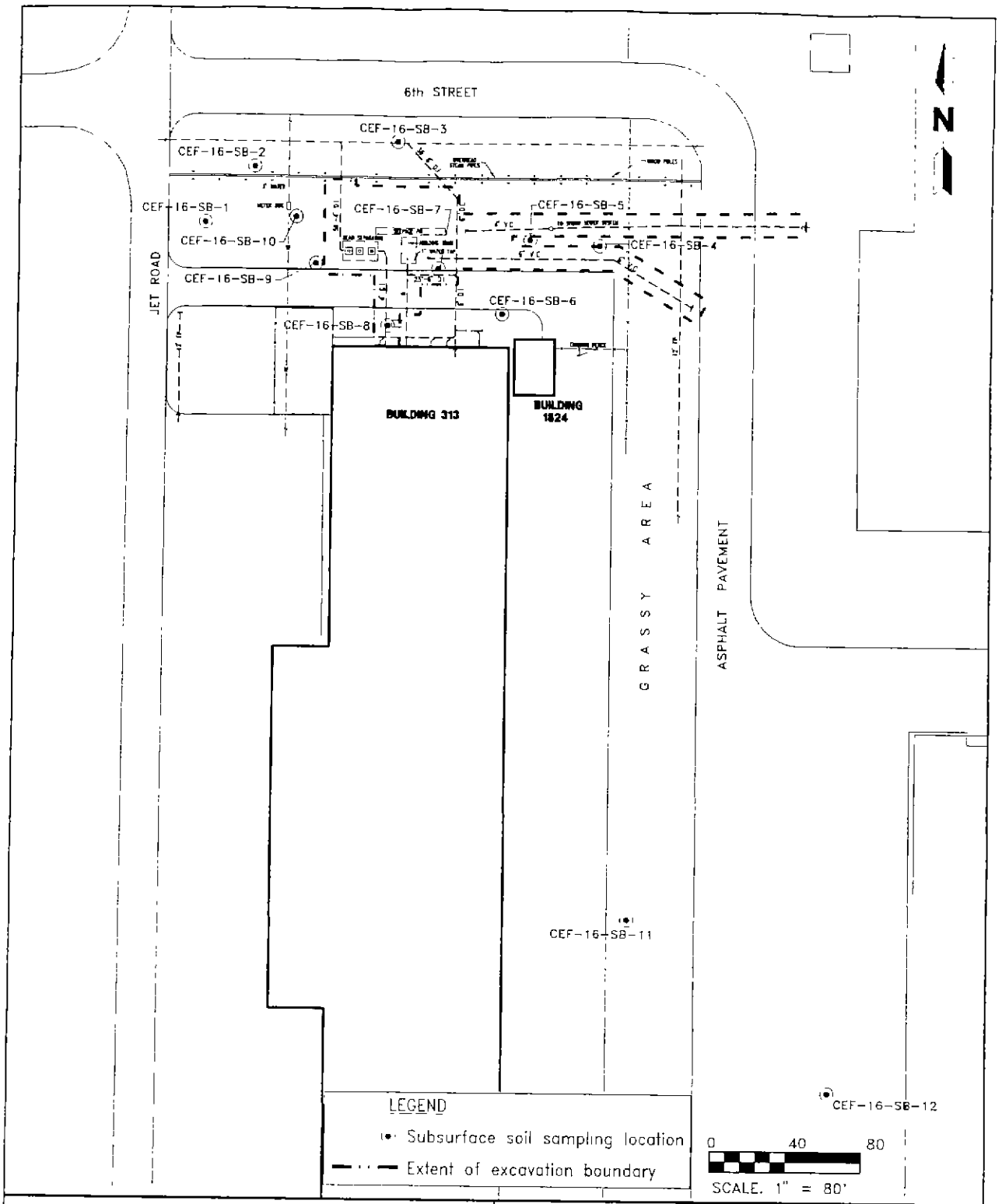

FIGURE 2-6
CONFIRMATORY SUBSURFACE SOIL SAMPLING LOCATIONS

REMEDIAL INVESTIGATION, OPERABLE UNIT 7

NAS CECIL FIELD
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desired sampling interval. The Aquaprobe™ is then placed inside the augers with the outer casing firmly seated against the drive point and lowered to the bottom of the boring. The probe can be advanced to the desired sampling interval by hammering like a split spoon (the most common method) or by pushing with the drill rig. After measuring the level of any water that may have leaked into the probe stem, the 4-foot section of screen is exposed to the formation and the groundwater sample is collected using a Teflon™ bailer. Following collection of each sample, the Aquaprobe™ is removed from the boring and decontaminated.

Because of the absence of any contaminant pathways that may have been separated by interbedded sands and clays, the samples were typically collected from six depth intervals at each location: 11 to 15 feet bls, 18 to 22 feet bls, 28 to 32 feet bls, 52 to 56 feet bls, 72 to 76 feet bls, and 98 to 102 feet bls (top of dolomite). The samples collected from the top of dolomite southeast of OU 7 ranged in depth from 85 to 98 feet bls because the upper surface of the dolomite was encountered at a shallower depth. Samples were also collected in the dolomite at one location near the source area (GS-16-13) to a depth of 135 feet bls. The sample from the dolomite was collected from a temporary wellpoint installed by the mud rotary drilling method. The groundwater samples were analyzed onsite using USEPA Methods 8010 and 8020, modified by targeting only select VOCs and naphthalene.

2.5.2 **Monitoring Well Installation, Sampling, and Analysis** A total of 30 groundwater monitoring wells were installed from April 22 to July 1, 1994, to confirm the nature and extent of contamination identified during the groundwater screening program. The wells were also installed to determine migration of possible contaminants, and to periodically measure piezometric water levels to estimate groundwater flow direction, patterns, and rate. The monitoring well locations are shown on Figure 2-7 and a summary of the construction details is presented in Table 2-1. Monitoring well lithologic logs and construction diagrams are presented in Appendix F. The rationale for the selection of the monitoring well locations is documented in the memorandum, dated April 13, 1994, presented in Appendix B.

Prior to this investigation, monitoring wells were installed in the source area. The monitoring well designation for the previously installed wells was different from the current nomenclature. To prevent confusion from multiple well designations, a standardized monitoring well designation system was implemented during the investigation, and monitoring wells from previous investigations have been renamed. The first numerical character in the monitoring well name indicates the site location. The last numerical character in the monitoring well name is the unique location within the site, and has not changed. The letter at the end of the monitoring well name indicates the relative depth of the well (i.e., "S" is shallow, "I" is intermediate, and "D" is deep in the surficial aquifer, and "DD" is the dolomite, or upper zone of the Hawthorn, in the intermediate aquifer). For example, CEF-16-19S, indicates a well at location 19 on Site 16 completed in the shallow zone of the surficial aquifer. The renaming corresponds with the nomenclature used on the chain-of custody forms during the 1994 sampling program.

Monitoring wells CEF-16-1, CEF-16-2, and CEF-16-3 were installed during the RFI, but abandoned in June 1994 because the screened intervals (30 feet) were too long to accurately identify and delineate groundwater contamination. Monitoring wells CEF-16-4S, CEF-16-5S, CEF-16-6S, CEF-16-7S, CEF-16-8DD, CEF-16-9D, and CEF-16-10S

Table 2-1
Monitoring Well Construction Summary

Remedial Investigation
Operable Unit 7, NAS Cecil Field
Jacksonville, Florida

Well Number	Date Installed	Land Surface Elevation[1] (feet, msl)	Total Depth of Well[2] (feet bls)	Screened Interval (feet bls)	Lithology Screened	Construction Method[3]
CEF-16-1	06/19/87	NA	NA	NA	Abandoned	NA
CEF-16-2	06/18/87	NA	NA	NA	Abandoned	NA
CEF-16-3	06/17/87	NA	NA	NA	Abandoned	NA
CEF-16-4S	10/24/91	NA	NA	NA	Destroyed during IRA	NA
CEF-16-5S	10/24/91	78.8	14	4 to 14	Surficial aquifer, silty sand	HSA
CEF-16-6S	10/25/91	NA	NA	NA	Destroyed during IRA	NA
CEF-16-7S	10/25/91	78.7	14	4 to 14	Surficial aquifer, silty sand	HSA
CEF-16-8DD	11/04/91	NA	NA	NA	Abandoned	NA
CEF-16-9D	11/05/91	78.4	101	91 to 101	Surficial aquifer, poorly graded sand with clay	MR
CEF-16-10S	11/05/91	78.4	14	4 to 14	Surficial aquifer, silty sand	HSA
CEF-16-11DD	07/01/94	78.2	118	108 to 118	Intermediate aquifer, dolomite	ODEX
CEF-16-12I	06/21/94	78 3	81	71 to 81	Surficial aquifer, fine- to medium-grained sand	HSA
CEF-16-13S	04/26/94	78.1	16	6 to 16	Surficial aquifer, silty sand	HSA
CEF-16-14D	05/08/94	78.1	101	91 to 101	Surficial aquifer, fine- to medium-grained sand	ODEX
CEF-16-15S	05/09/94	77.3	16	6 to 16	Surficial aquifer, silty sand	HSA

See notes at end of table.

Table 2-1 (Continued)
Monitoring Well Construction Detail Summary

Remedial Investigation
Operable Unit 7, NAS Cecil Field
Jacksonville, Florida

Well Number	Date Installed	Land Surface Elevation[1] (feet, msl)	Total Depth of Well[2] (feet bls)	Screened Interval (feet bls)	Lithology Screened	Construction Method[3]
CEF-16-16D	05/11/94	77.3	101	91 to 101	Surficial aquifer, fine- to medium-grained sand	ODEX
CEF-16-17S	04/25/94	76.8	17	7 to 17	Surficial aquifer, silty sand	HSA
CEF-16-18D	04/24/94	76.8	100	90 to 100	Surficial aquifer, fine- to medium-grained sand	ODEX
CEF-16-19S	05/03/94	70.8	17	7 to 17	Surficial aquifer, silty sand	HSA
CEF-16-20D	05/18/94	78.2	101	91 to 101	Surficial aquifer, fine- to medium-grained sand	ODEX
CEF-16-21S	04/24/94	78.0	17	7 to 17	Surficial aquifer, silty sand	HSA
CEF-16-22I	04/24/94	78.1	35	25 to 35	Surficial aquifer, silty sand	HSA
CEF-16-23D	04/22/94	78.2	17	7 to 17	Surficial aquifer, fine- to medium-grained sand	ODEX
CEF-16-24S	04/24/94	77.7	17	7 to 17	Surficial aquifer, silty sand	HSA
CEF-16-25D	05/04/94	77.6	94	84 to 94	Surficial aquifer, fine- to medium-grained sand	ODEX
CEF-16-26DD	05/03/94	77.4	118	108 to 118	Intermediate aquifer, dolomite	ODEX
CEF-16-27I	05/21/94	77.5	35	25 to 35	Surficial aquifer, silty sand	HSA
CEF-16-28D	05/24/94	77.5	99	89 to 99	Surficial aquifer, fine- to medium-grained sand	HSA
CEF-16-29S	05/31/94	75.6	17	7 to 17	Surficial aquifer, silty sand	HSA

See notes at end of table.

Table 2-1 (Continued)
Monitoring Well Construction Detail Summary

Remedial Investigation
Operable Unit 7, NAS Cecil Field
Jacksonville, Florida

Well Number	Date Installed	Land Surface Elevation[1] (feet, msl)	Total Depth of Well[2] (feet bls)	Screened Interval (feet bls)	Lithology Screened	Construction Method[3]
CEF-16-30D	06/19/94	75.6	92	82 to 92	Surficial aquifer, silty sand and clayey sand	ODEX
CEF-16-31DD	06/16/94	75.6	107	97 to 107	Intermediate aquifer, dolomite	ODEX
CEF-16-32S	05/19/94	76.4	17	7 to 17	Surficial aquifer, silty sand	HSA
CEF-16-33D	05/24/94	76.3	90	80 to 90	Surficial aquifer, fine- to medium-grained sand	ODEX
CEF-16-34DD	06/07/94	76.3	107	97 to 107	Intermediate aquifer, dolomite	ODEX
CEF-16-35S	05/11/94	77.6	17	7 to 17	Surficial aquifer, silty sand	HSA
CEF-16-36I	05/17/94	77 5	55	45 to 55	Surficial aquifer, silty sand	HSA
CEF-16-37D	05/22/94	77 4	91	81 to 91	Surficial aquifer, fine- to medium-grained sand	ODEX
CEF-16-38S	05/04/94	76 9	17	7 to 17	Surficial aquifer, silty sand	HSA
CEF-16-39I	05/06/94	76.9	55	45 to 55	Surficial aquifer, silty sand	HSA
CEF-16-40D	05/20/94	77.0	89	79 to 89	Surficial aquifer, fine- to medium-grained sand	ODEX

[1] Elevation of northeast corner of concrete pad
[2] Measured from land surface; includes any sump.
[3] All wells installed with 2-inch interior diameter (ID), flush threaded, schedule 40 polyvinyl chloride (PVC), with 10-foot long screen (0.010 inch screen slot size) and silica sand filter pack (90 percent passing the 20 sieve and 10 percent passing the 30 sieve) in boreholes advanced by the noted drilling method.

Notes: msl = mean sea level datum (National Geodetic Vertical Datum [NGVD], 1929).
bls = below land surface.
NA = not applicable.
IRA = Interim Remedial Action.
HSA = hollow-stem auger.
MR = mud-rotary.
ODEX = reverse circulation.

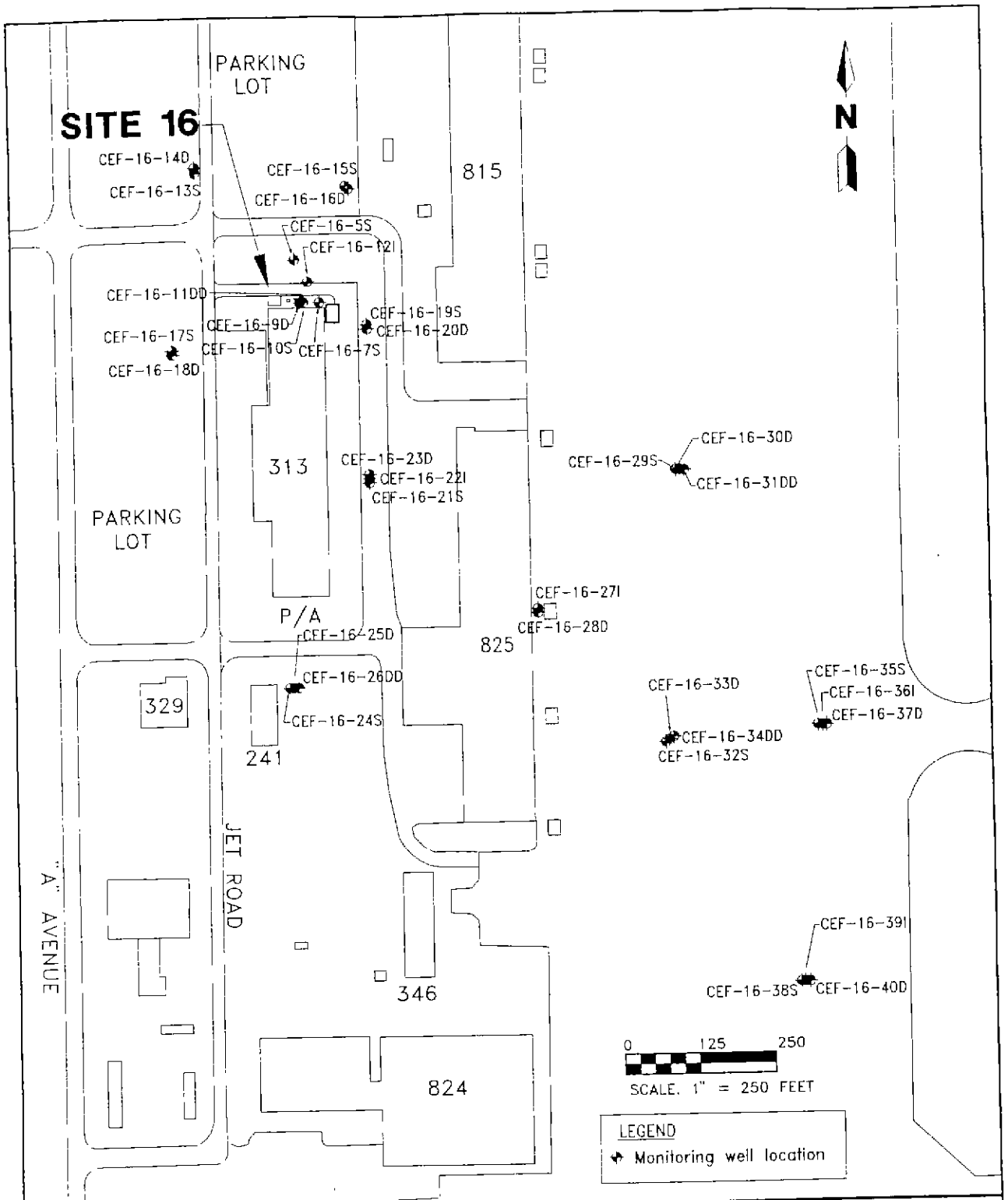

FIGURE 2-7
MONITORING WELL LOCATIONS

REMEDIAL INVESTIGATION, OPERABLE UNIT 7

NAS CECIL FIELD
JACKSONVILLE, FLORIDA

were installed during the 1991-92 RI activities, but wells CEF-16-4S and CEF-16-6S were destroyed in May 1994 during the IRA soil excavation. Monitoring well CEF-16-8DD was installed during the 1991-92 RI activities but was abandoned in June 1994 because the outer casing was terminated in the sand and would not effectively seal off the UZH from the LZS. The monitoring wells were abandoned in accordance with St. Johns River Water Management District procedures (Florida Legislature, 1989).

Monitoring wells CEF-16-13S, CEF-16-15S, CEF-16-17S, CEF-16-19S, CEF-16-21S, CEF-16-24S, CEF-16-29S, CEF-16-32S, CEF-16-35S, and CEF-16-38S were installed between April 26 and May 31, 1994, to investigate groundwater in the upper part of the surficial aquifer. All UZS wells have 10-foot screens across the water table, with the top of the screens ranging from approximately 4 feet to 7 feet bls. Intermediate depth (IZS) monitoring wells CEF-16-12I, CEF-16-22I, CEF-16-27I, CEF-16-36I, and CEF-16-39I were installed with 10-foot screens, with the top of the screens ranging from 25 feet to 71 feet bls. The deep (LZS) monitoring wells CEF-16-9D, CEF-16-14D, CEF-16-16D, CEF-16-18D, CEF-16-20D, CEF-16-23D, CEF-16-25D, CEF-16-28D, CEF-16-30D, CEF-16-33D, CEF-16-37D, and CEF-16-40D were installed to investigate the groundwater in the lower part of the surficial aquifer at OU 7 and have 10-foot screens, with the top of the screens ranging from 81 feet to 91 feet bls, and the bottoms of which sit on top of the clay layer (the bottom of the LZS). Monitoring wells CEF-16-11DD, CEF-16-26DD, CEF-16-31DD, and CEF-16-34DD were screened in the dolomite to investigate the groundwater in the UZH. The UZH wells have 10-foot screens, with the top of the screens ranging from 97 feet to 108 feet bls.

The "S" and "I" monitoring well borings, as well as the boring for CEF-16-28D, were advanced using the HSA method. The "D" and "DD" monitoring well borings were drilled using the ODEX method. The ODEX drilling method uses a flush-threaded, temporary steel casing that is advanced with a casing hammer and an acentric bit. The acentric bit is spring-loaded and expands when rotated to a diameter slightly greater than that of the casing; when counter-rotated, the drill bit decreases in diameter to a size slightly smaller than that of the casing. Drill cuttings are evacuated from inside the casing through suction or air-lifting, preventing any potentially contaminated cuttings from circulating throughout the depth of the borehole.

Split-spoon samples were collected and logged continuously from the well boreholes advanced by HSA method. Drill cuttings were used for logging purposes from the well boreholes advanced by the ODEX method. Monitoring well boring logs are presented in Appendix F. Physical characteristics of the OU 7 study area are presented in Chapter 3.0.

Monitoring wells were constructed of flush-threaded, 2-inch inside diameter, Schedule 40, polyvinyl chloride (PVC) screen and riser that meets National Sanitation Foundation (NSF) Standard 14. Monitoring wells were constructed and installed in accordance with SOUTHNAVFACENGCOM *Guidelines for Groundwater Monitoring Well Installation* and as specified by USEPA Region IV Guidance (USEPA, 1991a). All monitoring wells were constructed as outlined in the Sampling and Analysis Plan (SAP) of the RI/FS workplan. Monitoring well construction details for OU 7 are summarized in Table 2-1 (see also Appendix F). The wells were developed to remove fine-grained soil particles, improve the hydraulic connection within the natural formation, and to obtain a representative groundwater sample. Preliminary development of the wells occurred after hydration of the bentonite

seal by pumping for approximately 30 minutes on the shallow wells and 60 minutes on the deeper wells. The deeper wells were pumped longer to remove water that may have been introduced to the aquifer during the ODEX drilling operations. Approximately 24 hours after installation and initial development, the wells were more fully developed by pumping. Prior to sampling, the wells were purged until turbidity readings were less than 5 nephelometric turbidity units (NTUs). If the 5-NTU limit could not be attained during purging, both filtered and unfiltered samples were collected for TAL analysis. The physical parameter measurements recorded during development and purging are presented in Appendix G.

Groundwater samples were collected from all monitoring wells during July and August 1994 and analyzed according to USEPA CLP procedures for TCL organics, TAL inorganics, hexavalent chromium, cyanide, sulfides, TRPH, TDS, TOC, and major cations and anions. Sample collection and analyses were performed in accordance with USEPA Level IV requirements. Data validation was performed on all analytical results in accordance with USEPA functional guidelines (USEPA, 1991b). Appendix G presents logs completed during groundwater sample collection. Laboratory analytical results are discussed in Chapter 4.0.

In situ hydraulic conductivity tests (slug tests) were conducted on all monitoring wells at OU 7. The method used consists of submersing a slug (PVC tube filled with sand) of known volume within the monitoring well and allowing the well to stabilize at a static water level. After the groundwater in the well has stabilized, the slug is removed as quickly as possible (in theory instantaneously) and the resulting drop in head and subsequent recharge are recorded over time using a pressure transducer and a data logger. The aquifer slug test data were analyzed using a computer program (Geraghty & Miller, 1989) based on the Bouwer and Rice (1976) method. The results of the aquifer slug tests are presented in Section 3.6. Appendix H contains the aquifer slug test data.

Groundwater level measurements were collected monthly, beginning in August 1993, for all monitoring wells at OU 7. The groundwater levels were measured using an electric water level indicator and an engineering scale accurate to 0.01 foot. Water level elevations were calculated by subtracting the measured depth to groundwater from the elevation of the top of well riser pipe. Groundwater level data are found in Appendix I. Groundwater elevation contour maps are presented in Chapter 3.0.

2.6 BACKGROUND INVESTIGATIONS. A sampling program was designed to characterize existing background conditions for NAS Cecil Field and to support the RI, RA, and FS for OU 7. The background monitoring network consisted of monitoring well installation and the collection of surface soil, subsurface soil, and groundwater samples. Surface water and sediment sampling was also completed over much of the drainage system for NAS Cecil Field.

Figure 2-8 shows the stations included in the background sampling network. Appendix J presents a detailed summary of rationale for the selection of base-wide background sampling locations as well as the chemical and physical analyses completed at each of these locations. At OU 7, surface and subsurface soil was compared to basewide background soil classified as Arents. Groundwater background was established using the results from upgradient monitoring wells CEF-16-13S, CEF-16-14D, CEF-16-15S, and CEF-16-16D. Surface water and sediment background was established using the results from samples STC-SW-R1 and STC-SD-R1, which are

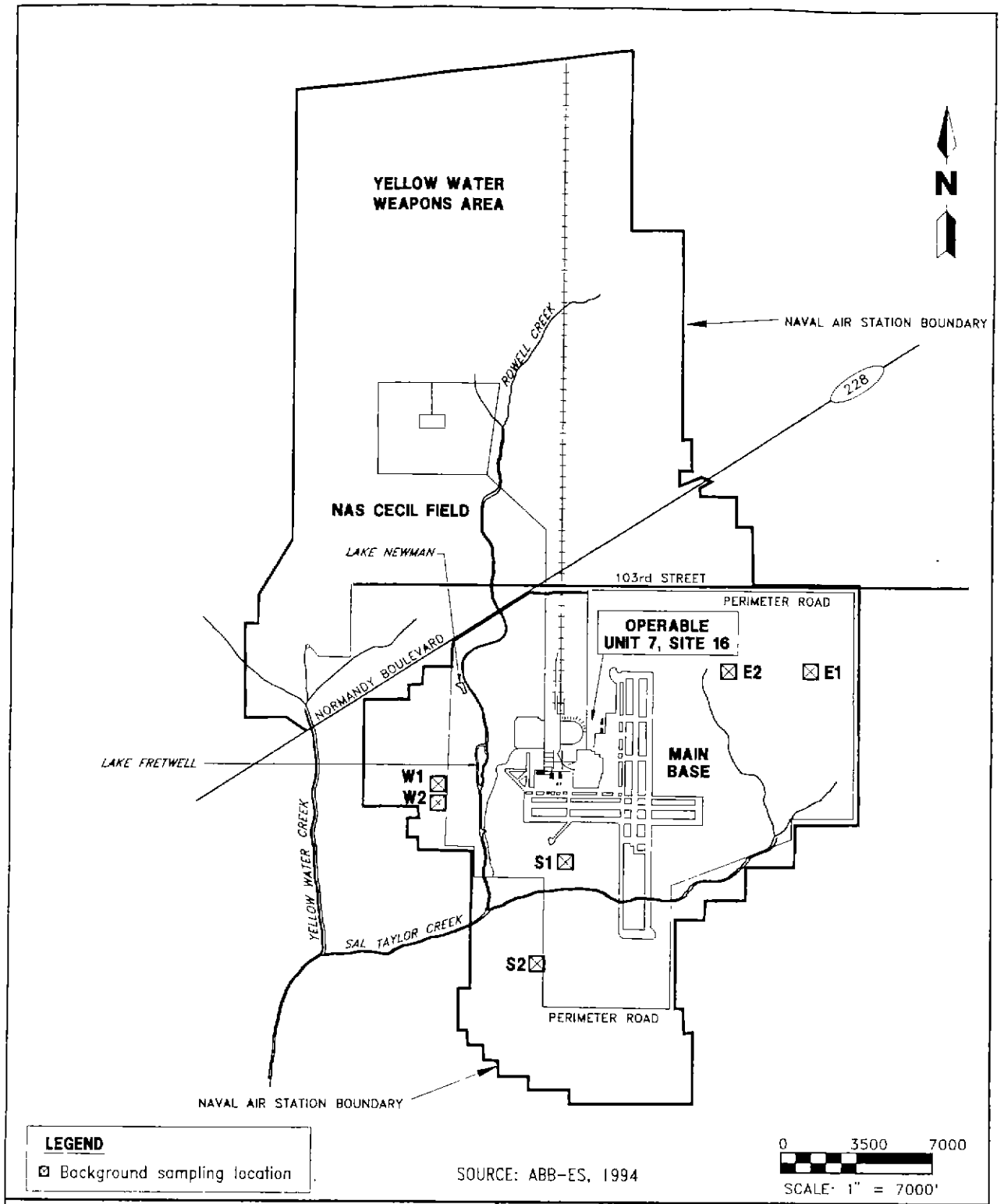

FIGURE 2-8
BACKGROUND SOIL AND GROUNDWATER SAMPLING LOCATIONS

REMEDIAL INVESTIGATION, OPERABLE UNIT 7

NAS CECIL FIELD
JACKSONVILLE, FLORIDA

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located in Sal Taylor Creek, upstream of its confluence with the drainage ditches east of the runway.

The objectives of the background sampling program were to: (1) develop an accurate representation of existing physical and chemical background conditions at NAS Cecil Field, (2) establish a database for these physical and chemical measurements to be used during the IR program investigations, and (3) provide permanent and representative monitoring stations in the surficial aquifer. The establishment of existing background conditions is most important for the inorganics (metals), which are naturally occurring and will be detected (at varying concentrations) in all surface soil, subsurface soil, and groundwater samples collected. Characterization of existing background conditions is also important for the interpretation of certain organic analyses, such as pesticides, naturally occurring hydrocarbons, and organic carbon.

2.7 ECOLOGICAL INVESTIGATION. A sampling program was implemented to provide information necessary for completion of the Ecological Risk Assessment and FS. The ecological investigation included toxicity testing of the sediment and an aquatic sampling field program. Each of these components is described in the following subsections. Information from the investigation was used to identify ecological receptors, characterize the ecotoxicity of contamination in surface soil and sediment, and to identify risks in the Ecological Risk Assessment.

2.7.1 Sediment Toxicity Testing Toxicity testing of sediment was completed in coordination with the sampling for chemical analyses as described in Section 2.3. The sediment samples for toxicity testing were collected with the samples for chemical analyses, homogenized, and split. The sediment samples were submitted for toxicity testing with two organisms, water flea (*Ceriodaphnia dubia*) and amphipod or crustacean (*Hyallela azteca*). The methods for toxicity testing are included as Appendix Q of the BRA (ABB-ES, 1995a). The methods used are based on USEPA Method 1002.0 prescribed by the USEPA (1989a) and generally meet the standard procedures described in the ASTM guidelines for completing sediment toxicity tests with freshwater invertebrates (ASTM, 1991). The purposes of the toxicity testing were to determine location-specific toxicity of sediments and risk for aquatic receptors in the Ecological Risk Assessment. The toxicity testing of sediment and results are presented in Chapter 6.0 of the BRA (ABB-ES, 1995a).

2.7.2 Aquatic Invertebrate and Fish Sampling The aquatic field sampling completed for OU 7 included sampling of the benthic macroinvertebrate community, fish, water quality parameters, and aquatic habitat quality parameters. The benthic macroinvertebrate community was sampled at each of the surface water and sediment sampling locations shown on Figure 2-1. The sampling procedures and results are included in the BRA (ABB-ES, 1995a). The purpose of the ecological investigation was to determine the status of the structure and function of the existing benthic macroinvertebrate community in the area of OU 7 and to ascertain if contaminants present at OU 7 may be having an adverse effect on the health of that community.

3.0 PHYSICAL CHARACTERISTICS OF THE OPERABLE UNIT 7 STUDY AREA

This chapter presents a description of the physical characteristics of the OU 7 study area. Discussion of the physical characteristics is divided into the following sections: surface features, meteorology, surface water hydrology, geology, soil, hydrogeology, demography and land use, and ecology.

3.1 SURFACE FEATURES AND DRAINAGE. Surface features and topography are presented on Figure 3-1. OU 7 is vegetated with grass that is mowed regularly. The general area adjacent to OU 7 is relatively flat and is covered with asphalt and concrete. The immediate area is crisscrossed with several utilities (Figure 3-1), including a water line, overhead steam line, fire water main, a sanitary sewer main, and storm drain lines (both active and abandoned). There are no inlets to the storm sewer system in the immediate vicinity of OU 7 (ABB-ES, 1992). The nearest inlet is on the east side of Building 313, near the northeast corner. Adverse effects, such as surface soil staining or stressed vegetation, were not visible during site visits in 1988, 1991, and 1993.

Surface water flow from OU 7 is typically toward the adjacent paved roads and parking lots. To the east, an unlined, grassy drainage swale may receive some runoff from OU 7 and carry it to the south toward a catch basin. It is believed that the runoff from the paved roads and parking lots in the vicinity of OU 7 ultimately flows to the NAS Cecil Field stormwater sewer system (Harding Lawson Associates, 1988). The storm sewer system is depicted on Figure 3-2.

The storm sewer system collects surface water runoff in catch basins and transports it through underground piping as indicated by the flow arrows on Figure 3-2. Most of the storm sewer trunk lines (main lines) intersect the water table as do some of the lateral lines (smaller sewer lines draining into the trunk lines).

The storm sewer system discharges into drainage ditches that lead to the wetlands on the east side of the runways and eventually discharge into Sal Taylor Creek farther to the east.

Prior to construction of the runways (circa 1952), runoff was transported from the area of OU 7 to the wetlands via a drainage ditch. During construction of the runways, the ditch was filled and the storm drain system discussed above was installed.

3.2 CLIMATOLOGY. The Jacksonville area has a climate approaching the semi-tropical range as it lies near the northern limit of the trade winds, which are the prevailing easterly breezes that moderate summer and winter temperatures. This influence is pronounced along the coast but decreases in the vicinity of NAS Cecil Field. Prevailing winds are generally northeasterly in the fall and winter and southwesterly in the spring and summer. A wind rose for NAS Cecil Field is shown on Figure 3-3.

The annual mean temperature is 68 to 70 degrees Fahrenheit (°F) with an average summer maximum temperature of 82 to 83 °F. Between December and February, the temperature averages 56 to 57 °F. Summer highs are in the middle to upper 90's

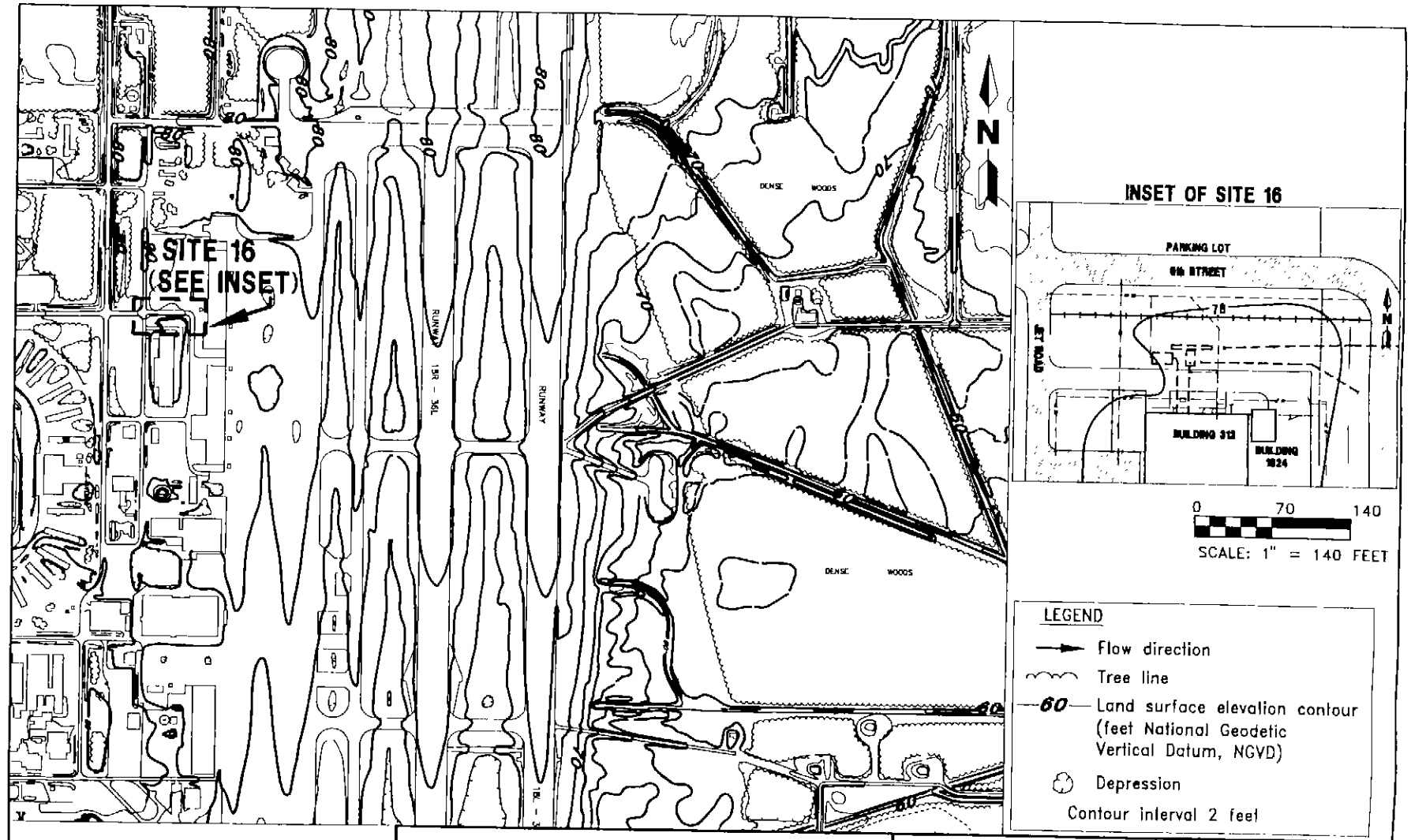

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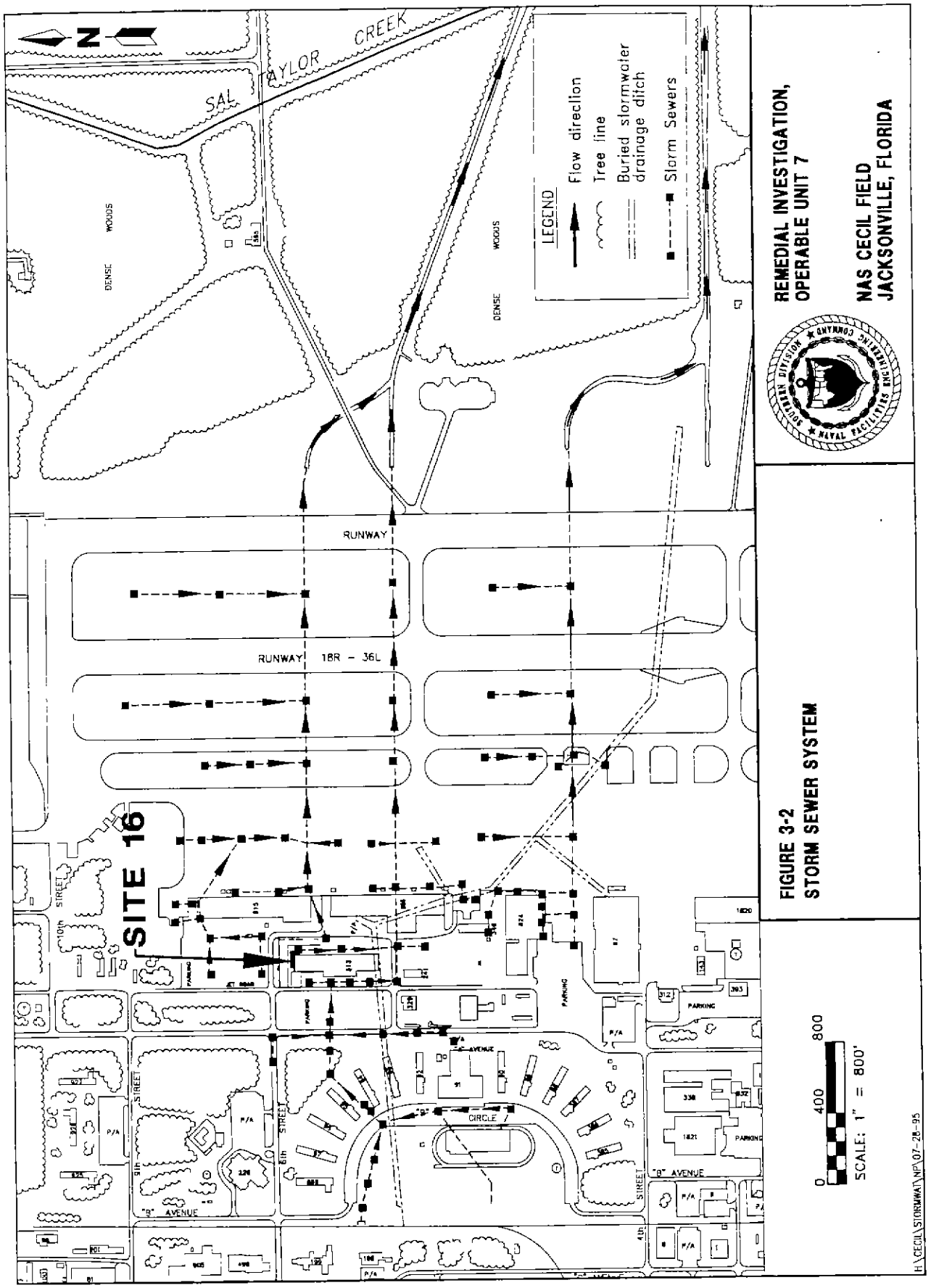
FIGURE 3-1
SURFACE FEATURES AND TOPOGRAPHY

REMEDIAL INVESTIGATION, OPERABLE UNIT 7

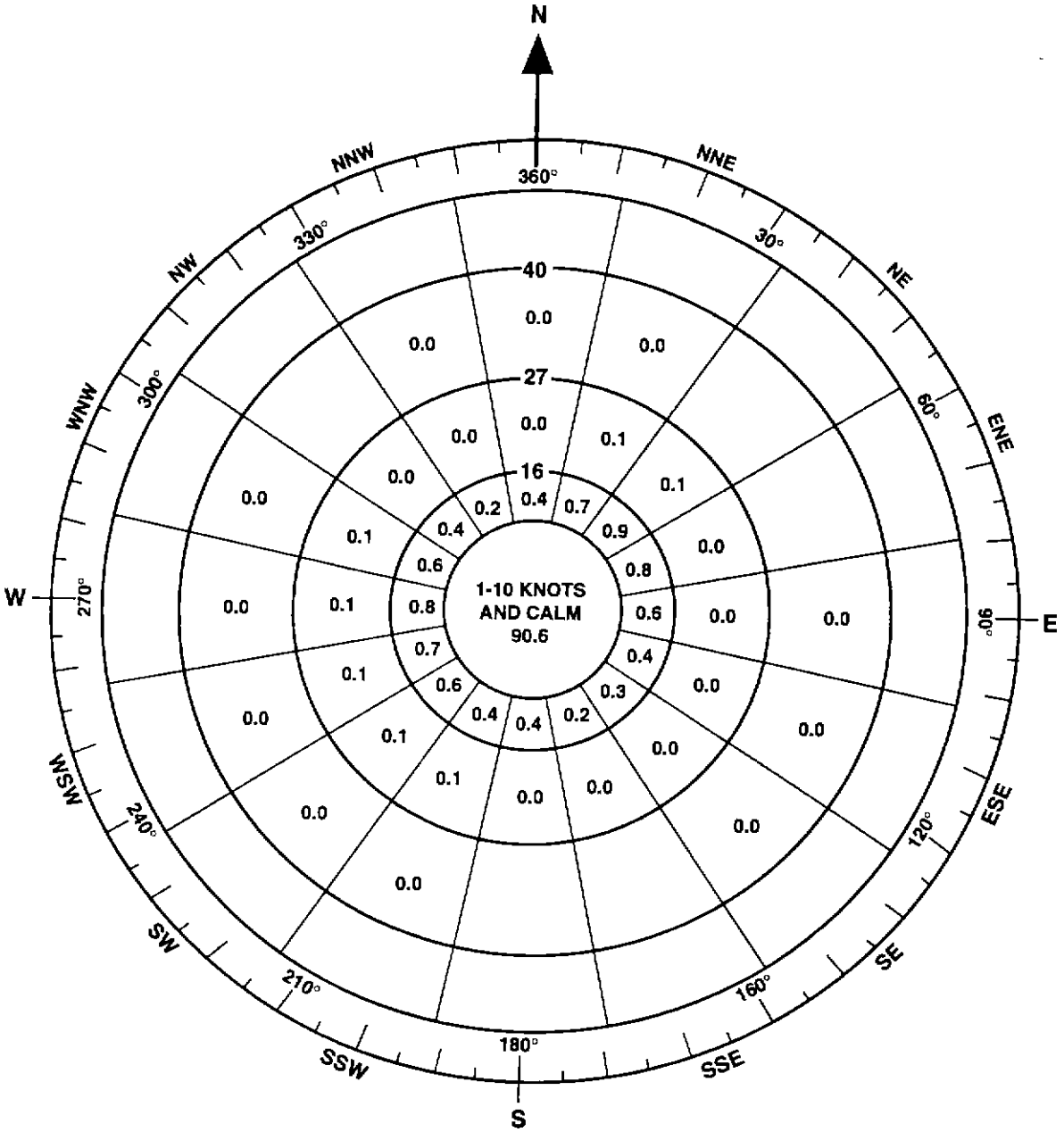
NAS CECIL FIELD
JACKSONVILLE, FLORIDA



REMEDIAL INVESTIGATION, OPERABLE UNIT 7

NAS CECIL FIELD
JACKSONVILLE, FLORIDA

FIGURE 3-2
STORM SEWER SYSTEM



ANNUAL PERCENTAGE FREQUENCY

SURFACE WIND ROSE

1970

Note:
Wind speed is in Knots

Source: NAS Cecil Field Station Map (Undated).

FIGURE 3-3

WIND ROSE

REMEDIAL INVESTIGATION,
OPERABLE UNIT 7

NAS CECIL FIELD
JACKSONVILLE, FLORIDA

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°F and winter lows reach to the upper teens, although temperatures seldom drop below freezing.

The region experiences an average of 53 to 54 inches of rainfall per year, most of which accumulates during frequent summer rain showers. At times, 2 or 3 inches of rain may fall within 1 hour. Extended periods of dry weather may occur in any season but are most common in spring and fall. The relative humidity averages 87 percent, and the average annual sunshine is 62 percent. Flying conditions are usually excellent, with NAS Jacksonville reporting 86 percent Visual Flight Rules (VFR) and NAS Cecil Field reporting 90 percent VFR. Table 3-1 provides a compilation of local climatic data.

Winds of hurricane force (75 miles per hour and above with resulting damage) can be expected once in 5 years with significant deviations from the average. Most occur in August, September, and October, although the 6-month period from June 1 to November 30 is considered the Atlantic Ocean hurricane season. On an average of once a year, NAS Cecil Field is in the predicted path of a hurricane.

CLIMATE SUMMARY

Temperature (°F):	82 to 83 summer mean upper 90's summer high 56 to 57 winter mean upper teens winter low 68 to 70 annual mean
Rainfall:	53 to 54 inches per year annual 2 to 3 inches per hour intensity 7 inches frequency of 24 hour, 10 year storm
Hurricane:	one predicted pathway per year

3.3 SURFACE-WATER HYDROLOGY. NAS Cecil Field lies mostly within the St. Johns River basin with a small part (not including OU 7) lying in the St. Marys River basin. Because of the extremely low gradient, the surface water divide between the St. Johns River basin and the St. Marys River basin is mobile, being dependent on severity and location of recent rain events (Figure 3-4).

Most surface water in Duval County is derived from rainfall within the county, except for a small amount of inflow from neighboring Baker County to the west (Anderson, 1972). Groundwater seepage and springs also contribute to surface water, but to a lesser extent than rainfall.

Drainage at NAS Cecil Field consists of sheet flow across areas of low topographic relief combined with streams and canals of low order (having few to no tributaries). In the St. Johns River basin, streams from west to east include Yellow Water Creek, Rowell Creek, and Sal Taylor Creek. Sal Taylor Creek drains the eastern part of the facility, whereas Rowell Creek receives drainage from the central part and flows into Sal Taylor Creek in the south central part of the facility. Sal Taylor Creek then flows west into Yellow Water Creek, which flows southward, joining Black Creek approximately 1.5 miles south of the facility boundary (Figure 3-4). Black Creek eventually flows into the St. Johns River.

Table 3-1
Climatic Data

Remedial Investigation
Operable Unit 7, NAS Cecil Field
Jacksonville, Florida

Month	Air Temperature (°F)			Precipitation (inches)		Percent Relative Humidity		Wind Speed (knots)				Mean Number of Days			
	Normal		Average Monthly	Normal Total	24 Hour Maximum	7:00 a.m.	1:00 p.m.	Mean Speed	Pre-vailing Direction	Maximum Speed and Direction		Clear	Partly Cloudy	Cloudy	Foggy
	Maximum	Minimum													
January	67	45	56	2.45	3 02	87	56	7.5	NE	34	S	9	9	13	5
February	69	47	57	2.91	3.84	86	52	8.6	WSW	45	NE	9	7	12	4
March	73	51	62	3.49	3 21	85	49	8.5	NW	38	W	9	10	12	3
April	80	58	69	3.55	4.88	84	47	8 3	SE	42	SW	10	10	10	2
May	86	65	76	3.47	5.09	83	48	7.8	WSW	44	E	10	12	9	2
June	91	71	81	6.33	5.93	85	55	7.6	SW	66	NE	6	12	12	1
July	92	73	83	7.68	10.09	87	57	7.0	SW	43	SW	4	15	12	1
August	91	73	82	6 85	7.93	90	59	6 7	SW	3	NE	5	16	10	1
September	88	71	79	7.56	10.17	90	62	7.8	NE	71	N	5	11	14	1
October	80	62	71	5 16	6.66	90	57	7.8	NE	63	E	11	8	12	3
November	72	51	62	1.69	4.21	88	55	7.5	NE	52	S	12	8	10	5
December	67	45	56	2.22	2.51	88	57	7.2	NW	54	N	9	9	13	5

Notes: Table adapted from master plan (SOUTHNAVFACENGCOM, 1989).
°F = degrees Fahrenheit.
NE = northeast.
S = south.
WSW = west to southwest.
NW = northwest.
W = west.
SE = southeast.
SW = southwest.
E = east.
N = north.

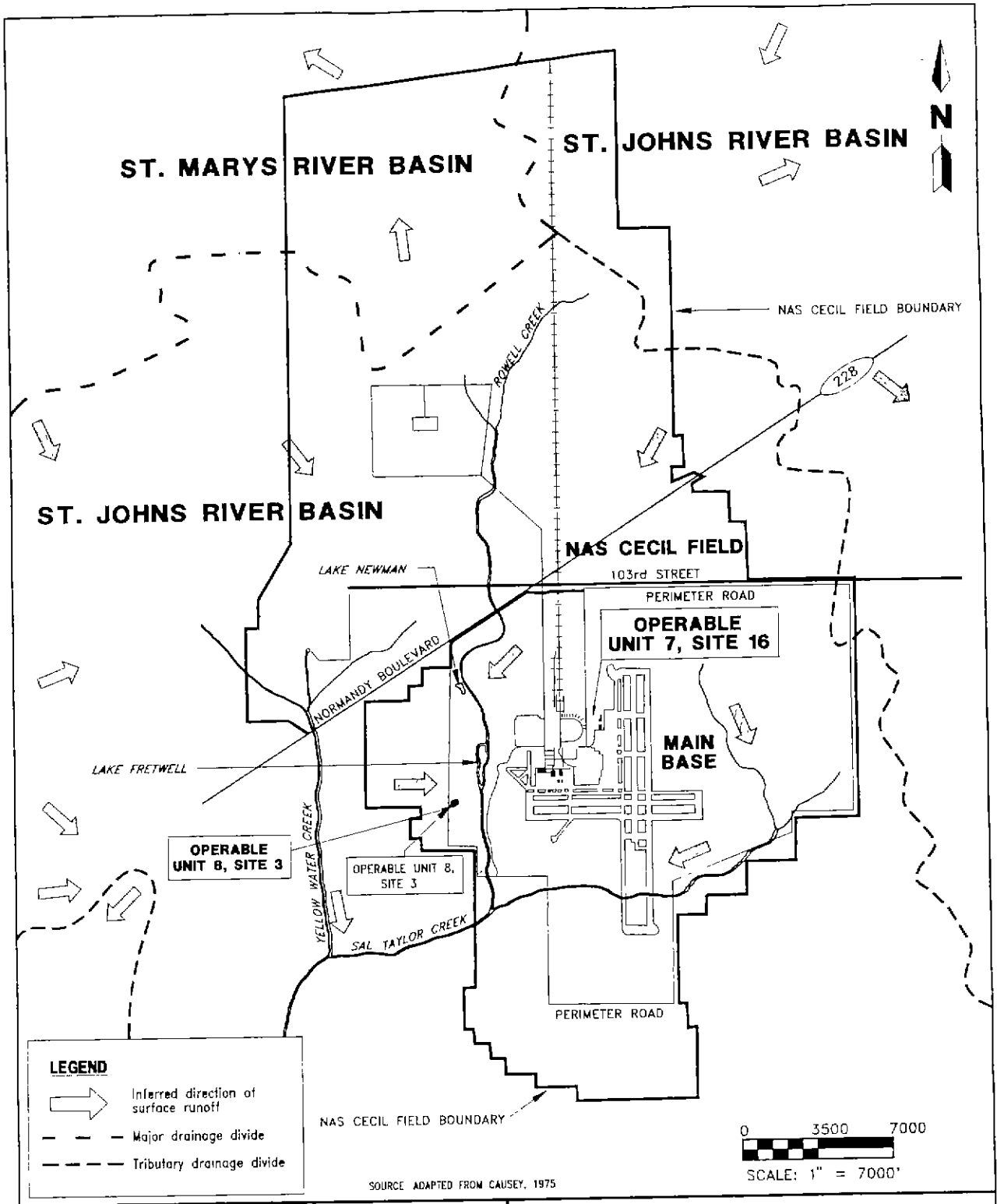

FIGURE 3-4
AREA WATERSHED DRAINAGE BASINS

REMEDIAL INVESTIGATION, OPERABLE UNIT 7

NAS CECIL FIELD
JACKSONVILLE, FLORIDA

CECIL/PI-DRAIN/WDW-GLC/07-27-95

The effects of minor changes in local topography on streamflow direction are clearly shown by the occurrence of stream pirating of these first order tributaries from one drainage to another. Minor alterations to local conditions can favor a new drainage path over an existing one.

A stream gauging data collection effort was conducted by the U.S. Geological Survey (USGS) in the NAS Cecil Field area. The only gauging station on Sal Taylor Creek was Station 02245913, located approximately 3 miles downstream from the confluence of the drainage swales from the runways and developed area in the vicinity of OU 7. The recorded flow volume at that point since 1992 ranged from 760 cubic feet per second (ft^3/sec) to 3 ft^3/sec. A conservative estimate of the amount of dilution that may occur as any groundwater contamination reaches Sal Taylor Creek can be calculated by comparing the estimated volumetric flow of the contaminant plume with the lowest volumetric flow recorded in Sal Taylor Creek. These calculations are presented in Appendix K, and discussed in Chapter 5.0.

3.4 SOIL. Based on the U.S. Department of Agriculture (USDA) Soil Conservation Service Soil Survey of Duval County (USDA, 1978), the soil at OU 7 and the immediate surrounding area is identified as Urban Land.

Urban Land is described as areas that are 85 percent or more covered with streets, houses, commercial buildings, parking lots, shopping centers, industrial parks, airports, and related facilities (USDA, 1978). The soil is probably similar to those present at the adjacent runway area, which is classified as Arents. For the purposes of this investigation and report, the Arents soil type will be used for background comparison of the OU 7 surface soil. Excavation and reworking of the soil in the OU 7 area occurred during the construction of Building 313 and installation of underground utilities, including the seepage pit, holding tank, bead separator, and associated piping.

Arents soils are described as nearly level, poorly drained soils that have been reworked by manmade earthmoving operations. Individual areas range in size from 5 to 500 acres. Slopes range from 0 to 2 percent and are smooth to convex. Typically, the soils consist of mixed soil material. Arents material includes a light gray, grayish brown, very pale brown, yellow, black, dark reddish brown, strong brown, and red fine-grained sand, sandy loam, and sandy clay loam. Sandy textures are dominant in most areas. The sandy loam and sandy clay loam part is fragments or pieces of subsoil material. Pieces of weakly cemented subsoil material are also present in most of these soils. Thickness of the material ranges from 2 to 20 feet. This soil does not have an orderly sequence of horizons (USDA, 1978). The soils encountered at OU 7 correlate well with the description of Arents provided above.

3.5 GEOLOGY.

3.5.1 Historic and Regional NAS Cecil Field lies within a physiographic feature called the Duval Uplands, a feature composed of various Pleistocene marine terraces (Scott, 1988). The Duval Uplands is an irregular flat plain and is composed mostly of the Wicomico marine terrace. Much of NAS Cecil Field is situated on remnants of the Wicomico marine terrace. The remainder of the facility (generally the more southern parts) is located on remnants of the Penholoway marine terrace.

Locally, the shallow marine sediment that makes up the surficial aquifer is undifferentiated. This sediment consists of mostly quartz sand with some clayey sand and clay. The rest of the surficial aquifer system is formed in the Pliocene-Pleistocene Nashua Formation. Scott and Others (1991) describe the Nashua as a fossiliferous, variably calcareous, sometimes clayey quartz sand. The fossil content is variable from a shelly sand to a shell hash. The dominant fossils are mollusks.

In the area of investigation, the intermediate aquifer system or confining unit consists of sediment of the Miocene Hawthorn Group. In addition to its clay rich sediment, the Hawthorn includes near its top a locally continuous carbonate rich unit of dolostone or shell hash that forms the historical "rock aquifer" or "secondary artesian aquifer," a water-bearing unit often used near the area of interest as a private drinking water source (Scott and others, 1991).

Below the Hawthorn Group is a series of carbonate rich units that form the Floridan aquifer system. In the area of investigation, these units are (from oldest to youngest): the Oldsmar Formation, the Avon Park Formation, and the Ocala Limestone. The lower part of the Hawthorn Formation, which forms the intermediate aquifer and confining zone, unconformably overlies and confines the Floridan aquifer system. The Ocala Limestone is Middle to Late Eocene in age and the formation is comprised of a homogeneous sequence of permeable, hydraulically connected, marine limestone containing a few hard, less transmissive dolomite or limestone beds that restrict the vertical movement of water (Scott and others, 1991). The Avon Park Formation is Middle Eocene in age and is comprised almost entirely of interbedded hard, relatively impermeable dolostone confining beds and soft permeable fossiliferous limestone (Scott and others, 1991). The Oldsmar Formation is Lower to Middle Eocene in age and consists of limestone interbedded with vuggy dolostone. Dolomitization tends to increase toward the base of the unit, where pore-filling gypsum and thin beds of anhydride reduce the permeability of the Floridan aquifer system.

The Cedar Key Formation is Paleocene in age and consists mostly of dolostone and evaporites. The upper part of the unit is permeable enough to form the lowest part of the Floridan aquifer system. The lower part of the unit is significantly less porous and evaporite rich and forms the lower confining unit for the Floridan aquifer system (Scott and others, 1991). A regional geologic column is presented as Figure 3-5.

3.5.2 Site-Specific Geology Generally, subsurface geologic materials recovered during drilling operations at OU 7 indicate that the site is underlain by approximately 90 feet of fine-grained silty sand. This sand is typically brown to gray throughout, and varies in shade from light to dark. Layers of clayey sand, sandy clay, and clay, ranging in thickness from less than an inch to 6 inches, were encountered throughout this lithologic strata. Beneath the sand is a layer of clay containing between 40 percent to 50 percent dolomite fragments. This clay is underlain by dolomite. The dolomite is typically gray, microcrystalline, moderately well cemented, moderately hard to soft, and contains mineral replacement of shell material.

More specifically, undifferentiated sediments, probably of Holocene age (recent, less than 10 thousand years old) to Pliocene age (less than 6 million years old), are between 90 and 102 feet thick at OU 7. These sediments generally grade in

TIME (million years ago)	Stratigraphic Units	Approximate Elevation (feet, mean sea level)
		50
1.8	Undifferentiated Pleistocene and Recent Sediments	
	Nashua Formation	
5		
	Hawthorn Group	
	Coosawatchie Formation	20
	(Charlton Member)	(20 to -10)
	Marks Head Formation	-110
	Penny Farms Formation	-200
24		
	Ocala Limestone	-350
	Avon Park Formation	-700
	Oldsmar Formation	< -1,000
55		
	Cedar Key	< -1,200
62		-1,700

Sources:
Scott, 1988; and Scott and others, 1991.

FIGURE 3-5

GEOLOGIC COLUMN

REMEDIAL INVESTIGATION,
OPERABLE UNIT 7

NAS CECIL FIELD
JACKSONVILLE, FLORIDA

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tone from dark brown at land surface to brown at approximately 15 feet bls to light brown at 25 feet bls to an approximate depth of between 40 to 50 feet bls.

At this point, the sediments grade to a light gray, and continue to approximately 70 feet bls where the tone grades to dark gray. These sediments consist of fine- to medium-grained, poorly to well-sorted quartz sands with some silty sands, clayey sands, and clays. The sand layer is underlain by a layer of clay. This clay is approximately 6 to 10 feet thick, dark gray, plastic, with soft to medium stiffness, and contains dolomite fragments. This clay layer was found in all boreholes that reached the dolomite and acts as a boundary between the unconsolidated sands and the dolomite.

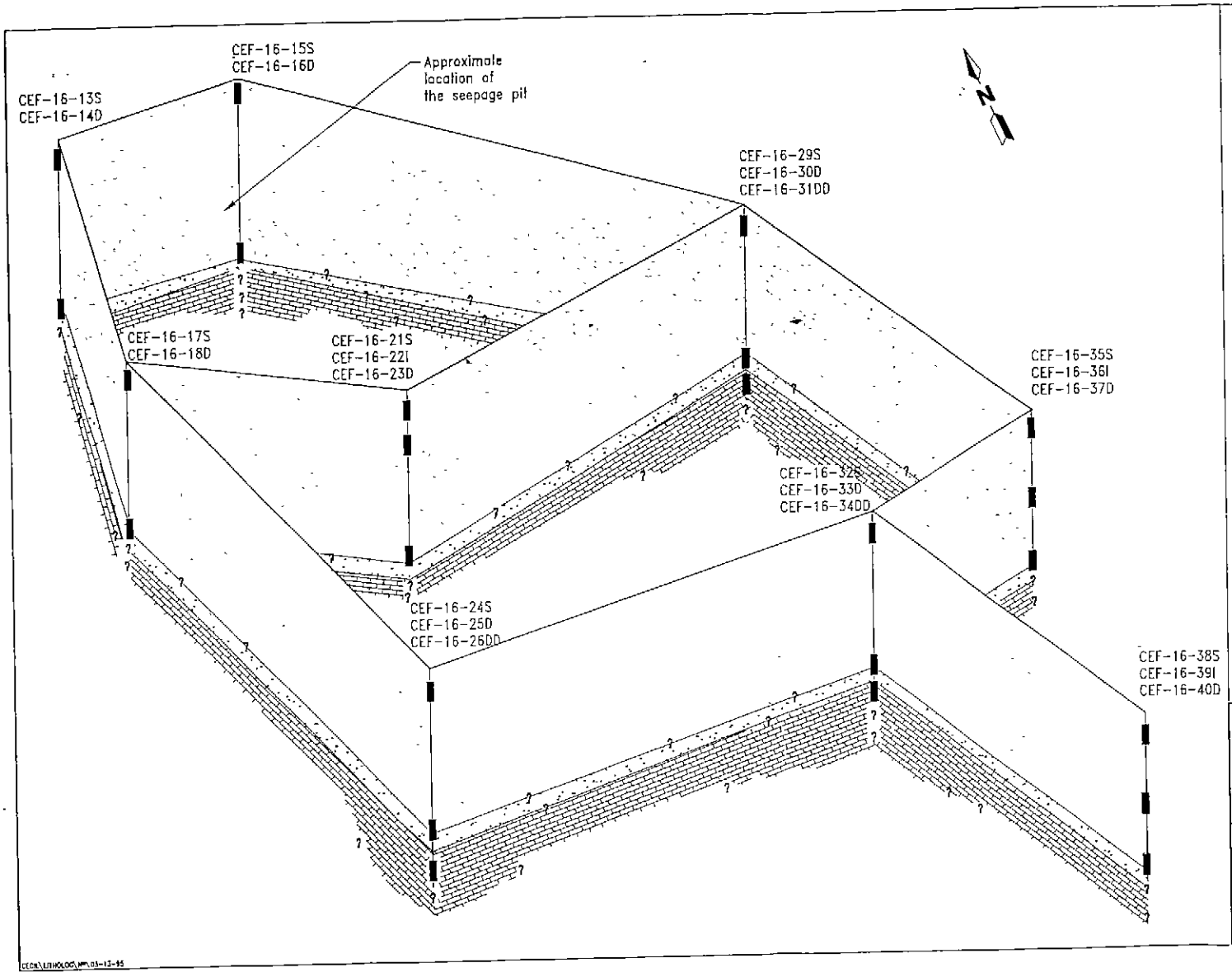
Beneath the clay layer are sediments of the Miocene (between 6 and 24 million years old) age Hawthorn Group. Locally, the uppermost layers of the Hawthorn Group include a continuous carbonate-rich unit of dolomite, a limestone or marble rich in magnesium carbonate, and/or shell hash. Historically, this unit has been called the "rock aquifer" or "secondary artesian aquifer." In this report, this unit is simply considered to be a water producing zone of the intermediate aquifer system. This unit was encountered in deep monitoring well boreholes located immediately below and downgradient of the waste facilities (CEF-16-11DD, CEF-16-26DD, CEF-16-31DD, and CEF-16-34DD). Beneath OU 7, the unit consists of a moderate yellowish brown to medium dark gray dolomite. The unit can be oolitic (small round coated grains, resembling roe of fish, usually of calcium carbonate, silica, or iron oxide, cemented together) and fossiliferous. Fossils are generally shell fragments. The dolomite also contains voids and caverns, which contain shell fragments, clay, and sand. At the site, this unit is at least 15 feet thick and the top is encountered at depths of approximately 90 to 105 feet bls.

Lithologic logs from OU 7 are presented in Appendix C for soil borings and Appendix F for monitoring wells. A three-dimensional diagram of the subsurface at OU 7 is presented as Figure 3-6. A contour map of the top of dolomite elevation is presented as Figure 3-7.

3.6 HYDROGEOLOGY. In the area of this investigation, there are three water-bearing systems. According to the Florida hydrostratographic nomenclature (FGS, 1986) these units, from most shallow to deepest are: the surficial aquifer system, the intermediate aquifer system and confining unit, and the carbonate-rich Floridan aquifer system.

3.6.1 Aquifer Systems At OU 7, the surficial aquifer system is present in the undifferentiated sediments described above. The intermediate aquifer system and confining unit is present as the dolomite (historical "rock" or "secondary wells are screened in the "artesian" aquifer) underlying the layer of clay with dolomite fragments. The Floridan aquifer system was not encountered during the investigation at OU 7.

3.6.1.1 **Surficial Aquifer System** The surficial aquifer system in the area of OU 7 is composed of undifferentiated sediments. The undifferentiated sediments consist of mostly quartz sands with some clayey sands and clays. The Pliocene-Pleistocene Nashua Formation and the thick clay layer separating the Nashua from the differentiated sediments at other OUs on Cecil Field, were not encountered at OU 7. As a result, the surficial aquifer at OU 7 is not separated into an



LEGEND

- Sand
- Dolomite cobbles and clay
- Dolomite
- ? Interpreted stratigraphy
- Monitoring well
- Screened interval

HORIZONTAL SCALE
0 60 120
SCALE: 1" = 120 FEET

VERTICAL SCALE
0 30 60
SCALE: 1" = 60 FEET

FIGURE 3-6
LITHOLOGIC FENCE DIAGRAM

REMEDIAL INVESTIGATION, OPERABLE UNIT 7

NAS CECIL FIELD
JACKSONVILLE, FLORIDA

CECIL\LITHOLOGY\MP\03-13-95

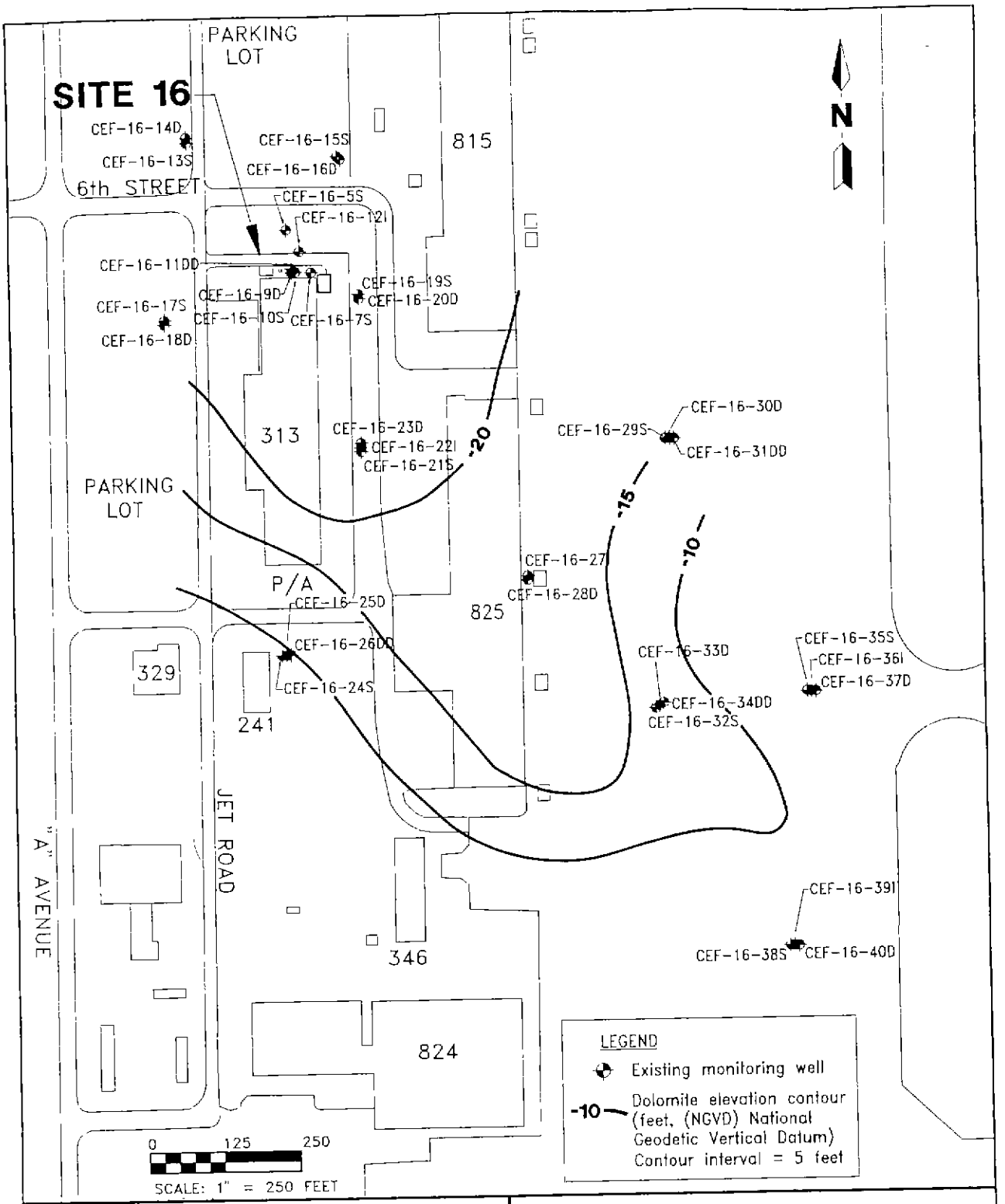


FIGURE 3-7
TOP OF DOLOMITE ELEVATION CONTOUR MAP

REMEDIAL INVESTIGATION, OPERABLE UNIT 7

NAS CECIL FIELD
JACKSONVILLE, FLORIDA

upper and lower zone based on geology, but rather is considered as one unit. Still, well screens were placed to investigate conditions in the shallow (UZS), intermediate (IZS), and deep (LZS) parts of the surficial aquifer system.

The surficial aquifer system is under water table conditions (unconfined) and is a very fine-grained quartz sand with up to 10 percent silts and clays. The unconsolidated sediments extend downward to the top of the clay unit, which separates the surficial aquifer system from the intermediate aquifer system (Figure 3-5).

3.6.1.2 **Intermediate Aquifer System** In Duval County, the intermediate aquifer system or confining unit consists of sediments assigned to the Miocene Hawthorn Group. In addition to its clay rich sediments, the Hawthorn includes near its top a locally continuous carbonate rich unit of dolomite with significant secondary (e.g., fractures) porosity (pore space or void volume ratio), possibly including shell hash, or sand bodies. This carbonate-rich unit forms the historical "rock aquifer" or "secondary artesian aquifer," a water-bearing unit widely used in this region as a private drinking water source. For this report, this unit will be referred to as the UZH. In the NAS Cecil Field area, the unit is approximately 20 to 25 feet thick and occurs at a depth of 60 to 120 feet bls. The top of this unit is irregular and may represent an erosional unconformity. The total thickness of the entire Hawthorn Group (including the underlying clayey confining beds) exceeds 300 feet in this area (Scott and others, 1991). At OU 7, all of the "DD" monitoring wells are screened in the UZH.

3.6.1.3 **Floridan Aquifer System** The Floridan aquifer system is the principal source of groundwater derived for public drinking water in most of northern peninsular Florida. At Cecil Field, at least five Navy potable water supply wells (these are Navy wells and are not connected to a public water supply system) and an irrigation well are producing water from this aquifer system. In the area of investigation, the system is comprised of (from oldest to youngest) the Oldsmar Formation, the Avon Park Formation, and the Ocala Limestone. The Hawthorn Group, which forms a confining zone, unconformably overlies the Floridan aquifer system. Geraghty & Miller (1983) report that the transmissivity of the Floridan aquifer a few miles east of the base is 25,400 square feet per day (ft^2/day). Leve (1966) and Geraghty & Miller (1983) report that groundwater within the Floridan aquifer flows east-northeast in the vicinity of NAS Cecil field.

The physical and geochemical characteristics of the aquifers encountered at OU 7 are discussed below.

3.6.2 **Physical Aquifer Characteristics** To better understand the rate and direction of groundwater movement beneath OU 7, certain physical properties of the aquifers were measured at the various well locations. These properties include hydraulic gradient (calculated from groundwater level elevation data) and hydraulic conductivity (calculated from slug test data). Using these data and an estimated effective porosity (the pore space through which water flows), groundwater flow rates within the aquifers are subsequently estimated.

3.6.2.1 **Groundwater Elevations and Flow Directions** As described in Subsection 2.7.2, groundwater level measurements were recorded at monthly intervals for all monitoring wells at OU 7. By subtracting these measurements from the surveyed top of well casing elevation, a groundwater level elevation (to 0.01 foot NVGD)

is calculated for each well. The water level and groundwater elevation data are presented in Appendix I. The interpretation of these results is discussed below.

Surficial Aquifer System. The groundwater elevation data for the surficial aquifer have been plotted on plan view and cross-section contour maps to facilitate the interpretation of the hydraulic gradients. Plan views for the UZS wells and LZS wells are presented as Figures 3-8 and 3-9, respectively. Two cross sections were prepared, running from OU 7 and the western extent of contamination in a downgradient direction, as indicated on the plan view maps. These cross sections are presented as Figure 3-10.

The general groundwater flow direction in the surficial aquifer is to the southeast. This general flow direction indicates that the groundwater discharges to the wetland area and Sal Taylor Creek east of the runways. However, the cross sections also show a dramatic upward vertical gradient in the surficial aquifer before groundwater even reaches the west side of the runways. The groundwater appears to be upwelling from the intermediate aquifer to the surficial aquifer beginning southeast of well cluster CEF-16-21S, CEF-16-22I, and CEF-16-23D. The surficial aquifer, in turn, drains to an area south-southeast of well cluster CEF-16-38S, CEF-16-39I, and CEF-16-40D. The upwelling is interpreted to be caused by a localized absence, thinning, or increased hydraulic conductivity of the clay layer on top of the dolomite.

The horizontal gradient in the surficial aquifer measured along the flowpath from the seepage pit area (CEF-16-5S) to the lead edge of the plume (CEF-16-32S) is approximately 0.0029 foot per foot (ft/ft), based on water level data collected in August 1994. Water levels were also collected from all wells in July, September, and October 1994. Changes in water levels were observed between months, but the differences between wells within each of the four data sets were consistent.

Intermediate Aquifer System. Regional groundwater flow in the UZH is to the east (Fairchild, 1972), although the top part of the UZH encountered in the OU 7 investigation shows flow to the south-southeast. The potentiometric surface in this unit is generally higher than the potentiometric surface in the lower zone of the surficial aquifer. As a result, there is the potential for upward leakage of water from this unit to the surficial aquifer system. This is particularly true near creeks, where topographic relief and lowering of surficial heads due to gaining streams accentuates this head difference. At OU 7, the groundwater flow direction in intermediate aquifer is to the southeast, toward the wetlands. A plan view map of the groundwater elevation contours for the intermediate aquifer is presented as Figure 3-11. The horizontal hydraulic gradient in the intermediate aquifer is approximately 0.0018 ft/ft, based on water level data collected in August 1994. Water levels were also collected from all wells in July, September, and October 1994. Changes in water levels were observed between months, but the differences between wells within each of the four data sets were consistent.

A vertical upward gradient from the intermediate aquifer to the surficial aquifer is present, as documented by the higher head in the "DD" wells compared to the surficial wells. The groundwater appears to be upwelling from the intermediate aquifer to the surficial aquifer beginning southeast of well cluster CEF-16-21S, CEF-16-22I, and CEF-16-23D. The vertical gradients and directions based on water

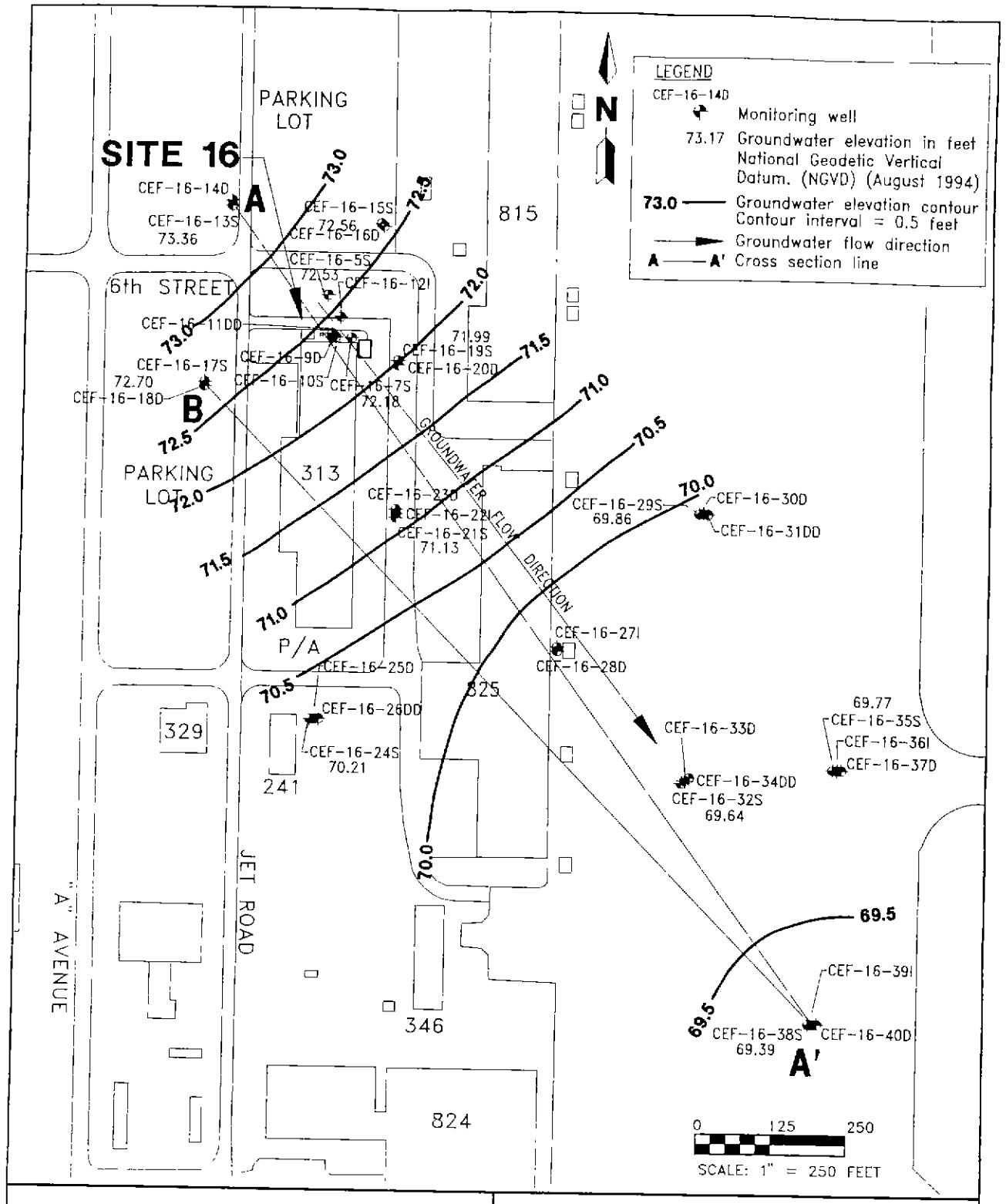


FIGURE 3-8
SHALLOW SURFICIAL AQUIFER GROUNDWATER ELEVATION

REMEDIAL INVESTIGATION, OPERABLE UNIT 7

NAS CECIL FIELD
JACKSONVILLE, FLORIDA

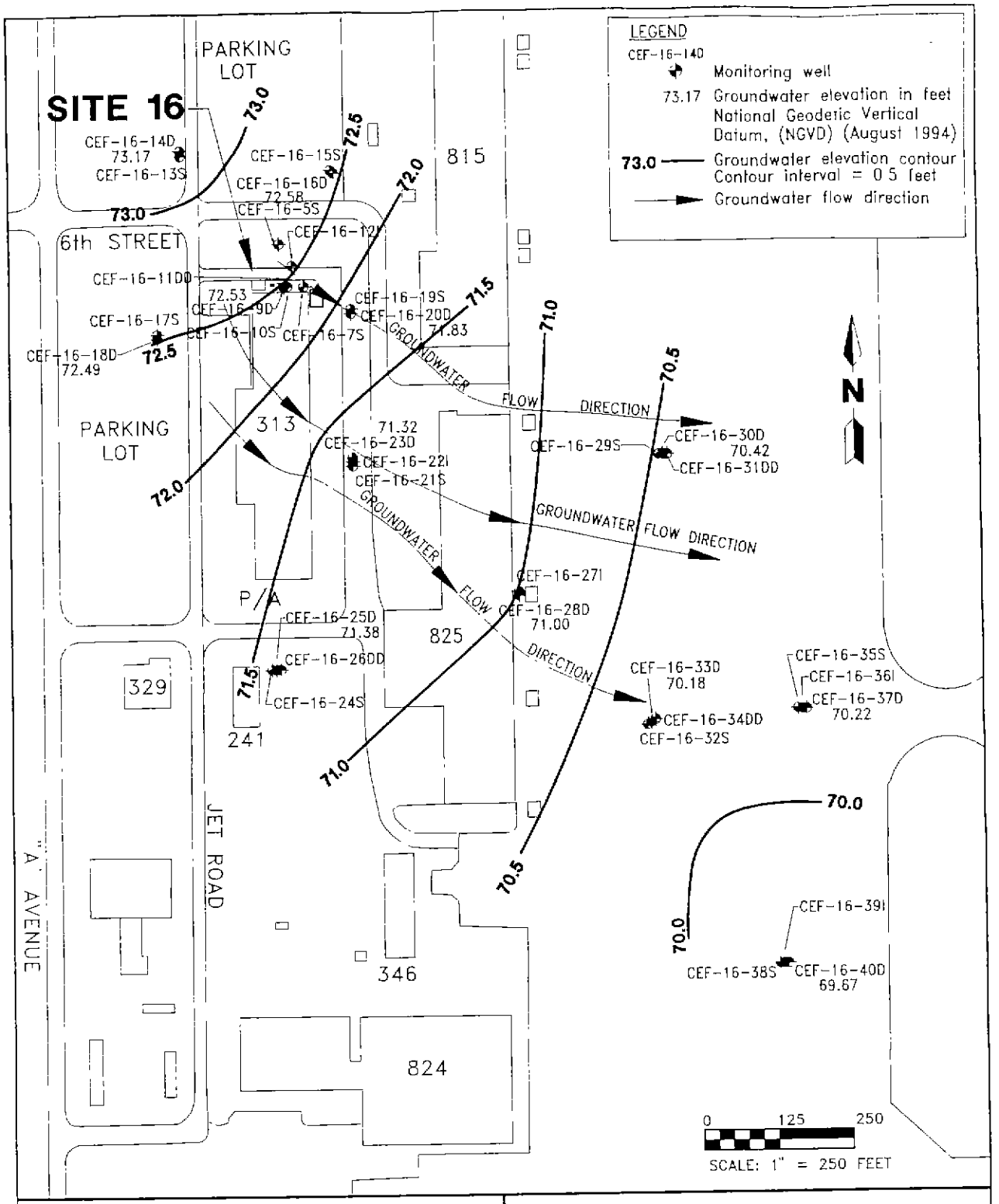


FIGURE 3-9
DEEP SURFICIAL AQUIFER GROUNDWATER ELEVATION

REMEDIAL INVESTIGATION, OPERABLE UNIT 7

NAS CECIL FIELD
JACKSONVILLE, FLORIDA

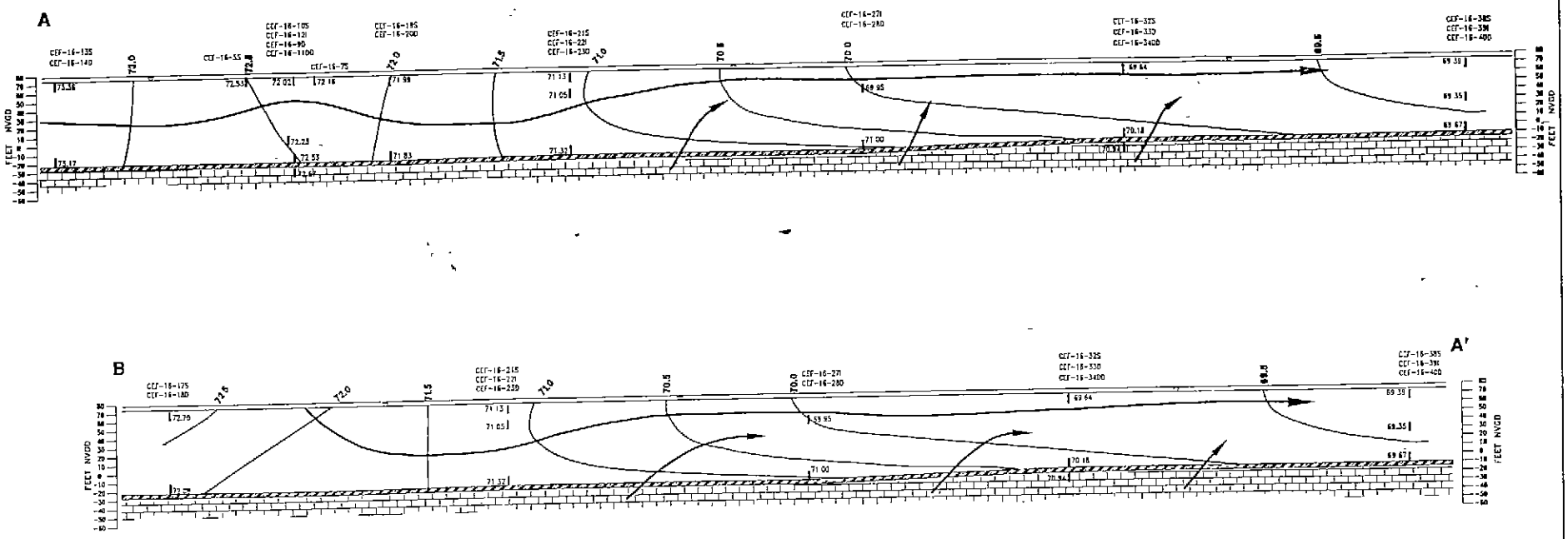


FIGURE 3-10
GROUNDWATER ELEVATION AND FLOWPATH CROSS SECTIONS

REMEDIAL INVESTIGATION, OPERABLE UNIT 7

NAS CECIL FIELD
JACKSONVILLE, FLORIDA

CECIL\CONCROSS\NP\03-15-95

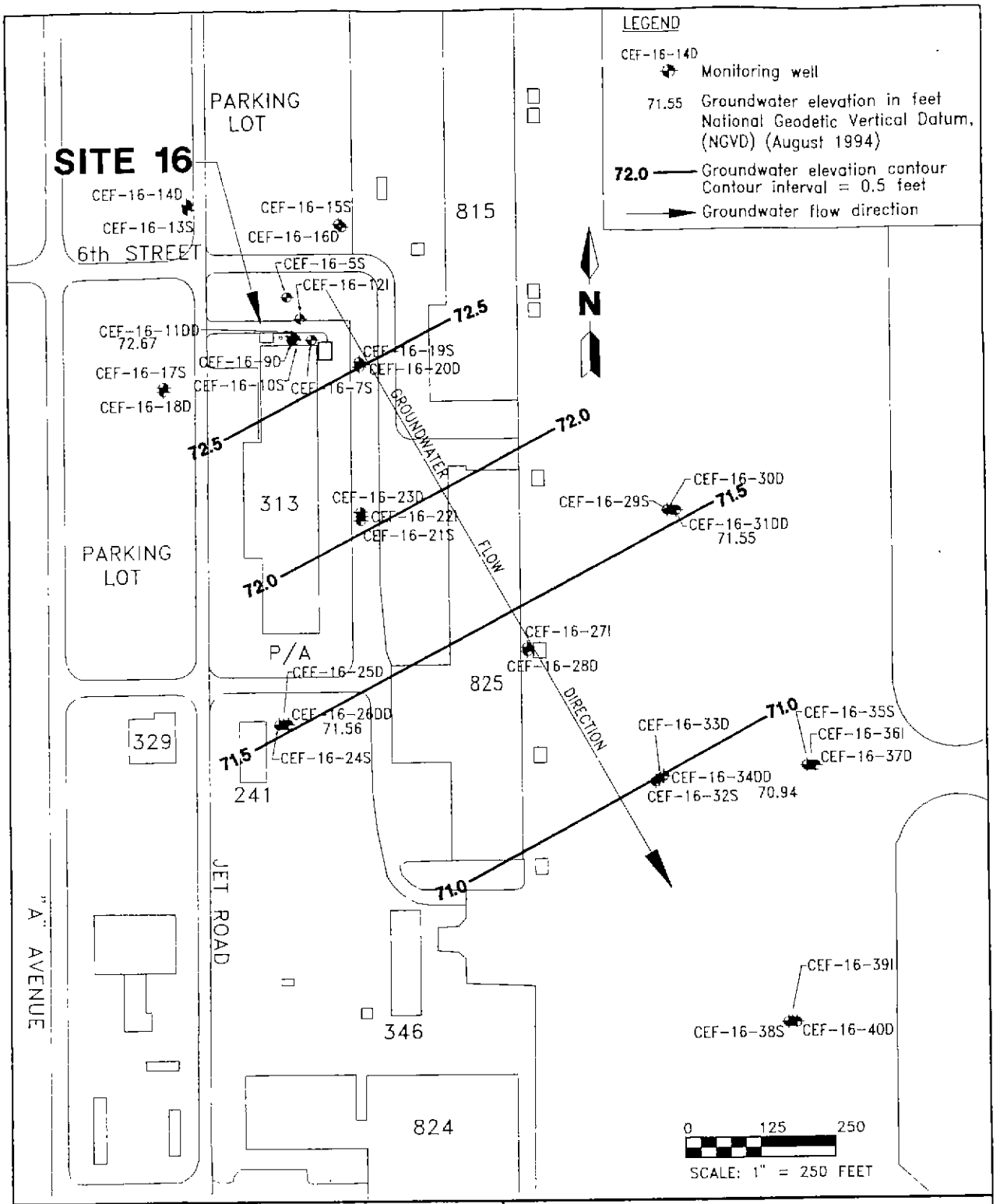


FIGURE 3-11
INTERMEDIATE AQUIFER GROUNDWATER ELEVATION

REMEDIAL INVESTIGATION, OPERABLE UNIT 7

NAS CECIL FIELD
JACKSONVILLE, FLORIDA

level data collected in August 1994 for each well cluster at OU 7 are summarized in Table 3-2.

3.6.2.2 **Hydraulic Conductivity** Slug tests were conducted at all existing monitoring wells at OU 7 to estimate hydraulic conductivity (see Subsection 2.7.2). The results of the slug tests are presented in Appendix H, and the calculated hydraulic conductivities are summarized in Table 3-3 for the surficial aquifer and Table 3-4 for the intermediate aquifer.

Surficial Aquifer System. Hydraulic conductivity (K) values were estimated for each well in the Surficial Aquifer at OU 7. The mean K values for the UZS wells, IZS wells, and LZS wells are 2.5 ft/day, 19 ft/day, and 18 ft/day, respectively. Based on the results of the aquifer test conducted by the USGS at Cecil Field, the hydraulic conductivity of the surficial aquifer ranges from 3 to 5 ft/day (USGS, 1994).

Intermediate Aquifer System. K values were estimated for each well in the intermediate aquifer at OU 7. The mean K value for the intermediate aquifer (UZH wells) is 15 ft/day. Based on the results of the USGS aquifer test at Cecil Field, the hydraulic conductivity of the upper part of the intermediate aquifer is estimated at 40 ft/day.

3.6.2.3 **Aquifer Flow Rate** The seepage velocity for the groundwater at OU 7 was calculated using the hydraulic conductivities and hydraulic gradients presented above, and an estimated effective porosity. The formula used is:

$$V = Ki / n \qquad (1)$$

where

- V = horizontal seepage velocity,
- K = horizontal hydraulic conductivity,
- i = horizontal hydraulic gradient, and
- n = estimated effective porosity.

Surficial Aquifer System. The results of the slug tests show a much higher hydraulic conductivity in the IZS (19 ft/day) and the LZS (18 ft/day) than in the UZS (2.5 ft/day). The aquifer tests conducted by the USGS at the base indicate that a representative hydraulic conductivity for the surficial aquifer is 4 ft/day (USGS, 1994). Using the USGS hydraulic conductivity value, a hydraulic gradient of 0.0029 ft/ft (based on August 1994 water levels), and an effective porosity of 0.20 (USGS, 1995), a seepage velocity of 0.058 ft/day or 21 feet per year (ft/yr) is calculated. In comparison, a seepage velocity of 13 ft/yr was estimated for the UZS using the mean hydraulic conductivity of 2.5 ft/day from the slug test results.

Intermediate Aquifer System. For the intermediate aquifer, a hydraulic conductivity of 40 ft/day (USGS, 1995) a gradient of 0.0018 ft/ft (based on August 1994 water levels), and an effective porosity of 0.20 (USGS, 1995) is used, resulting in a seepage velocity of 0.36 ft/day or 131 ft/yr. In comparison, using the mean hydraulic conductivity from the slug test results, a seepage velocity of 49 ft/yr was estimated.

A summary of the physical characteristics of each aquifer encountered at OU 7 is presented in Table 3-5. Since aquifer tests generally provide more reliable estimates of hydraulic conductivity than slug tests and the lithology in the upper

Table 3-2
Vertical Hydraulic Gradient Summary

Remedial Investigation
Operable Unit 7, NAS Cecil Field
Jacksonville, Florida

Aquifer Zone	Well Pair	Average Vertical Hydraulic Gradient (feet/foot)[1]	Average Direction of Flow
Surficial Aquifer, Shallow and Intermediate Zone			
	CEF-16-21S and CEF-16-22I	0.0056	Down
	CEF-16-35S and CEF-16-36I	0.0028	Up
	CEF-16-38S and CEF-16-39I	0.0018	Down
Surficial Aquifer, Shallow and Deep Zone			
	CEF-16-10S and CEF-16-9D	0.0032	Up
	CEF-16-13S and CEF-16-14D	0.0020	Down
	CEF-16-15S and CEF-16-16D	0.0058	Down
	CEF-16-17S and CEF-16-18D	0.0061	Up
	CEF-16-19S and CEF-16-20D	0.0019	Down
	CEF-16-21S and CEF-16-23D	0.0021	Up
	CEF-16-24S and CEF-16-25D	0.015	Up
	CEF-16-29S and CEF-16-30D	0.0087	Up
	CEF-16-32S and CEF-16-33D	0.0079	Up
	CEF-16-35S and CEF-16-37D	0.0063	Up
	CEF-16-38S and CEF-16-40D	0.0035	Up
Surficial Aquifer, Intermediate and Deep Zone			
	CEF-16-22I and CEF-16-23D	0.0042	Up
	CEF-16-27I and CEF-16-28D	0.013	Up
	CEF-16-36I and CEF-16-37D	0.010	Up
	CEF-16-39I and CEF-16-40D	0.0094	Up
Surficial Aquifer, Deep Zone and Intermediate Aquifer			
	CEF-16-9D and CEF-16-11DD	0.019	Up
	CEF-16-25D and CEF-16-26DD	0.0076	Up
	CEF-16-30D and CEF-16-31DD	0.077	Up
	CEF-16-33D and CEF-16-34DD	0.048	Up

Note: Average of monthly water level readings from July, August, September, and October 1994

Table 3-3
Hydraulic Conductivity Estimates for the Surficial Aquifer System

Remedial Investigation
Operable Unit 7, NAS Cecil Field
Jacksonville, Florida

Upper Zone of Surficial System (UZS)		Intermediate Zone of Surficial System (IZS)		Lower Zone of Surficial System (LZS)	
Well	K in ft/day	Well	K in ft/day	Well	K in ft/day
CEF-16-13S	2.6	CEF-16-12I	15	CEF-16-14D	17
CEF-16-15S	1.0	CEF-16-22I	12	CEF-16-16D	18
CEF-16-17S	5.7	CEF-16-27I	22	CEF-16-18D	23
CEF-16-19s	2.9	CEF-16-36I	24	CEF-16-20D	21
CEF-16-21S	1.8	CEF-16-39I	21	CEF-16-23D	26
CEF-16-24S	1.9			CEF-16-28D	15
CEF-16-29S	1.1			CEF-16-30D	17
CEF-16-32S	3.1			CEF-16-33D	14
CEF-16-35S	1.3			CEF-16-37D	12
CEF-16-38S	3.3			CEF-16-40D	18

Notes. K in ft/day = hydraulic conductivity from slug test data in feet per day.

Upper Zone of Surficial System (UZS):
number of runs = 10.
minimum = 1.0 ft/day.
maximum = 5.7 ft/day.
mean = 2.5 ft/day.
median = 2.25 ft/day.

Intermediate Zone of Surficial System (IZS):
number of runs = 5.
minimum = 12 ft/day.
maximum = 24 ft/day.
mean = 19 ft/day.
median = 21 ft/day.

Lower Zone of Surficial System (LZS):
number of runs = 10.
minimum = 12 ft/day.
maximum = 26 ft/day
mean = 18 ft/day.
median = 17.5 ft/day.

Table 3-4
Hydraulic Conductivity Estimates for the Upper Zone of the Hawthorn Group

Remedial Investigation
Operable Unit 7, NAS Cecil Field
Jacksonville, Florida

Well	K in ft/day
CEF-16-11DD	6.3
CEF-16-25D	23
CEF-16-26DD	16
CEF-16-31DD	13
CEF-16-34DD	18

Notes: K in ft/day = hydraulic conductivity from slug test data in feet per day assuming an aquifer thickness of 15 feet (one and a half times the screen length).

number of runs = 5.
minimum = 6.3 ft/day.
maximum = 23 ft/day.
mean = 15 ft/day.
median = 16 ft/day.

zone of the surficial aquifer at the aquifer test location is quite comparable to that of OU 7, USGS aquifer test results were used for contaminant fate and transport calculations in Chapter 5.0.

Table 3-5
Summary of Aquifer Characteristics

Remedial Investigation
Operable Unit 7, NAS Cecil Field
Jacksonville, Florida

Parameter	Surficial Aquifer	Intermediate Aquifer
Hydraulic gradient (feet per foot)	0.0029	0 0018
Hydraulic conductivity (feet per day)	2.5 to 19	15 to 40
Effective porosity	0.20	0.20
Groundwater seepage velocity (feet per year)	13 to 101	49 to 131

3.6.3 Aquifer Geochemistry Statistical analyses were conducted on the inorganic analytical results from all wells at OU 7 to identify natural geochemical characteristics. First, a descriptive analysis was performed for all inorganics in all wells. Then, a comparative statistical analysis was conducted (Mann-Whitney U test) for select inorganic parameters. Comparisons were made between site data and background data, and between the various depth intervals at the site. The statistical analyses indicate there are three distinct geochemical zones at OU 7. These are the "S" interval (UZS) wells, the "I" interval (IZS) wells, and the "D" (LZS) plus "DD" (UZH) interval wells. The statistical analytical data are presented in Appendix L and summarized below.

The UZS interval wells typically had large geochemical variations associated with shallow water table aquifers. The UZS wells contained widely varying water types (from sodium [Na], magnesium/sulfate [Mg/SO_4] through sodium/chloride [Na/Cl] to calcium/bicarbonate [Ca/HCO_3]) with total dissolved solids ranging from 34 to 390 milligrams per liter (mg/ℓ) (most wells are at the low end of this range) and low trace metal concentrations.

The IZS interval wells have a consistent Na/Cl to Na/HCO_3 water type with low total dissolved solids (31 to 48 mg/ℓ), low sulfate (9 or fewer mg/ℓ) and minor concentrations of trace metals (but higher than the other intervals). The water chemistry in these wells is consistent with short duration, large volume infiltration of rainwater. If supplied in sufficient volume, this meteoric water might not be significantly mixed with existing groundwater before reaching the IZS interval and would still be low in TDS and have a fairly low pH (approximately 5 standard units). This relatively low pH water could easily mobilize some adsorbed cations, leading to an increased dissolved metals content. These characteristics are likely being attenuated as the water moves horizontally toward the discharge zone as is illustrated by the relative positions of the three wells CEF-16-22I, CEF-16-36I, and CEF-16-39I on the Piper diagram (Appendix L).

The LZS and UZH interval wells are typical of wells in a carbonate-rich environment. They are of predominantly Ca or Ca, Mg, and HCO_3 water types with moderate total dissolved solids (50 to 290 mg/ℓ) and no significant trace metals. The LZS wells are less carbonate-rich upgradient of OU 7, where flow is predominantly horizontal, and more carbonate-rich downgradient of OU 7, where a

strong upward gradient from the carbonate-rich UZH is present. Upgradient of OU 7, the system appears to be well stratified, indicating predominantly horizontal flow in the surficial aquifer. Downgradient of where flow begins to have a strong upward component (approximately 400 feet downgradient of OU 7), the IZS and UZS interval wells begin to resemble the typical LZS and UZH interval water type as can be seen from their position midway between the UZS-IZS cluster and the LZS-UZH cluster on the Piper diagram (Appendix L).

3.6.4 Summary of the Hydrogeologic Discussion In the area of investigation, there are three water-bearing systems. In descending order, these are the surficial aquifer (UZS, IZS, and LZS), the intermediate aquifer (UZH), and the Floridan aquifer system. Between each system is an aquitard (less permeable unit). At OU 7, only the surficial aquifer and the top of the intermediate aquifer were investigated.

The surficial aquifer is unconfined and composed of undifferentiated fine-grained sand with some clayey sand and clay. These sediments extend to approximately 100 feet bls and are underlain by a layer of clay with dolomite fragments. The water table in the surficial aquifer is typically between 5 and 10 feet bls. Groundwater flow in the surficial aquifer is generally to the southeast, toward the wetlands east of the runways, at an average rate of 21 feet per year. At this rate, contaminants from OU 7 would have migrated approximately 735 feet downgradient over the 35 years since wastes were initially released. A pronounced upward gradient is observed before reaching the west side of the runways, beginning approximately 400 feet downgradient of OU 7.

Upgradient of OU 7, the geochemistry of the surficial aquifer is indicative of recharge by rainfall, but downgradient, where the upward gradient is present, the geochemistry is increasingly bicarbonate-rich with depth, to the point of resembling the geochemistry of the intermediate aquifer. This change in geochemistry, along with the upward gradient in the surficial aquifer and widespread upward vertical potential between the intermediate and surficial aquifer, indicates that groundwater is flowing from the intermediate aquifer into the surficial aquifer. It is unclear if this upward migration is due to increased hydraulic conductivity or gaps in the clay layer.

The intermediate aquifer is encountered at OU 7 source area at approximately 105 feet bls. In addition to its clay rich sediments, the Hawthorn includes near its top a locally continuous carbonate rich unit of dolomite with significant secondary porosity. This carbonate-rich unit forms the historical "rock aquifer" or "secondary artesian aquifer," a water-bearing unit widely used in this region as a private drinking water source. In the NAS Cecil Field area, the unit is approximately 20 to 25 feet thick. The top of this unit is irregular and may represent an erosional unconformity. The groundwater flow in the intermediate aquifer at OU 7 is to the south-southeast, toward the wetlands east of the runways, at an average rate of approximately 131 feet per year.

3.7 DEMOGRAPHY AND LAND USE. Information presented in this section was collected to identify, enumerate, and characterize human populations potentially exposed to contaminants released from OU 7. This information is necessary to support the human health risk assessment for OU 7.

3.7.1 Population and Land Use In the Resource Availability Inventory Report distributed by the St. Johns River Water Management District (1990), the population of Duval County is reported to be increasing with time and continued growth is projected through the year 2000. The military personnel at NAS Cecil Field and surrounding military bases such as NAS Jacksonville, Naval Station Mayport, and Naval Fuel Depot (NFD) Jacksonville contribute significantly to this population. NAS Cecil Field is a subordinate command under the Commander Strikefighter Wings, Atlantic Fleet. The facility supports a workforce of approximately 10,000 civilian and military personnel and can accommodate approximately 3,500 residents in base quarters and housing (ABB-ES,1992b).

The area surrounding NAS Cecil Field is rural and sparsely populated. The city of Jacksonville lies approximately 14 miles to the northeast. Surrounding land use is primarily forestry with some light agricultural and ranching use. Small communities and scattered dwellings associated with these activities are located in the vicinity. A small residential area on Nathan Hale Road, which abuts the NAS Cecil Field property to the west, typifies these rural communities. The nearest incorporated municipality is the town of Baldwin, whose center lies approximately 6 miles to the northwest of the main facility entrance.

To the east of NAS Cecil Field, the rural surroundings grade into a suburban fringe bordering the major east-west roadways. Low commercial use, such as convenience stores, and low density residential areas characterize the land use (ABB-ES, 1992b). A development called Villages of Argyle, when complete, is planned to consist of seven separate villages or communities that will ultimately abut NAS Cecil Field to the south and southeast. A golf course and residential area also border NAS Cecil Field to the east (SOUTHNAVFACENGCOM, 1989).

Security passes are needed for admittance onto NAS Cecil Field. OU 7 is an area surrounded by military industrial activity and is in a controlled access part of the base. Jet Road and 6th Street intersect the industrial area that surrounds OU 7. The north-south runways, associated jet hangers, and support units are located approximately 200 feet east of OU 7. Building 313 (AIMD and NDI) is approximately 60 feet south of OU 7. Generally, Navy and civilian employees work in the industrial area that surrounds OU 7 approximately 350 days per year. Navy personnel and civilians are not expected to contact OU 7, except to possibly walk over the grass, surface soil, and concrete that currently comprise the surface of OU 7.

There is no housing in the immediate vicinity of OU 7. However, bachelor enlisted quarters are located approximately 500 feet to the west, family enlisted housing is approximately 1,500 feet to the northwest, and senior officer housing is approximately 2,000 feet to the west. Children would be expected to reside only in the family enlisted housing or the senior officer housing areas.

Under the proposed Base Reuse Plan (BRP), the current plan is to maintain the area at and around OU 7 as an industrial activity, and continue the use of the runways as an airfield.

3.7.2 Public Water Supply and Groundwater Use The groundwater in the surficial, intermediate, and Floridan aquifers is potable, Class G-II (Florida Legislature, 1990a).

The surficial aquifer system is described in Section 3.6. Water obtained from the surficial aquifer system is primarily used for lawn irrigation and domestic purposes, including heat exchange units in heating and air conditioning systems. The yield of the wells is typically between 30 and 100 gallons per minute and water use estimates for the surficial aquifer system are approximately 10 to 25 million gallons per day for the city of Jacksonville (Jacksonville Planning Department, 1990a). The surficial aquifer level and flow directions have been altered over time because of increased water use and pumping rates.

The intermediate aquifer system is described in Section 3.6. The quality of water from the limestone, shell, and sand part of the UZH is hard to very hard and has moderate dissolved solids levels. The iron content is variable and some areas contain hydrogen sulfide (Geraghty & Miller, 1985). At least 50,000 homes in the Jacksonville area obtain water from private wells in the UZH.

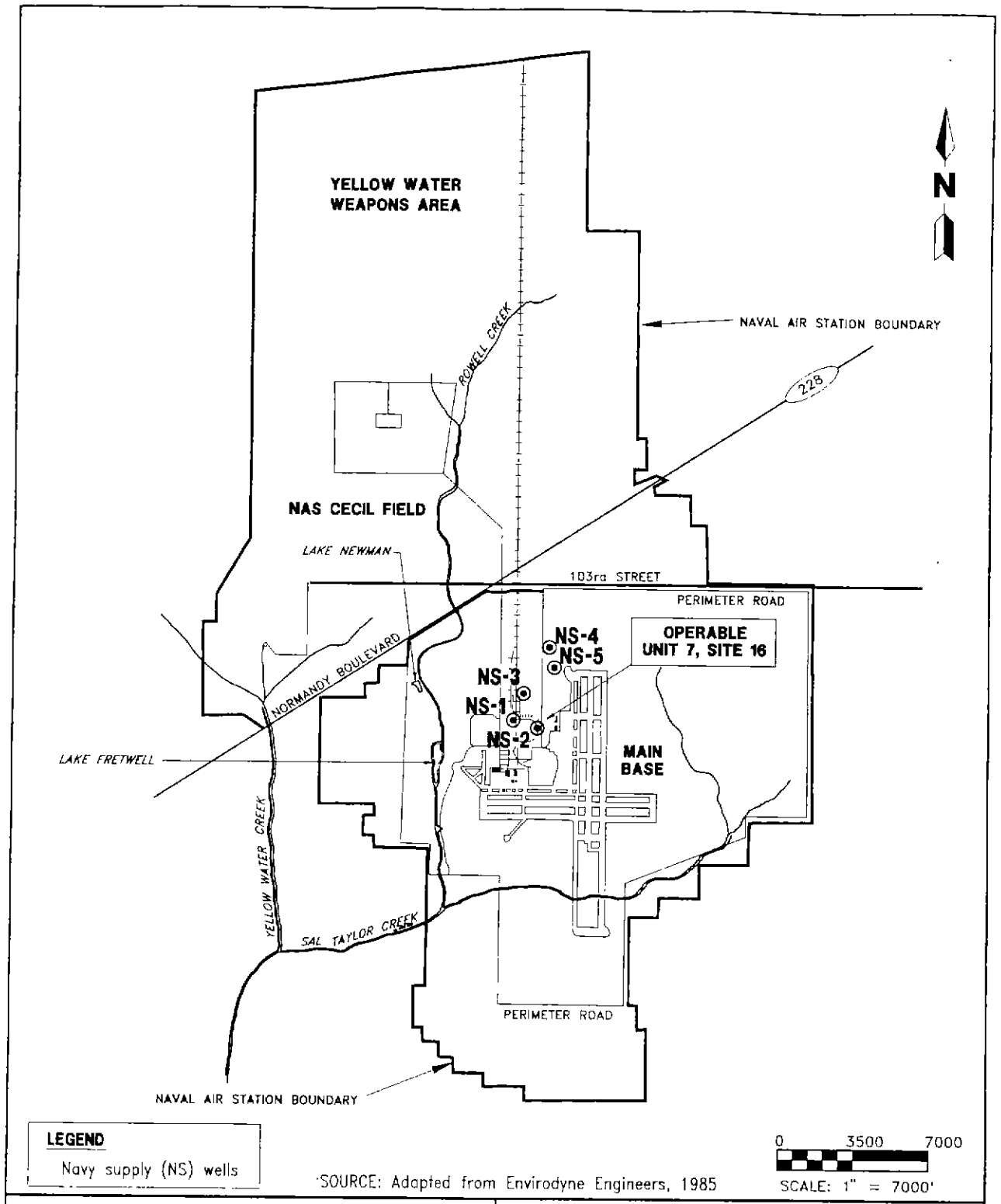
The Floridan aquifer system is described in Section 3.6. It is one of the most productive aquifers in the world, and is the primary source of water in the Jacksonville area.

NAS Cecil Field obtains its potable water from five Navy potable water supply production wells cased in the Floridan aquifer system within the property boundary (Figure 3-12). These wells are range in depth from 400 to 800 feet bls (NAS Cecil Field, 1990). Water is extracted from these wells and stored in reservoirs and elevated water tanks. There is one 500,000-gallon reservoir, one 200,000-gallon reservoir, and two 250,000-gallon elevated water tanks at NAS Cecil Field. The five wells have a combined capacity of approximately 4.8 million gallons per day (Envirodyne Engineers, 1985). Water from these wells is used for potable, industrial, and heating purposes. Treatment consists of chlorination and aeration. Evaluation of recent analytical information from these wells indicates hazardous substances were not detected. There are no backup supplies of potable water currently on the base.

Other wells on NAS Cecil Field reportedly tap the UZH (Geraghty & Miller, 1983). These wells are not a part of the NAS Cecil Field water supply system and are not used for drinking water. These wells are used as individual water supplies along the outlying areas of the base that are not served by the main water system. Water from these wells is used for flushing toilets and irrigation (Envirodyne Engineers, 1985).

The Florida Department of Health and Rehabilitative Services estimates that there are approximately 75 private wells located within a 2-mile radius of NAS Cecil Field and they reportedly produce from within the UZH. Two potable supply wells are present in a small unincorporated community on Nathan Hale Road, immediately west of NAS Cecil Field and south of Normandy Boulevard (State Road 228). These private wells are 64 and 125 feet deep (Geraghty & Miller, 1983).

3.7.3 **Surface Water and Drainage** Surface runoff from NAS Cecil Field is conveyed by a system of storm sewers and vegetated ditches to receiving streams bordering the facility, as indicated on Figure 3-4. Generally, the eastern and southern parts of NAS Cecil Field drain to Sal Taylor Creek. Sal Taylor Creek drains in a westerly direction, discharging to Yellow Water Creek, which drains south to the St. Johns River via Black Creek. The St. Johns River drains north and east to the Atlantic Ocean with the lower section influenced by tides.



SOURCE: Adapted from Envirodyne Engineers, 1985

FIGURE 3-12
POTABLE WATER SUPPLY WELLS

CECIL\CI-FACIL\NP\02-13-95

REMEDIAL INVESTIGATION,
OPERABLE UNIT 7

NAS CECIL FIELD
JACKSONVILLE, FLORIDA

Sal Taylor Creek is classified by the FDEP as Class III surface waters and, as such, is designated for recreation, propagation, and management of fish and wildlife, and is not used as a drinking water resource (Jacksonville Area Planning Board, 1980; Florida Legislature, 1995). Where groundwater or stormwater from OU 7 discharges to wetlands associated with Sal Taylor Creek, recreational use is limited to fishing and wading.

3.8 ECOLOGY. Ecological resources at OU 7 were characterized based on the results of several field investigations and a review of the literature. Aquatic habitats adjacent to OU 7 and expected aquatic receptors are discussed in Subsection 3.8.1. Terrestrial wildlife habitat and wetlands are described in Subsections 3.8.2 and 3.8.3, respectively.

3.8.1 Aquatic Habitats Aquatic habitats near OU 7 were characterized as part of a field survey completed in June and July, 1993 (EA Engineering, Science, and Technology [EA], 1994). Although aquatic habitats are not present at OU 7 proper, a series of drainage ditches east of the runways receives stormwater drainage from the runway area and much of the developed area west of the runways including Site 16. The drainage ditches are approximately 2,400 feet in length before they terminate into Sal Taylor Creek. During the 1993 field survey, the depth of the ditches at sampling stations ranged from approximately 0.3 to 1.0 meter and width ranged from approximately 1 to 5 meters. These waters are classified as Class III water for recreation, propagation, and management of fish and wildlife by the FDER (Florida Legislature, 1995).

Two fish species were collected from the Site 16 fish sampling stations in the drainage ditches and Sal Taylor Creek. Two eastern killifish (*Gambusia affinis*) were collected in the upstream reference location in Sal Taylor Creek. Thirty-six eastern killifish and four least killifish (*Heterandria formosa*) were collected at one of the drainage ditch sampling locations.

3.8.2 Terrestrial Habitats OU 7 consists of Site 16, the AIMD seepage pit, and adjacent area. Site 16 is vegetated with a small patch of mowed grass. Adverse effects, such as surface soil staining or stressed vegetation, from waste activities were not visible during site visits in 1988, 1991, and 1993. The general area adjacent to Site 16 is relatively flat and is covered with asphalt and concrete. Because Site 16 is a small area of mowed grass surrounded by paved lots in an industrialized area, terrestrial receptors are not expected to reside at this site.

3.8.3 Wetlands Although wetlands were not identified in the immediate area of OU 7 (CDM, 1994), wetlands are located to the east of OU 7, as shown on Figure 3-13. Sal Taylor Creek, which is located approximately 5,000 feet east of Site 16, flows through and directly influences these wetlands. National Wetland Inventory Maps (USGS, 1983) were used to assist in the classification of the wetlands to the east of OU 7. Wetland communities are described according to the U.S. Fish and Wildlife Service (USFWS) classification system (Cowardin and others, 1979). Table 3-6 presents the USFWS wetland classification for the wetlands east of OU 7, a brief description of the wetland characteristics, a list of the dominant plant species expected in each wetland cover type, and a summary list of representative vegetation expected in each wetland cover type. According to the USGS National Wetland Inventory Map, no upland habitats are located in the area of interest.

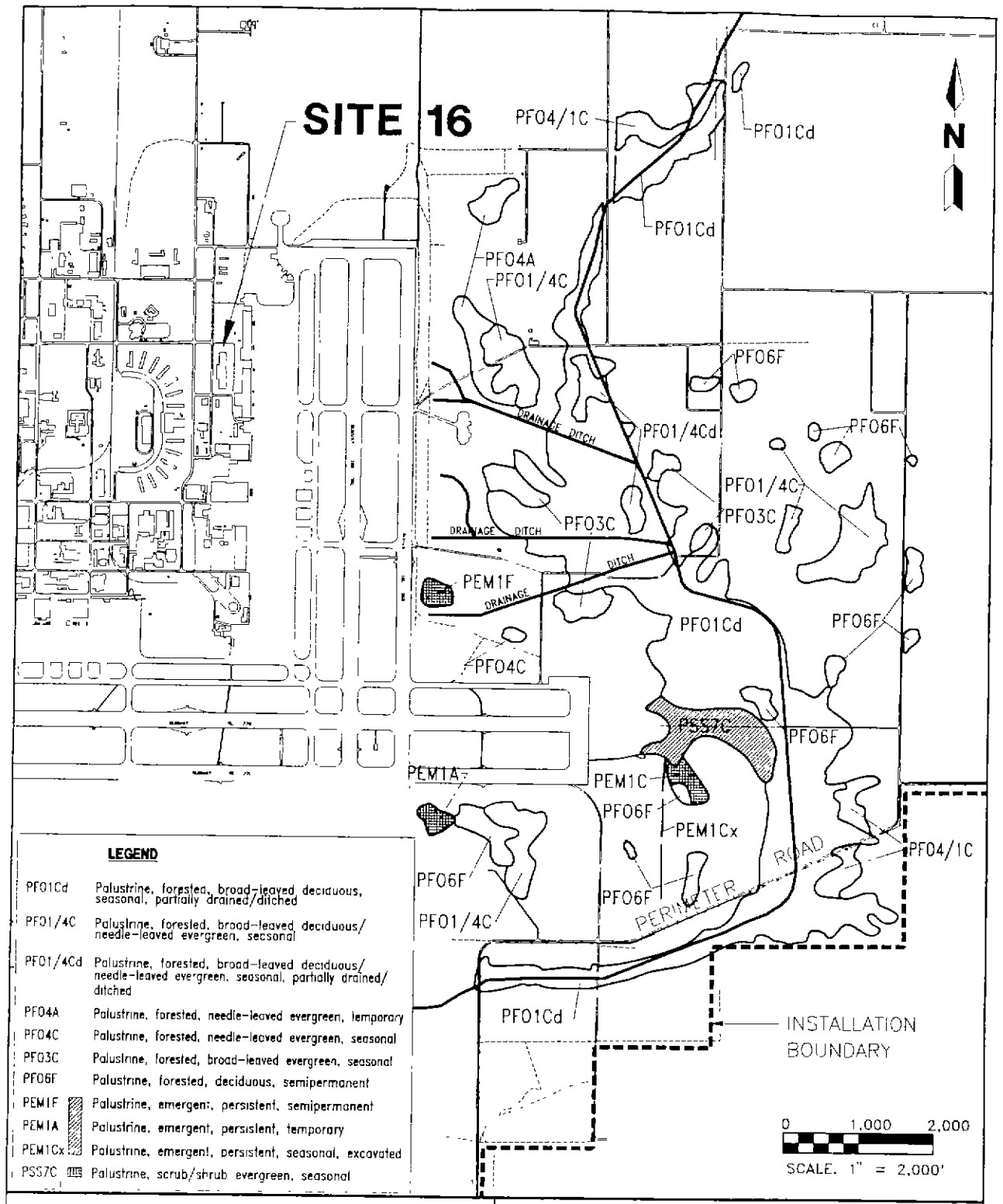


FIGURE 3-13
MAPPED WETLANDS

REMEDIAL INVESTIGATION, OPERABLE UNIT 7

NAS CECIL FIELD
JACKSONVILLE, FLORIDA

Table 3-6
Wetland Classification System Characteristics[1]

Remedial Investigation
Operable Unit 7, NAS Cecil Field
Jacksonville, Florida

USFWS Classification	Description	Expected Dominant Species (common name)	Representative Vegetation (common name)
Palustrine forested broad-leaved deciduous	Occurs on seasonally flooded soil along stream channels. East of OU 7, a large part of this wetland type is partially drained or ditched.	Red maple	Laurel oak, water ash, bald cypress, sweetgum, slash pine, loblolly pine, sweetbay, cinnamon fern, and wax myrtle.
Palustrine forested needle-leaved evergreen	Occurs on temporarily or seasonally flooded soil	Pond pine	Pond pine in association with dense stands of broad-leaved evergreen and deciduous shrubs.
Palustrine forested broad-leaved evergreen	Occurs on seasonally flooded soil.	Sweet bay	Red bay and loblolly bay
Palustrine emergent persistent	Usually flooded with flowing water.	Cattails	Bulrushes, saw grass, sedges, reed, manna grasses, slough grass, whitetop, purple loosestrife, dock, water willow, and smartweeds.
Palustrine scrub and shrub evergreen	Woody vegetation less than 6 meters tall. Occurs on seasonally flooded soil.	Fetterbush, young or stunted black spruce, or pond pine	Coastal sweetbells, gallberry, and black titi.
Palustrine forested broad-leaved deciduous and needle-leaved evergreen	Occurs on seasonally flooded soil. East of OU 7, patches of this wetland type are partially drained or ditched.	Red maple and pond pine	Combination of typical vegetation of broad-leaved deciduous and needle-leaved evergreen (see above).
Palustrine forested deciduous	Surface water is present throughout the growing season in most years, or semipermanent.	Red maple and bald cypress	Typical vegetation of broad-leaved deciduous (see above) in addition to pond cypress.

Source: Cowardin and others, 1979.

Notes: USFWS = U S. Fish and Wildlife Service.
OU = Operable Unit.

According to the USGS National Wetland Inventory Map, the wetlands east of Site 16 fall under the following seven general USFWS classes (Cowardin and others, 1979):

- palustrine forested broad-leaved deciduous,
- palustrine forested needle-leaved evergreen,
- palustrine forested broad-leaved evergreen,
- palustrine emergent persistent,
- palustrine scrub and shrub evergreen,
- combination palustrine forested broad-leaved deciduous and needle-leaved evergreen, and
- palustrine forested deciduous (unspecified).

According to the USGS National Wetland Inventory Map, the majority of the wetlands associated with OU 7 and the Sal Taylor Creek floodplain are palustrine forested broad-leaved deciduous wetlands (Figure 3-13). This area is prone to seasonal flooding by Sal Taylor Creek. The dominant tree commonly found in this type of wetland is red maple (*Acer rubrum*), with occasional sweet bay (*Magnolia virginiana*) and bald cypress (*Taxodium distichum*). American elm (*Ulmus americana*), ashes (*Fraxinus* sp.), black gum (*Nyssa sylvatica*), and tupelo gum (*N. aquatica*) are also often found in this wetland type. The shrub understory expected is open, and includes alder (*Alnus serrulata*), titi (*Cyrilla racemiflora*), wax myrtle (*Myrica cerifera*), gallberry (*Ilex glabra*), fetterbush (*Lyonia lucida*), and swamp bay (*Persea palustris*). Herbaceous species commonly include cinnamon fern (*Osmunca cinnamomea*), royal fern (*Osmunda regalis*), netted chain fern (*Woodwardia areolata*), and poison ivy (*Toxicodendron radicans*) (Cowardin and others, 1979; ABB-ES, 1995a).

Patches of combination palustrine forested broad-leaved deciduous and needle-leaved evergreen wetlands occur along the edges of the large area of broad-leaved deciduous wetland (Figure 3-13) discussed above. These wetlands are commonly considered a transitional wetland area between broad-leaved deciduous and needle-leaved evergreen wetlands and include vegetation found in both. The needle-leaved evergreen wetland commonly consists of pond pine (*Pinus serotina*) in association with deciduous shrubs and dense stands of broad-leaved evergreen (Cowardin and others, 1979). Three patches of palustrine forested needle-leaved evergreen wetlands are located west of Sal Taylor Creek (Figure 3-13).

Two patches of palustrine forested broad-leaved evergreen wetland are located west of Sal Taylor Creek along the edge of the large broad-leaved deciduous wetland (Figure 3-13) discussed above. Sweet bay (*Magnolia virginiana*), red bay (*Persea borbonia*), and loblolly bay (*Gordonia lasianthus*) are usually prevalent in this wetland type, especially on organic soil (Cowardin and others, 1979).

Palustrine emergent persistent wetlands are located in four areas west of Sal Taylor Creek between the creek and OU 7 (Figure 3-13). These wetlands typically contain a vast array of grasslike plants such as cattails (*Typha* spp.), bulrushes (*Scirpus* spp.), saw grass (*Cladium jamaicense*), sedges (*Carex* spp.), and true

grasses such as reed (*Phragmites communis*), manna grasses (*Glyceria* spp.), slough grass (*Beckmannia syzigachne*), and whitetop (*Scolochloa festucacea*). There is also a variety of broad-leaved persistent emergents such as purple loosestrife (*Lythrum salicaria*), dock (*Rumex mexicanus*), waterwillow (*Decodon verticillatus*), and many species of smartweeds (*Polygonum*) (Cowardin and others, 1979).

An area of palustrine scrub and shrub evergreen wetland is located west of Sal Taylor Creek along the edge of the large broad-leaved deciduous wetland area (Figure 3-13). The USGS National Wetland Inventory Map does not specify the area as broad-leaved or needle-leaved, but typical vegetation expected in this wetland includes fetterbush, coastal sweetbells (*Leucothoe axillaris*), gallberry, and black titi (*Cyrilla racemiflora*), as well as young or stunted trees such as black spruce (*Picea mariana*) or pond pine (Cowardin and others, 1979).

Patches of palustrine forested deciduous are located east and west of Sal Taylor Creek (Figure 3-13). These areas are expected to include plant species common to the forested broad-leaved deciduous wetland as well as bald cypress (*Taxodium distichum*) and pond cypress (*Taxodium ascendens*) (Cowardin and others, 1979).

4.0 NATURE AND EXTENT OF CONTAMINATION

The results of the field investigation concerning the nature and extent of contamination detected at OU 7, Site 16, have been assessed and the findings are presented in this chapter.

Four rounds of investigation have been completed at OU 7, starting with work (IAS) by Envirodyne Engineers in 1985 and ending with the ABB-ES investigation (RI) of 1993-94. Most of these investigations have included a field program that provided physical and chemical information on the site conditions. The most recent investigation, completed in 1994 (Chapters 2.0 and 3.0), represents the most comprehensive set of site information developed to date. For this reason, discussion of the nature and extent of contamination at OU 7 centers on the data accumulated during this last investigation. Relevant data and findings from previous studies (including the 1991-92 ABB-ES investigation [RI] and field screening data) will be discussed as appropriate. The complete TCL and TAL chemical analytical data set generated for all media during the 1993-94 investigation, and validated per USEPA guidance, is presented in Appendix M. Chemical analyses were also completed on groundwater samples for water quality parameters such as hardness, alkalinity, total dissolved solids, etc.; these results are presented in Appendix L. Tables and figures summarizing detections and distribution of contaminants are presented in this chapter. Chemical analyses from previous investigations are presented in Appendix A and summarized in Chapter 1.0.

The quality of the chemical analytical data collected during the investigation of OU 7 has been evaluated by assessing the precision, accuracy, representativeness, completeness, and comparability (PARCC) of the analytical data on a per medium basis. PARCC reports summarize the quality control measures taken during the investigation and discuss the suitability of the data for use in this investigation. The PARCC summary reports for media sampled at OU 7 are presented in Appendix N. In general, the data complied with PARCC criteria and are considered acceptable for use in this RI and the associated BRA and FS.

Discussion of the nature and extent of contamination at OU 7 is structured according to the RI/FS guidance (USEPA, 1988). Sources of contamination are discussed first. Environmental media sampled during the investigation are then discussed in the following order: surface soil, subsurface soil, groundwater, surface water, and sediment. Within each of these media, analytical fractions are discussed in the following order: organics (VOCs, SVOCs, pesticides, and PCBs) and inorganics. The regulatory standards for chemicals by media are presented in Appendix O for reference.

In the case of duplicate samples, the average of the sample and duplicate concentrations is used to be consistent with the procedure employed in the BRA. In accordance with that procedure, if either the sample or duplicate is reported as not detected, half of the reported detection limit (RDL) value is used as the concentration.

To identify the inorganic constituents for inclusion in the Nature and Extent of Contamination discussion, inorganic analytical results are screened by comparison to background criteria for each medium sampled. This background value is twice the mean of the concentrations detected in the background samples of each medium.

Complete analytical data from the background sampling program are presented in Appendix J.

Other analyses completed (water quality parameters, grain size analyses, etc.) are discussed as appropriate. Following the evaluation of each analytical fraction for a particular medium, a summary of relevant results and findings for the medium is presented.

4.1 SOURCES. At OU 7, the primary source of contamination is the liquid waste generated during the machine and engine parts cleaning process conducted within Building 313. From 1959 to 1980, these wastes were discharged to a holding tank, seepage pit, and bead separator (from late 1960's to 1980). The waste disposal process and facilities are described in Subsection 1.2.4. Based on operations occurring within Building 313 during this time, waste components disposed may have included sodium cyanide, TCE, creosol, phenol, methylene chloride, and oil (Harding Lawson Associates, 1988).

Based on the historical information collected, waste liquids resulting from paint preparation and parts cleaning operations are anticipated to have discharged from Building 313 to the holding tank, and more recently to the bead separator, providing gravity separation of wastes. Drainage from these units went to the seepage pit that drained directly to the underlying vadose and phreatic zone soil and groundwater. The addition of the wastewater to the groundwater would be expected to create a localized groundwater mound. The contaminants would initially migrate horizontally and vertically within the influence of the mound. When the discharge ceased, the mounding subsided, leaving contaminants in the vadose zone soil (soil above the water table).

After the initial spreading of contaminants caused by the mounding, the contaminants would migrate with the natural flow of groundwater. Contaminants remaining within the initial mound area (in soil both above and below the water table) could serve as a continuing source of groundwater contamination.

To document the nature and extent of potential contamination from the OU 7 sources, samples for laboratory analyses were collected from surface soil, subsurface soil, groundwater, surface water, and sediment that could potentially be affected. The results of these analyses are discussed below.

4.2 SAMPLE ANALYTICAL RESULTS. Samples were collected from surface soil, subsurface soil, groundwater, surface water, and sediment media. Summaries of the data generated are presented as tables and/or figures whenever possible. The complete analytical data set for OU 7 is presented in Appendix M.

Results of the biological toxicity testing of soil contamination are discussed in the ecological portion of the risk assessment and are summarized in Chapter 6.0, Summary of Baseline Risk Assessment. The results of geotechnical testing, intended for use in the FS, are presented in Appendix E.

The results of inorganic analyses are compared to background screening criteria. This criteria are set at 2 times the mean of the inorganic analytical results of the background samples. The complete analytical data from the background sampling program for soil are presented in Appendix J. Site-specific background samples

were used for the other media, as noted in the following media-specific discussions.

4.2.1 Surface Soil Surface soil samples were collected at Site 16 during the 1991 investigation and in both the screening and the confirmatory sampling programs conducted during the 1993-94 investigation. The results of the 1991 surface soil investigation are presented in Chapter 1.0 and will not be discussed in this chapter because they represent site conditions prior to the IRA, which consisted of source area soil excavation in May 1994. It should also be noted that the current investigative soil screening results were used to delineate the approximate extent of the soil excavation and also represent site conditions prior to the excavation. However, to portray current site conditions, the confirmatory surface soil samples were collected in August 1994, after the completion of the soil excavation. An activity that was completed shortly before sampling in August 1994 (that may influence the inorganic results and to a lesser extent organic results of the surface soil analysis) was the installation and abandonment of monitoring wells near the location of the former seepage pit. Drilling materials and products including grout, bentonite, and soil cuttings were observed to be present on the ground surface where several surface soil samples were collected. Results of the field screening surface soil samples will be briefly discussed, followed by a more detailed discussion of the confirmatory sample results.

4.2.1.1 Organic Compounds in Surface Soil

Field Screening Sample Results. Surface soil screening was not conducted at Site 16 because the source of the soil contamination was anticipated to be below the surface soil sampling interval of 0 to 1 foot bls.

Confirmatory Sample Results. The TCL organic analytical results for surface soil are presented in Appendix M, summarized in Table 4-1, and shown on Figure 4-1.

VOCs in Surface Soil. Ten confirmatory surface soil samples were collected from 0 to 1 foot bls at OU 7. Results indicate that only two VOCs, 1,2-dichloroethene and trichloroethene, were detected in Site 16 surface soil samples. Both compounds are chlorinated solvents and appear to be related to the historical waste disposal operations at Site 16. However, these detections in the surface soil are interpreted to be the result of the movement and stockpiling of subsurface soil during the IRA soil excavation as discussed in the following paragraph.

1,2-dichloroethene (1,2-DCE) was detected in 1 (CEF-16-SS-8) of the 10 samples at a concentration of 6.5 micrograms per kilogram (μg/kg) and trichloroethene was detected in 6 of the 10 samples with a maximum concentration of 150 μg/kg (CEF-16-SS-3). The two highest detections (CEF-16-SS-3 and 8) of TCE were from samples located near the former seepage pit on the north (near the stockpiled soil) and south sides of the excavation boundary. TCE was also detected at CEF-16-SS-2 (at 33 μg/kg) where, during the IRA, excavated soil was also stockpiled prior to removal from the site. TCE was not detected in surface soil at CEF-16-SS-5 where excavated soil was also stockpiled. Concentrations of TCE in subsurface soil samples collected below 2 feet bls in this area were less than 150 μg/kg, further supporting the interpretation that the source of TCE in the surface soil is from the stockpiled soil.

Table 4-1
Summary of Organic Compounds Detected in Surface Soil

Remedial Investigation
Operable Unit 7, NAS Cecil Field
Jacksonville, Florida

Analyte	Frequency of Detection [1]	Range of Detected Concentrations	Range of Reporting Limits	FDEP Clean-up Goals[3]
Volatiles (µg/kg)				
1,2-Dichloroethene (total)	1/10	[2] 6.5	5 to 11	NP
Trichloroethene	6/10	3J to 150	5 to 12	12,000
Semivolatiles (µg/kg)				
Acenaphthene	3/10	32J to 82J	360 to 380	4,000,000
Acenaphthylene	1/10	31J	360 to 380	ND
Anthracene	3/10	46J to 170J	360 to 380	18,300,000
Benzo(a)anthracene	3/10	200J to 420	360 to 380	1,480
Benzo(a)pyrene	5/10	[2] 29J to 310J	360 to 380	148
Benzo(b)fluoranthene	9/10	23J to 620	360 to 380	1,480
Benzo(g,h,i)perylene	5/10	82J to 140	360 to 380	ND
Benzo(k)fluoranthene	5/10	[2] 20J to 180J	360 to 380	1,470
Butylbenzylphthalate	6/10	[2] 32J to 140J	360 to 380	15,300,000
Carbazole	3/10	65J to 140J	360 to 380	58,100
Chrysene	7/10	26J to 360J	360 to 380	14,800
Dibenz(a,h)anthracene	3/10	29J to 52J	360 to 380	148
Dibenzofuran	1/10	44J	360 to 380	290,000
Fluoranthene	7/10	41J to 870	360 to 380	2,990,000
Fluorene	3/10	26J to 97J	360 to 380	2,760,000
Indeno(1,2,3-cd)pyrene	5/10	62J to 190J	360 to 380	1,480
Naphthalene	1/10	28J	360 to 380	2,290,000
Phenanthrene	6/10	[2] 39J to 740	360 to 380	ND
Pyrene	8/10	24J to 600	360 to 380	2,224,000
Pesticides and PCBs (µg/kg)				
4,4-DDD	1/10	[2] 5.85	3.6 to 4	4,470
4,4-DDE	7/10	0.32J to 3.1J	3.6 to 4	3,340
Aroclor-1260	4/10	5.5J to 33J	36 to 38	NP
Endosulfan sulfate	1/10	0.27J	3.6 to 4	NP
alpha-Chlordane	4/10	0.6J to [2] 26	1.9 to 2	869
gamma-Chlordane	1/10	[2] 30	1.9 to 2	869

[1] Frequency of detection is the number of samples in which the analyte was detected divided by the total number of samples analyzed (16SS01, 16SS02, 16SS03, 16SS04, 16SS05, 16SS06, 16SS07, 16SS08, 16SS09, and 16SS10, including a duplicate at 16SS08).
[2] Value is the average of a sample and its duplicate.
[3] Florida Department of Environmental Protection (FDEP) memorandum dated July 5, 1994. Values presented are the lesser of the Clean-up Goals based on the hazard index for the child resident or the cancer risk for the aggregate resident.

Notes: µg/kg = micrograms per kilogram.
PCBs = polychlorinated biphenyls.
DDD = dichlorodiphenyldichloroethane.
DDE = dichlorodiphenyldichloroethene.

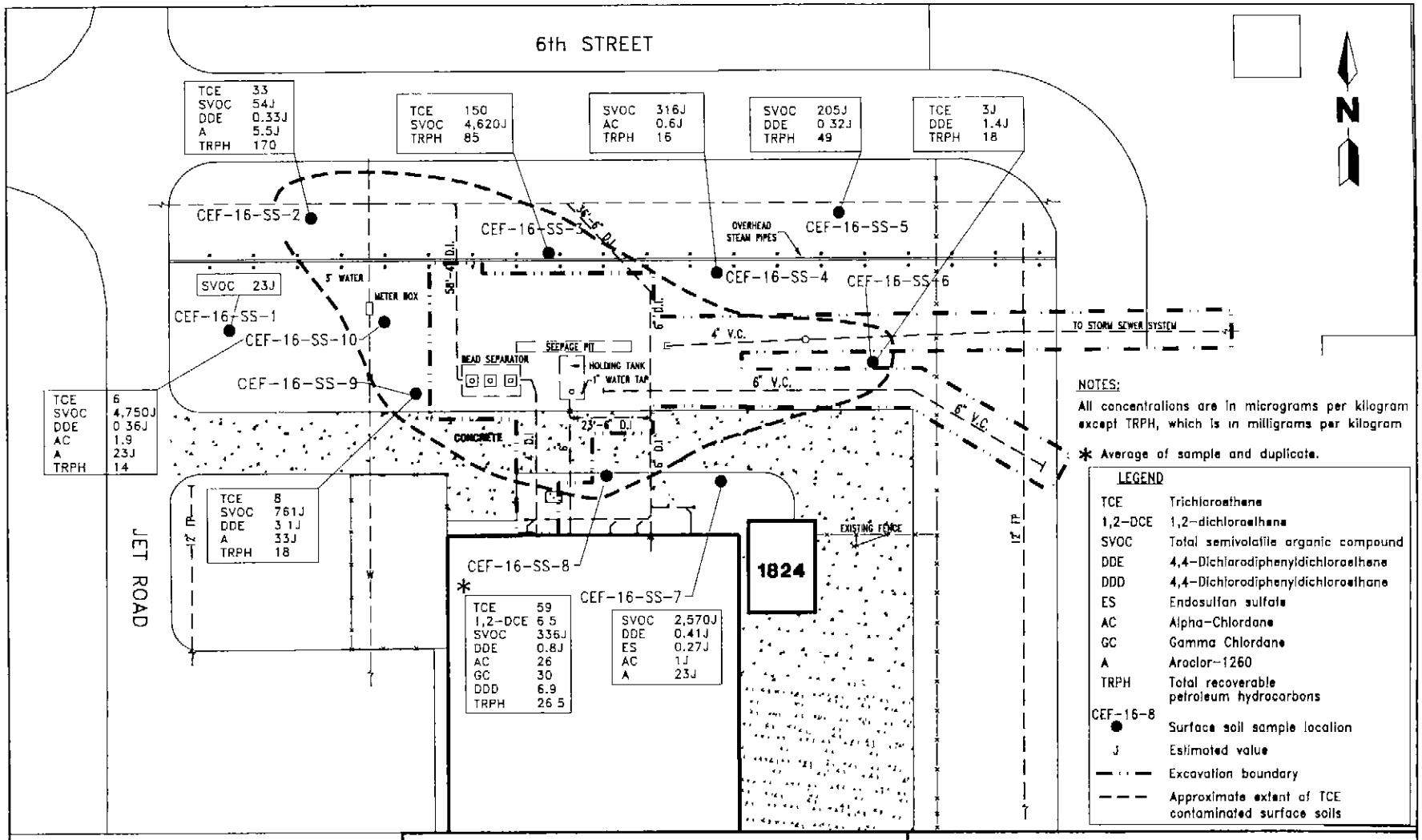


FIGURE 4-1
ORGANICS DETECTED IN SURFACE SOIL

REMEDIAL INVESTIGATION, OPERABLE UNIT 7

NAS CECIL FIELD
JACKSONVILLE, FLORIDA

SVOCs in Surface Soil. SVOCs were detected in 9 of the 10 surface soil samples collected at OU 7. A total of 19 SVOCs were detected at least once in the 9 samples. Due to the large number of SVOC detections at OU 7, the discussion will reference total SVOC detections. Many of the detected SVOCs are commonly found in diesel fuel and oil and are interpreted not to be associated with the former underground waste disposal operations at OU 7. The concentrations of total SVOCs in surface soil were often several orders of magnitude greater than total SVOC concentrations in subsurface soil. This concentration variation indicates that the SVOC contribution of the previous underground waste disposal operations was minimal and the surface soil detections do not appear to be related to the former OU 7 waste disposal operations.

The highest concentrations of SVOCs occurred at sample locations CEF-16-SS-3 (4,620 μg/kg), CEF-16-SS-7 (2,570 μg/kg) and CEF-16-SS-10 (4,750 μg/kg), which are located near the boundary of the excavated area.

Total Recoverable Petroleum Hydrocarbons (TRPH) in Surface Soil. TRPH was detected in all surface soil samples except CEF-16-SS-1 and CEF-16-SS-7 at concentrations ranging from 14 to 170 mg/kg. Only two samples, CEF-16-SS-2 and CEF-16-SS-3, exceeded the FDEP criterion of 50 mg/kg for treated petroleum contaminated soil. These samples were collected north of the former seepage pit area and the overhead steam lines adjacent to Sixth Avenue (Figure 4-1).

Pesticides and PCBs in Surface Soil. Few pesticides and PCBs were detected at OU 7. Sporadic detections of pesticides including 4,4-dichlorodiphenyl-dichloroethene (DDE), 4,4-dichlorodiphenyldichloroethane (DDD), endosulfan sulfate, alpha-Chlordane, and gamma-Chlordane were observed in the surface soil samples at OU 7. These pesticide detections are most likely the result of previous basewide use of pesticides and not the result of waste disposal operations of the AIMD Building 313.

The PCB Aroclor-1260 was detected in 4 of the 10 surface soil samples with a maximum detected concentration of 33J μg/kg in a sample from location CEF-16-SS-9.

4.2.1.2 **Inorganic Analytes in Surface Soil** The confirmatory inorganic analytical results for surface soil are presented in Appendix M, summarized in Table 4-2, and shown on Figure 4-2. The background screening concentrations for inorganics in surface soil are also presented in Table 4-2.

Confirmatory Sample Results. A total of 17 TAL inorganic analytes were detected in at least one confirmatory surface soil sample collected at OU 7. Due to the large number of analytes detected and the widespread distribution, only the inorganic analytes that were chemicals of potential concern (CPC) in the human health risk assessment (when present in surface or subsurface soil or groundwater) and exceeded twice the average of detected concentrations in the Arents background soil data set will be discussed in the RI report. However, results of all inorganic analytes detected in surface soil are presented in Table 4-2.

The CPCs identified for OU 7 surface soil in the human health risk assessment included calcium, cobalt, and sodium. These analytes were not screened out of the CPC selection process because they were not detected in the Arents background soil samples. Inorganic analytes that exceeded twice the average of detected concentrations in the Arents background soil data set but were not retained as CPCs included cadmium, copper, lead, silver, and zinc. Details and rationale for

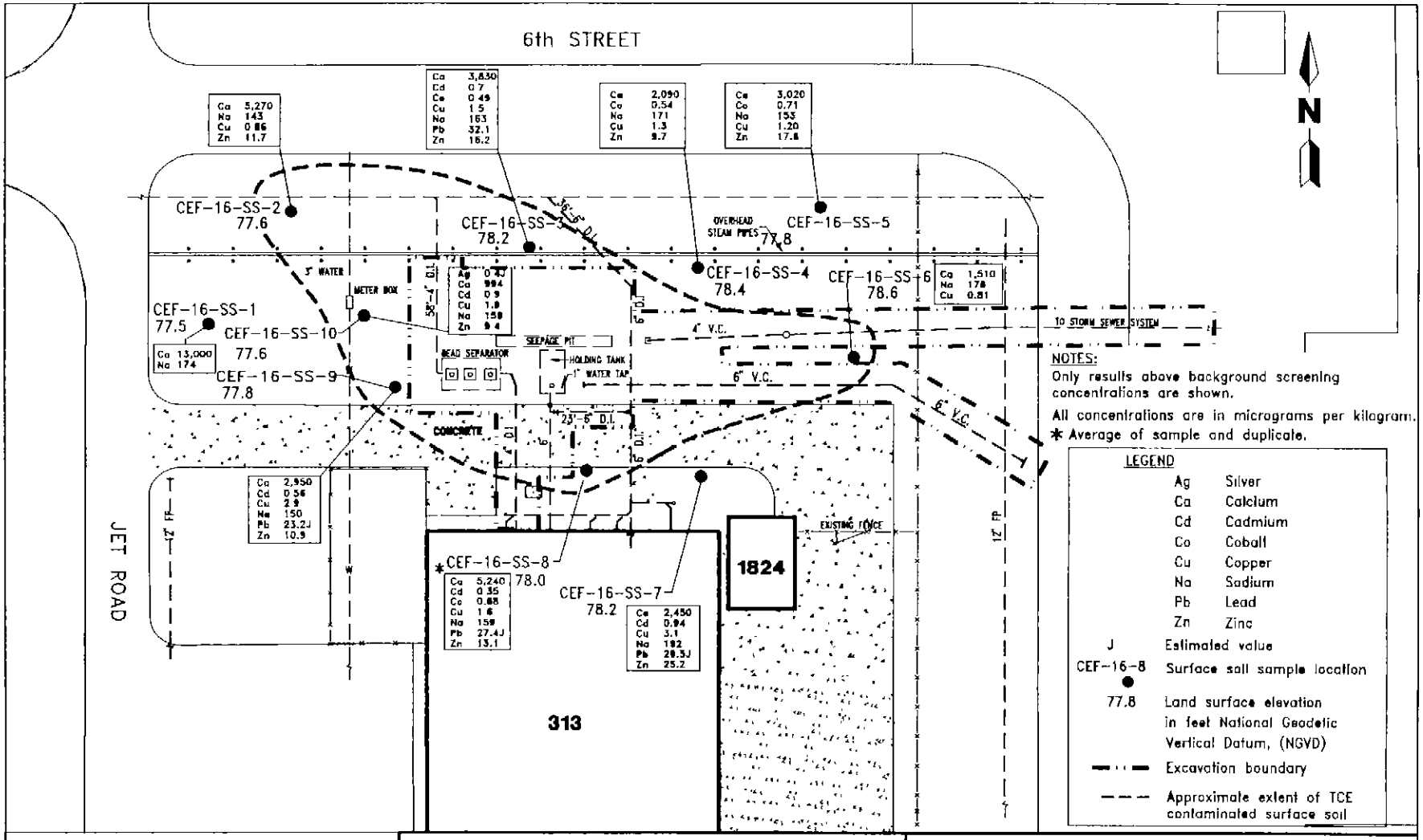


FIGURE 4-2
INORGANICS DETECTED IN SURFACE SOIL

REMEDIAL INVESTIGATION, OPERABLE UNIT 7

NAS CECIL FIELD
JACKSONVILLE, FLORIDA

Table 4-2
Summary of Inorganics Detected in Surface Soil

Remedial Investigation
Operable Unit 7, NAS Cecil Field
Jacksonville, Florida

Analyte	Frequency of Detection [1]	Range of Detected Concentrations	Range of Reporting Limits	Background Screening Concentration [2]	Maximum Background Concentration	FDEP Clean-up Goals[4]
Inorganics (mg/kg)						
Aluminum	10/10	932 to [3] 5,950	40 to 40	29,000	24,000	ND
Barium	10/10	1.7 to 8.7	40 to 40	21	[3]16.4	NP
Cadmium	5/10	[3] 0.35 to 0.94	1 to 1	ND	ND	37.5
Calcium	10/10	994 to 13,000	1,000 to 1,000	ND	ND	NP
Chromium	10/10	1.8 to [3] 13	2 to 2	31.2	24.9	[5]201
Cobalt	4/10	0.49 to 0.71	10 to 10	ND	ND	ND
Copper	9/10	0.81 to 3.1	5 to 5	ND	ND	2,880
Iron	10/10	207 to 1,030	20 to 20	8,060	7,140	ND
Lead	10/10	3.9J to 32.1J	0.6 to 0.6	15.6	[3]10.5	ND
Magnesium	10/10	66 to [3] 173	1,000 to 1,000	474	[3]376	NP
Manganese	10/10	2.9 to 14	3 to 3	18	10.9	5,710
Nickel	9/10	0.81J to 2.6	8 to 8	8	[3]5.7	1,510
Potassium	9/10	21.7J to 93.7J	1,000 to 1,000	310	236	NP
Silver	1/10	0.4J	2 to 2	ND	ND	NP
Sodium	10/10	143 to 192	1,000 to 1,000	ND	ND	NP
Vanadium	10/10	1.2 to 5	10 to 10	34.2	30.7	501
Zinc	8/10	9.4 to 25.2	4 to 4	ND	ND	23,330

[1] Frequency of detection is the number of samples in which the analyte was detected divided by the total number of samples analyzed (16SS01, 16SS02, 16SS03, 16SS04, 16SS05, 16SS06, 16SS07, 16SS08, 16SS09, and 16SS10, including a duplicate at 16SS08).
[2] Twice the average of detected concentrations for inorganic analytes at BSS01, BSS02, BSS03, and BSS04, including a duplicate at BSS02 (Arents soil unit) (Appendix I).
[3] Value is the average of a sample and its duplicate.
[4] Florida Department of Environmental Protection (FDEP) memorandum dated July 5, 1994. Values presented are the lesser of the Clean-up Goals based on the hazard index for the child resident or the cancer risk for the aggregate resident.
[5] Value is for chromium VI.

Notes: mg/kg = milligrams per kilogram.
ND = not detected in any background samples.
NP = analyte is not presented in FDEP guidance.

eliminating inorganic compounds as CPCs are presented in the OU 7 Baseline Risk Assessment (ABB-ES, 1995). The distribution and concentration of inorganic CPCs and detections exceeding twice the average background concentration in surface soil are shown on Figure 4-2. A brief summary of these is presented in the following paragraphs.

Cadmium was detected in 5 of the 10 surface soil samples at concentrations ranging from 0.35 to 0.94 mg/kg. Cadmium was not detected in the Arents background data set.

Calcium and sodium were detected in all 10 of the OU 7 surface soil samples but were not detected in any of the Arents background surface soil samples. Calcium concentrations ranged from 994 to 13,000 mg/kg and sodium concentrations ranged from 143 to 192 mg/kg. As shown on Figure 4-2, the detections of sodium are more evenly distributed across the site than the detections of calcium. The highest detection of sodium (192 mg/kg) was in a sample from location CEF-16-SS-7 and the highest detection of calcium (13,000) was in a sample from CEF-16-SS-1.

Cobalt was detected in 4 of the 10 samples at estimated concentrations ranging from 0.49J (CEF-16-SS-3) to 0.71J (CEF-16-SS-5) mg/kg, less than one tenth the reported detection limit. Cobalt was also not detected in the background surface soil samples.

Copper was detected in all but one OU 7 surface soil sample but was not detected in the background samples. The maximum copper concentration was estimated at 3.1 mg/kg in a sample from CEF-16-SS-7, which was below the reported detection limit of 5 mg/kg.

Lead was detected in all surface soil samples collected at OU 7 but only four detections (CEF-16-SS-3, CEF-16-SS-7, CEF-16-SS-8D, and CEF-16-SS-9) exceeded twice the mean background concentration of 15.6 mg/kg. The highest detected concentration of lead was 39.8 mg/kg in the duplicate sample of CEF-16-SS-8, which is well below the USEPA guideline of 400 mg/kg in soil. All four of these detections are located near the limits of the IRA soil excavation. It does not appear that these lead concentrations are elevated above background due to the potential mixing of subsurface soil with surface soil during the excavation.

Silver was only detected in one surface soil sample (CEF-16-SS-10) at an estimated concentration of 0.4 mg/kg, which is below the reported detection limit of 2.0. Silver was not detected in the background soil samples.

Zinc was also not detected in the background surface soil samples. However, zinc was detected in 8 of the 10 surface soil samples collected at Site 16 ranging in concentration from 9.4 to 25.2 mg/kg. All the detections of zinc were above the reported detection limit of 4 mg/kg. The highest concentration (25.2 mg/kg) was detected in a sample from location CEF-16-SS-7.

4.2.1.3 **Summary of Analytical Results for Surface Soil** The results of the confirmatory surface soil sampling program indicate the presence of VOCs, SVOCs, pesticides, PCBs, and inorganics. The results of the BRA (ABB-ES, 1995) indicate that none of the detections in the surface soil pose a risk to human receptors. Ecological risk was not assessed for surface soil due to the industrial setting of OU 7.

The only VOC detections were solvents (TCE and DCE) and they appear to be related to the movement and stockpiling of contaminated soil during the IRA soil excavation rather than from the underground wastewater disposal operations of the AIMD. The highest detection of TCE (CEF-16-SS-3) was 150 μg/kg and was in a sample collected north of the overhead steam line near the area where excavated soil was reportedly stockpiled prior to disposal. Concentrations of TCE in subsurface soil samples collected below 2 feet bls in this area were less than 150 μg/kg, further supporting the interpretation that the source of the TCE in the surface soil is from the stockpiled subsurface soil.

Several SVOCs were detected in surface soil samples. Many of the detected SVOCs are commonly found in diesel fuel and oil and are interpreted not to be associated with the former underground waste disposal operations at OU 7. The concentrations of total SVOCs in surface soil were often several orders of magnitude greater than total SVOC concentrations in subsurface soil. This concentration variation indicates that the SVOC contribution of the previous underground waste disposal operations was minimal and the surface soil detections do not appear to be related to the former OU 7 waste disposal operations.

Few pesticides and PCBs were detected in surface soil. The detections cannot be linked to the disposal operations at OU 7 and are most likely the result of former basewide pesticide application and use of PCBs.

Seven inorganics were detected above background concentrations in at least one sample. The most frequent exceedances of background concentrations were by calcium, copper, sodium, and zinc. Calcium, cobalt, copper, silver, sodium, and zinc were detected in OU 7 surface soil samples but were not detected in any background soil samples. Similar to the VOCs, it does not appear that the presence of inorganic analytes above the background concentration is a result of the previous underground waste disposal operations but rather the result of subsurface soil being brought to the surface and mixed with existing surface soil during the IRA excavation activities. In support, all of the inorganic analytes that exceeded surface soil background concentrations also exceeded the subsurface soil background concentrations.

4.2.2 **Subsurface Soil** As for surface soil samples, subsurface soil samples were collected during the 1991 investigation and both screening and confirmatory sampling programs were conducted during the 1993-94 investigation. The results of the 1991 subsurface soil investigation are presented in Chapter 1.0 and will not be discussed in this chapter because they represent site conditions prior to the IRA source area soil excavation that was conducted in May 1994. The results of the current investigative screening program were used to approximate the extent of the soil to be excavated and also to represent conditions prior to the excavation. Results of the subsurface soil screening program are presented in Appendix D. The confirmatory subsurface soil samples were collected in August 1994, after the IRA soil excavation to represent the current subsurface soil conditions at OU 7.

The confirmatory subsurface soil sample locations were selected to be located outside the soil excavation boundary to prevent the sampling and analysis of clean fill material. The 12 confirmatory subsurface soil sample locations were selected jointly with representatives from the USEPA, FDEP, and the Navy during a meeting on July 6, 1994.

4.2.2.1 Organic Compounds in Subsurface Soil

Field Screening Sample Results. An extensive subsurface soil screening program was conducted during the 1993-94 field program. A complete set of subsurface screening analytical data and contaminant distribution is found in Appendix D.

The most widely detected VOC in the vadose zone and phreatic zone soil was TCE. The highest detected concentration of TCE (83,000 μg/kg in a sample from AGSS-16-13) in the vadose zone was observed on the south side of the former seepage pit, which has since been removed during the IRA soil excavation. Based on the results of the confirmatory sampling (as presented in the next subsection), TCE concentrations in the vadose zone soil exceeding 1,000 μg/kg were removed during the soil excavation. The highest concentration of TCE detected in the phreatic soil was 1,000,000 μg/kg in a sample from AGSS-16-13 from 10 to 12 feet bls. Other TCE detections observed in the phreatic zone, which were detected at concentrations above 1,000 μg/kg included:

- from 8 to 10 feet bls, samples from AGSS-16-10 (1,300 μg/kg), AGSS-16-13 (150,000 μg/kg), AGSS-16-16 (32,000 μg/kg), and AGSS-16-2 (43,000 μg/kg);
- from 10 to 12 feet bls, samples from AGSS-16-2 (61,000 μg/kg), AGSS-16-45 (2,600 μg/kg), and AGSS-16-44 (1,300 μg/kg); and
- from 12 to 14 feet bls, samples from AGSS-16-45 (5,100 μg/kg), and AGSS-16-55 (6,100 μg/kg).

No detections of TCE above 1,000 μg/kg were observed in the phreatic soil samples collected from 14 to 22 feet bls. All soil TCE concentrations in borings from outside the excavation boundary were below 50 μg/kg. Based on the rule of thumb that a TCE soil concentration of 20,000,000 μg/kg may indicate the presence of non-aqueous phase liquid (NAPL), free-product TCE or NAPL were not identified and are not anticipated to be present in the soil.

Confirmatory Sample Results. The confirmatory organic analytical results for subsurface soil are presented in Appendix M, summarized in Table 4-3, and shown on Figure 4-3.

VOCs in Subsurface Soil. Twenty-four confirmatory subsurface soil samples were collected from 12 soil borings. Results indicate that five VOCs, 1,2-dichloroethene, 2-butanone, acetone, methylene chloride, and trichloroethene, were detected in at least one subsurface soil sample. Nearly all of the VOC detections were in samples collected from borings located near the limits of the IRA soil excavation. TCE and 1,2-DCE are solvents and are most likely related to the previous waste disposal operations of the adjacent Building 313.

Although acetone, 2-butanone, and methylene chloride are solvents and may have been used in the Building 313 operations, they are also common laboratory contaminants. Methylene chloride was the most widespread VOC detected (10 of 24 samples), ranging in estimated concentration from 2.5 to 10 μg/kg. All of the methylene chloride detections were less than the reported detection limits. Acetone was detected in four samples from soil borings CEF-16-SB-3, CEF-16-SB-9, and CEF-16-SB-12 at concentrations ranging from 46 to 220 μg/kg. TCE was detected in nine samples with a maximum concentration of 650 μg/kg in a sample from soil

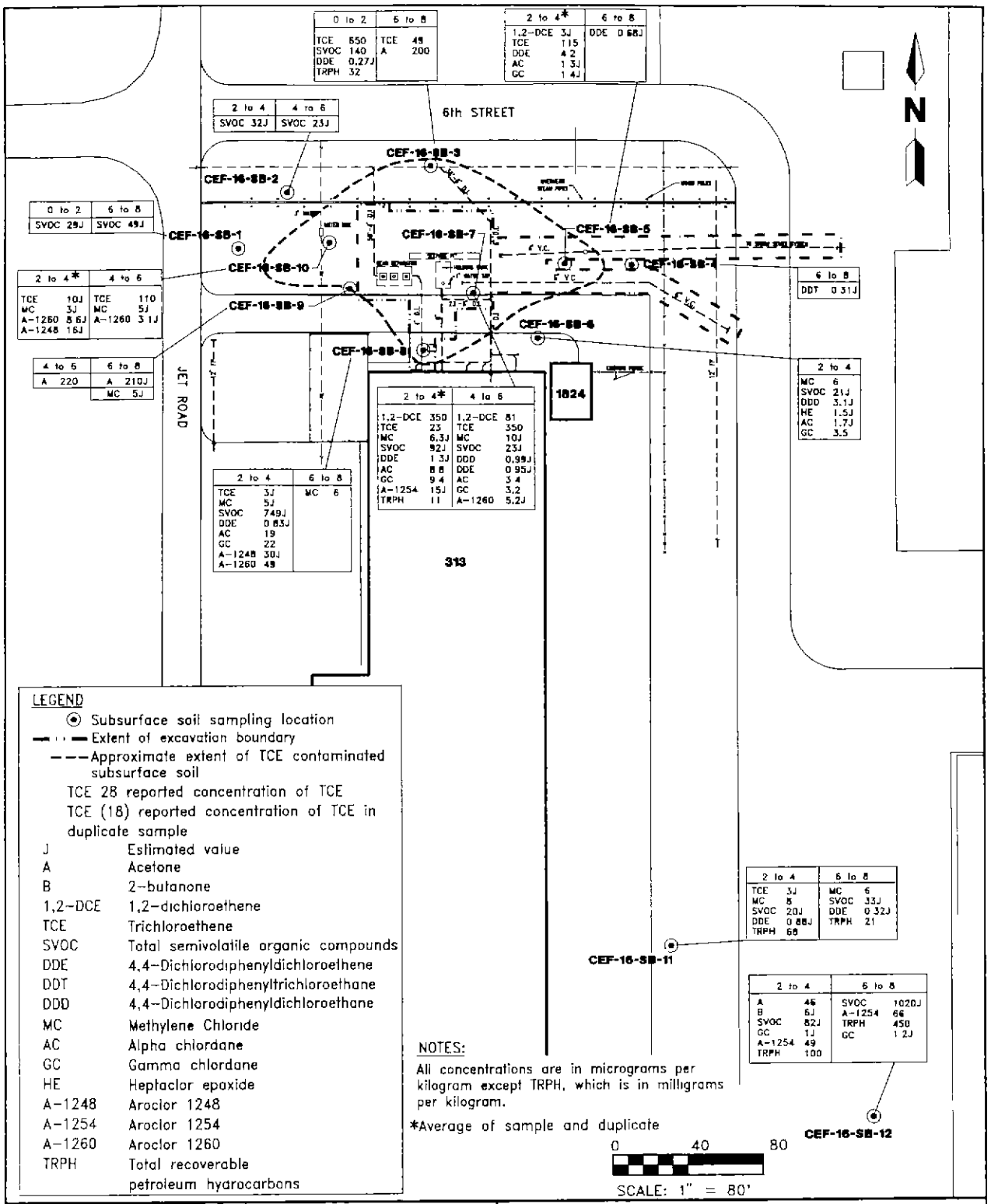


FIGURE 4-3
ORGANICS DETECTED IN SUBSURFACE SOIL

REMEDIAL INVESTIGATION, OPERABLE UNIT 7

NAS CECIL FIELD
JACKSONVILLE, FLORIDA

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Table 4-3
Summary of Organic Compounds Detected in Subsurface Soil

Remedial Investigation
Operable Unit 7, NAS Cecil Field
Jacksonville, Florida

Analyte	Frequency of Detection [1]	Range of Detected Concentrations	Range of Reporting Limits	FDEP Clean-up Goals Based on Leachability[3]
Volatiles (µg/kg)				
1,2-Dichloroethene (total)	3/24	[2] 3J to [2] 350	5 to 28	NP
2-Butanone	1/24	6J	11 to 54	878
Acetone	4/24	46 to 220	11 to 150	143
Methylene chloride	10/24	2.5J to 10J	5 to 28	1.13
Trichloroethene	9/24	3J to 650	5 to 54	1.46
Semivolatiles (µg/kg)				
2-Methylnaphthalene	1/24	21J	360 to 410	ND
Benzo(a)pyrene	2/24	20J to 21J	360 to 410	2,200
Benzo(b)fluoranthene	6/24	23J to 49J	360 to 410	4,400
Benzo(g,h,i)perylene	2/24	19J to 21J	360 to 410	32,000
Butylbenzylphthalate	4/24	21J to 750	360 to 410	24,200
Chrysene	1/24	46J	360 to 410	2,000
Diethylphthalate	1/24	23J	360 to 410	NP
Dimethylphthalate	1/24	29J	360 to 410	NP
Fluoranthene	2/24	23.5J to 28J	360 to 410	21,300
Indeno(1,2,3-cd)pyrene	1/24	20J	360 to 410	24,000
Phenol	2/24	20J to 33J	360 to 410	NP
Pyrene	2/24	21J to [2] 23J	360 to 410	16,000
bis(2-Ethylhexyl)phthalate	8/24	23J to 600	360 to 410	NP
Pesticides and PCBs (µg/kg)				
4,4-DDD	2/24	0.99J to 3.1J	0.6 to 4.1	154
4,4-DDE	8/24	0.27J to [2] 4.2	3.6 to 4.1	880
4,4-DDT	1/24	0.31J	2.25 to 4.1	48.6
Aroclor-1248	2/24	[2] 15.8J to 30J	33 to 41	NP
Aroclor-1254	3/24	[2]15J to 66	36 to 41	NP
Aroclor-1260	4/24	3.1J to 49	36 to 41	NP
Heptachlor epoxide	1/24	1.5J	0.4 to 2.1	0.128
alpha-Chlordane	5/24	[2]1.25J to 19	1.8 to 2.1	560
gamma-Chlordane	7/24	1J to 22	1.8 to 2.1	560

[1] Frequency of detection is the number of samples in which the analyte was detected divided by the total number of samples analyzed (16SB10S2, 16SB10S4, 16SB11S2, 16SB11S6, 16SB12S2,16SB12S6, 16SB1S0, 16SB1S6, 16SB2S2, 16SB2S4. 16SB3S0, 16SB3S6, 16SB4S2, 16SB4S6,16SB5S2, 16SB5S6, 16SB6S2, 16SB6S4, 16SB7S2, 16SB7S4, 16SB8S2, 16SB8S4, 16SB9S4,16SB9S6, including duplicates at 16SB10S2, 16SB5S2, and 16SB7S2).
[2] Value is the average of a sample and its duplicate.
[3] Florida Department of Environmental Protection (FDEP) memorandum dated July 5, 1994, Values presented are the Clean-up Goals based on Leachability.

Notes: µg/kg = micrograms per kilogram.
PCBs = polychlorinated biphenyls.
DDD = dichlorodiphenyldichloroethane.
DDE = dichlorodiphenyldichloroethene.
DDT = dichlorodiphenyltrichloroethane.
NP = analyte is not presented in FDEP guidance.
ND = analyte is presented in FDEP guidance but no criterion is provided.

boring CEF-16-SB-3 (0 to 2 feet bls) north of the excavated area. The TCE results are all below 1,000 μg/kg, indicating that the IRA soil excavation was effective in removing subsurface vadose soil TCE contamination below the IRA target cleanup level.

SVOCs in Subsurface Soil. Thirteen SVOCs were detected in subsurface soil samples. Of the SVOCs detected, only benzo(b)fluoranthene, butylbenzyl-phthalate, and bis(2-ethylhexyl)phthalate were detected in more than two samples. Because several SVOCs were detected sporadically at OU 7, the discussion of the SVOC results will be presented as total SVOCs. The highest concentration of total SVOCs (1,020 μg/kg) was detected in a sample from soil boring CEF-16-SB-12 at a depth of 6 to 8 feet bls. This boring is located to the southeast of the source area adjacent to the groundwater screening location GS-16-28 and was intended to assess the contamination in the vadose zone above groundwater containing TCE in a screening sample. The majority of SVOCs detected in nine samples from this location was from butylbenzyl phthalate (750 μg/kg). The land surface at this location is covered with asphalt, which may be the source of the other SVOCs. The second highest concentration (749J μg/kg) of total SVOCs and the highest concentration in the source area was detected in a sample from soil boring CEF-16-SB-8 from a depth of 2 to 4 feet bls. This boring is located in the small grassy area just north of Building 313 and is also along the boundary of the soil excavation. Of the 749J μg/kg total SVOCs detected, 600 μg/kg was from bis(2-ethylhexyl)phthalate. All other concentrations of total SVOCs were 140 μg/kg or less and are presented on Figure 4-3.

TRPH in Subsurface Soil. TRPH was detected in 6 of the 24 subsurface soil samples. The maximum concentration (450 mg/kg at 6 to 8 feet bls) was in a sample from soil boring CEF-16-SB-12, which is located to the southeast of Site 16. The highest detection in the source area was 32 mg/kg at a depth of 0 to 2 feet bls in a sample from soil boring CEF-16-SB-3. The FDEP guidance value of 50 mg/kg for petroleum-contaminated soil was exceeded in the sample collected from 2 to 4 feet bls (68 mg/kg) in boring CEF-16-SB-11 and in both samples from boring CEF-16-SB-12 (100 mg/kg at 0 to 2 feet bls, and 450 mg/kg at 6 to 8 feet bls).

Pesticides and PCBs in Subsurface Soil. Few pesticides and PCBs were detected in subsurface soil at Site 16. Sporadic detections of pesticides including 4,4-DDE, 4,4-DDD, 4,4-DDT, alpha-Chlordane, gamma-Chlordane, and heptachlor epoxide were observed in subsurface soil samples at Site 16. These pesticide detections are most likely the result of previous basewide use of pesticides and not the result of waste disposal operations of the AIMD Building 313.

The PCBs Aroclor-1248, Aroclor-1254, and Aroclor-1260 were detected in 4 or less of the 24 subsurface soil samples with a maximum detected concentration of 66 μg/kg (Aroclor-1254) in a sample from soil boring CEF-16-SB-12 from 6 to 8 feet bls. The second highest concentration of PCBs (49 μg/kg) was also Aroclor-1254 in a sample from boring CEF-16-SB-12 (2 to 4 feet bls)

4.2.2.2 Inorganic Analytes in Subsurface Soil

Confirmatory Sample Results. The confirmatory inorganic analytical data set for subsurface soil is presented in Appendix M, summarized in Table 4-4, and shown on Figure 4-4. The background screening concentrations for inorganics in surface soil is presented in Table 4-4.

Table 4-4
Summary of Inorganics Detected in Subsurface Soil

Remedial Investigation
Operable Unit 7, NAS Cecil Field
Jacksonville, Florida

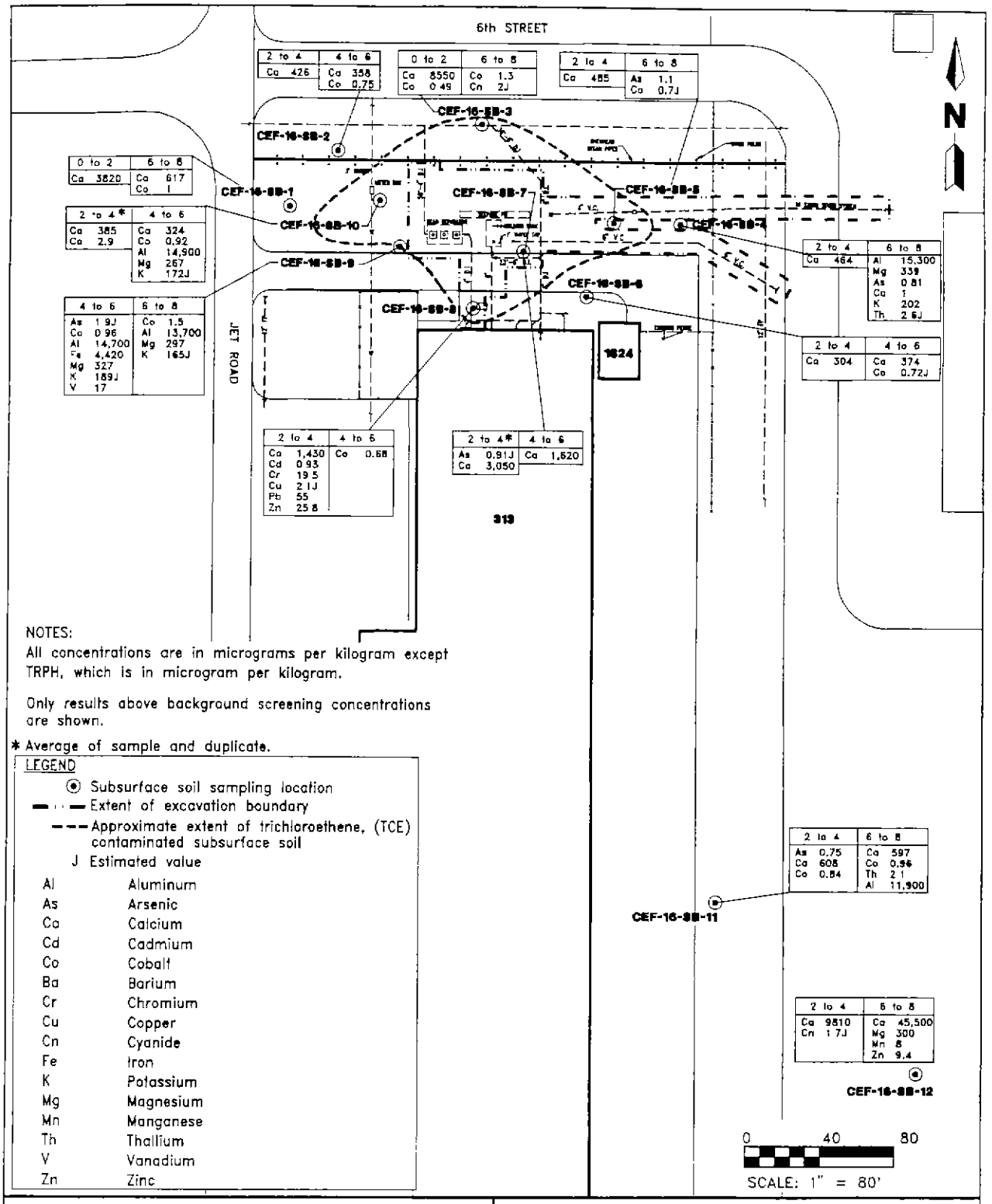
Analyte	Frequency of Detection [1]	Range of Detected Concentrations	Range of Reporting Limits	Background Screening Concentration [2]	Maximum Background Concentration	FDEP Clean-up Goals Based on Leachability[4]
Inorganics (mg/kg)						
Aluminum	24/24	882 to 15,300	40 to 140	11,200	15,600	–
Arsenic	5/24	0.75 to 1.9J	2 to 2	1.64	0.98	–
Barium	22/24	1.6 to 15.6	40 to 40	16	[3]12.2	NP
Cadmium	1/24	0.93	1 to 1	ND	ND	–
Calcium	18/24	304 to 45,500	1,000 to 1,000	320	277	NP
Chromium	24/24	[3]1.4J to 19.5	2 to 2	16	17.4	–
Cobalt	14/24	0.49 to [3]2.85	10 to 10	ND	ND	–
Copper	16/24	[3]0.525J to 2.1J	5 to 5	1.16	0.58	–
Cyanide	2/23	1.7J to 2J	0.5 to 0.5	ND	ND	NP
Iron	24/24	191 to 4,420	20 to 20	2,840	5,660	–
Lead	24/24	1.6J to 55	0.6 to 0.6	14	18.8	–
Magnesium	18/24	39.7 to 339	1,000 to 1,000	268	[3]256	NP
Manganese	24/24	2.8 to 8	3 to 3	7.8	4.5	–
Mercury	4/24	0.12J to [3]0.13J	0.1 to 0.1	1.1	.55	NP
Nickel	22/24	0.48 to 5J	8 to 8	5.4	3.9	–
Potassium	18/24	33.6J to [3]277J	1,000 to 1,000	152	158	NP
Sodium	8/24	142 to 781	1,000 to 1,000	312	225	NP
Thallium	2/24	2.1 to 2.6J	2 to 2	ND	ND	NP
Vanadium	24/24	[3] 1.1J to 17	10 to 10	16	15.1	–
Zinc	2/24	9.4 to 25.8	4 to 4	ND	ND	–

[1] Frequency of detection is the number of samples in which the analyte was detected divided by the total number of samples analyzed (16SB10S2, 16SB10S4, 16SB11S2, 16SB11S6, 16SB12S2, 16SB12S6, 16SB1S0, 16SB1S6, 16SB2S2, 16SB2S4, 16SB3S0, 16SB3S6, 16SB4S2, 16SB4S6, 16SB5S2, 16SB5S6, 16SB6S2, 16SB6S4, 16SB7S2, 16SB7S4, 16SB8S2, 16SB8S4, 16SB9S4, 16SB9S6, including duplicates at 16SB10S2, 16SB5S2, and 16SB7S2).[2] Twice the average of detected concentrations for inorganic analytes in background samples CEFBBMS1S0, CEFBBMS1S6, CEFBBMS2S2, CEFBBMS2S6, CEFBBMS312, CEFBBMS316, CEFBBMS4S2, CEFBBMS4S4, CEFBBMS5S2, CEFBBMS5S6, CEFBBMS610, CEFBBMS616, CEFBBMS7S0, CEFBBMS7S4, CEFBBMS8S2, CEFBBMS8S6, CEFBBMS910, and CEFBBMS916, including a duplicate at CEFBBMS7S0.

[3] Value is the average of a sample and its duplicate.

[4] Florida Department of Environmental Protection (FDEP) memorandum dated July 5, 1994. Values presented are the Clean-up Goals based on Leachability.

Notes: mg/kg = milligrams per kilogram.
ND = not detected in any background samples.
NP = analyte is not presented in FDEP guidance.
– = analyte is presented in FDEP guidance, but no data are provided.



NOTES:
All concentrations are in micrograms per kilogram except TRPH, which is in microgram per kilogram.

Only results above background screening concentrations are shown.

* Average of sample and duplicate.

LEGEND

- ⊙ Subsurface soil sampling location
- — · · — Extent of excavation boundary
- - - - Approximate extent of trichloroethene, (TCE) contaminated subsurface soil
- J Estimated value

Al	Aluminum
As	Arsenic
Ca	Calcium
Cd	Cadmium
Co	Cobalt
Ba	Barium
Cr	Chromium
Cu	Copper
Cn	Cyanide
Fe	Iron
K	Potassium
Mg	Magnesium
Mn	Manganese
Th	Thallium
V	Vanadium
Zn	Zinc

FIGURE 4-4
INORGANICS DETECTED IN SUBSURFACE SOIL

REMEDIAL INVESTIGATION, OPERABLE UNIT 7

NAS CECIL FIELD
JACKSONVILLE, FLORIDA

CECIL\ORGANICS\ NP\ 03-14-95

Twenty TAL inorganic analytes were detected in at least one confirmatory subsurface soil sample collected from each of the 12 soil borings at OU 7. Due to the widespread distribution of these analytes, only the analytes that were CPCs in the human health risk assessment and exceeded twice the average of detected concentrations in the background subsurface soil samples will be discussed in this section.

The CPCs identified for OU 7 subsurface soil in the human health risk assessment included arsenic, calcium, cobalt, and thallium. Inorganic analytes that exceeded twice the average background subsurface soil concentration but were not retained as CPCs included aluminum, cadmium, chromium, copper, cyanide, iron, lead, magnesium, manganese, potassium, sodium, vanadium, and zinc. Details and rationale for retaining or eliminating inorganic analytes as CPCs are presented in the OU 7 Baseline Risk Assessment (ABB-ES, 1995a). The distribution and concentration of inorganic CPCs and detections exceeding the background screening concentrations are shown on Figure 4-4. A brief summary of the significant inorganic detections is presented in the following paragraphs.

Aluminum was detected in all 24 subsurface soil samples at concentrations ranging from 882 to 15,300 mg/kg. Five samples had concentrations of aluminum higher than the background screening concentration of 11,100 mg/kg, but all detections were below the maximum background concentration of 15,600 mg/kg.

The CPC arsenic was detected slightly above the background screening concentration (1.64 mg/kg) in a sample from soil boring CEF-16-SB-9 at a depth of 4 to 6 feet bls at a concentration of 1.9 J mg/kg. No other detections of arsenic exceeded the background concentration.

Cadmium was only detected in one subsurface soil sample, CEF-16-SB-8 at a depth of 2 to 4 feet bls and a concentration of 0.93 mg/kg. Cadmium was not detected in background samples.

Another CPC, calcium, was detected in 18 of the 24 samples collected. Seventeen of the detections exceeded the background concentration of 320 mg/kg. The highest detection of calcium was in a sample from soil boring CEF-16-SB-12 at a concentration of 45,500 mg/kg.

Cobalt, which was also detected in several groundwater samples, was detected in 14 of the 24 samples at concentrations ranging from 0.49 to 1.5 mg/kg. The highest concentration of cobalt was detected in a sample from soil boring CEF-16-SB-9 at a depth of 6 to 8 feet bls (the average of the sample and duplicate from CEF-16-SB-10 from 2 to 4 feet bls is 2.9 mg/kg because the averaging procedure uses half of the RDL when the sample or duplicate result is non-detect). Because cobalt was not present in any of the background surface or subsurface soil samples, the detection of cobalt in the OU 7 soil may be a result of the former waste disposal operations of the AIMD. All the detections were in samples from borings throughout the source area and in samples from soil boring CEF-16-SB-11 where liquid wastes from the AIMD were reportedly dumped on the ground on the east side of Building 313. The only boring that was not near areas of liquid waste disposal from the AIMD was CEF-16-SB-12 and no cobalt was detected in either sample collected from this boring.

Cyanide was only detected in two samples and was not detected in the background samples. The highest detected concentration of cyanide was 2.0 mg/kg in a sample from CEF-16-SB-3 from 6 to 8 feet bls.

Lead was detected in all subsurface soil samples at OU 7, ranging in concentration from 1.6 to 55 mg/kg. The background screening concentration for lead was 14 mg/kg and the maximum background concentration was 18.8 mg/kg. However, the background screening concentration was exceeded in only one sample, from 2 to 4 feet bls in soil boring CEF-16-SB-8 (55 mg/kg), which is located approximately 40 feet south of the former seepage pit (see Figure 4-4). Because lead was detected in background samples and only one sample contained lead at a concentration above background screening concentrations, it does not appear that the presence of lead in subsurface soil at OU 7 can be attributable to the former waste disposal operations of AIMD Building 313.

Thallium, a CPC for the risk assessment, was only detected in two samples with a maximum detection of 2.6 mg/kg in a sample from soil boring CEF-16-SB-4 (from 6 to 8 feet bls), which is located approximately 60 feet east of the former seepage pit. Thallium was not detected in the background soil samples.

4.2.2.3 Summary of Analytical Results for Subsurface Soil The results of the confirmatory subsurface soil sampling program indicate the presence of VOCs, SVOCs, pesticides, PCBs, and inorganics. The distribution of VOCs, SVOCs, and inorganics is similar with the highest concentrations being detected in samples from soil borings nearest the limits of the soil excavation boundary. Pesticides and PCBs generally had a more sporadic distribution over the site. The results of the BRA (ABB-ES, 1995a), indicate that none of the detections in the subsurface soil pose a risk to human receptors. Ecological risk is not assessed for subsurface soil.

The VOC detections are all solvents and appear to be related to the previous wastewater disposal operations of AIMD Building 313 through the seepage pit. The highest VOC detection in subsurface soil was TCE at 650 μg/kg in a sample collected from 0 to 2 feet in soil boring CEF-16-SB-3, which is located just north of the soil excavation boundary. However, at CEF-16-SB-3, the TCE concentrati on decreased below 2 feet bls (49 μg/kg from 6 to 8 feet bls). The detection in the surface soil is most likely the result of IRA soil stockpiling near this location. The detection from 6 to 8 feet bls (below the water table) is likely the result of TCE transported in the groundwater mound.

The area of TCE contaminated vadose soil remaining at the site is approximately 5,000 square feet (ft^2). The original area comprised about 10,000 ft^2 and approximately 5,000 ft^2 of this area was removed during the IRA. Assuming the vadose zone to be from 0 to 6 feet bls, the volume of TCE contaminated vadose soil is approximately 30,000 ft^3. The average concentration of TCE in this volume, based on the confirmatory analytical results from 0 to 6 feet bls, is approximately 137 μg/kg.

The area of TCE contaminated phreatic soil, based on the screening results of soil samples collected below the water table, is approximately 4,000 ft^2. This soil is generally located beneath the area of the IRA excavation, approximately 8 to 12 feet bls, which would give an estimated volume of approximately 16,000 ft^3. The average concentration of TCE in this volume, based on the screening analytical results, is approximately 144,000 μg/kg.

Because TCE free-product, or NAPL, is typically associated with soil TCE concentrations above 20,000,000 μg/kg, it is interpreted (based on screening and confirmatory sample results) that NAPL has not been identified in the vadose or phreatic soil remaining at the site.

Several SVOCs were detected in subsurface soil samples at OU 7. The most commonly detected SVOCs included benzo(b)fluoranthene, butylbenzylphthalate, and bis(2-ethylhexyl)phthalate. Of these three compounds, bis(2-ethylhexyl)phthalate had the most detections (8) and butylbenzylphthalate was detected at the highest concentration (750 μg/kg). Similar to VOCs, SVOCs appear to have the highest concentrations in borings nearest the former seepage pit area and are most likely present from the past waste disposal operations at Building 313.

Seventeen inorganic analytes were detected above the background concentrations in at least one sample. The most frequent exceedances of background concentrations were by aluminum, calcium, cobalt, and magnesium. Cadmium, cobalt, thallium, and zinc were detected in subsurface soil samples at Site 16 but were not present in the background data set. Detections of inorganics above background concentrations were primarily observed in the borings (CEF-16-SB-8, 9, and 10) located nearest the former seepage pit area, indicating that these detections may also be related to the previous waste disposal from AIMD Building 313.

4.2.3 Groundwater The following discussion focuses on the significant findings of the groundwater investigation completed to support the RI at OU 7.

Only summaries of the data generated during the 1993-94 groundwater investigation are presented in this section; this information is presented on tables and/or figures whenever possible. The complete analytical data set for OU 7 is presented in Appendix M. Other information relating to the groundwater investigation (boring logs, well completion diagrams, water levels, etc.) is also fully presented in Appendices. The results of the 1991-92 field investigation for groundwater at OU 7 are presented in Appendix A.

A total of 40 monitoring wells were installed at OU 7 during the investigations of the seepage pit area. Six of these wells no longer exist: three wells (CEF-16-1, CEF-16-2, CEF-16-3) were abandoned because the screened intervals were (30 feet) too long to accurately identify and delineate groundwater contamination, one was abandoned because the outer casing was improperly installed (CEF-16-8DD) and could serve as a conduit from the shallow to deeper parts of the aquifer, and two were destroyed during the IRA soil excavation (CEF-16-4S and CEF-16-6S).

Of the remaining 34 wells, 30 are screened in the surficial aquifer and 4 are screened in the intermediate aquifer (UZH). Of the 30 wells installed in the surficial aquifer, 13 are screened in the shallow zone (water table, UZS: 4 to 17 feet bls), 5 are screened in the intermediate zone (IZS: 25 to 81 feet bls), and 12 are screened in the deep or lower zone (LZS: 79 to 101 feet bls). The four intermediate aquifer wells are screened at different intervals between 97 and 118 feet bls. Two of the UZS wells (CEF-16-13S and CEF-16-15S) and two of the LZS wells (CEF-16-14D and CEF-16-16D) are upgradient and are used to document background groundwater conditions.

Discussion of sampling results is presented by organic and inorganic analytical fractions for each of the depth zones investigated at OU 7; the UZS, the IZS, the

LZS, and the UZH. The discussion presents the results from the most recent sampling event (1994).

4.2.3.1 **Organic Analytes in Groundwater** A summary of the organic analytical results for groundwater are presented in Appendix M and summarized in Table 4-5. The results are graphically presented in plan view for each zone (Figures 4-5, 4-6, 4-7, and 4-8), and in cross section for all zones (Figure 4-9). Chemical analytical results for the volatile fraction are discussed for each of the aquifer units; this is followed by the results of the semivolatile fraction, pesticides, and PCBs.

VOCs in the Upper Zone Surficial (UZS). Based on the results of the VOC analyses of groundwater from the 11 UZS wells, 5 compounds were detected: 1,1-dichloroethane (1,1-DCA), 1,1-dichloroethene (1,1-DCE), 1,2-DCE, 1,1,1-TCA, and TCE. 1,1-DCA was detected in the sample from only one location (CEF-16-24S) at 1J $\mu g/\ell$, which was collected approximately 700 feet crossgradient of the source area and outside the organic groundwater plume. This detection does not appear to be hydraulically related to OU 7.

The 1,1-DCE, 1,2-DCE, 1,1,1- TCA, and the highest concentration of TCE (630J $\mu g/\ell$, average of sample and duplicate) were detected in samples from CEF-16-10S, less than 50 feet downgradient of the source area. TCE is the only VOC detected in monitoring well samples other than CEF-16-10S. As shown on Figure 4-5, TCE was detected slightly upgradient of the seepage pit area (probably due to mounding created during discharge of wastewater) at CEF-16-5S (20J $\mu g/\ell$), and about 60 feet downgradient of the source at well CEF-16-7S (500J $\mu g/\ell$). After being undetected farther downgradient in samples from the water table wells CEF-16-19S and CEF-16-21S, TCE was again detected in the samples from UZS at well CEF-16-32S (470J $\mu g/\ell$). This disappearance and re-emergence of TCE in the UZS is interpreted to be due to the downward and then upward flow of groundwater to the southeast as depicted on Figure 3-8. Cross sections parallel to groundwater flow with the detected organic contaminants are presented on Figure 4-9.

In plotting the plan view and cross section contaminant distribution figures, representative Aquaprobe™ groundwater screening results were included to present a complete picture based on available information. Representative Aquaprobe™ results are from sample locations where groundwater was not observed in the drill stem (potentially contaminating or diluting the sample) prior to deploying the 4 feet of screen for sample collection. To further support the use of groundwater screening data, representative Aquaprobe™ TCE results were compared to Level IV data quality TCE results from nearby monitoring wells and found to show good correlation between the detected concentrations as depicted on Figures 4-5, 4-6, and 4-9 and summarized as follows:

Aquaprobe™ Screening Data			Level IV Monitoring Well Data		
Location	Depth (feet bls)	Result ($\mu g/\ell$)	Location	Depth (feet bls)	Result ($\mu g/\ell$)
GS-16-34	11 to 15	640	CEF-16-32S	7 to 17	470J
GS-16-13	11 to 15	675	CEF-16-7S	4 to 14	500J
GS-16-8	11 to 15	24	CEF-16-5S	4 to 14	20J
GS-16-20	28 to 32	25	CEF-16-22I	25 to 35	15

Notes: bls = below land surface.
$\mu g/\ell$ = micrograms per liter.

Table 4-5
Summary of Organic Compounds Detected in Groundwater

Remedial Investigation
Operable Unit 7, NAS Cecil Field
Jacksonville, Florida

Analyte	Frequency of Detection [1]	Range of Detected Concentrations	Range of Reporting Limits	Federal Primary MCL[3]	Florida Primary Standard[4]	Florida Guidance Concentration[5]
Surficial Aquifer						
Volatiles (μg/ℓ)						
1,1,1-Trichloroethane	1/26	[2]3,000	1 to 830	200	200	200
1,1-Dichloroethane	1/26	1	1 to 420	NA	NA	700
1,1-Dichloroethene	1/26	[2]400	1 to 625	7	7	7
1,2-Dichloroethene (total)	2/26	270J to [2]12,500J	1 to 830	[6]70	[6]70	[6]70
4-Methyl-2-pentanone	1/21	1	2 to 830	NA	NA	350
Trichloroethene	7/26	12J to [2] 630J	1 to 830	5	3	3
Semivolatiles (μg/ℓ)						
2-Methylnaphthalene	1/26	[2]2.75J	10 to 10	NA	NA	NA
Diethylphthalate	2/26	1J	10 to 10	NA	NA	5,600
Naphthalene	1/26	[2]3.5J	10 to 10	NA	NA	6.8
Phenanthrene	1/26	3J	10 to 10	NA	NA	10
Phenol	3/26	0.8J to [2]1.45J	10 to 10	NA	NA	10
bis(2-Ethylhexyl) phthalate	21/26	0.5J to [2] 20.5	10 to 17	6	6	6
Pesticides and PCBs (μg/ℓ)						
Endrin	1/26	0.02J	0.01 to 0.1	2	2	2
Intermediate Aquifer						
Semivolatiles (μg/ℓ)						
Di-n-butylphthalate	1/4	1J	10 to 10	NA	NA	700
bis(2-Ethylhexyl) phthalate	4/4	1J to 10	10 to 10	6	6	6

[1] Frequency of detection is the number of samples in which the analyte was detected divided by the total number of samples analyzed (16MW10S, 16MW12I, 16MW17S, 16MW18D, 16MW19S, 16MW20D, 16MW21S, 16MW22I, 16MW23D, 16MW24S, 16MW25D, 16MW27I, 16MW28D, 16MW32S, 16MW33D, 16MW38S, 16MW39I, 16MW40D, 16MW5S, 16MW7S, and 16MW9D, including duplicates at 16MW10, 16MW21S, 16MW28D, and 16MW40D for surficial aquifer)(16MW11DD, 16MW26DD, 16MW31DD, and 6MW34DD for intermediate aquifer).
[2] Value is the average of a sample and its duplicate.
[3] Federal Primary MCLs are taken from USEPA Drinking Water Regulations and Health Advisories (May 1994).
[4] Florida Primary Standards are taken from Chapter 1 (Primary Standards) of the FDEP Groundwater Guidance Concentrations (June 1994).
[5] Florida Guidance Concentrations are taken from Chapter 6 (Guidance Concentrations Index) of the FEDP Groundwater Guidance Concentrations (June 1994).
[6] Primary MCL is for cis-1, 2-Dichloroethylene.
Notes: μg/ℓ = microgram per liter.
PCBs = polychlorinated biphenyls.
NA = not applicable.

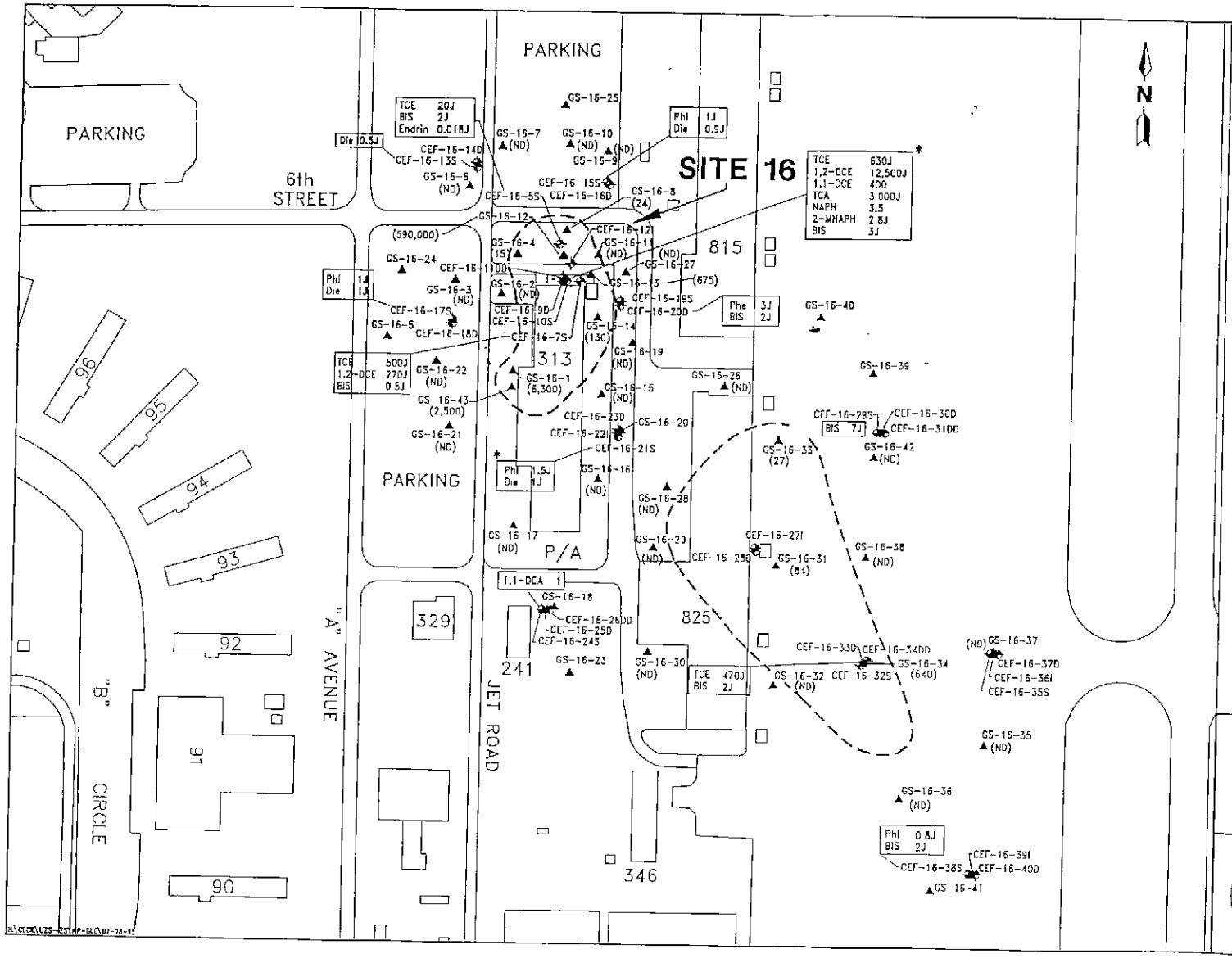


FIGURE 4-5
ORGANICS DETECTED IN THE UPPER ZONE SURFICIAL (UZS) AQUIFER

REMEDIAL INVESTIGATION, OPERABLE UNIT 7

NAS CECIL FIELD
JACKSONVILLE, FLORIDA

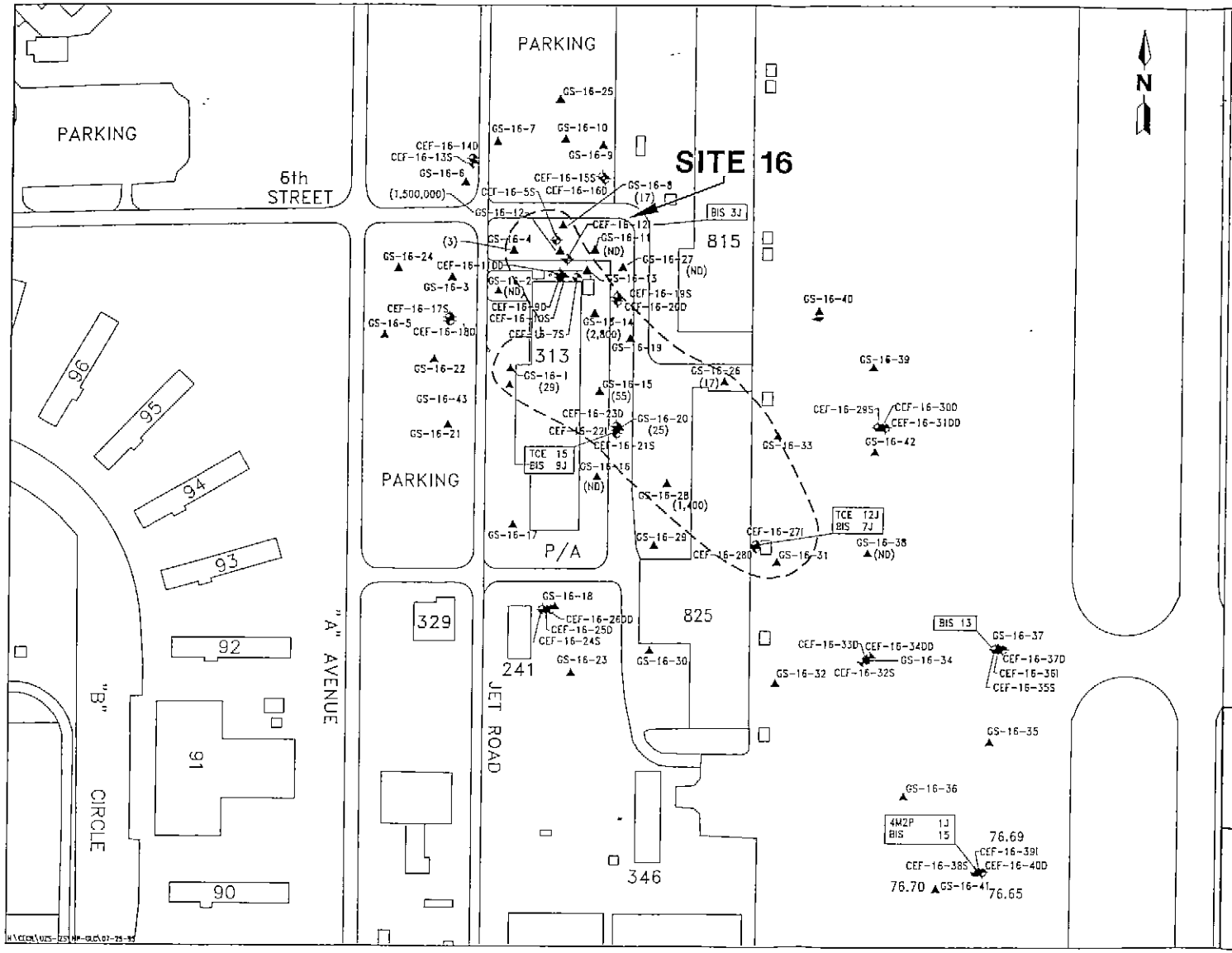


FIGURE 4-6
ORGANICS DETECTED IN THE INTERMEDIATE ZONE SURFICIAL (IZS) AQUIFER

REMEDIAL INVESTIGATION, OPERABLE UNIT 7

NAS CECIL FIELD
JACKSONVILLE, FLORIDA

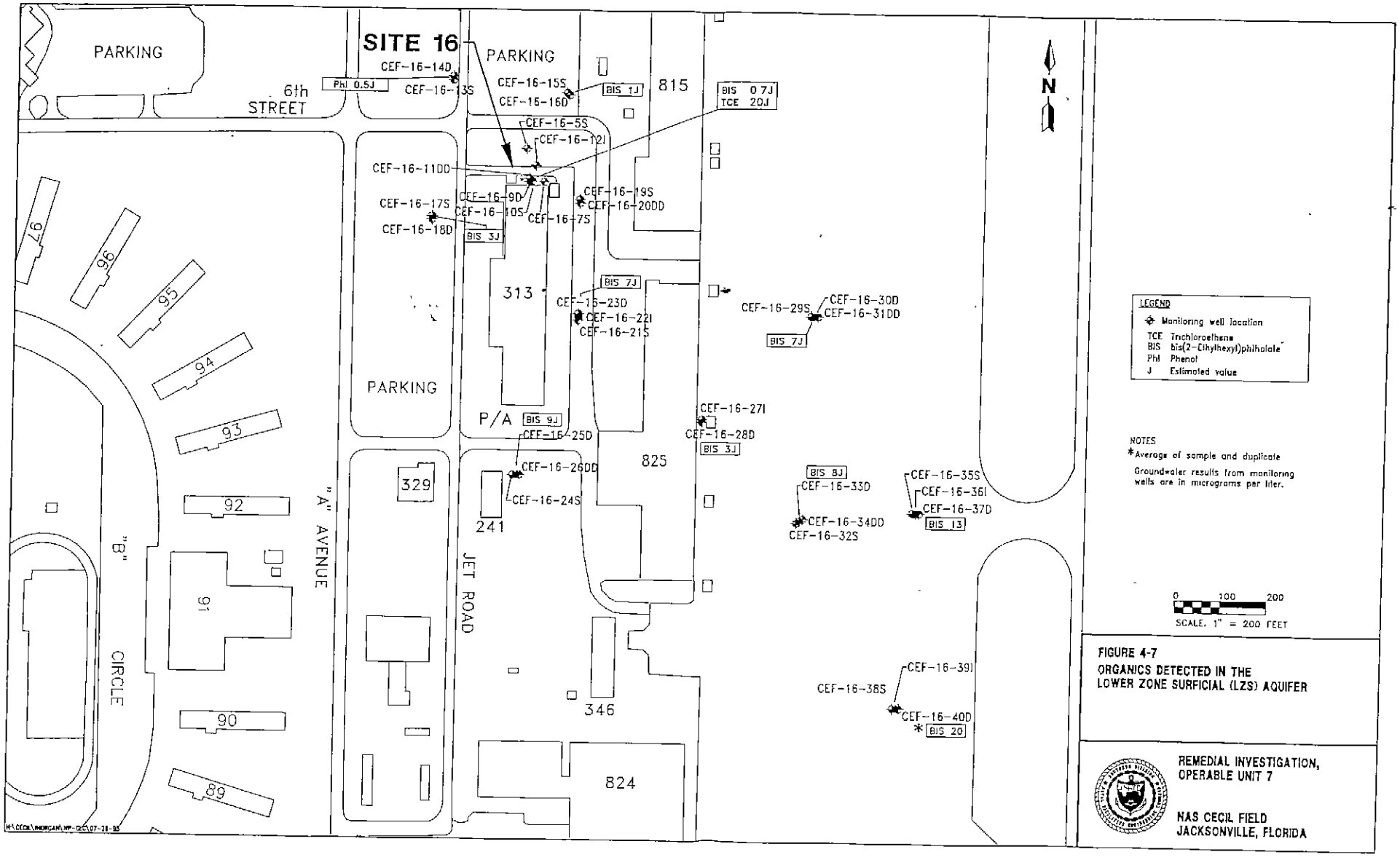


FIGURE 4-7
ORGANICS DETECTED IN THE LOWER ZONE SURFICIAL (LZS) AQUIFER

REMEDIAL INVESTIGATION, OPERABLE UNIT 7

NAS CECIL FIELD
JACKSONVILLE, FLORIDA

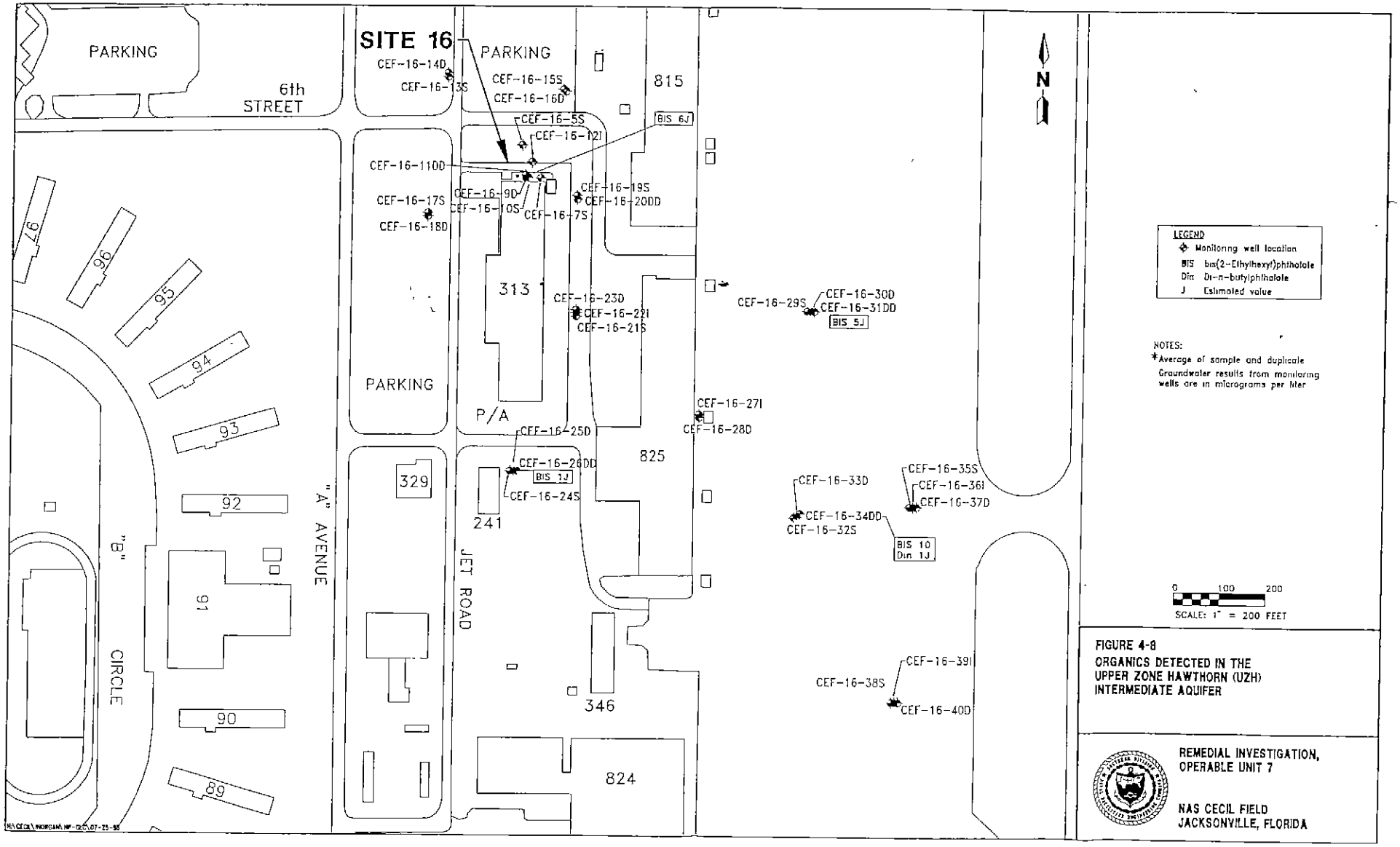
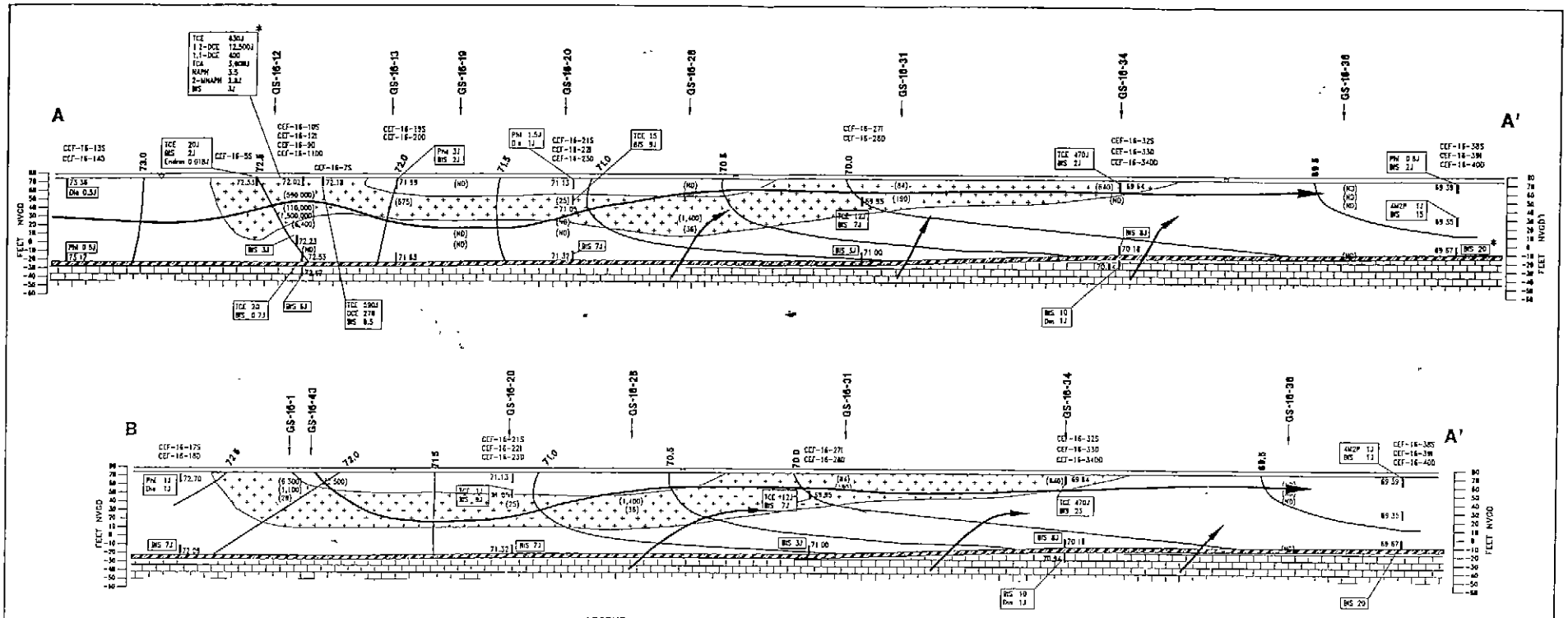


FIGURE 4-8
ORGANICS DETECTED IN THE UPPER ZONE HAWTHORN (UZH) INTERMEDIATE AQUIFER

REMEDIAL INVESTIGATION, OPERABLE UNIT 7

NAS CECIL FIELD
JACKSONVILLE, FLORIDA



LEGEND

- Estimated extent of TCE contamination
- Sand (surface aquifer)
- Clay and dolomite
- Dolomite (intermediate aquifer)
- Monitoring well screen location

TCE 15	Groundwater result from monitoring well in micrograms per liter
73.36	Groundwater elevation (August 1994) in feet National Geodetic Vertical Datum, (NGVD)
73.0	Groundwater equipotential line
(540)	Groundwater TCE concentration in micrograms per liter from representative Aquaprobe™ sample (GS-16-12)
ND	TCE not detected (Aquaprobe™)
J	Estimated value
*	Average of sample and duplicate

TCE	Trichloroethene	Din	Di-n-butylphthalate
1,1-DCE	1,1-Dichloroethene	NAPH	Naphthalene
1,2-DCE	1,2-Dichloroethene (total)	2-MNAPH	2-Methylnaphthalene
4M2P	4 Methyl-2-propanone	Die	Diethylphthalate
BIS	bis(2-Ethylhexyl)phthalate	Phl	Phenol
		Phe	Phenanthrene

0 60 120
SCALE: 1" = 120

FIGURE 4-9
ORGANICS DISTRIBUTION ALONG FLOWPATH PROFILES

REMEDIAL INVESTIGATION, OPERABLE UNIT 7

NAS CECIL FIELD
JACKSONVILLE, FLORIDA

CECIL\CONCROSS\MP\05-17-95

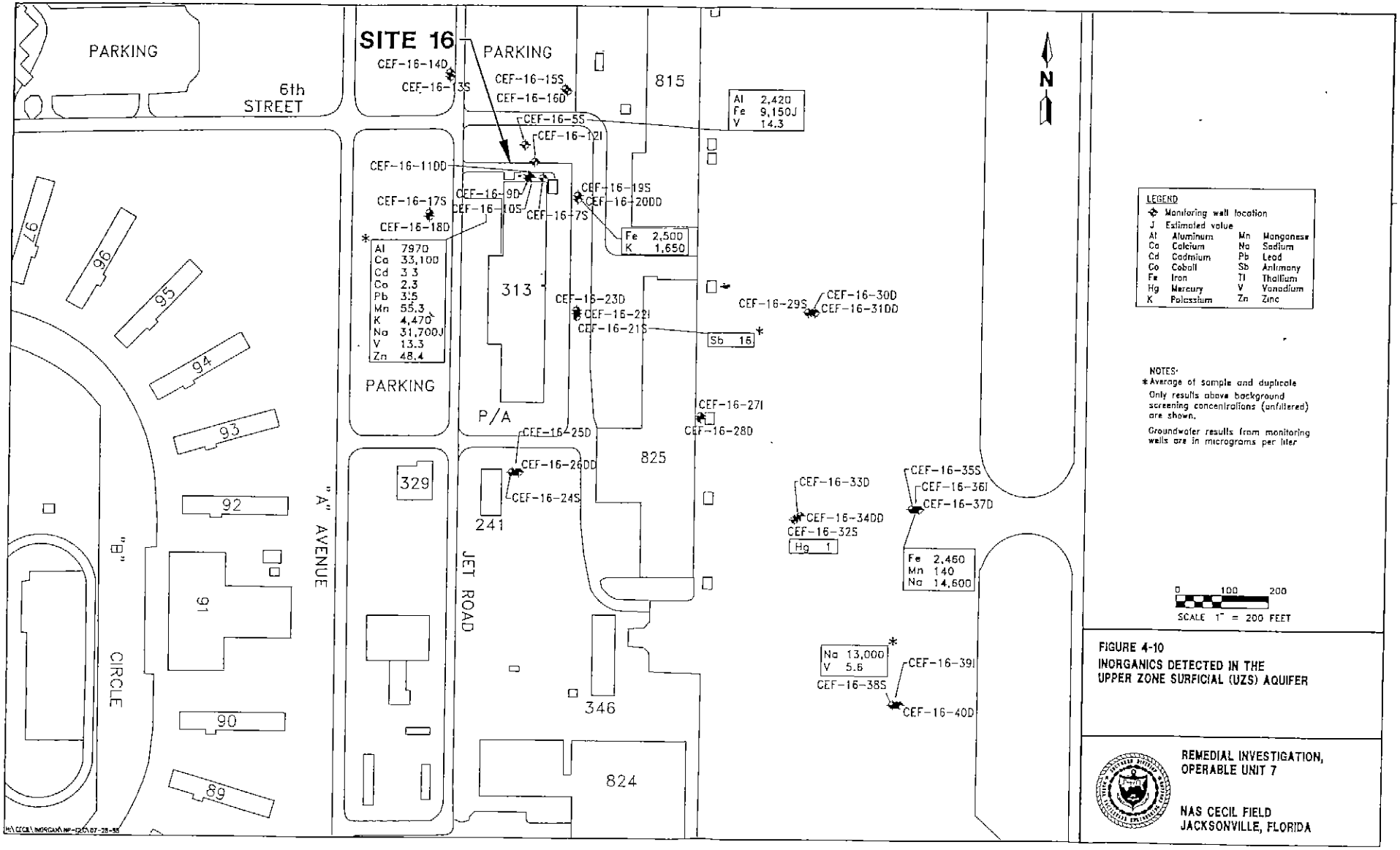


FIGURE 4-10
INORGANICS DETECTED IN THE UPPER ZONE SURFICIAL (UZS) AQUIFER

REMEDIAL INVESTIGATION, OPERABLE UNIT 7

NAS CECIL FIELD
JACKSONVILLE, FLORIDA

In addition to facilitating the interpretation of contaminant distribution, the representative Aquaprobe™ results provide data from the UZS where monitoring well data are not present. For example, the monitoring well results indicate the highest detected concentration of TCE in the UZS is 630J µg/ℓ (average of sample and duplicate) in a sample from well CEF-16-10S, and the Aquaprobe™ result from the source area (GS-16-12, 11 to 15 feet bls) indicates a concentration of 590,000 µg/ℓ. Aquaprobe™ results from the west side of Building 313, GS-16-1 and GS-16-43, indicate TCE concentrations of 6,300 µg/ℓ and 2,500 µg/ℓ, respectively, at 11 to 15 feet bls.

As a rule of thumb, 1 percent of the TCE water solubility concentration is an indication of the presence NAPL. Because the solubility of TCE is approximate ly 1,100,000 µg/ℓ, results over 11,000 µg/ℓ could indicate the potential presence of NAPL.

VOCs in the Intermediate Zone Surficial (IZS). Based on the results of VOC analysis of groundwater from the five IZS wells, two compounds were detected; TCE and 4-methyl-2-pentanone.

The 4-methyl-2-pentanone was detected in samples from one location, CEF-16-39I (1J µg/ℓ), approximately 1,400 feet downgradient of the source area. This location is also downgradient of the area where upward hydraulic gradients were observed from the intermediate aquifer up to the surficial aquifer, indicating that upward flow between these aquifers is occurring. Based on this information, the 4-methyl-2-pentanone detection does not appear to be associated with OU 7.

TCE was detected in samples from two locations in the IZS, CEF-16-22I and CEF-16-27I, at concentrations of 15 µg/ℓ and 12J µg/ℓ, respectively. These detections are expected at this depth based on the groundwater flow pattern and contaminant distribution as depicted in the cross sections (Figure 4-9).

TCE was not detected in the source area IZS well (CEF-16-12I), which is screened from 70 to 80 feet bls. However, shallower IZS Aquaprobe™ results, 20 feet west of well CEF-16-12I, show high levels of TCE. TCE was detected at 110,000 µg/ℓ at 18 to 22 feet bls; 1,500,000 µg/ℓ at 28 to 32 feet bls; and 6,400 µg/ℓ at 52 to 56 feet bls. The TCE concentration at 28 to 32 feet bls is the highest detected at OU 7, and is above the solubility limit (1,100,000 µg/ℓ), indicating the potential presence of undissolved TCE.

VOCs in the Lower Zone Surficial (LZS). Based on the results of VOC analyses of groundwater from the 10 LZS wells, one compound was detected, TCE.

The TCE was detected in well CEF-16-9D at 20 µg/ℓ. This well is screened from 91 to 101 feet bls beneath the source area. This is the only LZS well with a VOC detection, and TCE was not detected in the shallower CEF-16-12I (screened from 70 to 80 feet bls) beneath the source area. Based on these results, the TCE detection at CEF-16-9D is interpreted to be anomalous.

VOCs in the Upper Zone Hawthorn (UZH). No VOCs were detected in groundwater samples from the four UZH wells.

SVOCs in the Upper Zone Surficial (UZS). Based on the results of SVOC analyses of groundwater from the 11 UZS wells, 6 compounds were detected: naphthalene,

2-methylnaphthalene, phenanthrene, phenol, diethylphthalate, and bis(2-ethylhexyl)phthalate.

The phthalates and phenol were detected in the upgradient background wells and do not appear related to OU 7. The phenanthrene was detected only in a sample from CEF-16-19S (3J $\mu g/\ell$). Based on groundwater flow, CEF-16-19S appears to be screened above the path of the plume from the OU 7 source area. This low level, isolated detection of phenanthrene may be related to OU 7, but appears to have been introduced into the area of CEF-16-19S and not at the source area.

The naphthalene and 2-methylnaphthalene were detected only in a sample from well CEF-16-10S, adjacent to the source area.

SVOCs in the Intermediate Zone Surficial (IZS). Based on the results of SVOC analyses of groundwater from the five IZS wells, only one compound was detected: bis(2-ethylhexyl)phthalate.

The bis(2-ethylhexyl)phthalate detections do not appear to be associated with OU 7. Most of the results are estimated values, below the RDL (10 $\mu g/\ell$). However, over 1,000 feet downgradient of the source area, two values above the RDL are reported in samples from the IZS; 13 $\mu g/\ell$ at CEF-16-36I, and 15 $\mu g/\ell$ at CEF-16-39I. These locations are downgradient and above the area where upward flow from the intermediate aquifer to the surficial aquifer is occurring. These detections of bis(2-ethylhexyl)phthalate appear to be from the intermediate aquifer, explained below (following discussion of SVOCs in the UZH).

SVOCs in the Lower Zone Surficial (LZS). Based on the results of SVOC analyses of groundwater from the 10 LZS wells, 1 compound was detected: bis(2-ethylhexyl)phthalate.

Based on the groundwater flow pattern, the bis(2-ethylhexyl)phthalate does not appear to be associated with OU 7. Most of the results are estimated values, below the RDL (10 $\mu g/\ell$). However, over 1,000 feet downgradient of the source area, two values above the RDL is reported in samples from the LZS; 13 $\mu g/\ell$ at CEF-16-37D and 20 $\mu g/\ell$ (average of sample and duplicate) at CEF-16-40D. This location is downgradient and above the area where upward hydraulic gradients were observed from the intermediate aquifer to the surficial aquifer, indicating that upward flow between these aquifers is occurring. These detections of bis(2-ethylhexyl)-phthalate appear to be from the intermediate aquifer (UZH), as explained below.

SVOCs in the Upper Zone Hawthorn. Based on the results of SVOC analyses of groundwater from the four UZH wells, two compounds were detected: bis(2-ethylhexyl)phthalate and di-n-butylphthalate.

These phthalates do not appear to be associated with OU 7. Most of the results are estimated values, below the RDL (10 $\mu g/\ell$). However, over 1,000 feet downgradient of the source area, one value above the RDL is reported in samples from the UZH; 10 $\mu g/\ell$ at CEF-16-34DD (also the location of the di-n-butylphthalate detection of 1J $\mu g/\ell$). This location is downgradient and above the area where upward hydraulic gradients were observed from the intermediate aquifer flows to the surficial aquifer, indicating that upward flow between these aquifers is occurring. This detection of phthalate appears to be from the intermediate aquifer (UZH) as explained below.

Bis(2-ethylhexyl)phthalate is a common laboratory contaminant. However, the detections above the RDL may be attributable to the sample rather than laboratory contamination because: their distribution is consistent with groundwater flow from the intermediate aquifer to the surficial aquifer (a similar pattern is observed for inorganics such as zinc); bis(2-ethylhexyl)phthalate was not detected in the field and laboratory blanks associated with these samples. And, the samples were collected on different days, with those collected on the same day having samples with nondetected results for bis(2-ethylhexyl)phthalate collected between samples with detections.

Pesticides and PCBs in the Surficial and Intermediate Aquifers. The only detection of pesticides or PCBs in the groundwater samples collected at OU 7 was in the UZS samples from CEF-16-5S. Endrin was detected here at 0.018J $\mu g/\ell$. This detection does not appear to be associated with OU 7, and is probably associated with the former basewide pesticide application.

4.2.3.2 Inorganic Analytes in Groundwater The inorganic analytical results for groundwater are presented in Appendix M and summarized in Table 4-6. Table 4-6 also presents background screening concentrations for inorganics in the surficial aquifer. The results are graphically presented in plan view for each zone (Figures 4-10, 4-11, 4-12, and 4-13), and in cross section for all zones (Figure 4-14).

Inorganic Analytes in the Upper Zone Surficial (UZS). Based on the results of inorganics analyses of unfiltered groundwater from the 11 UZS wells, 19 inorganics were detected: aluminum, antimony, arsenic, barium, cadmium, calcium, chromium, cobalt, copper, iron, lead, magnesium, manganese, mercury, potassium, sodium, thallium, vanadium, and zinc. Of these 19 inorganics, 13 were detected above background screening concentrations: aluminum, antimony, cadmium, calcium, cobalt, iron, lead, manganese, mercury, potassium, sodium, thallium, and vanadium.

Aluminum was detected above background screening concentrations in samples from 2 of the 11 UZS wells; CEF-16-10S at 7,970 $\mu g/\ell$ (average of sample and duplicate), and CEF-16-5S at 2,420 $\mu g/\ell$. Both of these locations are adjacent to the source area (CEF-16-10S is slightly downgradient and CEF-16-5S is slightly upgradient but within the influence of mounding) indicating that the elevated aluminum may be associated with the source, but its extent is limited.

Antimony was detected in only a sample from one UZS well; the duplicate from CEF-16-21S (2.1J $\mu g/\ell$) (the average of the sample and duplicate from CEF-16-21S is 16 $\mu g/\ell$ because the averaging procedure uses half of the RDL when the sample or duplicate result is non-detect). CEF-21S is approximately 400 feet downgradient of the source but above the flow path of the plume, indicating that antimony is not associated with the source area.

Cadmium was detected in only a sample from one well at OU 7; CEF-16-10S at 3.3 $\mu g/\ell$ (average of sample and duplicate). CEF-16-10S is adjacent to the source area, indicating that cadmium may be associated with the source.

Calcium was detected above background concentrations in 1 of the 11 UZS wells; in a sample from CEF-16-10S (33,100 $\mu g/\ell$, average of sample and duplicate). Calcium is a major constituent of the underlying dolomite formation (intermediate aquifer) and is detected in increasing concentrations deeper in the surficial aquifer.

Table 4-6
Summary of Inorganics Detected in Groundwater

Remedial Investigation
Operable Unit 7, NAS Cecil Field
Jacksonville, Florida

Analyte	Frequency of Detection [1]	Range of Detected Concentrations	Range of Reporting Limits	Screening Background Concentration [2]	Maximum Background Concentration	Federal Primary MCL[4]	Florida Primary Standard[5]	Florida Guidance Concentration[6]
Surficial Aquifer								
Inorganics (µg/ℓ)								
Aluminum	15/26	[3]176 to[3]7,970	200 to 200	1,500	1,160J	[7]200	[8]200	200
Antimony	3/26	2.2 to 16.1J	60 to 60	ND	ND	6	6	6
Arsenic	13/26	3.3 to 56.2	10 to 10	6	3	50	50	50
Barium	26/26	4.7 to 108	200 to 200	44.4	31.4	2,000	2,000	2,000
Cadmium	1/26	[3]3.3	5 to 5	ND	ND	5	5	5
Calcium	25/26	479J to [3]58,500	5,000 to 5,000	25,300	27.00	NA	NA	NA
Chromium	5/26	2 1 to 7.9	10 to 10	17.6	8 8	100	100	100
Cobalt	3/26	[3]2.3 to 5.9	50 to 50	ND	ND	NA	NA	NA
Copper	5/26	[3]2.1 to 3.8	25 to 25	4.2	2.1	[7]1,000	[8]1,000	1,000
Iron	25/25	[3]260 to 9,150J	100 to 100	1,550	1,030	[7]300	[8]300	300
Lead	1/26	[3]2 55	3 to 3	ND	ND	[12]15	15	15
Magnesium	26/26	254 to 28,000	5,000 to 5,000	5,910	4,710	NA	NA	NA
Manganese	23/25	[3]4.9 to 140	15 to 15	36.4	24.2	[7]50	[8]50	50
Mercury	1/26	1 to 1	0.2 to 0.2	ND	ND	2	2	2
Nickel	2/26	[3]11 to 12.5	40 to 40	ND	ND	100	100	100
Potassium	26/26	125J to [3]4,470J	5,000 to 5,000	1,170	895	NA	NA	NA
Sodium	26/26/	[3]2,670J to [3]31,700J	5,000 to 5,000	10,200	8,290	NA	NA	NA
Thallium	3/26	6J to 6.3	10 to 10	ND	ND	2	2	2
Vanadium	15/26	1.1 to 14.3	50 to 50	5.4	2.7	NA	NA	49
Zinc	8/26	16 to 89.5	20 to 20	55.2	27.6	[7]5,000	[8]5,000	5,000

See notes below.

Table 4-6 (Continued)
Summary of Inorganics Detected in Groundwater

Remedial Investigation
Operable Unit 7, NAS Cecil Field
Jacksonville, Florida

Analyte	Frequency of Detection [1]	Range of Detected Concentrations	Range of Reporting Limits	Screening Background Concentration [2]	Maximum Background Concentration	Federal Primary MCL[4]	Florida Primary Standard[5]	Florida Guidance Concentration[6]
Intermediate Aquifer								
Inorganics (μg/ℓ) (Continued)								
Antimony	2/4	3.1J to 10.3	60 to 60	NA	NA	6	6	6
Barium	4/4	7 to 418	200 to 200	NA	N	2,000	2,000	2,000
Calcium	4/4	9,160 to 63,400	5,000 to 5,000	NA	NA	NA	NA	NA
Chromium	1/4	9.8 to 9.8	10 to 10	NA	NA	100	100	100
Copper	2/4	8 to 8.2	25 to 25	NA	NA	[7]1,000	[8]1,000	1,000
Iron	4/4	69.6 to 444J	100 to 100	NA	NA	[7]300	[8]300	300
Magnesium	4/4	16,000 to 28,700	5,000 to 5,000	NA	NA	NA	NA	NA
Manganese	4/4	6.7 to 57.5	15 to 15	NA	NA	[7]50	[8]50	50
Potassium	4/4	853J to 39,900J	5,000 to 5,000	NA	NA	NA	NA	NA
Sodium	4/4	8,050J to 30,600J	5,000 to 5,000	NA	NA	NA	NA	NA
Zinc	3/4	48.6J to 98.5	20 to 20	NA	NA	[7]5,000	[8]5,000	5,000

[1] Frequency of detection is the number of samples in which the analyte was detected divided by the total number of samples analyzed (16MW10S, 16MW12I, 16MW17S, 16MW18D, 16MW19S, 16MW20D, 16MW21S, 16MW22I, 16MW23D, 16MW24S, 16MW25D, 16MW27I, 16MW28D, 16MW32S, 16MW33D, 16MW38S, 16MW39I, 16MW40D, 16MW5S, 16MW7S, and 16MW9D, including duplicates at 16MW10, 16MW21S, 16MW28D, and 16MW40D for surficial aquifer)(16MW11DD, 16MW26DD, 16MW31DD, and 6MW34DD for intermediate aquifer).
[2] Twice the average of inorganics detected in background wells 16MW13S, 16MW14D, 16MW15S, 16MW16D.
[3] Value is the average of a sample and its duplicate.
[4] Federal Primary MCLs are taken from USEPA Drinking Water Regulations and Health Advisories (May 1994).
[5] Florida Primary Standards are taken from Chapter 1 (Primary Standards) of the FDEP Groundwater Guidance Concentrations (June 1994)
[6] Florida Guidance Concentrations are taken from Chapter 6 (Guidance concentrations Index) of the FDEP Groundwater Guidance Concentrations (June 1994).
[7] Value is a Federal Secondary MCL.
[8] Value is a Florida Secondary MCL.

Notes: μg/ℓ = microgram per liter.
ND = not detected.
NA = not applicable.

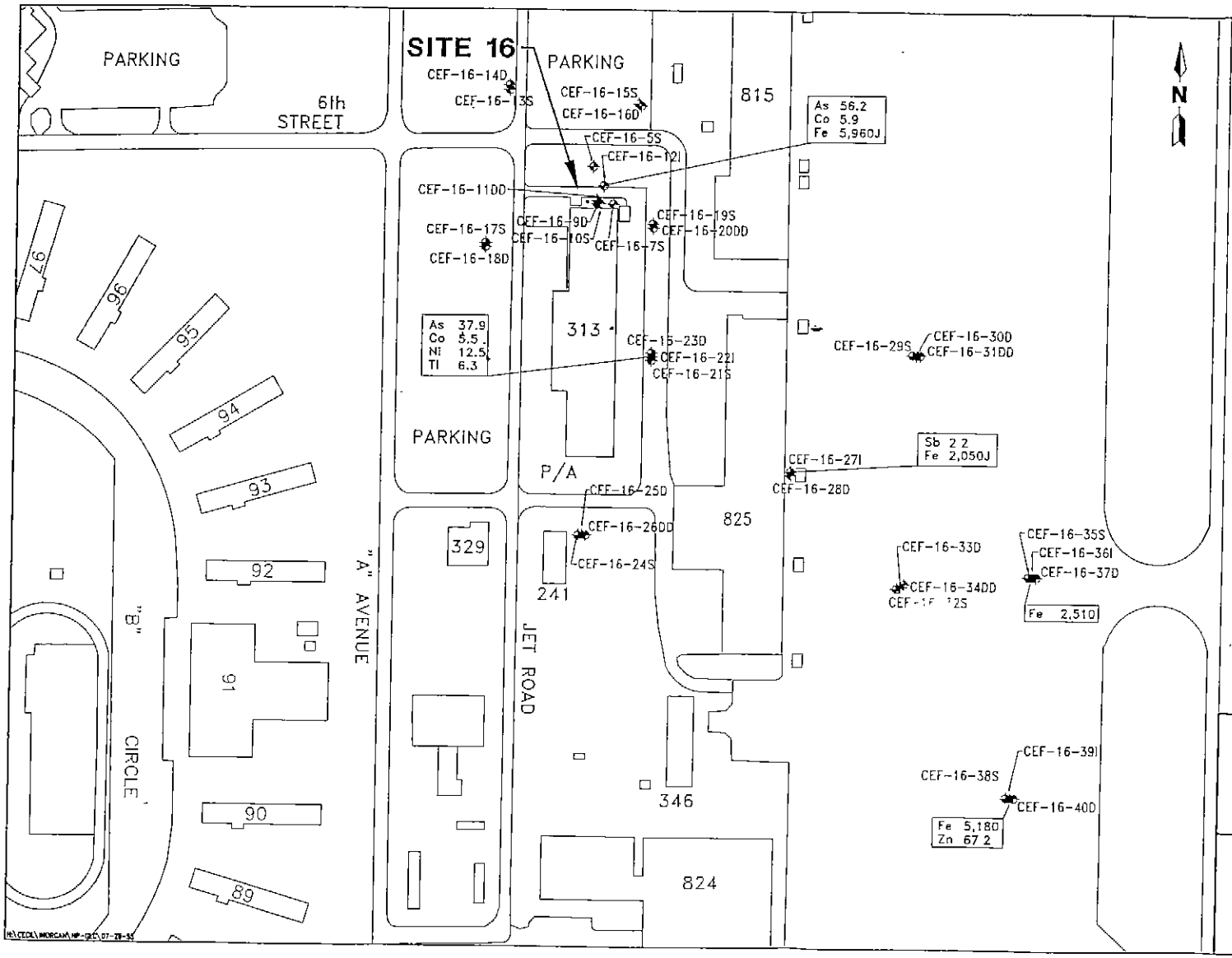


FIGURE 4-11
INORGANICS DETECTED IN THE INTERMEDIATE ZONE SURFICIAL (IZS) AQUIFER

REMEDIAL INVESTIGATION, OPERABLE UNIT 7

NAS CECIL FIELD
JACKSONVILLE, FLORIDA

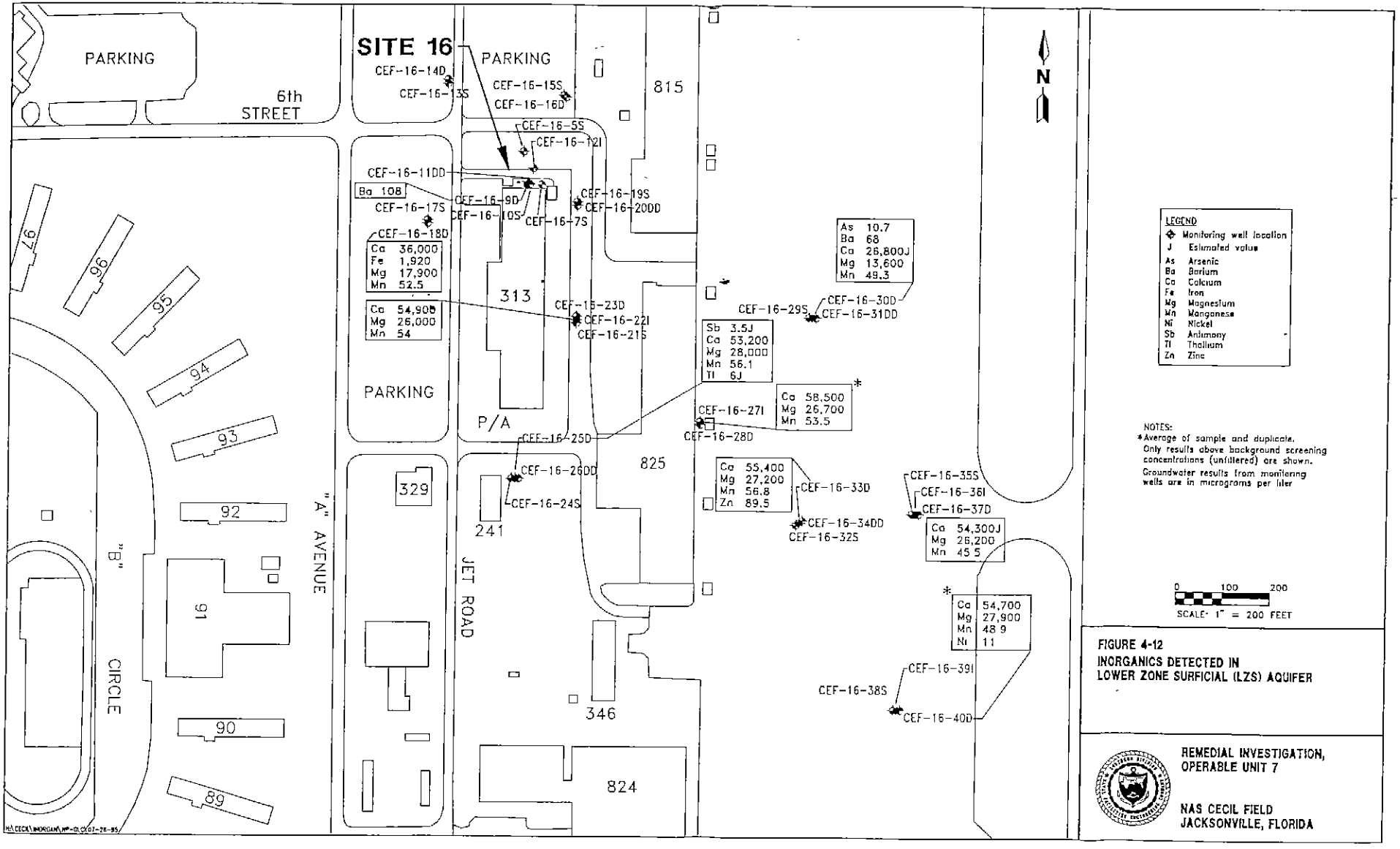


FIGURE 4-12
INORGANICS DETECTED IN LOWER ZONE SURFICIAL (LZS) AQUIFER

REMEDIAL INVESTIGATION, OPERABLE UNIT 7

NAS CECIL FIELD
JACKSONVILLE, FLORIDA

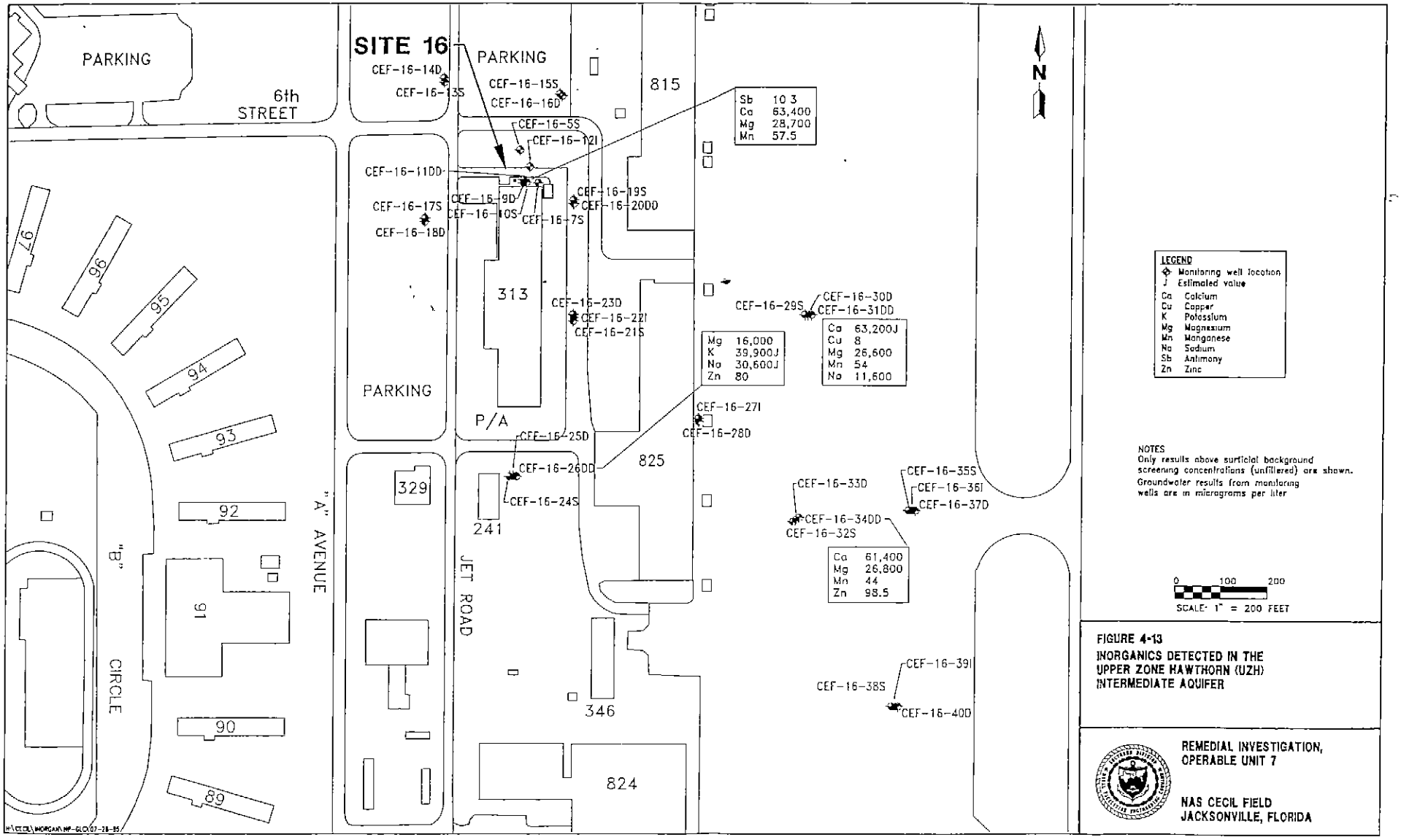
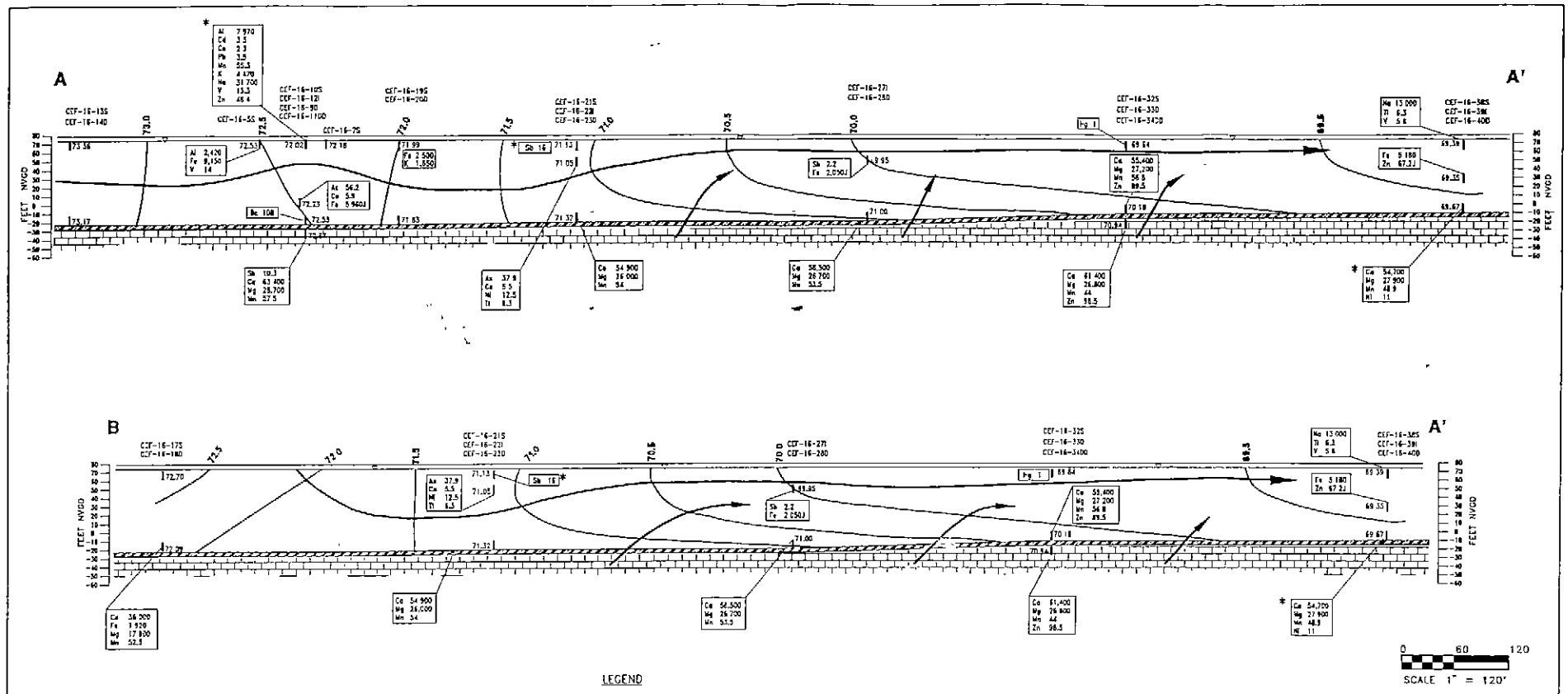


FIGURE 4-13
INORGANICS DETECTED IN THE UPPER ZONE HAWTHORN (UZH) INTERMEDIATE AQUIFER



LEGEND

- Sand (surficial aquifer)
- Dolomite (intermediate aquifer)
- Clay and dolomite
- Monitoring well screen location
- Fe 2,500 — Groundwater result in monitoring well in micrograms per liter
- 73.36 — Groundwater elevation in feet NVGD
- 73.0 — Groundwater equipotential line

Al Aluminum
As Arsenic
Ba Barium
Ca Calcium
Cd Cadmium
Co Cobalt
Fe Iron
K Potassium
Mg Magnesium
Mn Manganese
Na Sodium
Ni Nickel
Pb Lead
Sb Antimony
Tl Thallium
V Vanadium
Zn Zinc

NOTES:
Only results above background screening concentrations are shown

*Average of sample and duplicate

FIGURE 4-14
INORGANICS DISTRIBUTION ALONG FLOWPATH PROFILES

REMEDIAL INVESTIGATION, OPERABLE UNIT 7

NAS CECIL FIELD
JACKSONVILLE, FLORIDA

Cobalt was detected in only a sample from one UZS well; CEF-16-10S at 2.3 $\mu g/\ell$ (average of sample and duplicate). CEF-16-10S is adjacent to the source area, indicating that cobalt may be associated with the source.

Iron was detected above background concentrations in samples from three of the 11 UZS wells. The highest concentration was 9,150J $\mu g/\ell$ collected at CEF-16-5S. This location is adjacent to the source, indicating that iron may be associated with the source area. However, one of the UZS wells exceeding background screening concentrations for iron is CEF-16-35S, which is over 1,000 feet downgradient of the source area, and outside the organic plume. This elevated detection of iron may be associated with soil composition and/or manmade subsurface structures (ductile iron piping, etc.).

Lead was detected in only one sample at OU 7 (the duplicate from CEF-16-10S at 3.6 $\mu g/\ell$). Because this is the only detection and the well is located adjacent to the source area, it may be associated with the source.

Manganese was detected above background concentrations in samples from 2 of the 11 UZS wells: CEF-16-35S at 140 $\mu g/\ell$ and CEF-16-10S at 55.3 $\mu g/\ell$ (average of sample and duplicate). CEF-16-10S is adjacent to the source area, but the highest concentration is at CEF-16-35S, which is over 1,000 feet downgradient of the source area, and outside the organic plume. Manganese does not appear to be associated with the source area. Manganese is prevalent in the underlying intermediate aquifer and is detected in increasing concentrations deeper in the surficial aquifer.

Mercury was detected in a sample from only one well at OU 7; CEF-16-32S at 1 $\mu g/\ell$. This location is approximately 1,000 feet downgradient of the source, near the leading edge of the organic plume. However, mercury was not detected in samples from any other wells at OU 7, indicating that it is not associated with the source area.

Potassium was detected above background screening concentrations in samples from two of the 11 UZS wells; CEF-16-10S at 4,470 $\mu g/\ell$ (average of sample and duplicate), and CEF-16-19S at 1,650 $\mu g/\ell$. CEF-16-10S is located adjacent to the source area, and CEF-16-19S is about 150 feet downgradient. Potassium is prevalent in the groundwater at OU 7, but the source may have locally contributed slightly higher levels of potassium to groundwater. These higher levels do not extend beyond wells CEF-16-10S and CEF-16-19S in the UZS.

Sodium was detected above background screening concentrations in samples from 3 of the 11 UZS wells; CEF-16-10S at 31,700J $\mu g/\ell$ (average of sample and duplicate), CEF-16-35S at 14,600 $\mu g/\ell$, and CEF-16-38S at 13,000 $\mu g/\ell$. CEF-16-10S is located adjacent to the source area, indicating that the sodium detected there may be associated with the source. However, sodium is prevalent in the intermediate aquifer and in the deeper surficial wells. The elevated sodium detections in samples from the UZS wells over 1,000 feet downgradient of the source (CEF-16-35S and CEF-16-38S) are most likely due to the movement of water from the intermediate aquifer to the surficial aquifer in the area upgradient and beneath these locations.

Thallium was detected in only a sample from one UZS well, CEF-16-38S at 6.3 $\mu g/\ell$. This location is over 1,000 feet downgradient of the source area and outside the

organic plume. This detection of thallium does not appear to be associated with the source.

Vanadium was detected above background concentrations in samples from 3 of the 11 UZS wells: CEF-16-5S at 14.3 μg/ℓ, CEF-16-10S at 13.3 μg/ℓ (average of sample and duplicate), and CEF-16-38S at 5.6 μg/ℓ. CEF-16-5S and CEF-16-10S are adjacent to the source area, indicating that the elevated levels of vanadium detected in these wells may be associated with the source.

Inorganic Analytes in the Intermediate Zone Surficial (IZS). Based on the results of inorganics analyses of unfiltered groundwater from the 5 IZS wells, 16 inorganics were detected: aluminum, antimony, arsenic, barium, calcium, chromium, cobalt, iron, magnesium, manganese, nickel, potassium, sodium, thallium, vanadium, and zinc. Of these 16 inorganics, 7 were detected above background screening concentrations: antimony, arsenic, cobalt, iron, nickel, thallium, and zinc.

Antimony was detected in only a sample from one IZS well, CEF-16-27I at 2.2 μg/ℓ. CEF-27I is approximately 700 feet downgradient of the source and in the flow path of the organic plume. However, antimony was not detected in samples from wells at the source area, and is at higher concentrations in samples from the intermediate aquifer. The detection of antimony at CEF-16-27I is most likely the result of groundwater migration from the intermediate aquifer to the surficial aquifer.

Arsenic was detected above background screening concentrations in samples from two of the five IZS wells: CEF-16-12I at 56.2 μg/ℓ, and CEF-16-22I at 37.9 μg/ℓ. CEF-16-12I is located at the source area, but beneath the extent of the organics plume. CEF-16-22I is located about 400 feet downgradient of the source area, and in the organics plume. However, arsenic was not detected above background screening concentrations in samples from any of the UZS wells adjacent to the source area and was not detected in samples from CEF-16-10S (the greatest number and highest levels of contaminants were detected in CEF-16-10S). Because it was detected in all five IZS wells, and was absent or below background screening concentrations in the source area UZS wells, arsenic does not appear to be associated with the source area.

Cobalt was detected in samples from two of the IZS wells: CEF-16-12I at 5.9 μg/ℓ and CEF-16-22I at 5.5 μg/ℓ. CEF-16-12I is located at the source area, but outside the organic plume. CEF-16-22I is located about 400 feet downgradient of the source area, and within the organics plume. Because cobalt was detected in samples from CEF-16-10S (UZS well adjacent to the source), these detections in the IZS wells appear to be associated with the source.

Iron was detected above background screening concentrations in samples from four of the five IZS wells: CEF-16-12I at 5,960J μg/ℓ, CEF-16-39I at 5,180 μg/ℓ, CEF-16-36I at 2,510 μg/ℓ, and CEF-16-27I at 2,050J μg/ℓ. It appears from these results that iron is prevalent in the IZS (there are no IZS-specific background wells) and these detections are not associated with the source area.

Nickel was detected in a sample from one IZS well, CEF-16-22I at 12.5 μg/ℓ. This location is about 400 feet downgradient of the source area and within the organic plume. Because nickel was not detected in any other IZS or UZS well samples, it does not appear to be associated with the source area.

Thallium was detected in only a sample from one IZS well, CEF-16-22I at 6.3 $\mu g/\ell$. This location is about 400 feet downgradient of the source area and within the organic plume. Because thallium was not detected in samples from any well at or adjacent to the source area, it does not appear to be associated with the source.

Zinc was detected above background screening concentrations in samples from one of the five IZS wells, CEF-16-39I at 67.2J $\mu g/\ell$. This well is located over 1,000 feet downgradient of the source area and beyond the leading edge of the organics plume. Zinc was not detected above background screening concentrations in samples from any well adjacent to the source area, in any UZS well. This detection of zinc does not appear to be associated with the source.

Inorganic Analytes in the Lower Zone Surficial (LZS). Based on the results of inorganic analyses of unfiltered groundwater samples from the 10 LZS wells, 16 inorganics were detected: aluminum, antimony, arsenic, barium, cadmium, calcium, chromium, copper, iron, magnesium, manganese, nickel, potassium, sodium, thallium, and zinc. Of these 16 inorganics, 10 were detected above background concentrations: antimony, arsenic, barium, calcium, iron, magnesium, manganese, nickel, thallium, and zinc.

Antimony was detected in only a sample from one LZS well, CEF-16-25D at 3.5J $\mu g/\ell$. This well is located approximately 700 feet sidegradient of the source and outside the organic plume. Groundwater flow in this area is upward from the intermediate aquifer to the surficial aquifer. It is interpreted that antimony is not associated with the source area and is most likely migrating upward from the intermediate aquifer.

Arsenic was detected above the background screening concentration in samples from 2 of the 10 IZS wells: CEF-16-30D at 10.7 $\mu g/\ell$, and CEF-16-25D at 7.9 $\mu g/\ell$. CEF-16-30D is located approximately 700 feet downgradient of the source and CEF-16-25D is located about 700 feet sidegradient of the source area. Both locations are outside the organic plume. Arsenic was not detected above background in samples from any of the UZS wells adjacent to the source area and was not detected at all in samples from CEF-16-10S (the greatest number and highest levels of contaminants were detected in samples from CEF-16-10S). Arsenic was detected in samples from all 5 IZS wells and 7 of the 12 LZS wells and is interpreted to be prevalent in the surficial aquifer at OU 7, but not associated with the source area.

Barium was detected in samples from 2 of the 10 LZS wells: CEF-16-9D at 108 $\mu g/\ell$ and CEF-16-30D at 68.4 $\mu g/\ell$, which are both above the background screening concentration. CEF-16-9D is located adjacent to the source area and CEF-16-30D is located approximately 700 feet downgradient. Both locations are outside the organic plume. Barium is most prevalent and at highest concentrations in samples from the intermediate aquifer wells and the LZS wells, indicating that it is migrating with the flow of groundwater from the intermediate aquifer to the surficial aquifer and is not associated with the source area.

Calcium was detected above the background screening concentration in samples from 8 of the 10 LZS wells, with concentrations ranging from 26,800 $\mu g/\ell$ (below maximum background concentration of 27,000 $\mu g/\ell$) at CEF-16-30D to 58,450 $\mu g/\ell$ at CEF-16-28D (average of sample and duplicate). Calcium is a major constituent of the underlying dolomite formation (intermediate aquifer) and is detected at highest surficial aquifer concentrations in samples from the LZS wells downgradient of the source area where the upward flow from the underlying intermediate aquifer

is most evident. The detections of calcium do not appear to be associated with the source area.

Iron was detected above the background screening concentration in a sample from 1 of the 10 LZS wells, CEF-16-18D at 1,920 $\mu g/\ell$. This location is approximately 250 feet sidegradient of the source area and, based on groundwater flow direction, this detection does not appear associated with the source. As indicated above, iron is prevalent in the groundwater at OU 7.

Magnesium was detected above the background concentration in samples from 8 of the 10 LZS wells with concentrations ranging from 13,600 $\mu g/\ell$ at CEF-16-30D to 28,100 $\mu g/\ell$ at CEF-16-40D. Magnesium is a major constituent of the underlying dolomite formation (intermediate aquifer) and is detected at highest surficial aquifer concentrations in samples from the LZS wells downgradient of the source area where the upward flow from the underlying intermediate aquifer is most evident. The detections of magnesium do not appear to be associated with the source area.

Manganese was detected above the background concentration in samples from 8 of the 10 LZS wells with concentrations ranging from 45.5 $\mu g/\ell$ at CEF-16-37D to 56.8 $\mu g/\ell$ at CEF-16-33D. Manganese is prevalent in the underlying intermediate aquifer and is detected at highest surficial aquifer concentrations in samples from the LZS wells downgradient of the source area where the upward flow from the underlying intermediate aquifer is most evident. Manganese does not appear to be associated with the source area.

Nickel was detected in a sample from one LZS well, CEF-16-40D at 2 $\mu g/\ell$ (duplicate sample only) (the average of the sample and duplicate from CEF-16-40D is 11 $\mu g/\ell$ because the averaging procedure uses half of the RDL when the sample or duplicate result is non-detect). This location is over 1,000 feet downgradient of the source area but beyond the leading edge of the organic plume. Because nickel was not detected in samples from any UZS well and only one IZS well (CEF-16-22I), it does not appear to be associated with the source area.

Thallium was detected in only a sample from one LZS well, CEF-16-25D at 6J $\mu g/\ell$. This location is about 700 feet sidegradient of the source area and outside the organic plume. Because thallium was not detected in samples from any well at or adjacent to the source area, it does not appear to be associated with the source.

Zinc was detected above the background concentration in a sample from 1 of the 10 LZS wells, CEF-16-33D at 89.5 $\mu g/\ell$. This well is located approximately 1,000 feet downgradient of the source area and below the leading edge of the organic plume. Zinc was not detected above background concentrations in samples from any well adjacent to the source area, in any UZS well, and in only one IZS well. This detection of zinc does not appear to be associated with the source.

Inorganic Analytes in the Upper Zone Hawthorn (UZH). Based on the results of inorganics analyses of unfiltered groundwater samples from the 4 UZH wells, 11 inorganics were detected: antimony, barium, calcium, chromium, copper, iron, magnesium, manganese, potassium, sodium, and zinc. No background wells were installed in the UZH. These detections are not believed to be associated with the source area because groundwater flow potential is from the UZH (intermediate aquifer) upward to the surficial aquifer. All of these inorganics, except barium,

chromium, and iron, exceed the surficial aquifer background screening concentration as shown on Figure 4-13.

4.2.3.3 Summary of Analytical Results for Groundwater.

Summary of Organics in the Surficial Aquifer. Twelve organic compounds were detected in samples from the UZS at OU 7: five VOCs, six SVOCs, and one pesticide. Of these 12 compounds, 7 appear to be associated with the source area: the 4 VOCs 1,1-DCE, 1,2-DCE, 1,1,1-TCA, and TCE and the 3 SVOCs naphthalene, 2-methylnaphthalene, and phenanthrene (not detected at the source area, but included because the detection is downgradient [150 feet]).

Two organic compounds were detected in samples from the IZS at OU 7: one VOC, TCE, and one SVOC, bis(2-ethylhexyl)phthalate. Only the TCE appears to be associated with the source area.

Two organic compounds were detected in samples from the LZS at OU 7, one VOC, TCE, and one SVOC, bis(2-ethylhexyl)phthalate. Only the TCE appears to be associated with the source area.

The results of the BRA (ABB-ES, 1995a) indicate that three of the organic compounds detected in samples from the surficial aquifer and associated with the source (TCE, 1,2-DCE, and 1,1-DCE) pose a risk to human receptors, and none pose a risk to ecological receptors.

Based on the estimated horizontal and vertical extent of the TCE contamination in the surficial aquifer, the estimated volume of groundwater with TCE concentrations above 5 $\mu g/\ell$ is approximately 3.3 million cubic feet or 25 million gallons assuming 30 percent porosity (as opposed to 20 percent effective porosity used in Chapter 3.0). Soil sample results did not identify the presence of NAPL; however, several groundwater Aquaprobe™ samples from beneath the former seepage pit area (GS-16-12) show concentrations exceeding 1 percent (11,000 $\mu g/\ell$) of the solubility (1,100,000 $\mu g/\ell$) of TCE: 590,000 $\mu g/\ell$ at 11 to 15 feet bls; 110,000 $\mu g/\ell$ at 18 to 22 feet bls; and 1,500,000 $\mu g/\ell$ at 28 to 32 feet bls. These results, especially the 1,500,000 $\mu g/\ell$, which exceeds the solubility of TCE, indicate the presence of some NAPL. However, the NAPL is not believed to be present in any significant volume, but rather as small streaks or globules scattered in a relatively narrow column extending to approximately 40 feet directly beneath the former seepage pit area.

Summary of Inorganics in the Surficial Aquifer. Of the 13 inorganics detected above background concentrations in samples from the UZS at OU 7, 6 appear to have an association with the source area: aluminum, cadmium, cobalt, lead, sodium, and vanadium.

Of the six inorganics detected above background screening concentrations in samples from the IZS at OU 7, only cobalt appears to have an association with the source area.

Of the 10 inorganics detected above background screening concentrations in samples from the LZS at OU 7, none appear to have an association with the source area.

The results of the BRA (ABB-ES, 1995a) indicate that none of the inorganics detected in the surficial aquifer samples and associated with the source pose a

risk to human receptors, and only aluminum and iron pose a risk to ecological receptors.

Summary of Organics in the Intermediate Aquifer. TCE, found in samples from the surficial aquifer, was not detected in samples from the UZH. Two organic compounds were detected in samples from the LZS at OU 7: the SVOCs bis(2-ethylhexyl)phthalate and di-n-butyl phthalate. Neither of these compounds appears to be associated with the source area.

Summary of Inorganics in the Intermediate Aquifer. Based on the results of inorganic analyses of unfiltered groundwater samples from the four UZH wells, 11 inorganics were detected: antimony, barium, calcium, chromium, copper, iron, magnesium, manganese, potassium, sodium, and zinc. No background wells were installed in the UZH. These detections are not believed to be associated with OU 7 because groundwater flow potential is from the UZH (intermediate aquifer) upward to the surficial aquifer. All of these inorganics, except barium, chromium, and iron, exceed the surficial aquifer background screening concentrations.

4.2.4 Surface Water and Sediment The following discussion focuses on the significant findings of the surface water and sediment investigation completed at OU 7.

Surface water and sediment samples were collected in 1993 to support the RI, RA, and FS for OU 7. The following discussion, focusing on the nature and extent of contamination detected, evaluates only the results of TCL and TAL analyses.

The data generated during the surface water and sediment sampling program is summarized in this section and presented on tables and/or figures whenever possible. The complete chemical analytical data set for OU 7 is presented in Appendix M.

Sampling location STCSW/SD1 is approximately 100 feet downgradient of the outfall of the storm sewer line, which may have received overflow discharge from the seepage pit from approximately 1969 to 1980. Location STCSW/SD3 is approximately 100 feet downgradient of the outfall of the storm sewer line that receives drainage from the west side of Building 313. STCSW/SD4 is downgradient of the confluence of drainage ditches from the outfalls mentioned above.

Discussion of sampling results is presented by organic and inorganic analytical fractions.

4.2.4.1 **Organics in Surface Water and Sediment** The organic analytical results for surface water and sediment are presented in Appendix M, summarized in Tables 4-7 and 4-8, and shown on Figure 4-15. No pesticides or PCBs were detected in the surface water or sediment samples.

VOCs in Surface Water. VOCs were the only organic compounds detected in surface water samples. Based on the results of VOC analyses of the four surface water samples, three compounds were detected: toluene, 1,2-DCE, and TCE.

Toluene, a common component of fuel, was detected in a sample from one location, STCSW1 at 2J $\mu g/\ell$. This detection appears to be the result of the general

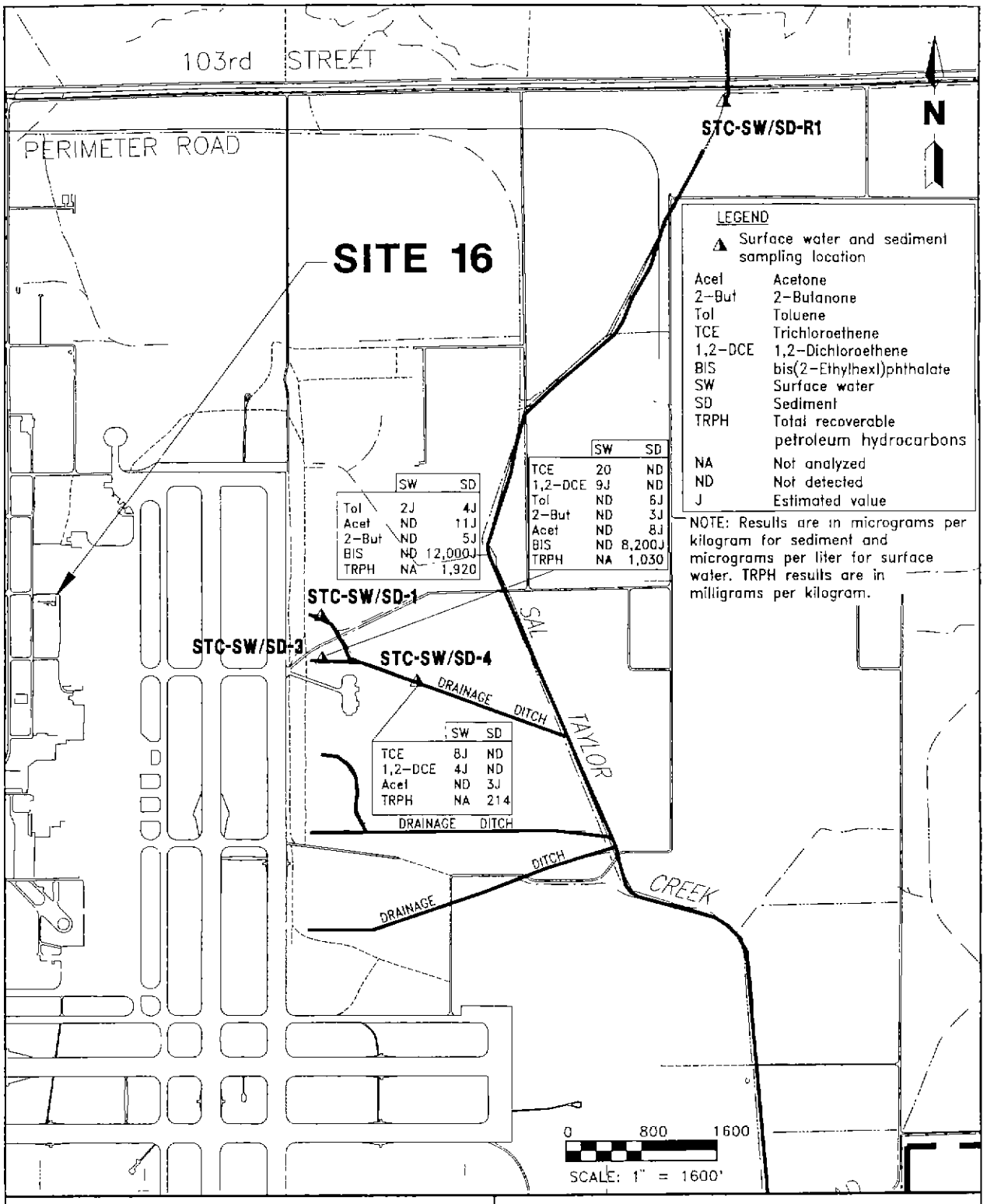


FIGURE 4-15
ORGANICS DETECTED IN SURFACE WATER AND SEDIMENT

CEC L/STCRK/MAH-NP/03-14-95

REMEDIAL INVESTIGATION, OPERABLE UNIT 7

NAS CECIL FIELD
JACKSONVILLE, FLORIDA

Table 4-7
Summary of Organic Compounds Detected in Surface Water

Operable Unit 7
Remedial investigation, NAS Cecil Field
Jacksonville, Florida

Analyte	Frequency of Detection[1]	Range of Detected Concentrations	Range of Reporting Limits	AWQC[2]	State of Florida Surface Water Quality Standard[3]
Volatiles (µg/ℓ)					
1,2-Dichloroethene (total)	2/3	4J to 9J	10 to 10	NA	NA
Toluene	1/3	2J	10 to 10	NA	NA
Trichloroethene	2/3	8J to 20	10 to 10	[4]21,900	80.7

[1] Frequency of detection is the number of samples in which the analyte is detected divided by the total number of samples analyzed (STCSW1, STCSW3, and STCSW4).
[2] Federal Ambient Water Quality Criteria (AWQC) USEPA, 1988 AND 1991.
[3] Florida Department of Environmental Protection (17-302; 4/25/93 version) Surface Water Quality standards. Values for cadmium, copper, lead, and zinc are based upon equations using the average measured hardness for surface water samples of 47 mg/l from Sal Taylor Creek, including STC-SW-R1, STC-SW-3, and STC-SW-4.
[4] Value is the lowest observed effect level (LOEL).

Note: µg/ℓ = micrograms per liter.
NA = not applicable.

Table 4-8
Summary of Organic Compounds Detected in Sediment

Remedial Investigation
Operable Unit 7, NAS Cecil Field
Jacksonville, Florida

Analyte	Frequency of Detection [1]	Range of Detected Concentrations	Range of Reporting Limits	Region IV Sediment Quality Screening Values[2]
Volatiles (µg/kg)				
2-Butanone	2/3	3J to 5J	13 to 19	NA
Acetone	3/3	3J to 11J	13 to 19	NA
Toluene	2/3	4J to 6J	13 to 19	NA
Semivolatiles (µg/kg)				
bis(2-Ethylhexyl)phthalate	2/3	8,200J to 12,000J	6,500 to 24,000	NA

[1] Frequency of detection is the number of samples in which the analyte is detected divided by the total number of samples analyzed (STCSD1, STCSD3, and STCSD4).
[2] Region IV Waste Management Division Sediment Screening Values for Hazardous Waste Sites (2/16/94 Version)

Note: µg/kg = micrograms per kilogram.
NA = not applicable.

activity of the area that contributes runoff to these storm drains, and does not appear to be associated with the source area.

TCE and 1,2-DCE were detected in a sample from STCSW3 at 20 $\mu g/\ell$ and 9J $\mu g/\ell$, respectively. The storm sewer line that discharges to this location runs along the west side of Building 313 and through the organic groundwater plume southeast of OU 7. TCE was also detected in water samples collected from catch basins along the line. The invert of the storm sewer line is below the water table and dry weather flow was observed in the line, indicating that groundwater may be entering through joints or cracks. The TCE detections in the storm sewer line and in the drainage ditch beyond its outfall may be the result of some TCE contaminated groundwater entering the line. A summary of the storm sewer sampling and analysis is presented in Appendix P.

VOCs in Sediment. Based on the results of VOC analyses of the three sediment samples, three compounds were detected: acetone, 2-butanone, and toluene.

Toluene was detected in samples from STCSD1 at 4J $\mu g/\ell$ and STCSD3 at 6J $\mu g/\ell$. Both of these locations could potentially receive runoff from the vicinity of the source area. However, toluene was not detected in any of the media at the source area and does not appear to be associated with the source. These detections are likely the result of the general activity in the larger area that contributes runoff to these drainage swales.

Acetone was detected in samples from STCSD1 (11J $\mu g/\ell$), STCSD3 (8J $\mu g/\ell$), and STCSD4 (3J $\mu g/\ell$). 2-Butanone was detected in samples from STCSD1 (5J $\mu g/\ell$) and STCSD3 (3J $\mu g/\ell$). Both of these compounds were detected in samples of the subsurface soil at the source area, indicating a potential association to these detections in the sediment. There is, of course, the potential for these contaminants to reach the sediment as a result of the general activity in the larger area that contributes runoff to the swales.

SVOCs in Sediment. Based on the results of SVOC analyses of the three sediment samples, bis(2-ethylhexyl)phthalate was detected in samples from STCSD1 (12,000J $\mu g/kg$) and STCSD3 (8,200J $\mu g/kg$). These phthalate detections are not believed to be associated with the source area, and are most likely laboratory contamination or the result of other activity in the area.

TRPH in Sediment. TRPH was detected in all three sediment samples. Of the three detections, the two highest were from samples collected at the two storm sewer outfalls. STCSD1 had the highest TRPH concentration at 1,920 mg/kg and STCSD3 had a concentration of 1,030 mg/kg. The presence of TRPH in the sediment is interpreted to be the result of flightline activities (i.e., fueling of planes), rather than the Disposal activities that took place at OU 7.

4.2.4.2 **Inorganics in Surface Water and Sediment** The inorganic analytical results for surface water and sediment are presented in Appendix M, summarized in Tables 4-9 and 4-10, and shown on Figure 4-16. The background screening concentrations for inorganics in surface water and sediment are also presented in Tables 4-9 and 4-10.

Inorganics in Surface Water. Based on the results of inorganic analyses of the 3 surface water samples, 10 analytes were detected: beryllium, cadmium, calcium, copper, iron, lead, magnesium, manganese, sodium, and zinc. Of these 10

Table 4-9
Summary of Inorganics Detected in Surface Water

Remedial Investigation
Operable Unit 7, NAS Cecil Field
Jacksonville, Florida

Analyte	Frequency of Detection[1]	Range of Detected Concentrations	Range of Reporting Limits	Reference Station Screening Concentration [2]	AWQC[3]	State of Florida Surface Water Quality Standard [4]
Inorganics (µg/l)						
Aluminum	3/3	292 to 490	200 to 200	696	[5]748	NA
Barium	3/3	17.6J to 18.6J	200 to 200	28.6	NA	NA
Beryllium	1/3	0.49J	5 to 5	ND	5.3	0.13
Cadmium	2/3	0.32J to 37.3	5 to 5	ND	1.1	0.63
Calcium	3/3	6,510 to 10,800	5,000 to 5,000	66,000	NA	NA
Copper	3/3	2.4J to 11.9J	25 to 25	ND	12	6.2
Iron	3/3	847 to 1,470	100 to 100	762	1,000	1.0
Lead	1/3	14.1 to 14.1	5 to 5	5.8	3.2	1.22
Magnesium	3/3	1,190J to 3,290J	5,000 to 5,000	2,560	NA	NA
Manganese	1/3	9.6J	15 to 15	14.8	NA	NA
Sodium	3/3	3,120J to 5,200	5,000 to 5,000	5,960	NA	NA
Zinc	3/3	25.4 to 68.4	20 to 20	36.8	110	55.9

[1] Frequency of detection is the number of samples in which the analyte is detected divided by the total number of samples analyzed (STCSW1, STCSW3, and STCSW4).
[2] The upstream reference sample location is STCSWR1. The screening concentration is 2 times the concentration detected in the reference station sample.
[3] Federal Ambient Water Quality Criteria (AWQC) (USEPA), 1988 and 1991.
[4] Florida Department of Environmental Protection (17-302; 4/25/93 version) Surface Water Quality Standards. Values for cadmium, copper, lead, and zinc are based upon equations using the average measured hardness for surface water samples of 47 mg/l from Sal Taylor Creek, including STC-SW-R1, STC-SW-1, STC-SW-3, and STC-SW-4.
[5] The AWQC represented is the Final Chronic Value for aluminum of 748/µg/l. The Federal AWQC for aluminum of 87 µg/l is not appropriate as a screening value because it represents extra protection for brook trout and striped bass, which are not present in the wetlands.

Notes: µg/l = micrograms per liter.
ND = not detected in any background samples.
NA = not applicable.

Table 4-10
Summary of Inorganics Detected in Sediment

Remedial Investigation
Operable Unit 7, NAS Cecil Field
Jacksonville, Florida

Analyte	Frequency of Detection[1]	Range of Detected Concentrations	Range of Reporting Limits	Reference Station Screening Concentration [2]	Region IV Sediment Quality Screening Values[3]
Inorganics (mg/kg)					
Aluminum	3/3	1,820 to 3,890	40 to 40	2,200	NA
Barium	3/3	3J to 11.1J	40 to 40	8	NA
Cadmium	1/3	4.6	1 to 1	ND	1.0
Calcium	2/3	142J to 436J	1,000 to 1,000	11,300	NA
Chromium	2/3	11.4 to 11.9	2 to 2	4.4	33
Chromium,hexavalent	1/1	0.99	0.01 to 0.01	NA	NA
Copper	3/3	2.8J to 13.5	5 to 5	2	28
Iron	3/3	463J to 1,500J	20 to 20	826	NA
Lead	3/3	4.7 to 30.6	1 to 1	14.4	21
Magnesium	2/3	60.1J to 138J	1,000 to 1,000	202	NA
Manganese	1/3	4.9J	3 to 3	3.8	NA
Mercury	2/3	0.06J to 0.12J	0.1 to 0.1	ND	0.1
Nickel	1/3	4.6J	8 to 8	ND	20.9
Sodium	1/3	21.2J	1,000 to 1,000	ND	NA
Vanadium	2/3	4.1J to 6.8J	10 to 10	ND	NA
Zinc	3/3	19.5 to 109	4 to 4	21.8	68

[1] Frequency of detection is the number of samples in which the analyte is detected divided by the total number of samples analyzed (STCSD1, STCSD3, and STCSD4).
[2] The upstream sample location is STCSDR1. The screening concentration is two times the concentration detected in the reference station sample.
[3] Region IV Waste Management Division Sediment Screening Values for Hazardous Waste Sites (2/16/94 Version).

Notes: mg/kg = milligrams per kilogram.
ND = not detected in any background samples.
NA = not applicable.

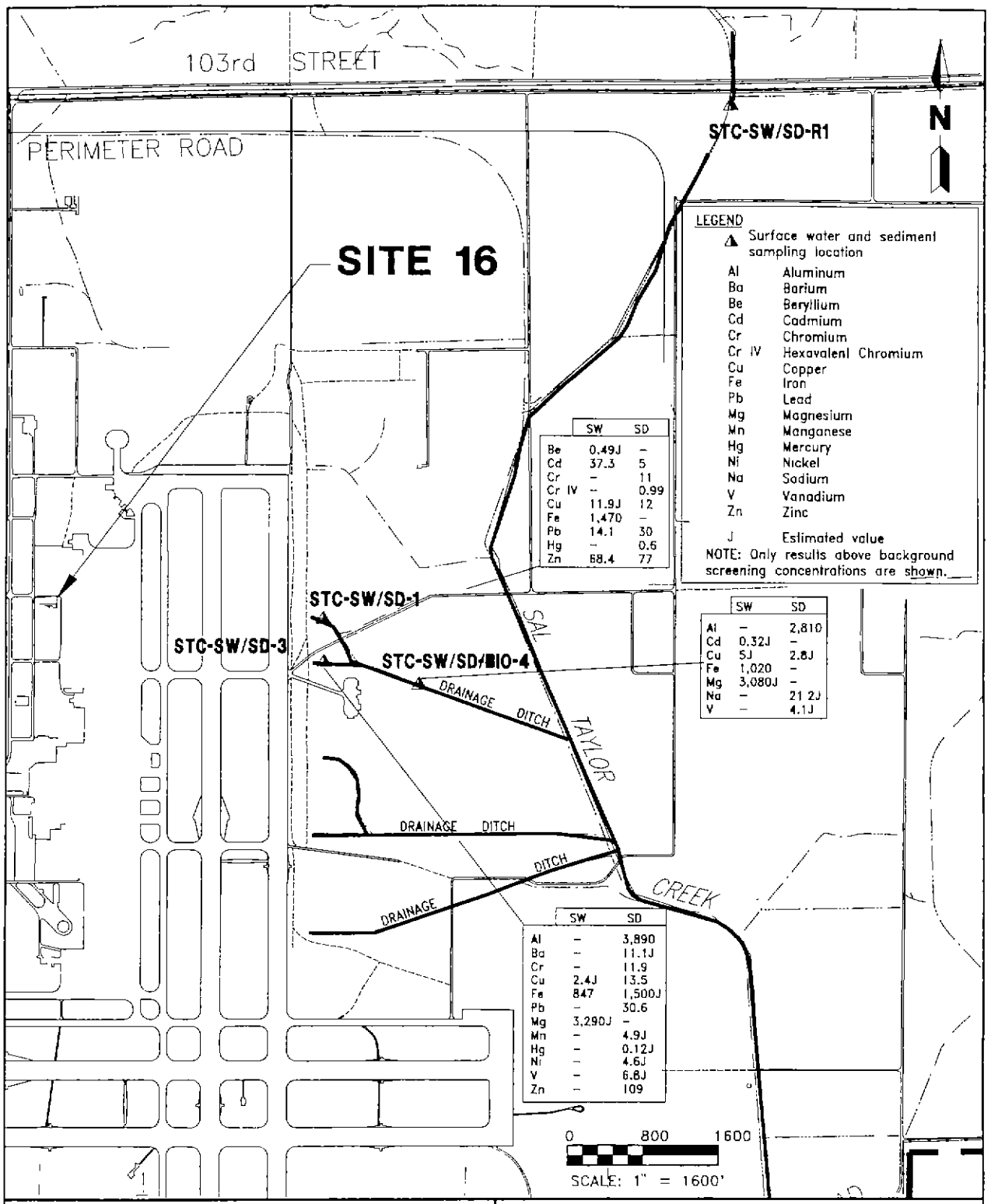


FIGURE 4-16
INORGANICS DETECTED IN SURFACE WATER AND SEDIMENT

CECIL/STCRK/MAH-NP/05-14-95

REMEDIAL INVESTIGATION, OPERABLE UNIT 7

NAS CECIL FIELD
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inorganics, all but 3 (calcium, manganese, and sodium) were detected above background screening concentrations.

Copper and iron were detected above background screening concentrations in all three samples. Cadmium above background screening concentrations (STCSW1 and STCSW4) and magnesium (STCSW3 and STCSW4) were each detected in samples from two locations. Beryllium, lead, and zinc were detected above background screening concentrations only in a sample from STCSW1.

All of these inorganics, with the exception of beryllium, were detected in at least one medium at the source area, and could be interpreted as being related to the source. However, the storm sewer lines that discharge to the drainage ditches where these samples were collected have many inlets, presenting the opportunity for contributions of these inorganics from sources other than OU 7.

Inorganics in Sediment. Based on the results of inorganic analyses of the 4 sediment samples, 14 analytes were detected: aluminum, barium, cadmium, calcium, chromium (total and hexavalent), copper, iron, lead, magnesium, mercury, nickel, sodium, vanadium, and zinc. Of these 14 inorganics, all but calcium were detected above background screening concentrations.

Copper was detected in all three sediment samples. Aluminum was detected in two samples (STCSD3 and STCSD4). Chromium (total), lead, mercury, vanadium, and zinc were also detected in samples from two locations (STCSD1 and STCSD3). Barium, iron, manganese, and nickel were detected in a sample from STCSD3 only, and cadmium (STCSD1), hexavalent chromium (STCSD1), and sodium (STCSD4) were also detected in a sample from one location only.

All of these inorganics were detected in at least one medium at the source area, and could be interpreted as being related to the source. However, the storm sewer lines that discharge to the drainage ditches where these samples were collected have many inlets, presenting the opportunity for contributions of these inorganics from sources other than OU 7.

4.2.4.3 Summary of Analytical Results for Surface Water and Sediment

Summary of Organics in Surface Water. Three organic compounds were detected in the surface water samples collected for OU 7: the VOCs toluene, 1,2-DCE, and TCE. Of these three compounds, only TCE (20 $\mu g/\ell$) and 1,2-DCE (9J $\mu g/\ell$) appear to be associated with the source area. The BRA (ABB-ES, 1995a) indicates that none of these pose a risk to ecological receptors.

Summary of Organics in Sediment. Four organic compounds were detected in the sediment samples collected for OU 7: the three VOCs, acetone, 2-butanone, and toluene and one SVOC, bis(2-ethylhexyl)phthalate. Toluene was not detected in any media at the source area and does not appear associated with the source. Acetone, 2-butanone, and bis(2-ethylhexyl)phthalate were all detected in at least one medium at the source area and could be interpreted to be related to the source. However, these compounds are also common laboratory contaminants and may not represent real detections in the media. Also, if they are interpreted to be real, the storm sewer lines that discharge to the drainage ditches where these sediment samples were collected have many inlets, presenting the opportunity for contributions of these compounds from sources other than OU 7. The BRA (ABB-ES,

1995a) indicates that none of these detections in sediment pose a risk to ecological receptors.

Summary of Inorganics in Surface Water. Of the eight inorganics detected above background screening concentrations in the surface water samples collected for OU 7, seven could be interpreted to be associated with the source area: cadmium, copper, iron, lead, magnesium, manganese, and zinc. This association is based on the inorganic being detected in a medium at the source area. However, the storm sewer lines that discharge to the drainage ditches where these samples were collected have many inlets, presenting the opportunity for contributions of these inorganics from sources other than OU 7. The BRA (ABB-ES, 1995a) indicates that none of these detections in surface water pose a risk to ecological receptors.

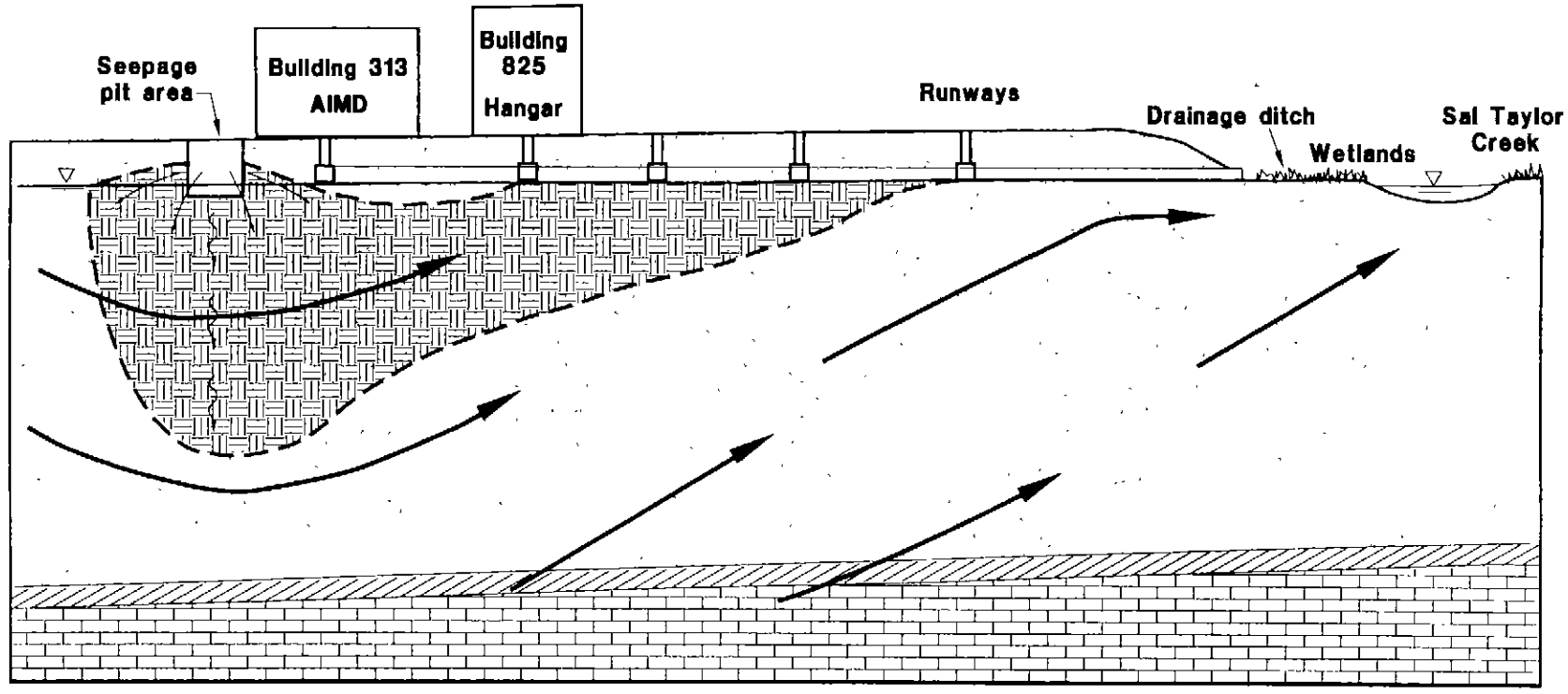
Summary of Inorganics in Sediment. All 13 of the inorganics detected above background screening concentrations in the sediment samples collected for OU 7 could be interpreted to have an association with the source area: aluminum, barium, cadmium, chromium (total and hexavalent), copper, iron, lead, manganese, mercury, nickel, sodium, vanadium, and zinc. The association to the source is based on the inorganic being detected in a medium at the source area. However, the storm sewer lines that discharge to the drainage ditches where these samples were collected have many inlets, presenting the opportunity for contributions of these inorganics from sources other than OU 7. The BRA (ABB-ES, 1995a) indicates that the aluminum, chromium, and iron detections in the sediment may pose a risk to ecological receptors.

4.3 SUMMARY OF CONTAMINANT NATURE AND EXTENT. The results of the investigation to delineate the nature and extent of contamination resulting from the past discharge to the seepage pit area indicated the presence of contaminants in all media sampled. However, not all of these detections appear related to the source area. TCE is the primary contaminant that is associated with the source and is observed to migrate from the source area. A conceptual model presenting the extent of TCE contamination and transport pathways is presented as Figure 4-17.

Soil. As previously discussed, the discharge of wastewater to the seepage pit apparently caused the water table to mound and spread contaminants radially (horizontally and vertically). When the discharge ceased, the mound subsided and left TCE contamination in what is now the vadose zone. During the IRA, soil with TCE concentrations in excess of 1,000 μg/kg were removed and replaced with clean fill. Confirmatory sampling conducted in the area confirmed that TCE above 1,000 μg/kg in the vadose soil had been removed during the IRA.

The results of the surface soil analyses indicated the presence of VOCs (TCE and its transformation product 1,2-DCE), SVOCs (PAHs), pesticides and PCBs, and inorganics. The detections in surface soil are randomly distributed and are not believed to have been introduced by the subsurface discharge from the seepage pit. Those that may be associated with the discharge, such as TCE, appear to have been randomly introduced to the surface soil during the IRA excavation activities.

The results of the subsurface soil analyses also indicated the presence of VOCs, SVOCs, pesticides, PCBs, and inorganics. The VOCs, SVOCs, and inorganics appear to be related to the past discharge as they are detected at highest concentrations near the former seepage pit area, whereas the pesticides and PCBs had a more sporadic distribution across the site. The VOCs include TCE and 1,2-DCE as well



Not to scale

LEGEND

- Groundwater flow direction
- Estimated extent of TCE plume
- Possible traces of NAPL
- Sand
- Clay and dolomite
- Dolomite
- Water table
- Storm sewer system

NOTES:

NAPL Non-aqueous phase liquid

AIMD Aircraft intermediate maintenance department

CECIL\TCE-EXT\NP\03-15-95

FIGURE 4-17
CONCEPTUAL MODEL OF THE EXTENT OF TRICHLOROETHENE CONTAMINATION

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as methylene chloride, 2-butanone, and acetone (common artifacts). The SVOCs include 11 PAHs, 2 phthalates, and phenol. The inorganics most frequently exceeding background screening concentrations were aluminum, calcium, cobalt, and magnesium. Cadmium, cobalt, thallium, and zinc were detected in the subsurface soil samples at the site but not in the background data set.

Groundwater. Because the invert of the former seepage pit was below the water table, contaminants were discharged directly to the groundwater. The resultant mounding caused radial dispersion of the contaminants. The groundwater analytical results indicate that contaminants, primarily TCE, extend radially outward approximately 60 feet and downward approximately 65 feet from the source area. The lateral extent in the UZS is actually farther (over 150 feet) to the southeast, the direction of groundwater flow. The distribution of TCE appears to follow groundwater flow, being detected in the IZS well samples and undetected in the UZS well samples 150 feet downgradient of the source where groundwater flow is slightly downward and then horizontal through that area (Chapter 3.0).

The TCE reappears in the UZS samples approximately 500 feet downgradient of the source area, at the point where a strong upward flow from the intermediate aquifer to the surficial aquifer begins. The TCE is detected to approximately 1,000 feet downgradient of the source in this zone. In this area, bis(2-ethylhexyl)-phthalate is detected in samples from the intermediate aquifer and the LZS and IZS of the surficial aquifer. Many inorganics (including antimony, calcium, magnesium, manganese, and zinc) were detected at higher concentrations in samples from the intermediate aquifer and in the LZS and IZS of the surficial aquifer at and downgradient of the point where upward flow is observed indicating that their presence originated from groundwater in the intermediate aquifer. Several inorganics were detected in samples from the UZS at the source area (including aluminum, cadmium, cobalt, lead, sodium, and vanadium), but with the exception of cobalt, they have not been observed to migrate from the source area.

Surface Water and Sediment. Surface water and sediment samples were collected from drainage ditches (east of the runways) downgradient of the outfalls of two storm sewer lines that receive drainage from the runways and the developed area west of the runways, including OU 7. These storm sewer lines have many inlets, which indicates that the results may represent the impact of numerous sources other than OU 7. The evaluation of the surface water results indicates that the TCE and 1,2-DCE detected from location STCSW3 appear associated with OU 7. The storm sewer line that discharges to this location runs along the west side of Building 313 and through the TCE groundwater plume southeast of OU 7. The invert of the storm sewer line is below the water table and dry weather flow was observed in the line, indicating that groundwater may be entering through joints or cracks. TCE was detected in several water samples collected from catch basins along the line. The TCE detections in the storm sewer line and in the drainage ditch beyond its outfall may be the result of TCE contaminated groundwater from OU 7 entering the line.

5.0 CONTAMINANT FATE AND TRANSPORT

This chapter discusses the fate and transport of contaminants detected in the environment at OU 7, Site 16. Fate, in the context of this chapter, refers to the ultimate disposition of a given contaminant following its release into the environment. Transport refers to the mechanism(s) by which a given contaminant released into the environment will arrive at its fate.

Several organic and inorganic compounds were detected in the four media sampled at OU 7 (soil, sediment, surface water, and groundwater). Because of the number of contaminants detected and the number of fate and transport scenarios possible for those contaminants in the four media, this discussion will focus only on those compounds and metals that may pose significant risk to human health or the environment, as identified by the BRA (ABB-ES, 1995a) and summarized in Chapter 6.0.

The following discussion of contaminant fate and transport is divided into two sections. Section 5.1 discusses potential routes of contaminant migration in the media evaluated at OU 7. The site-specific persistence, fate, and transport of those compounds and elements found to pose a potential risk to human health or the environment are discussed in Section 5.2.

5.1 POTENTIAL ROUTES OF MIGRATION. Several routes of migration are possible for OU 7 contaminants through the various media: air, soil, surface water, and groundwater. These routes are summarized below.

5.1.1 Air Organic compounds, metals, and metal complexes that exist as gases, or are volatile, at surface temperature and pressure, or are particulate that may become entrained in air may migrate in the air from the OU 7 source area. The extent to which gaseous constituents and particulate material remain airborne is a function of their density, the level of excitation of the air (wind and temperature), and fate processes acting on the constituent. Particulate material may contain (or consist of) organic compounds and elements that would otherwise not be present in air.

5.1.2 Soil Organic and inorganic compounds are present in soil at OU 7. The primary agents of contaminant migration acting on soil include: wind, rainwater, running water, and human activity. Wind could potentially transport surface soil in the form of particulate material throughout and beyond the installation. Rainwater may cause surface soil to migrate either by washing soil particles downward into the subsurface or by carrying soil particles overland to the nearest catch basin and areas adjacent to Building 313. Human activity has been very common at OU 7 because it is located in the middle of the industrialized part of the base. Other human activity including maintenance and excavation operations have been common at OU 7 and may continue in the future.

5.1.3 Surface Water Organic and inorganic compounds can migrate from the OU 7 source area through the groundwater and storm sewers to surface water and be further transported downstream. The primary mechanism for migration of contaminants once they reach surface water are volatilization, dissolution, and suspension. Several organic compounds and metals are soluble in water and will remain in the aqueous phase until fate mechanisms cause removal or degradation.

Other organic compounds and elements are not soluble in water, but may be transported by surface water via suspension. The amount of suspended particulate material in surface water is largely a function of the water's energy and as that energy decreases, suspended material will settle and become part of the soil or sediment. Colloidal material may remain in suspension (by electrochemical forces) even in water of very low energy (e.g., standing water).

5.1.4 Sediment Organic and inorganic compounds from OU 7 can migrate with sediment through storm sewers and to and in surface water east of the north-south runways. Erosion, biological action, and human action are the primary transport mechanisms for sediment. Sediment transport in surface water is greatest under high stream flow conditions.

5.1.5 Groundwater Groundwater flow is the major migration mechanism for transporting dissolved constituents from the source area at OU 7. Organic compounds and elements at OU 7 are believed to have reached groundwater by the discharge of wastewater into the seepage pit or by being leached from soil to the water table by physical or chemical processes. Contaminated groundwater may eventually discharge to the wetlands and surface water bodies to the east.

5.2 CONTAMINANT PERSISTENCE AND FATE. The discussion of contaminant persistence and fate in the environment is divided into three subsections. Subsection 5.2.1 discusses the processes that control the persistence and fate of organic compounds and elements in the environment. Subsection 5.2.2 discussed the primary persistence and fate characteristics of the constituents detected at OU 7. Subsection 5.2.3 discusses contaminant transport.

5.2.1 Processes The persistence and fate of chemical constituents in the environment depends on various chemical, physical, and biological processes. The predominant processes affecting the environmental persistence and fate of chemical constituents include solubility, photolysis, volatilization, hydrolysis, oxidation, chemical specification, complexation, precipitation and co-precipitation, cationic exchange, sorption, bioaccumulation, and biodegradation and biotrans-formation. The more important and prevalent of these processes, with regard to the risk-driving chemicals identified at OU 7, are described below.

5.2.2 Persistence and Fate of OU 7 Specific Contaminants The human health and ecological risk assessment (summarized in Chapter 6.0) has identified organic and inorganic compounds that potentially pose a significant risk to either human health or the environment. These constituents are summarized below by medium.

Human Health Risk Assessment

- Groundwater: 1,1-DCE, 1,2-DCE, TCE, antimony, and thallium.

Ecological Risk Assessment

- Sediment: TRPH.
- Groundwater: bis(2-ethylhexyl)phthalate, aluminum, iron, and zinc.

Only media in which a contaminant poses a risk were identified and presented in the above list. The fate and persistence characteristics of the constituents that may pose a significant risk are summarized below by analytical fraction.

5.2.2.1 **VOCs** As indicated above, TCE, 1,2-DCE, and 1,1-DCE were identified as potentially posing a risk to human health in groundwater at OU 7.

Based upon groundwater concentrations and the risk assessment, the primary VOC of concern at OU 7 is TCE. TCE can be biologically transformed under aerobic (with oxygen) and anaerobic (without oxygen) conditions. Because oxygen is generally limited in groundwater, natural (unaided) biotransformation of TCE in groundwater most often occurs under anaerobic conditions. Anaerobic biodegradation of chlorinated VOCs is a reductive dechlorination process in which anaerobic bacteria use a chlorinated VOC molecule as an electron acceptor (respiration) when degrading organic carbon present in the soil and groundwater system. The anaerobic biotransformation of TCE results in less-chlorinated transformation products such as cis-1,2-dichloroethene (cis-DCE), vinyl chloride, and ethylene. The presence of such transformation products in groundwater indicates that anaerobic biodegradation of TCE has occurred.

At OU 7, cis-DCE was detected near the seepage pit area. No TCE transformation products were detected in samples from any of the monitoring wells farther downgradient of the source, and only low levels (2 to 7 $\mu g/\ell$) of DCE were detected in a few downgradient Aquaprobe™ groundwater screening samples. TCE and cis-DCE detected in the drainage ditch surface water samples (east of the runways) were apparently transported there via the storm sewer system. The presence of cis-DCE near the source area indicates biodegradation of TCE occurred in that area. The biodegradation of TCE near the source area (and not in other areas) is most likely due to the existence of favorable environmental or microbial conditions (e.g., nutrients, organic carbon, and redox potential) in that area.

5.2.2.2 **SVOCs** Only one SVOC at OU 7, bis(2-ethylhexyl)phthalate, was found to possibly be a risk to human health and the environment. This risk was only found to be present for groundwater. Bis(2-ethylhexyl)phthalate is one of several phthalate esters (compounds produced by reaction of an acid and an alcohol with the elimination of a molecule of water) frequently encountered in environmental contamination assessments. The persistence of phthalates, a common constituent of plastics, in the environment is as follows.

Although their solubilities vary from sparingly soluble to moderately soluble, they all are probably readily adsorbed onto suspended particles and biota and, under certain conditions, are likely to form a water soluble complex with humic substances. Their transport will largely depend on the hydrogeologic conditions of the aquatic system (USEPA, 1979).

A variety of organisms have demonstrated the ability to take up and accumulate phthalate esters; this is probably due to the solubility of phthalates in lipids. Mixed microbial systems can degrade phthalate esters under aerobic conditions. Degradation is generally slower under anaerobic conditions and ceases to be effective for bis(2-ethylhexyl)phthalate (USEPA, 1979).

Bioaccumulation, biotransformation, and biodegradation are all considered to make substantial contribution to fate processes, but the degree of influence on the ultimate fate of phthalate esters is unclear. Phthalate esters appear to be more readily biodegradable than other well studied persistent compounds, such as PCBs and DDT (USEPA, 1979).

5.2.2.3 **Inorganics** As listed above, inorganics were identified as potentially posing a risk to human health or the environment in the surface water, sediment, and groundwater at Site 16. A brief discussion of the persistence of these inorganic analytes is presented in the following paragraphs.

Aluminum. Aluminum is the third most abundant element in the earth's crust. Despite this, aluminum is seldom found in great concentrations dissolved in naturally occurring waters. Aluminum is known to complex strongly and readily with many complexing agents, and high concentrations of aluminum in water are usually due to these complexes or finely disseminated particles of aluminum-containing compounds, often clays or aluminum hydroxides like gibbsite.

Antimony. Antimony exists in three common valence states, Sb^{5+}, Sb^{3+}, an Sb^{3-}, and has characteristics similar to arsenic. Antimonide and antimonate ions have a relatively high solubility and generally remain in solution. Antimony dissolved in groundwater will be discharged to surface water or absorbed onto clays. Dissolution in the ocean is the primary fate for antimony released into the environment. Processes such as absorption and co-precipitation may cause sediment to act as temporary sinks for antimony, but biologically mediated methylation or reduction can remobilize antimony from sediment under reducing conditions. Bioaccumulation of antimony is thought to be low (USEPA, 1979). Although antimony is soluble in water, the overall abundance of the element in the earth's crust and, therefore, natural waters, is low (Hem, 1989).

Chromium. Chromium exists in primarily two valence states, Cr^{3+} and Cr^{6+}. Trivalent chromium forms an hydroxide, $Cr(OH)_3$ that is essentially insoluble. Hexavalent chromium remains in solution (under alkaline oxidizing conditions) until it is reduced to the trivalent species (USEPA, 1979). In groundwater with a pH of 5 to 9, trivalent chromium is the dominant species. Therefore, the chromium's fate in groundwater is to remain in the ground as an oxide in the aquifer matrix. If chromium (either 3+ or 6+ valence state) is discharged to surface water from groundwater, it quickly hydrolyzes (or reduces to the 3+ and then hydrolyzes) and becomes part of the stream's or lake's sediment.

Iron. Iron is a common element in many soils and rocks and is an essential element in the metabolism of both plants and animals and, as such, is commonly encountered in the environment. Iron exists in two valence states, $F3^{+2}$ (or ferrous) and Fe^{+3} (or ferric) ions. Aqueous iron's form is almost totally dependent on Eh (measure of the oxidization and reduction potential) and pH. In general, reducing environments favor the ferrous form, which is much more soluble than the ferric form under normally encountered conditions. Iron also commonly complexes with organic molecules, especially fluvic and humic acids.

Oxidizing a reduced, iron-rich solution often causes the development of colloidal ferric hydroxide precipitate, which absorbs and co-precipitates many other metallic ions.

Bacteria may catalyze or even drive iron reactions, leading to seemingly anomalous chemical behavior.

Dissolved iron can be sorbed to sediment, and iron carbonate (siderite) can precipitate from solution if bicarbonate concentrations are high enough. Iron hydroxide precipitates can further oxidize to form various iron oxides and iron

oxyhydroxides. Both iron carbonates and the various oxides can become part of the sediment.

Thallium. Thallium, a heavy metal, is a member of the Group III elements. It is not used extensively by industry and is introduced into the environment primarily as waste from production of other metals (USEPA, 1979).

In compounds, it has a valence of +1 or +3. The +3 state is much less stable in water than is the +1 state. Thallium (III) forms some organo-metallic compounds; however, Tl(I) forms relatively few complexes with the exception of those with halogen, oxygen, and sulfur ligands (USEPA, 1979).

Thallium can be removed from solution by adsorption onto clay minerals, bioaccumulation, or (in reducing environments) precipitation of the sulfide. Most of the ligands common to aerobic waters form soluble salts with thallium, so that precipitation is not important under oxic conditions (USEPA, 1979).

Zinc. Zinc (Zn) is a metallic element, atomic number 30, atomic weight 65.38. The chemistry of zinc is similar to that of cadmium, which is directly below it in the periodic table. In aqueous solution, zinc always has a valence of +2, and it exhibits amphoteric properties, dissolving in acids to form hydrated Az(II) cations and in strong bases to form zincate anions (probably $Zn(OH)_4^{-2}$). Compounds of zinc with the common ligands of surface waters are soluble in neutral and acidic solutions, so that zinc is readily transported in most natural waters and is one of the most mobile of the heavy metals. The geochemistry of zinc in surface water has been extensively reviewed by Hem (1972). Because the divalent zinc ion does substitute to some extent for magnesium in the silicate minerals of igneous rocks, weathering of this zinc-containing bedrock gives rise to Zn^{+2} in solution, whereupon the hydrated cation remains dominant to pH values of about 9. Zinc forms complexes with a variety of organic and inorganic ligands, but these compounds are sufficiently soluble to prevent their becoming a limiting factor for solubility of the small concentrations of zinc found in most aquatic environments. Adsorption on clay minerals, hydrous oxides, and organic matter is a more probable limiting mechanism (USEPA, 1979).

5.2.3 Transport of Contaminants This section presents a discussion of the anticipated migration of contaminants at OU 7.

The human health and ecological risk assessment (summarized in Chapter 6.0) has identified organic compounds and/or inorganics that potentially pose a significant risk to either human health or the environment in three media at OU 7: surface water, sediment, and groundwater.

5.2.3.1 Surface Water The only permanent surface water that can be associated with OU 7 is in the drainage ditches that begin at the end of the storm sewers east of the north-south runways approximately 2,800 feet east of OU 7. The drainage ditches carry water from the storm sewer outfall approximately 1,400 feet east to Sal Taylor Creek.

As indicated in Subsection 5.2.2, none of the detections of chemicals in the drainage ditch surface water were identified as posing significant human health and ecological risk.

5.2.3.2 **Sediment** Similar to surface water, sediment may also enter catch basins from surface water runoff from OU 7, travel through the storm sewer, and either be deposited in the bottom of the drainage ditches or be carried downstream.

As presented in Subsection 5.2.2, TRPH may pose a significant ecological risk to aquatic receptors. However, the presence of TRPH in sediment is interpreted to be the result of flightline activities, rather than the past waste disposal activities at OU 7.

During dry periods, the flow through the storm sewer and the drainage ditches is very low, indicating that the tributary's ability to transport sediment is also low. However, the area drained by the storm sewers is several acres and during periods of heavy rain the potential for surface water to transport the sediment to Sal Taylor Creek is greater.

5.2.3.3 **Groundwater** The primary route for contaminant migration in groundwater from OU 7 would be through the surficial aquifer.

As mentioned in Subsection 5.2.2, contaminants associated with human health and ecological risk include: the VOCs TCE and its transformation products 1,2-DCE and 1,1-DCE, the SVOC bis(2-ethylhexyl)phthalate), and the inorganics aluminum, antimony, iron, thallium, and zinc. Of these, only TCE, 1,2-DCE, 1,1-DCE, aluminum, and iron appear to have an association with the source area.

The chlorinated VOCs are the most prevalent organic contaminants detected at OU 7. Although 1,1,1-TCA was detected in a sample from one well (CEF-16-10S) near the source area, TCE is the most and widespread contaminant identified at OU 7. TCE was detected in all media sampled, except sediment. Considering this, the following discussion will first focus on the migration of TCE in groundwater. The other groundwater contaminants for which a risk has been identified will then be addressed.

TCE is one of the constituents of the wastewater that was previously discharged to the seepage pit. The discharge began in 1959 and continued until 1980. These waste liquids (primarily spent solvents and TCE contaminated wash water) resulting from paint preparation and parts cleaning operations are believed to have discharged from Building 313 to the holding tank, and more recently the bead separator, providing gravity separation of wastes. Drainage from the holding tank went to the seepage pit, which drained directly to the underlying vadose and phreatic zone soil and groundwater.

The addition of these wastewaters to the groundwater apparently created a localized mounding effect. The contaminant distribution indicates that mounding had the potential to spread the contaminants radially (horizontally and vertically) from the source. When the discharge ceased, the mound would have flattened, leaving contaminants in what is now the vadose zone.

After the initial spreading caused by the mounding, the contaminants would migrate with the flow of groundwater. The dissolved contaminants in the shallow groundwater (UZS) appear to have migrated approximately 1,000 feet to the southeast. Any contaminants remaining in the initial mound area would serve as a continuing source of groundwater contamination.

As described in Chapter 3, the general flow direction of groundwater in the surficial aquifer is to the southeast. Vertically the aquifer flows slightly downward at the seepage pit area, but a strong upward gradient is observed beginning approximately 400 feet downgradient. This upward gradient is interpreted to be the result of groundwater from both the surficial and intermediate aquifers flowing towards discharge areas in the wetlands and surface waters east of the runways. This flow pattern is interpreted to explain the detection of some TCE beneath the seepage pit area, and the observed horizontal movement of TCE to the southeast, with upward vertical migration. The upward gradients are expected to be as strong or stronger closer to the discharge area; therefore, future downward migration of TCE is not expected along the projected plume pathway.

One of the storm sewer lines, which discharges to a drainage ditch east of the runways, intersects the plume approximately 800 feet southeast of the seepage pit area. The invert of this line is below the water table and dry weather flow was observed at the outfall to the drainage ditch, indicating that some groundwater may be entering the line through cracks or joints. This would provide a much more rapid transport of some of the contaminants to surface water than the transport of the majority of the plume by natural groundwater flow, discussed below. The drainage ditch, which receives discharge from this storm sewer line, has been sampled and analyzed, and the results are addressed in the BRA.

Based on the estimated groundwater flow direction, and topographic and surface drainage features, the UZS would be expected to eventually discharge to the wetlands east of the north-south runways and north of the east-west runways and, subsequently, to Sal Taylor Creek, which drains these wetlands.

The discussion of the TCE migration in groundwater at OU 7 will address the following items:

1. the estimated concentration and duration of TCE leachate from vadose soil to the groundwater,

2. the estimated concentration and duration of TCE contributions to groundwater from soil below the water table,

3. the estimated elapsed time and concentration of the TCE plume upon arrival at its anticipated discharge point and through complete discharge at that point, and

4 the estimated dilution of the TCE plume upon entering and mixing with surface water.

The calculations and documentation to support this discussion are presented in Appendix K.

1. Leaching of TCE from Vadose Soil. As discussed in previous chapters, TCE contaminated vadose soil with concentrations above 1,000 μg/kg was removed from the source area during the IRA. Subsequent confirmatory sampling and analyses verified that this was accomplished. As discussed in Chapter 4.0, the estimated volume of TCE contaminated vadose soil remaining is approximately 30,000 cubic feet (ft^3), with an average TCE concentration of 137 μg/kg. Using the Summers model (USEPA, 1989b), the concentration of the leachate resulting from

precipitation infiltration through the vadose soil is estimated at 217 $\mu g/\ell$. After entering, and mixing with, the top 10 feet of the surficial aquifer during migration, the leachate would be diluted to approximately 62 $\mu g/\ell$. Using the USEPA batch model (USEPA, 1988b), it would take approximately 46 years for the precipitation infiltration to flush the soil to the point that the leachate would be less than the MCL of 5 $\mu g/\ell$, or approximately 30 years to flush the soil to the point that the leachate would be less than 5 $\mu g/\ell$ after mixing with the top 10 feet of the surficial aquifer (Appendix K).

2. Release of TCE from Phreatic Soil. TCE was detected in the groundwater beneath the source area at concentrations as high as 1,500,000 $\mu g/\ell$, which is above the solubility of TCE (1,100,000 $\mu g/\ell$). Using the Summers model, the TCE concentration in the phreatic soil associated with a groundwater TCE concentration of 1,100,000 $\mu g/\ell$ is estimated to be 166,000 $\mu g/kg$ (Appendix K). Using the USEPA batch model, it would take approximately 20 years from now (1995) for the flow of groundwater to flush the soil to the point that the concentrations of TCE in groundwater beneath the source would be less than 5 $\mu g/\ell$.

As discussed in Chapter 4.0, concentrations of TCE detected in groundwater directly beneath the former seepage pit area indicate the presence of some NAPL. The Summers model is not appropriate for estimating concentrations when NAPL is present. However, the NAPL is not interpreted to be present in any measurable quantity, but rather as scattered streaks or globules in a localized area extending approximately 40 feet directly beneath the former seepage pit area.

3. TCE Transport in Groundwater. The leading edge of the TCE plume has migrated over 1,000 feet to the southeast of the source in the 35 years since the discharge to the seepage pit began. It is estimated that it will travel another 3,300 feet to the southeast before discharging to the drainage ditches and wetlands east of the runways. Currently, the plume has travelled approximately 300 feet farther than would be expected based on estimated groundwater flow rate. This observation is interpreted to be a result of longitudinal dispersion.

A two dimensional transport model (see Appendix K), which takes into account longitudinal and lateral dispersion, was used to estimate the elapsed time and concentration of the TCE plume upon arrival at its anticipated discharge point. Because no TCE transformation products were observed in samples from monitoring wells downgradient of the source, no degradation factors were included in the modeling. Although TCE volatile losses from the plume are anticipated when the plume is at the water table, these losses were not taken into account in the model. Also, the model assumes the source to remain constant at the seepage pit area, when it has been estimated to decrease to 5 $\mu g/\ell$ in approximately 25 years. As a result, the TCE concentrations (especially the peak concentration) estimated at discharge to the drainage ditches and wetlands are greater than would be expected. A time line for past and projected plume milestones is presented for reference as Figure 5-1. The present depiction of the TCE plume is presented on Figure 5-2, and the projected depictions of the plume are presented on Figures 5-3 and 5-4.

The results of the model indicate that the leading edge of the plume will reach the drainage ditch in about 105 years (2099). The concentration discharging from the plume at 105 years is estimated at approximately 10 $\mu g/\ell$. The concentration of TCE discharging from the plume would then increase, reaching a maximum discharge concentration of less than 730 $\mu g/\ell$, in approximately 195 years (2189).

1959	1980	1994	2015	2099	2159
Waste discharge begins	Waste discharge stops	Source concentration approximately 1,175,000. Leading edge found 1,000 feet from source at concentration of 470 ug/l	Groundwater concentration drops below 5 ug/l at source.	Plume reaches wetlands on east side of runway	Plume discharge concentration begins to decrease after reaching high of approximately 730 ug/l

NOTE:
ug/l = micrograms per liter

FIGURE 5-1
ESTIMATED GROUNDWATER TRICHLOROETHENE PLUME MILESTONES

REMEDIAL INVESTIGATION, OPERABLE UNIT 7

NAS CECIL FIELD
JACKSONVILLE, FLORIDA

CECIL\TCE-EXT\NP\03-14-95

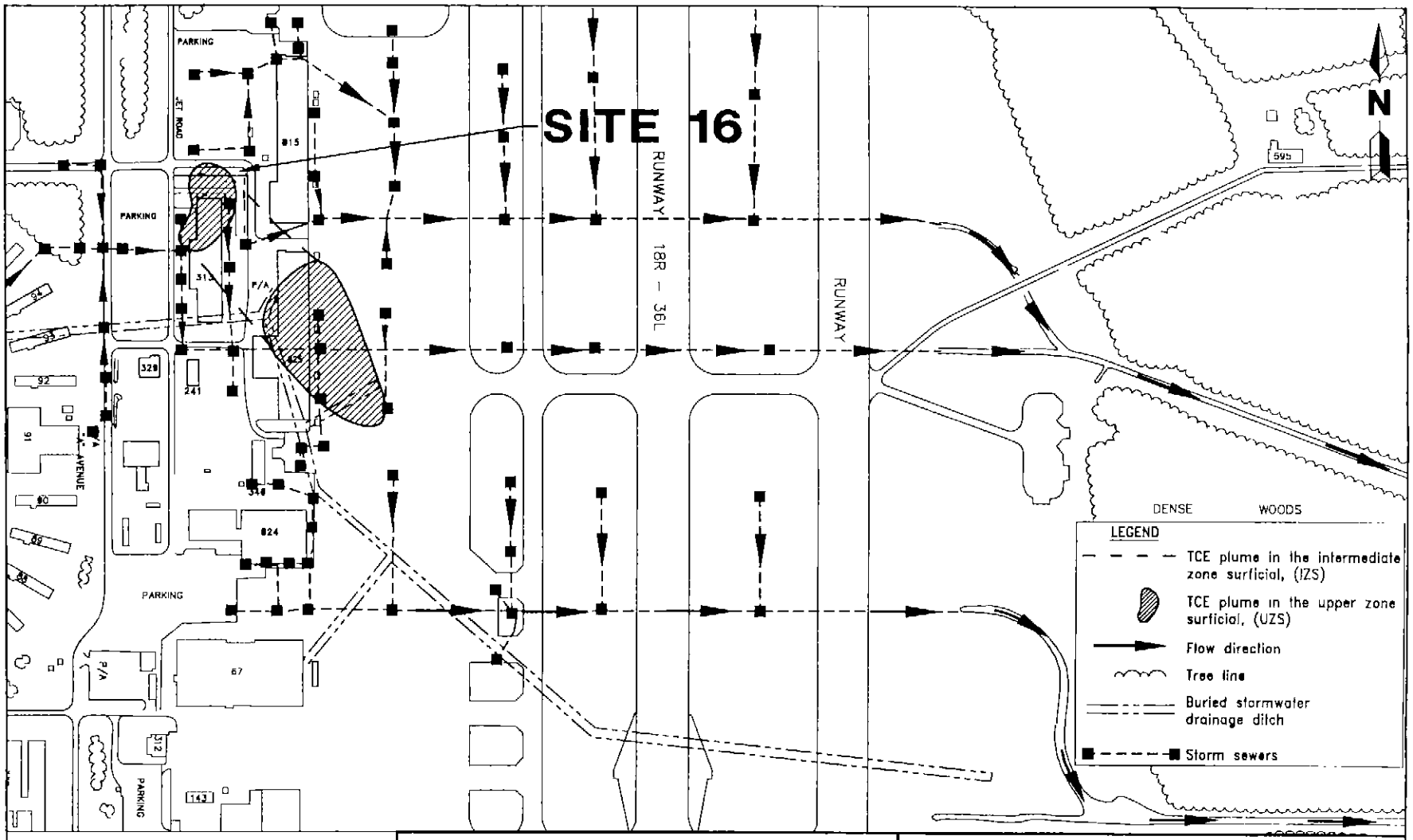


FIGURE 5-2
TRICHLOROETHENE PLUME TODAY (1994)

REMEDIAL INVESTIGATION, OPERABLE UNIT 7

NAS CECIL FIELD
JACKSONVILLE, FLORIDA

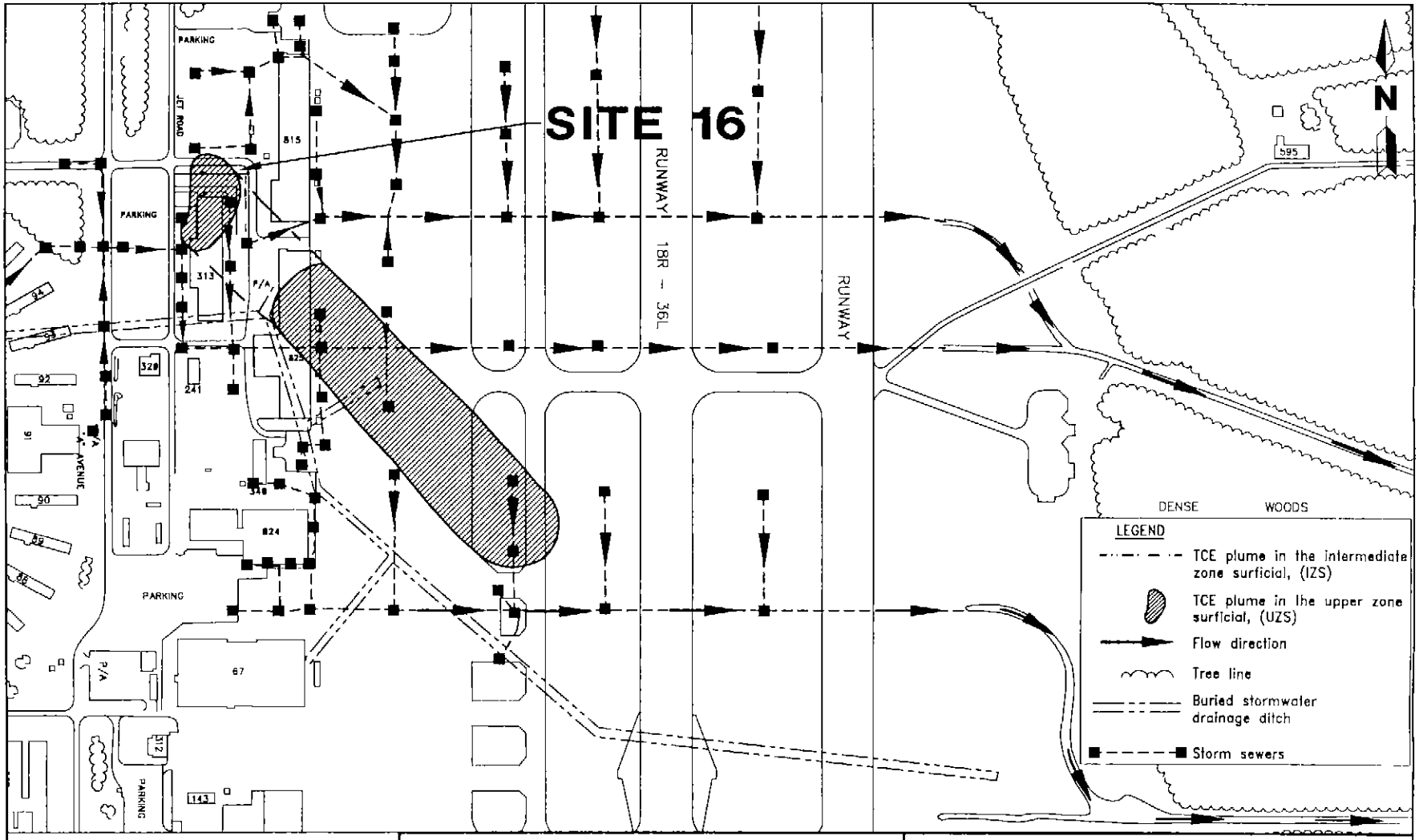


FIGURE 5-3
TRICHLOROETHENE PLUME IN 20 YEARS (2014), (BACK END OF PLUME LEAVING THE SEEPAGE PIT AREA)

REMEDIAL INVESTIGATION, OPERABLE UNIT 7

NAS CECIL FIELD
JACKSONVILLE, FLORIDA

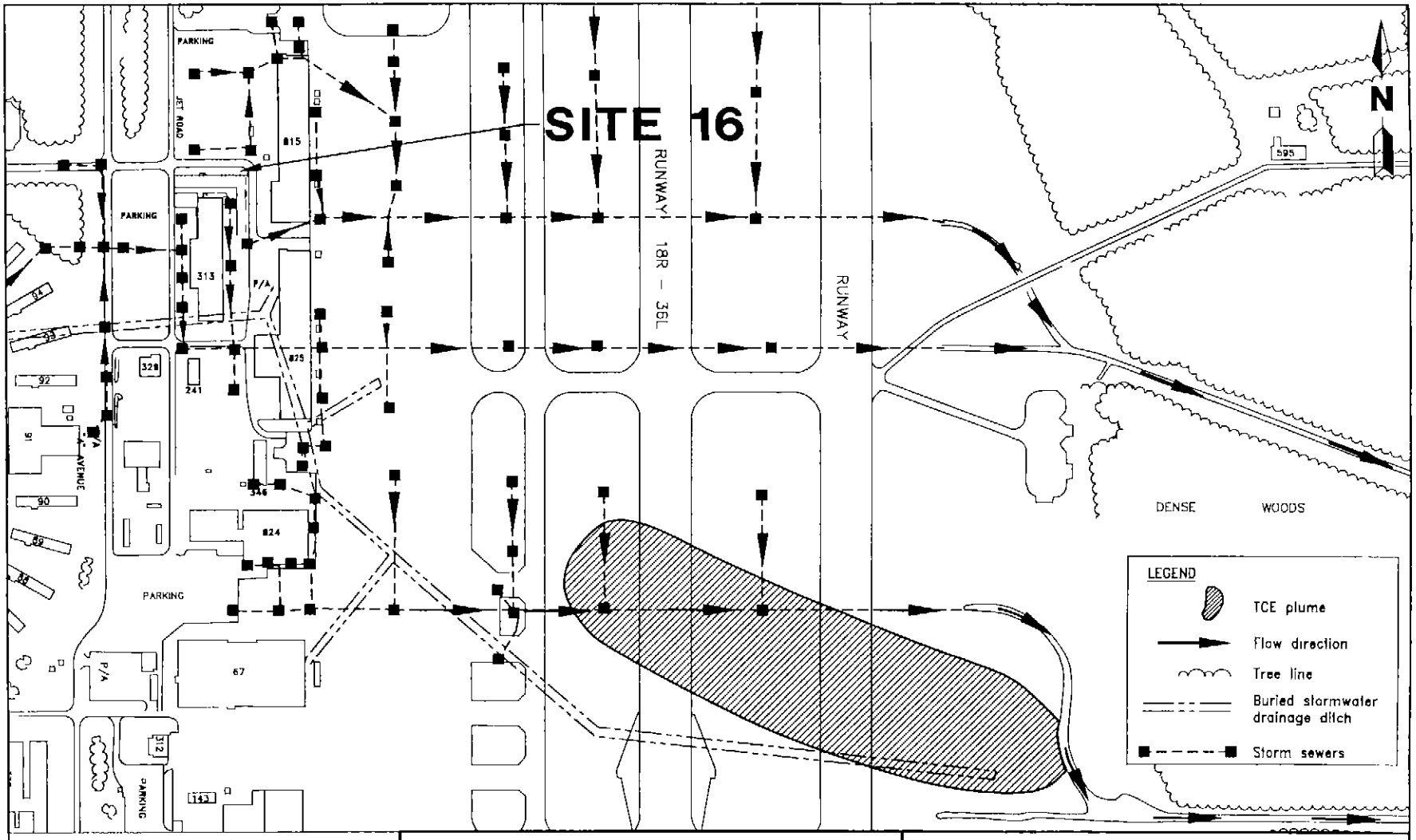


FIGURE 5-4
TRICHLOROETHENE PLUME IN 105 YEARS (2099), (LEADING EDGE REACHES THE DRAINAGE DITCH)

REMEDIAL INVESTIGATION, OPERABLE UNIT 7

NAS CECIL FIELD
JACKSONVILLE, FLORIDA

However, based on the previous estimation that the TCE concentration beneath the source will be less than 5 $\mu g/\ell$ 20 years from now (60 years since the discharge to the seepage pit began, and 39 years since the discharge ceased), the concentration of the discharge from the plume to the wetlands (drainage ditch) should actually begin to decrease approximately 60 years after the leading edge arrived at the wetlands, or 165 years from now (2159).

4. Plume Dilution in Surface Water. Some dilution of the TCE plume concentrations would be expected to occur as it discharges to surface water. For the purposes of this discussion, the plume is projected to discharge to the drainage ditch, which in turn flows into Sal Taylor Creek (Figure 5-4). Dilution of the plume was estimated for both of these surface water bodies. The estimated flow rate in the drainage ditch, based on visual observations at the outfall discharging to the ditch, is approximately 5 to 10 gallons per minute (gpm). Using 5 gpm results in an estimated volumetric flow of 959 ft^3/day. The estimated width of the TCE plume at the drainage ditch is approximately 500 feet, based on the results of the transport model. The discharge width is conservatively estimated at 10 feet (the entire bottom and side slopes of the drainage ditch). This results in a cross-sectional discharge area of 5,000 ft^2. Groundwater flow rate is estimated at 0.012 ft/day, resulting in an estimated volumetric flow of 58 ft^3/day for the plume. Comparison of the volumetric flows indicate that the plume will be diluted by a factor of 17 upon entering and mixing with the surface water in the drainage ditch. The water in the drainage ditch, in turn, will be diluted by a factor of approximately 260 upon discharging to and mixing with the water in Sal Taylor Creek.

The drainage ditch ultimately discharges into Sal Taylor Creek. If the plume did not enter the drainage ditches, it would eventually discharge directly to Sal Taylor Creek. To be conservative, the dilution factor for Sal Taylor Creek was calculated assuming direct discharge from the plume. The USGS has recorded the volumetric flow rate in Sal Taylor Creek at a location (Station 02245913) approximately 3 miles downstream of its confluence with the drainage ditch discussed above. Review of the records from July 1992 through June 1994 shows that the volumetric flow ranged from a high of 760 ft^3/sec (October 1992) to a low of 3 ft^3/sec (May 1994). The discharge of groundwater to the creek between the confluence with the drainage ditches and the gaging station was calculated and subtracted from the lowest recorded volumetric flow in Sal Taylor Creek (3 ft^3/sec). The resultant estimated volumetric flow for Sal Taylor Creek at the confluence with the drainage ditches was compared to the estimated volumetric flow of the TCE plume (same as calculated for the drainage ditch) and a dilution factor of approximately 4,400 was obtained (Appendix K).

All dissolved groundwater contaminants originating from the source area would be subject to the same hydrologic transport as TCE. However, TCE is the only risk-related groundwater contaminant that appears to originate at the source area and migrate from there via groundwater. Of the other risk-related groundwater contaminants, bis(2-ethylhexyl)phthalate, antimony, and zinc appear to originate in the intermediate aquifer and flow up into the surficial aquifer.downgradient of the OU 7 source area. Aluminum and iron appear at concentrations above background screening criteria at the source area, but if transport is occurring, their migratory concentration distribution is being masked by widespread detections of these inorganics below the background screening concentrations. Thallium is detected at three scattered locations in the surficial aquifer, and there is no indication of its origin. The groundwater in both the surficial and

intermediate aquifers is interpreted to flow toward discharge points in the wetlands and Sal Taylor Creek. Because TCE specific degradation or retardation factors were not considered, dilution on the order of that calculated for the TCE plume is assumed for these other risk-related groundwater contaminants upon their discharging to and mixing with surface water in the drainage ditch and/or Sal Taylor Creek.

5.3 SUMMARY OF CONTAMINANT FATE AND TRANSPORT. The fate and transport of contaminants at OU 7 focuses on TCE, which is the only risk-related contaminant that appears to originate at the source area and migrate from it.

TCE was apparently introduced to the soil and groundwater at the former seepage pit area by the wastewater discharge that occurred there from 1959 to 1980. Other contaminants may have also been introduced to these media via the same discharge, including SVOCs (such as PAHs) and inorganics (such as aluminum, cadmium, cobalt, iron, lead, and vanadium). With the exception of cobalt, none of these contaminants is observed to have migrated from the source area in the 35 years since the discharge to the seepage pit began.

Some transformation products of TCE (1,2-DCE and 1,1-DCE) were detected in the soil and groundwater near the seepage pit area, but none were detected in the monitoring wells downgradient and only low levels (2 to 7 $\mu g/\ell$) were detected in a few Aquaprobe™ locations downgradient. The anaerobic biodegradation of TCE near the source area (and not in other areas) is most likely due to the existence of favorable environmental or microbial conditions (e.g., nutrients, organic carbon, and redox potential) in that area.

During the IRA, TCE contaminated soil with concentrations above 1,000 $\mu g/kg$ was removed from the vadose zone at the source area and replaced with clean fill. Based on the results of the confirmatory soil sampling and analysis, it is estimated that concentrations of 137 $\mu g/kg$ remain in the vadose soil over an area of approximately 5,000 ft^2. It is further estimated that the TCE concentration of the leachate generated from the infiltration of precipitation through the soil would be approximately 217 $\mu g/\ell$. It would take approximately 30 years for the concentration of the leachate to be reduced so that its concentration after mixing with the top 10 feet of the surficial aquifer would be less than 5 $\mu g/\ell$.

The highest groundwater concentrations of TCE were detected in an Aquaprobe™ sample taken at the source area. The highest of these detections was 1,500,000 $\mu g/\ell$ in the 28 to 32 feet bls interval. It is estimated to take approximately 20 years for the flow of groundwater to reduce this concentration at this location to 5 $\mu g/\ell$. If NAPL is present, this period would be longer.

The leading edge of the plume has migrated approximately 1,000 feet downgradient of the source in the 35 years since the discharge to the seepage pit began. The plume has migrated approximately 300 feet farther than would be expected during that period, based on the estimated groundwater flow rate of 21 feet per year. This observation is interpreted to be the result of longitudinal dispersion.

The projected path of the plume is to the southeast, ultimately discharging into a drainage ditch and wetlands that are, in turn, drained by Sal Taylor Creek. Using a two dimensional transport model (which takes into account longitudinal and lateral dispersion) it is estimated that the plume will reach the drainage

ditch in approximately 105 years (2099). The concentration discharging from the plume at 105 years is estimated at approximately 10 $\mu g/\ell$. The concentrations of TCE discharging from the plume would then increase, reaching a maximum discharge concentration of less than 730 $\mu g/\ell$, in approximately 195 years (2189). However, based on the previous calculation that the TCE concentration beneath the source will be less than 5 $\mu g/\ell$ in 20 years (60 years since the discharge to the seepage pit began and 39 years since the discharge ceased), the concentration of the discharge from the plume to the wetlands (drainage ditch) should begin to decrease approximately 60 years after the leading edge arrives at the wetlands, or 165 years from now (2159).

Because no transformation products of TCE were observed in the monitoring wells downgradient of the source area, no degradation factor was included in the transport model. Other TCE losses, such as volatilization from the water table, were also not estimated. As a result, the estimated future concentrations are considered very conservative. In addition, as the plume discharges and mixes with surface water, some dilution is expected to occur. Upon discharging to and mixing with the water in the drainage ditch, TCE concentrations would be diluted by a factor of approximately 17. Upon discharging to and mixing with the water in Sal Taylor Creek, TCE concentrations would be diluted by a factor of approximately 4,400.

All dissolved groundwater contaminants originating from the source area would be subject to the same hydrologic transport as TCE. Dilution on the order of that calculated for the TCE plume is assumed for these other risk-related groundwater contaminants upon their discharging to and mixing with surface water in the drainage ditch and/or Sal Taylor Creek.

The only other contaminants that appear to originate from OU 7 are the TCE and 1,2-DCE detected in the surface water of the drainage ditch (east of the runways) downgradient of the outfall of a storm sewer line that runs along the west side of Building 313 and intersects the TCE plume southeast of the source area. These detections are interpreted to be the result of some TCE contaminated groundwater entering the storm sewer line through joints or cracks. The water in the drainage ditch would be diluted by a factor of approximately 260 upon discharging to, and mixing with, the water in Sal Taylor Creek.

6.0 SUMMARY OF BASELINE RISK ASSESSMENT

A baseline RA was completed at OU 7 to characterize the risks associated with exposures to site-related contaminants at OU 7 for human health and ecological receptors (ABB-ES, 1995a). This chapter presents a summary of the human health and ecological BRAs for OU 7. Although the BRA is presented as a separate document, it is summarized here to provide the rationale for developing remedial action objectives and alternatives as part of the FS.

6.1 APPROACH TO THE BASELINE RISK ASSESSMENT. The BRA was completed in accordance with the USEPA's human health risk assessment guidance for Superfund (USEPA, 1989c; USEPA, 1989d; USEPA, 1991e; USEPA, 1992a); Region IV Risk Assessment Guidance (USEPA, 1991d); Ecological Assessment of Hazardous Waste Sites, A Field and Laboratory Reference (USEPA, 1989a); and Ecological Assessment of Superfund Sites, An Overview (USEPA, 1991e). Recent risk assessment guidance including the USEPA "Eco Update" bulletins (USEPA, 1991f; 1992b; 1992c) and recent publications (Maughan 1993; Suter, 1993) were also consulted.

The BRA for OU 7 consisted of three primary components: (1) data evaluation, (2) human health risk assessment, and (3) ecological assessment. The purpose of the BRA was to evaluate whether or not contamination present at OU 7 poses unacceptable risks to human health and/or environmental receptors in the absence of any remedial action.

6.2 DATA EVALUATION. The purpose of the data evaluation process was to identify the environmental data suitable for use in the BRA based on results of the RI. The data from OU 7 were evaluated to determine which data were of sufficient quality for use in a quantitative risk assessment. Data from the RI were first compiled and sorted by environmental medium (i.e., surface and subsurface soil, groundwater, surface water, and sediment). Then, based on results of the data validation, overall quality of the data was reviewed to determine which data were of sufficient quality for use in a quantitative risk assessment.

In the human health and ecological risk assessments (ABB-ES, 1995a), the analytical data were used to select chemicals of potential concern (CPCs). Data collected from previous investigations were evaluated qualitatively.

6.3 HUMAN HEALTH RISK ASSESSMENT (HHRA). The purpose of the HHRA was to characterize the risks associated with potential exposures to site-related contaminants at Site 16 for human health receptors. Five components for the HHRA were completed: (1) data evaluation (including selection of human health chemicals of potential concern), (2) exposure assessment, (3) toxicity assessment, and (4) risk characterization (including an uncertainty analysis). In addition, a review of available criteria is presented.

6.3.1 Selection of Chemicals of Potential Concern Generally, chemicals for which data of sufficient quality are available and which are potentially site related are defined as human health chemicals of potential concern (HHCPCs). These contaminants are typically a subset of all inorganics and organics detected in the various media at the site and are selected based on concentration;

physical, chemical, and toxicological characteristics; frequency of detection (normally greater than 5 percent of the total sample set); comparison of detected values to background or baseline concentrations and associated blanks; and comparison to USEPA Region III risk-based concentrations (USEPA, 1993; USEPA, 1994a) and appropriate Florida criteria. The HHCPCs for Site 16 for each medium (surface soil, surface water, sediment, and groundwater) are presented in Table 6-1.

6.3.2 Exposure Assessment Site 16 was evaluated to identify actual or hypothetical populations that could contact site-related contaminants and the pathways through which exposure could occur. There are five potential sources of exposure associated with Site 16: surface soil, subsurface soil, surface water, sediment, and groundwater. Based on current site uses, surface soil, surface water, and sediment are the only media that are appropriate for evaluation because there is no current exposure to subsurface soil or groundwater. Under future land use, all the media were evaluated in the assessment based on the assumptions that subsurface soil may be exposed for contact and that groundwater may be used as an alternate potable water supply at Site 16.

As a result of the exposure assessment, the following exposure scenarios were identified as being possible at Site 16 under current use conditions: (1) incidental ingestion, direct contact, and inhalation of fugitive dust associated with surface soil by an child and adult trespasser, an adult site worker, and an adult maintenance worker; (2) incidental ingestion and direct contact with surface water or sediment by a child and adult trespasser; and (3) consumption of fish tissue by an adult and child transient. Under future land use, the following exposure scenarios were identified as being possible at Site 16: (1) incidental ingestion, direct contact, and inhalation of fugitive dust associated with surface soil by an adult and child resident; (2) incidental ingestion, direct contact, and inhalation of fugitive dust associated with subsurface soil by an adult excavation worker; (3) domestic use of groundwater by an adult resident; (4) incidental ingestion and dermal contact with surface water and sediment by an adult and child resident wader; and (5) consumption of fish tissue by an adult and child resident.

Generally, exposure scenarios associated with future land use are difficult to predict. Residential land use was selected as a future land use scenario at Site 16 based on USEPA Region IV guidance (USEPA, 1991d). The inclusion of a residential land use scenario at Site 16 is intended to represent a worst case scenario. Future residential land use at or near Site 16 is possible. Because NAS Cecil Field is scheduled for closure in the late 1990's as part of Base Realignment and Closure (BRAC), land use near Site 16 may be altered from its current daily use. It is likely, based on BRAC reuse plans and the interest of future land users, that the area near Site 16 will remain industrial after the facility closure.

6.3.3 Toxicity Assessment A toxicity assessment was conducted to identify the relevant oral, dermal, and inhalation toxicity values for carcinogenic and non-carcinogenic effects of Site 16 HHCPCs. These values were identified from either the USEPA's Integrated Risk Information System database (USEPA, 1994b) or USEPA's Health Effects Assessment Summary Tables (USEPA, 1994c).

6.3.4 Risk Characterization Quantitative estimates of both carcinogenic and non-carcinogenic risks were calculated for each HHCPC and each complete exposure

Table 6-1
Summary of Human Health Chemicals of Potential Concern (HHCPCs)

Remedial Investigation
Operable Unit 7, NAS Cecil Field
Jacksonville, Florida

Environmental Medium	Human Health Chemicals of Potential Concern [1]
Surface Soil	**Inorganics**: calcium, cobalt, and sodium **Organics**: benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, dibenz(a,h)anthracene, indeno(1,2,3-dc)pyrene, and dibenzofuran
Subsurface Soil	**Inorganics**: arsenic, calcium, cobalt, and thallium **Organics**: none
Surface Water	**Inorganics**: beryllium, cadmium, and iron **Organics**: 1,2-dichloroethene and trichloroethene
Sediment	**Inorganics**: cadmium and sodium **Organics**: none
Surficial Aquifer	**Inorganic**: antimony, arsenic, cobalt, iron, magnesium, manganese, and thallium **Organics**: 1,1,1-trichloroethane, 1,1-dichloroethene, 1,2-dichloroethene, bis(2-ethylhexyl)phthalate, and trichloroethene
Intermediate Aquifer	**Inorganics**: antimony and manganese **Organic**: bis(2-ethylhexyl)phthalate

[1] HHCPCs were selected for each medium in the Baseline Risk Assessment Report (ABB-ES, 1995).

scenario selected for evaluation in the exposure assessment. Carcinogenic risks associated with exposure to individual chemicals were estimated by multiplying the estimated chemical intake for each carcinogen (in units of milligram of chemical per kilogram of body weight each day [mg/kg-day]) by its USEPA cancer slope factor (CSF) (in units of $(mg/kg\text{-}day)^{-1}$). The result is a chemical-specific excess lifetime cancer risk (ELCR). This value represents the probability of developing cancer over the course of a 70-year lifetime as a result of the assumed exposure to site chemicals. The term excess refers to the increase in risk of cancer associated with exposure to site-related chemicals that is above and beyond baseline cancer risks. The average cancer burden in the United States in 1993 was 1 in 3 for women and 1 in 2 for men (American Cancer Society, 1994).

Within each exposure pathway, cancer risks associated with multiple carcinogenic compounds are determined by summing the chemical-specific risks to yield a pathway-specific ELCR. USEPA guidelines state that the acceptable total incremental carcinogenic risk for an individual resulting from exposure at a hazardous waste site is in a range of 1 in a million (10^{-6}) to 1 in 10,000 (10^{-4}) (USEPA, 1990).

Non-carcinogenic risk estimates are determined by dividing estimated chemical intakes (in units of mg/kg-day) by the appropriate reference dose (RfD) developed by USEPA (in units of mg/kg-day). The resulting ratio is called the hazard quotient (HQ). The HQs for individual compounds within an exposure pathway were summed resulting in a hazard index (HI) for that pathway. An HI equal to 1 represents concentrations and levels of exposure that are generally considered to be without deleterious effects for a lifetime exposure, even for sensitive individuals. As the HI increases above 1, the risk of adverse effects also increases if the toxic endpoint (organic or bodily function) is the same and the effects are additive.

6.3.4.1 Risk Characterization for Human Health at Site 16 Health risks associated with current land use are not of concern. Cancer risk estimates associated with Site 16 surface soil, subsurface soil, surface water, sediment, and the intermediate aquifer are all below or within the acceptable risk range defined by USEPA (10^{-6} to 10^{-4}). The risk estimate for the surficial aquifer under future land use conditions (adult resident) is 3×10^{-3}, which is at a level of concern. The major contaminant contributing cancer risk to the ELCR for the resident is 1,1-dichloroethene (ELCR=3×10^{-3}).

Noncancer risk estimates associated with Site 16 surface soil, subsurface soil, surface water, sediment, and the intermediate aquifer are all equal to or less than an HI of 1. The noncancer risk estimate (HI) for the surficial aquifer under future land use conditions (adult resident) is 50. Major contributors to this HI are 1,2-dichloroethene (HQ=38), 1,1-dichloroethene (HQ=1.2), trichloroethene (HQ=2.5), antimony (HQ=1.1), and thallium (HQ=1.8).

Human exposure to fish tissue was not evaluated in the risk characterization of the HHRA because lipophilic compounds that commonly accumulate in fish tissue were not detected in the surface water or sediment collected in the drainage ditches associated with Site 16. Further, fish that might be consumed by humans are not present in drainage ditches.

6.3.5 Comparison to Available Criteria Available criteria for groundwater (USEPA, 1994d; Florida Legislature, 1994; FDEP, 1994a), surface soil (FDEP,

1994b), and subsurface soil (FDEP, 1994b) were considered in the HHRA for Site 16. A comparison (see Appendix O) of the maximum detected concentrations for each chemical detected in the Site 16 surficial aquifer (Table O-1), intermediate aquifer (Table O-2), surface soil (Table O-3), and subsurface soil (Table O-4) was compared to available criteria.

Groundwater. In the surficial aquifer, the maximum detected concentrations of 1,1,1-trichloroethane, 1,1-dichloroethene, 1,2-dichloroethene, trichloroethene, bis(2-ethylhexyl)phthalate, aluminum, antimony, arsenic, iron, manganese, and thallium exceeded their respective Federal MCL, Florida Standard, and Florida guidance values (Appendix O, O-1). Each of these chemicals was retained as a HHCPC (except aluminum) in the surficial aquifer because it was detected at a concentration that exceeded background (upgradient) or risk-based screening concentrations. Aluminum was not selected as an HHCPC because the maximum concentration detected was less than its risk-based screening concentration.

In the intermediate aquifer, the maximum concentrations of bis(2-ethylhexyl)phthalate (a common laboratory contaminant), antimony, iron, and manganese exceeded their respective Federal MCL, Florida Standard, and Florida guidance values (Appendix O, Table O-2). Each of these chemicals was retained as a HHCPC (except iron) in the intermediate aquifer because it was detected at a concentration that exceeded a risk-based screening concentration. Iron was not selected as an HHCPC because it is an essential nutrient.

Soil. The concentrations of contaminants detected in OU 7 surface soil did not exceed any of the available FDEP guidance concentrations established for direct contact and inhalation exposures at military sites (Appendix O, Table O-3).

In subsurface soil, the maximum concentrations of acetone, methylene chloride, and trichloroethene exceed their available FDEP guidance concentrations established for leaching to groundwater at military sites (Appendix O, Table O-4). This comparison was conducted because subsurface soil may be contributing to contamination in the surficial aquifer. It should be noted that acetone and methylene chloride are both common laboratory contaminants. Both had low frequencies of detection.

TPH. TPH data were collected in surface and subsurface soil as well as sediment at OU 7. The TPH value for each sample location has been compared to the available Florida criterion for thermally treated petroleum-contaminated soil (50 mg/kg) (Florida Legislature, 1992) in Table O-5 of Appendix O. Each medium exceeds the 50 mg/kg at one or more sample location; however, TRPH was not detected in the groundwater above the Florida Petroleum Cleanup Criterion of 5 mg/l; (Florida Legislature, 1990b); therefore, TRPH is not considered a concern.

6.3.6 Summary of Human Health Risk Assessment The purpose of the HHRA at Site 16 was to characterize the risks associated with the potential exposures to site-related contaminants. Potential health risks were evaluated under current and assumed future land use conditions for a subset of contaminants detected in surface soil, subsurface soil, surface water, sediment, and groundwater (surficial and intermediate aquifers) associated with OU 7 (Table 6-2).

In summary, the risk estimates for surface soil, subsurface soil, surface water, sediment, and the intermediate aquifer indicate that human exposure to these media at OU 7, under the conditions evaluated in this assessment, is not associated with

Table 6-2
Human Health Risk Summary

Remedial Investigation
Operable Unit 7, NAS Cecil Field
Jacksonville, Florida

Medium	Risks Above USEPA Risk Range? [1]		Concentrations Above Florida Guidance Criteria? [2]
	Current Land Use [3]	Future Land Use [4]	
Surface Soil	No	No	No
Subsurface Soil	No	No	Yes [5]
Surface Water	No	No	NA
Sediment	No	No	NA
Surficial Aquifer	NA	Yes	Yes [6]
Intermediate Aquifer	NA	No	Yes [7]

[1] The U.S. Environmental Protection Agency (USEPA) regulations, established in the National Contingency Plan, indicate that the total lifetime cancer risk due to exposure to the Human Health Chemicals of Potential Concern (HHCPCs) at a site, by each complete exposure pathway, should not exceed a range of 1 in 1,000,000 (1×10^{-6}) to 1 in 10,000 (1×10^{-4}) (USEPA, 1990) or a hazard index of 1.

[2] Florida Soil Cleanup Goals for Military Sites in Florida are identified in the Florida Department of Environmental Protection (FDEP) memorandum dated July 5, 1994 (FDEP, 1994b). Florida Guidance Concentrations are taken from Chapter 6 (Guidance Concentrations Index) of the FDEP Groundwater Guidance Concentrations issued in June 1994 (FDEP, 1994a). Appendix L provides a comparison of each medium with available criteria.

[3] Current land uses evaluated in this report include non-residential exposures with no current use of groundwater.

[4] Potential future land uses evaluated in this report include residential exposures with the use of groundwater as drinking water.

[5] In subsurface soil, the maximum concentrations of acetone, methylene chloride, and trichloroethene exceed their available Florida guidance concentrations for leaching to groundwater (Appendix O, Table O-4).

[6] In the surficial aquifer, the maximum detected concentrations of 1,1,1-trichloroethane, 1,1-dichloroethene, 1,2-dichloroethene, trichloroethene, bis(2-ethylhexyl)phthalate, aluminum, antimony, arsenic, iron, manganese, and thallium exceeded the respective Florida guidance concentrations (Appendix O, O-1)).

[7] In the intermediate aquifer, the maximum concentrations of bis(2-ethylhexyl)phthalate, antimony, iron, and manganese exceeded their respective Florida guidance concentrations (Appendix O, O-2)).

Notes: NA = not applicable.
USEPA = U.S. Environmental Protection Agency.

unacceptable risk of adverse health effects (cancer or noncancer) (Figures 6-1 through 6-4). Concern over the contamination in the surficial aquifer may be warranted (Figures 6-3 and 6-4), however, because of the risk of adverse health effects (cancer and noncancer) associated with assumed future use of the groundwater as a potable water supply. It should be noted, however, that continued industrial use of OU 7 is planned. Use of the surficial aquifer as a drinking water supply at OU 7 may never occur because the area is served by a community water supply system.

Based on the results of the human health portion of the BRA, including the results of the criteria comparison (Subsection 6.3.5), the development of remedial action strategies may be necessary for the surficial aquifer at OU 7.

6.4 ECOLOGICAL RISK EVALUATION. The purpose of the ecological risk assessment for OU 7 was to assess potential adverse effects to ecological receptors resulting from contamination in surface water, sediment, and groundwater. Surface soil contamination was not evaluated as part of the ERA. It is unlikely that terrestrial receptors would be exposed to surface soil contamination because the majority of OU 7 is located in an industrial area surrounded by paved roads and mowed grass. Separate evaluations including four components were completed for OU 7. The components include: (1) problem formulation, (2) selection of ecological chemicals of potential concern, (3) ecological effects assessment, and (4) risk characterization.

6.4.1 Problem Formulation The problem formulation component identifies ecological receptors and exposure pathways for the receptors. Exposure pathways are discussed for two groups of ecological receptors including terrestrial wildlife and aquatic receptors. The exposure pathway includes a source of contamination, contaminated media (surface water, sediment, groundwater, and food), and an exposure route.

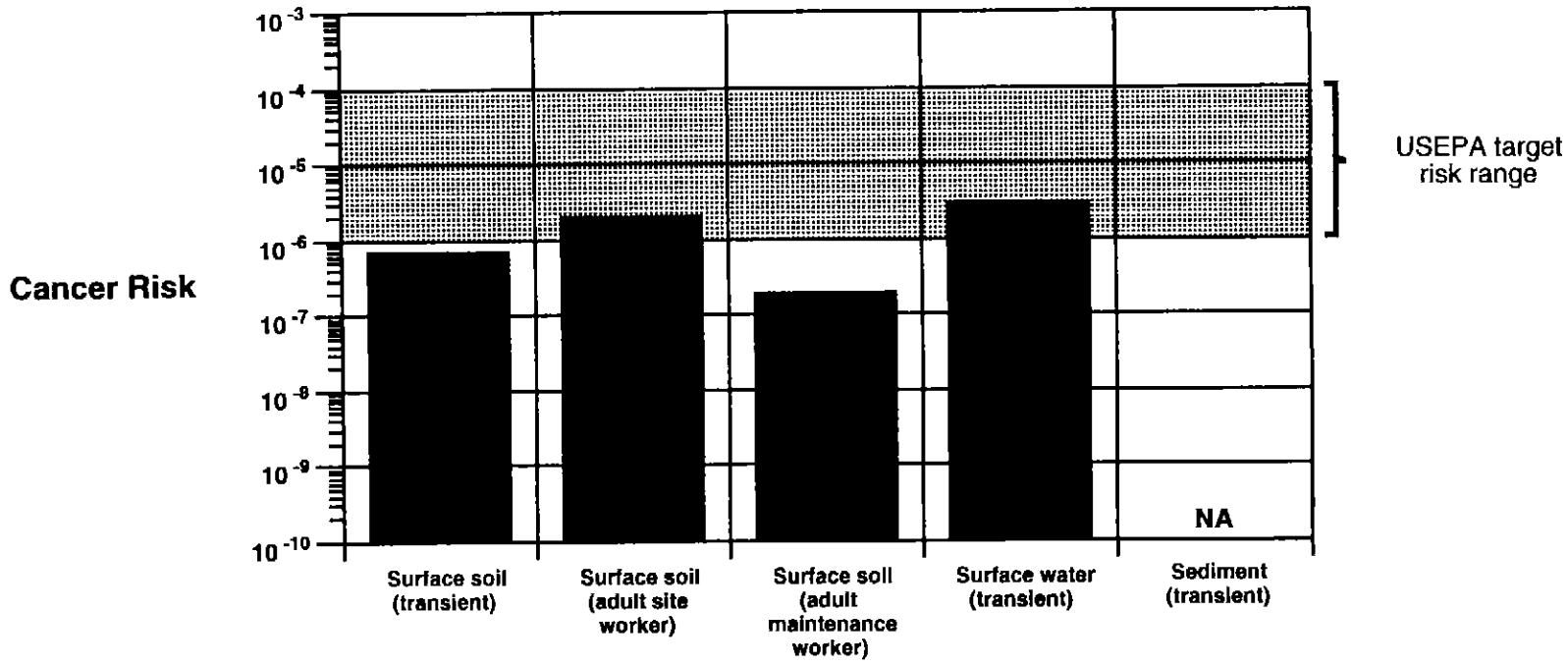
The ecological assessment is based on those pathways for which contaminant exposures are believed to be the highest and most likely to occur. The assessment is also focused on those pathways for which there are adequate data (pertaining to the receptors, contaminant exposures, and toxicity) to complete the risk analyses.

The exposure pathways evaluated for terrestrial wildlife include ingestion of surface water, indirect ingestion of sediment, and ingestion of aquatic prey that have accumulated contaminants from surface water and/or sediment.

Exposure pathways evaluated for aquatic receptors (including invertebrates, plants, amphibians, algae, and fish) include direct contact with surface water, sediment, and groundwater (as it discharges to surface water).

6.4.2 Selection of Ecological Chemicals of Potential Concern (ECPCs) ECPCs represent the analytes detected in media (surface water, sediment, and groundwater) that were considered in the risk assessment process. The ECPCs are assumed to be associated with hazardous waste practices at OU 7 that could present a potential risk for ecological receptors. ECPCs were selected separately for OU 7 for surface water, sediment, and groundwater. For surface water and sediment, ECPCs were selected separately for terrestrial wildlife and aquatic

Cancer Risk Summary, Current Land Use



NA = No carcinogens were selected as Human Health Chemicals of Potential Concern in sediment.

FIGURE 6-1

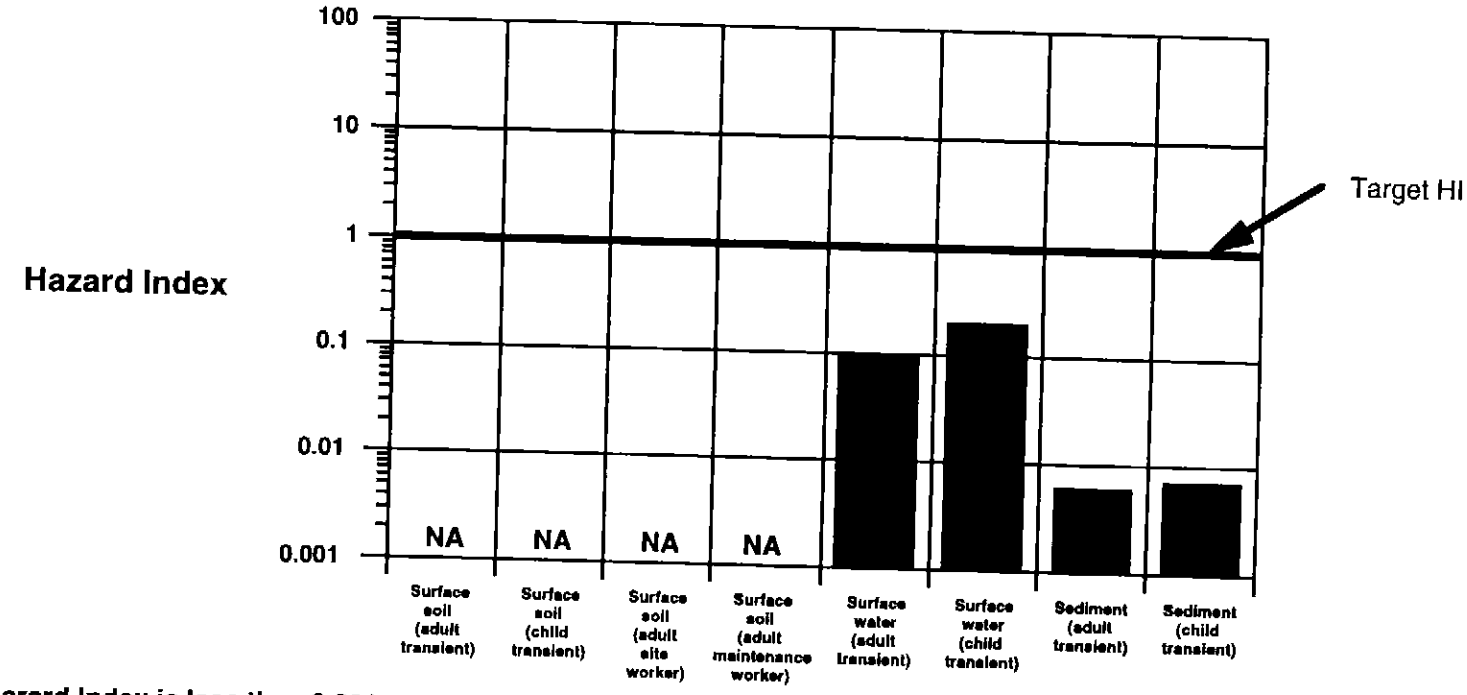
CANCER RISK SUMMARY, CURRENT LAND USE

REMEDIAL INVESTIGATION, OPERABLE UNIT 7

NAS CECIL FIELD
JACKSONVILLE, FLORIDA

8500-13 950317WEM

Hazard Index Summary, Current Land Use



NA = Harard Index is less than 0.001.

FIGURE 6-2

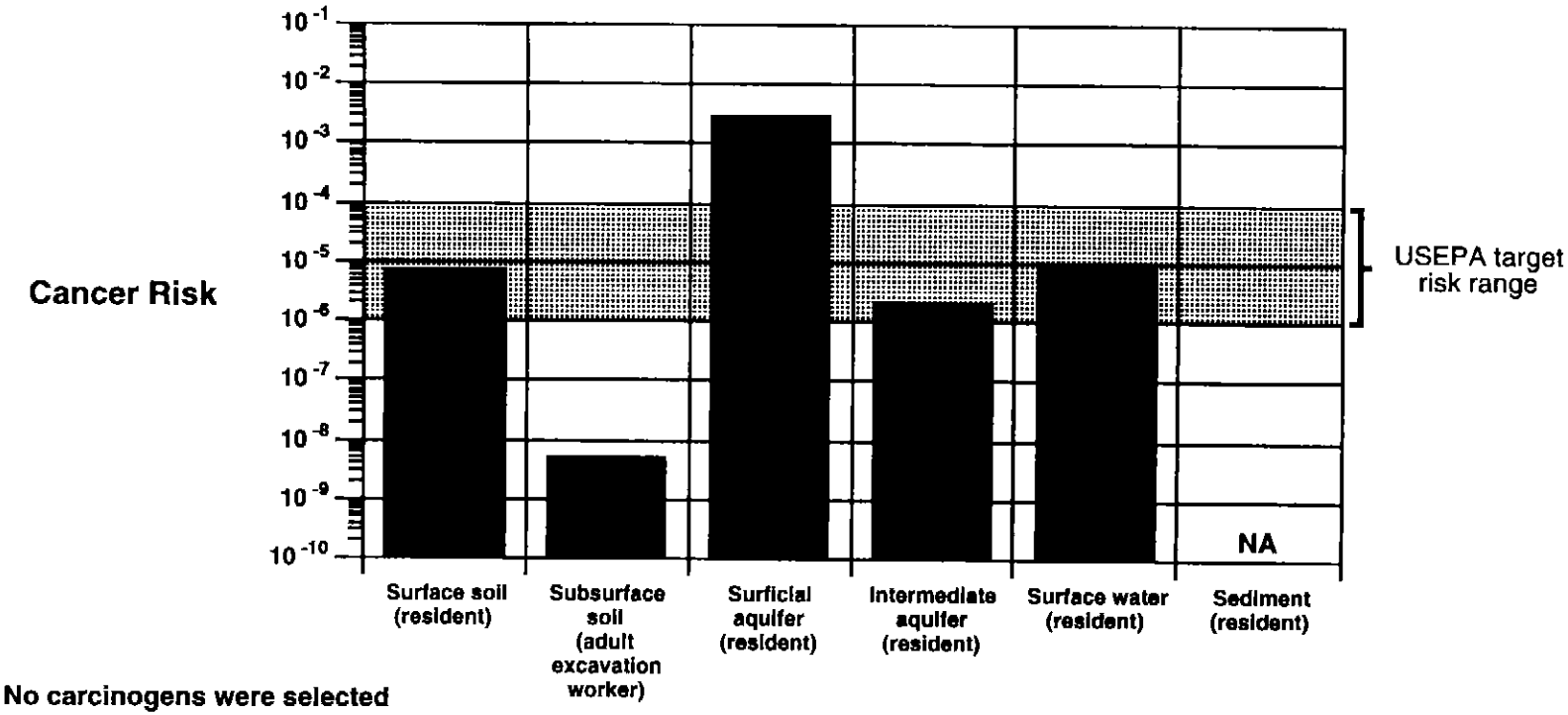
HAZARD INDEX SUMMARY, CURRENT LAND USE

REMEDIAL INVESTIGATION, OPERABLE UNIT 7

NAS CECIL FIELD
JACKSONVILLE, FLORIDA

8500-13 950317WEM

Cancer Risk Summary, Future Land Use



NA = No carcinogens were selected as Human Health Chemical of Potential Concern in sediment.

FIGURE 6-3

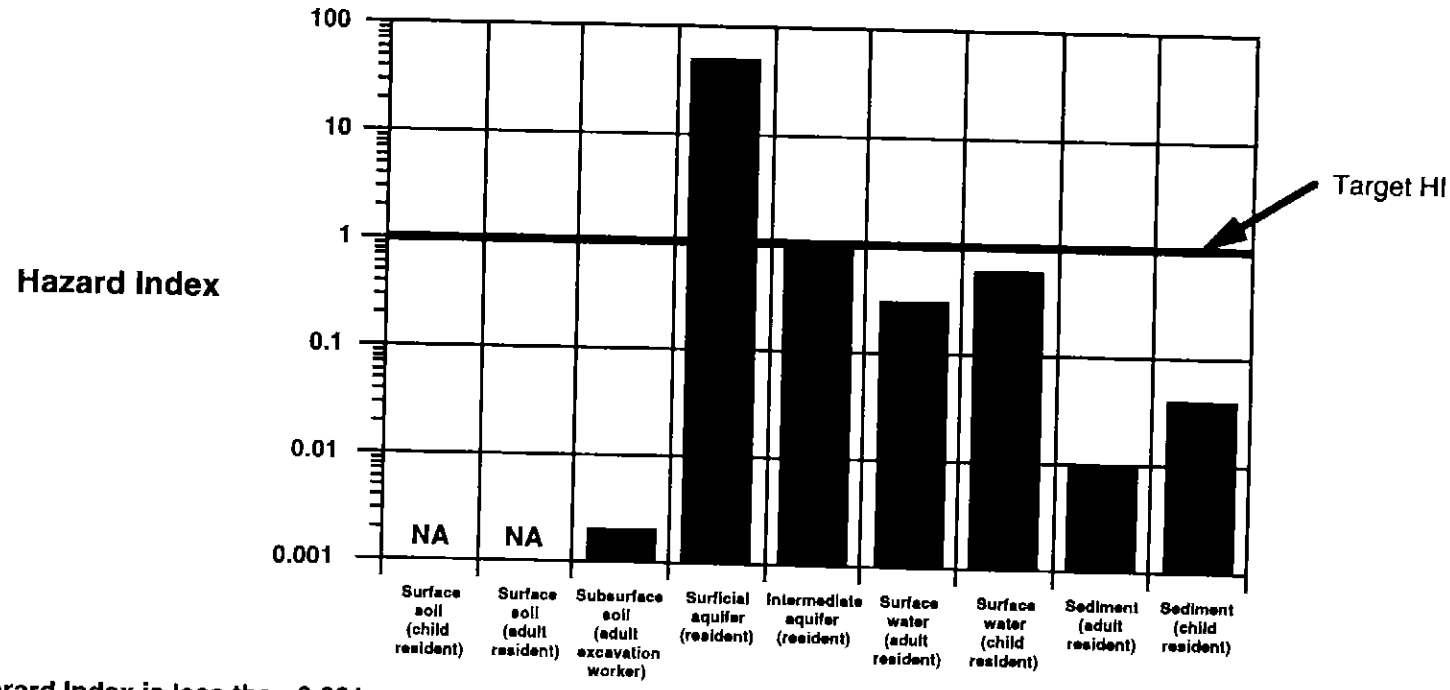
CANCER RISK SUMMARY, FUTURE LAND USE

REMEDIAL INVESTIGATION, OPERABLE UNIT 7

NAS CECIL FIELD
JACKSONVILLE, FLORIDA

8500-13 950317WEM

Hazard Index Summary, Future Land Use



NA = Harard Index is less than 0.001.

FIGURE 6-4

HAZARD INDEX SUMMARY, FUTURE LAND USE

REMEDIAL INVESTIGATION, OPERABLE UNIT 7

NAS CECIL FIELD
JACKSONVILLE, FLORIDA

8500-13 950317WEM

receptors. Table 6-3 provides a summary of the ECPCs selected for OU 7 for each medium.

6.4.3 **Ecological Effects Assessment** The ecological effects assessment describes the potential adverse effects associated with the ECPCs to ecological receptors. The methods for identifying and characterizing ecological effects for ECPCs in surface water, sediment, and groundwater are described in the following subsections.

6.4.3.1 **Surface Water and Sediment** The measures of adverse ecological effects for terrestrial wildlife and aquatic receptors are discussed in the ERA (ABB-ES, 1995a). Potential adverse ecological effects for aquatic life are directly measured for the entire mixture of ECPCs.

Sediment toxicity was evaluated with a short-term chronic test using the water flea, *Ceriodaphnia dubia*, and an acute test using the amphipod, *Hyallela azteca* (Springborn Laboratories, 1993). Analyses of the benthic macroinvertebrate community in the drainage ditches were also completed.

6.4.3.2 **Groundwater** Potential adverse effects associated with groundwater ECPCs are available in the form of laboratory aquatic toxicity testing results for individual ECPCs. Aquatic toxicity information for the ECPCs was obtained from searches of the USEPA Aquatic Information Retrieval (AQUIRE) database. Additional toxicity benchmarks used to assess the potential for adverse effects from groundwater ECPCs include the State of Florida Surface Water Quality Standards (Florida Legislature, 1995) and USEPA, Ambient Water Quality Criteria (AWQC) (USEPA, 1991g). These benchmarks are also used to describe potential adverse ecological effects for the ECPCs in surface water.

6.4.4 **Risk Characterization** The following sections describe how risks were characterized for ecological receptors. Potential adverse effects were characterized for terrestrial wildlife resulting from exposure to ECPCs in surface water and sediment. Risks were also characterized for aquatic receptors for exposures resulting from ECPCs in surface water, sediment, and groundwater.

Terrestrial Wildlife Exposure to Surface Water and Sediment. Risks for the representative wildlife species associated with the ingestion of surface water, potentially contaminated aquatic life, and sediment were quantitatively evaluated using HQs, which were calculated for each ECPC by dividing the estimated potential dietary exposure (PDE) concentration by the toxicological benchmark (reference toxicity value [RTV]). HIs were determined for each representative wildlife species by summing the HQs for all ECPCs. When the estimated exposure concentration was less than the RTV (i.e., the HQ was less than 1), the contaminant exposures were assumed to fall below the range considered to be associated with adverse effects for growth, reproduction, and survival (of the individual organism) and no risks to the wildlife populations were assumed. When the ratio was greater than 1 (i.e., HQ greater than 1), a discussion of the ecological significance was included and risk was assumed.

Aquatic Receptor Exposure to Surface Water and Sediment. Risks for aquatic receptors were characterized for each sampling location within the drainage ditches based on a weight-of-evidence evaluation of the following factors:

- presence or absence of analytes in surface water and sediment samples,

Table 6-3
Summary of Ecological Chemicals of Potential Concern (ECPCs)

Remedial Investigation
Operable Unit 7, NAS Cecil Field
Jacksonville, Florida

Environmental Medium	Ecological Chemicals of Potential Concern [1]
Surface Water	**Inorganics:** Aquatic and wildlife receptors: cadmium (Cd), copper (Cu), iron (Fe), lead (Pb), and zinc (Zn). Wildlife only: beryllium (Be). **Organics:** Aquatic and wildlife receptors: 1,2-dichloroethene and trichloroethene. Wildlife only: toluene.
Sediment	**Inorganics:** Aquatic and wildlife receptors: aluminum (Al), barium (Ba), Cd, hexavalent chromium (Cr^{+6}), Fe, Pb, manganese (Mn), mercury (Hg), vanadium (V), and Zn. Wildlife only: Cr and Cu. **Organics:** Aquatic and wildlife receptors: 2-butanone, acetone, and toluene.
Groundwater	**Inorganic:** Aquatic receptors only: Al, arsenic (As), cobalt (Co), Fe, Mn, thallium (Tl), V, and Zn. **Organics:** Aquatic receptors only: 1,1,1-trichloroethane, 1,1-dichloroethene, 1,2-dichloroethene, 4-methyl-2-pentanone, trichloroethene, and bis(2-ethylhexyl)phthalate.

[1] ECPCs were selected for each medium in the Baseline Risk Assessment Report (ABB-ES, 1995a).

- concentrations of analytes measured in surface water and sediment samples,
- responses of *H. azteca* and *C. dubia* in the sediment toxicity tests,
- measurements of the aquatic macroinvertebrate community structure and function,
- concentrations of ECPCs in surface water relative to reported toxicity of the ECPC in laboratory tests (AQUIRE information) and State of Florida Surface Water Quality Standards (Florida Legislature, 1995),
- concentrations of ECPCs in sediment relative to National Oceanic and Atmospheric Administration (NOAA) Effects Range-Low (ER-L) and Effects Range-Medium (ER-M) sediment guidelines (Long and Morgan, 1990), and
- physical and chemical factors in the aquatic environment (other than chemical contamination).

Aquatic Receptor Exposure to Groundwater. Risks for aquatic life associated with exposures to ECPCs in groundwater as it discharges to the Sal Taylor Creek and the wetlands were evaluated. A simple modeling effort was completed to estimate a dilution factor in groundwater entering Sal Taylor Creek. Predicted concentrations of the ECPCs in Sal Taylor Creek and the adjacent wetlands (resulting from discharge of groundwater) were compared to State of Florida Surface Water Quality Standards (Florida Legislature, 1995) and AWQC (USEPA, 1991). Where exposure concentrations exceed the standards or standards are unavailable, risks were characterized based on comparisons of the exposure concentrations with dose-response information from AQUIRE.

6.4.4.1 Risk Characterization for Site 16

Terrestrial Wildlife Exposure to Surface Water and Sediment. All of the HIs and HQs were less than 1, indicating no potential adverse effects to reproduction, growth, or survival for the representative wildlife species from exposure to ECPCs currently detected in surface water and sediment of the drainage ditches.

Aquatic Receptor Exposure to Surface Water. The risk characterization for aquatic receptors for both surface water and sediment contamination currently detected in the drainage ditches is summarized in Table 6-4. Risks for aquatic receptors resulting from exposure to the ECPCs in surface water were characterized based on field measurements of the benthic macroinvertebrate community and comparison of the ECPC exposure concentrations in surface water samples with respective toxicity benchmarks or standards.

Maximum concentrations of cadmium, copper, iron, lead, and zinc exceed the aquatic toxicity benchmarks. The concentration of lead measured in water samples from the reference location upstream in Sal Taylor Creek also exceeds available benchmarks.

Concentrations of cadmium, copper, lead, and zinc are greater than the respective lowest reported adverse effect concentration at one of the three sampling stations (STC-SW-1) located north of the groundwater plume. This station receives direct discharge from the Site 16 holding tank and/or seepage pit as well as runoff and possible discharges from other industrial facilities. Detected concentrations

Table 6-4
Summary of Risk Characterization for Aquatic Receptors, Site 16

Remedial Investigation
Operable Unit 7, NAS Cecil Field
Jacksonville, Florida

Sampling Location	Biological Parameters		ECPCs		Interpretation of Weight-of-Evidence
	Sediment Laboratory Toxicity Testing	Benthic Community Composition	Surface Water[1]	Sediments[2]	
STC-SW/SD/BIO/TOX-1	100 percent amphipod mortality	Inconclusive, but reduced relative to Five Mile Creek	Cd, Cu, Pb, Fe, and Zn	TPH	Sediment toxicity to amphipods may be associated with exposure to TPH in sediment. An oily sheen and strong petroleum sediment odor were observed at this sampling station.
STC-SW/SD/BIO/TOX-3	50 percent waterflea mortality; 80 percent amphipod mortality; *C. dubia* reproduction depressed compared to reference.	Inconclusive	Fe	TPH	Sediment toxicity to amphipods may be associated with exposure to TPH in sediment.
STC-SW/SD/BIO-4	Not tested	Inconclusive	Fe		No significant risks estimated.
STC-SW/SD/BIO/TOX-R1	No toxicity	Inconclusive, but reduced relative to Five Mile Creek			--

[1] Ecological chemicals of potential concern (ECPCs) that exceeded 2 times the reference concentration and also exceeded benchmarks.

Note: ECPCs = ecological chemicals of potential concern.
Cd = cadmium.
Cu = copper.
Pb = lead.
Fe iron.
Zn = zinc.
TPH = total petroleum hydrocarbon.

of iron ranging from 1,020 μg/ℓ to 1,470 μg/ℓ exceed the Federal AWQC of 1,000 μg/ℓ at two of the three sampling stations (STC-SW-1 and STC-SW-4). Station STC-SW-4 is located downgradient of the confluence of the two drainage ditches monitored by sampling stations STC-SW-1 and STC-SW-3.

Although concentrations of cadmium, copper, lead, iron, and zinc exceed available toxicity benchmarks, it is suspected that the presence of these metals in the surface water of the drainage ditches is not site related. The ditches receive stormwater drainage from the runway area and much of the developed area west of the runways.

Aquatic Receptor Exposure to Sediment. Table 6-4 summarizes the risk characterization for aquatic receptors for sediment contamination in the drainage ditches. Adverse biological effects were measured at two of the locations in the drainage ditches (STC-SD/Tox/Bio-01 and STC-SD/Tox/Bio-03). Sampling station STC-SD/TOX/BIO-03 is adjacent to the storm sewer that crosses the Site 16 groundwater plume and receives runoff from the industrial area.

Based on the weight-of-evidence for each of the sampling locations (toxicity testing results, benthic community, and chemical analyses), the following statements concerning risks for aquatic life associated with sediment contamination can be made.

- Risks may be present for certain macroinvertebrate receptors at two of the three drainage ditch sampling stations (STC-SD-01 and STC-SD-03). For station STC-SD-01, risks are based on mortality of amphipods in sediment toxicity testing. At sampling station STC-SD-03, risks are based on toxicity of the sediment to both amphipods and toxicity of the sediment elutriate to the water flea.

- Based on the results of the toxicity testing, the risks for aquatic life may be associated with elevated concentrations of TPH in sediment.

- Analyses of the benthic community metrics relative to contaminant concentrations in surface water and sediment are inconclusive.

Aquatic Receptor Exposure to Groundwater. Maximum and average exposure concentrations for the ECPCs in Site 16 groundwater were predicted for each migration path and compared to available toxicity benchmarks in Table 6-5. Risks to aquatic receptors from exposures to groundwater in Sal Taylor Creek surface water are not expected, based on a dilution factor of 4,400. The exposure concentrations of all groundwater ECPCs in Sal Taylor Creek are less than the respective lowest aquatic toxicity benchmarks. No dilution was applied to concentrations of groundwater ECPCs discharging to the wetlands. Maximum concentrations of bis(2-ethylhexyl)phthalate, aluminum, iron, and zinc exceed surface water toxicity benchmarks.

The maximum concentration of bis(2-ethylhexyl)phthalate exceeds both the Florida Surface Water Quality Standard and the lowest reported adverse effect concentration; however, bis(2-ethylhexyl)phthalate does not appear to be associated with Site 16. Concentrations of bis(2-ethylhexyl)phthalate appear to originate in the intermediate aquifer and flow up into the surficial aquifer downgradient of the Site 16 source area.

Table 6-5
Comparison of Unfiltered Groundwater Concentrations with Toxicity Benchmarks

Remedial Investigation
Operable Unit 7, NAS Cecil Field
Jacksonville, Florida

Analyte	Maximum/Average Detected Concentration in Groundwater[1]	Maximum/Average Exposure Concentration in Sal Taylor Creek[2]	Florida Surface Water Quality Standard[3]	Federal AWQC[4]	AQUIRE and other sources[5] (Lowest reported adverse effect concentration)	Concentrations Detected in Surface Waters of Drainage Ditches[6]	Results of Comparison
Volatiles (µg/ℓ)							
1,1,1-Trichloroethane	3,000 / 3,000	3.33 / 3.33	173,000	NA	1,300	ND	Not exceeded
1,1-Dichloroethene	400 / 400	0.44 / 0.44	3.2	NA	11,600	ND	Not exceeded[7]
1,2-Dichloroethene (total)	12,500 / 6,360	13.8 / 7.06	NA	NA	135,000	4 to 9	Not exceeded
4-Methyl-2-pentanone	1.0 / 1.0	0.001 / 0.001	NA	NA	7,800	ND	Not exceeded
Trichloroethene	630 / 238	0.7 / 0.26	80.7	[8]21,900	7,760	8 to 20	Not exceeded[7]
Semivolatiles (µg/ℓ)							
bis(2-ethylhexyl)phthalate	20.5 / 5.7	0.02 / 0.006	3.0	[9]360	2.5	ND	Exceeded, wetlands
Inorganics (µg/ℓ)							
Aluminum	7,970 / 1,480	8.85 / 1.65	NA	87	742	292 to 490	Exceeded, wetlands
Barium	108 / 27.5	0.12 / 0.03	NA	NA	8,900	17.6 to 18.6	Not exceeded
Cobalt	5.9 / 4.6	0.006 / 0.005	NA	NA	11	ND	Not exceeded
Iron	9,150 / 1,830	10.17 / 2.03	1,000	1,000	460	847 to 1,470	Exceeded, wetlands
Manganese	56.8 / 27.4	0.06 / 0.03	NA	NA	NA	9.6	No TBV
Thallium	6 3 / 6.2	0.007 / 0.007	48	NA	NA	ND	Not exceeded
Vanadium	14.3 / 4.1	0.02 / 0.005	NA	NA	128	ND	Not exceeded

See notes at end of table.

Table 6-5 (Continued)
Comparison of Unfiltered Groundwater Concentrations with Toxicity Benchmarks

Remedial Investigation
Operable Unit 7, NAS Cecil Field
Jacksonville, Florida

Analyte	Maximum/Average Detected Concentration in Groundwater[1]	Maximum/Average Exposure Concentration in Sal Taylor Creek[2]	Florida Surface Water Quality Standard[3]	Federal AWQC[4]	AQUIRE and other sources[5] (Lowest reported adverse effect concentration)	Concentrations Detected in Surface Waters of Drainage Ditches[6]	Results of Comparison
Inorganics (μg/ℓ) (continued)							
Zinc	89.5 / 40.4	0.1 / 0.05	53.9	110	NS	25.4 to 68.4	Exceeded - wetlands

[1] The maximum and average detected groundwater concentrations are equal to the exposure concentration of groundwater in the wetlands.
[2] A dilution factor of 900 is applied to the maximum and average detected groundwater concentration to derive the exposure concentration of groundwater in Sal Taylor Creek.
[3] Florida Department of Environmental Protection Class III Fresh Water Quality Standard, Chapter 62-302, Surface Water Quality Standards (Florida Legislature, 1995).
[4] Federal Ambient Water Quality Criteria (USEPA, 1988 and 1991).
[5] From results of AQUIRE search and other sources for toxicity of Site 16 groundwater ECPCs to aquatic receptors.
[6] From Selection of Ecological Contaminants of Potential summary table for surface water.
[7] The maximum detected concentration does not exceed the lowest reported adverse effect concentration. The Florida Surface Water Quality Standards for 1,1-dichloroethene and trichloroethene were not used for comparative purposes.
[8] Value is the lowest observed effect level (LOEL).
[9] Value is proposed criteria for bis(2-ethylhexyl)phthalate (FDEP, 62-302, January, 1995 version).

Notes: AWQC = Ambient Water Quality Criteria.
AQUIRE = Aquatic Information Retrieval.
μg/ℓ = micrograms per liter.
NA = not available.
ND = not detected.
TBV = toxicity benchmark value.
NS = not searched.

The presence of iron and zinc in the surficial aquifer is also related to an upwelling of groundwater from the intermediate aquifer in the OU 7 study area. Iron and zinc concentrations in the surficial aquifer are not believed to represent contamination emanating from OU 7 (see Chapter 4.0).

Under current conditions, groundwater contamination from OU 7 is not discharging directly to the surface water of the drainage ditches. The transport of the leading edge of the plume to surface water of the ditches is expected to take approximately 105 years. Exposures to aluminum in surface water and subsequent risks for aquatic life are not currently occurring. However, some contaminated groundwater may infiltrate the storm sewers and discharge to the drainage ditches.

If the maximum or average detected concentration of aluminum in groundwater is transported to the surface water of the wetland, then the exposure concentrations would be toxic to aquatic life at pH ranging from 6.5 to 9.0. However, the toxicity of aluminum is pH dependant. Because the pH of the surface water in the wetlands is unknown, it is not possible to predict the toxicity associated with aluminum in groundwater as it discharges to the wetlands.

Aluminum in surface water, as measured by the total digestion analyses procedure, does not represent the fraction of the metal that is dissolved and biologically available and toxic to aquatic organisms. The dissolved concentration of aluminum in filtered surface water would be lower than that measured as the total.

In summary, groundwater discharges to the surface water of Sal Taylor Creek do not pose a risk to aquatic receptors. However, risks associated with potential future exposures to bis(2-ethylhexyl)phthalate, aluminum, iron, and zinc are possible for aquatic receptors in the wetlands under worst case conditions. Concentrations of bis(2-ethylhexyl)phthalate, iron, and zinc appear to originate in the intermediate aquifer, which has not received wastes from OU 7, and flow upward to the surficial aquifer; therefore, these detections are not believed to be associated with contamination from OU 7.

7.0 SUMMARY AND CONCLUSIONS

7.1 SUMMARY. OU 7, located at NAS Cecil Field in Jacksonville, Florida, consists of Site 16, the AIMD seepage pit, holding tank, and affected area and is located adjacent to the north-south jet runways. The AIMD seepage pit and holding tank are located 60 feet north of Building 313. Currently, the Jet Engine Maintenance Shop and NDI Laboratory are located in Building 313.

7.1.1 Nature and Extent of Contamination Evaluation of investigative results to delineate the nature and extent of contamination from the past discharge to the seepage pit area indicated the presence of contaminants in all media sampled. However, not all of these detections appear related to the source area.

Discharge of wastewater to the seepage pit apparently caused the water table to mound and spread contaminants radially (horizontally and vertically). When the discharge ceased, the mound subsided and left contaminants in what is now the vadose (unsaturated) zone above the water table.

Evaluation of 10 surface soil sample chemical analytical results indicated the presence of VOCs (TCE and its transformation product, 1,2-DCE), SVOCs (PAHs), pesticides and PCBs, and inorganics. The detections in surface soil are randomly distributed and are not believed to have been introduced by the subsurface discharge from the seepage pit. Contaminants that may be associated with the discharge, such as TCE, appear to have been introduced to the surface soil during the IRA excavation activities in areas where excavated contaminated soil was stockpiled.

Evaluation of 24 subsurface soil sample chemical analytical results also indicated the presence of VOCs, SVOCs, pesticides, PCBs, and inorganics. The VOCs, SVOCs, and inorganics appear to be related to the past discharge as they are detected at highest concentrations near the former seepage pit area, whereas the pesticides and PCBs had a sporadic distribution across the site. The VOCs include TCE and 1,2-DCE as well as methylene chloride, 2-butanone, and acetone (common laboratory artifacts). The SVOCs include 11 PAHs, 2 phthalates, and phenol. The inorganics most frequently exceeding background screening concentrations were aluminum, calcium, cobalt, and magnesium. Cadmium, cobalt, thallium, and zinc were detected in the subsurface soil samples at the site but not in the background data set.

Because the invert of the former seepage pit was below the water table, contaminants were discharged directly to the groundwater as well as laterally to the vadose soil as wastewater accumulated in the seepage pit. The resultant groundwater mounding caused radial dispersion of the contaminants both horizontally and vertically. Evaluation of groundwater analytical results from 43 temporary groundwater sampling probes (Aquaprobe™ borings) and 34 monitoring wells indicate that contaminants, primarily TCE, extend radially outward approximately 60 feet and downward approximately 65 feet from the source area into both the UZS and IZS.

The lateral extent of contaminants to the southeast in the UZS is actually farther than the 60 foot radial flow (over 150 feet) as a result of the southeast groundwater flow direction. The distribution of TCE appears to be influenced by groundwater flow. TCE was detected in IZS wells and undetected in UZS wells from

approximately 150 feet downgradient of the seepage pit (where groundwater flow in the surficial aquifer is slightly downward), and then becomes horizontal in the IZS (see Figure 4-9) to 500 feet downgradient of the source. The TCE reappears in the UZS approximately 500 feet downgradient of the source area, at the point where upward flow from the intermediate aquifer to the surficial aquifer begins, and upward components of groundwater flow in the surficial aquifer bring the plume from the IZS to the UZS. The TCE is detected to approximately 1,000 feet downgradient of the source in the UZS.

From approximately 500 feet to over 1,000 feet downgradient of the source, bis(2-ethylhexyl)phthalate is detected in the intermediate aquifer and the LZS and IZS of the surficial aquifer. Bis(2-ethylhexyl)phthalate, a common sampling and laboratory contaminant, is detected over 1,000 feet downgradient of the source area in a pattern that appears to be associated with the upward flow of water from the intermediate aquifer to the surficial aquifer. Groundwater elevations indicate the potential for this upward flow and several inorganics demonstrate this same distribution pattern, supporting the interpretation of flow from the intermediate aquifer to the surficial aquifer.

Several inorganics were detected in the UZS at the source area (including aluminum, cadmium, cobalt, lead, sodium, and vanadium), but with the exception of cobalt, they do not appear to migrate from the source area as TCE does.

Three surface water and sediment samples were collected from drainage ditches (east of the runways) downgradient of the outfalls of two storm sewer lines that may have received drainage from the seepage pit area. The storm sewer lines have many inlets throughout the industrial area and runways, which indicates that the samples may represent the collective effect of multiple contaminant sources. TCE and 1,2-DCE were detected in one of the drainage ditches. The storm sewer that discharges to this ditch runs along the west side of Building 313 and intersects the TCE plume southeast of the source area. The inverts of these storm sewers are below the water table and dry weather flow in the lines was observed. The detections of the TCE and 1,2-DCE in the drainage ditch are interpreted to be the result of some contaminated groundwater entering the storm sewer line through joints or cracks.

7.1.2 Fate and Transport of Contamination The fate and transport of contaminants at OU 7 focuses on TCE, which is the only risk-related contaminant that appears to originate at the source area and migrate from it.

TCE was apparently introduced to the soil and groundwater at the former seepage pit area by the wastewater discharge that occurred there from 1959 to 1980. Other contaminants may have also been introduced to these media via the same discharge, including SVOCs (such as PAHs) and inorganics (such as aluminum, cadmium, cobalt, iron, lead, and vanadium). With the exception of TCE and cobalt, none of these contaminants is observed to have migrated from the source area in the 35 years since discharge to the seepage pit began.

Some transformation products of TCE (e.g., 1,2-DCE and 1,1-DCE) were detected in the soil and groundwater near the seepage pit area, but none was detected in any of the monitoring wells farther downgradient of the source area and only low levels (2 to 7 $\mu g/\ell$) were detected in a few downgradient Aquaprobe™ locations. This anaerobic biodegradation of TCE near the source area (and not in other areas)

is most likely due to the existence of favorable environmental and microbial conditions (e.g., nutrients, organic carbon, and redox potential) in that area.

During the IRA, TCE contaminated soil with concentrations above 1 mg/kg, were removed from the vadose zone at the source area and replaced with clean fill. Based on the results of the confirmatory soil sampling and analyses, it is estimated that an average TCE concentration of 137 $\mu g/kg$ remains in the 0 to 6 foot bls vadose soils over an area of approximately 5,000 ft^2. It is further estimated (Summers model) that the TCE concentration of leachate generated from the soil by infiltration of precipitation would be approximately 217 $\mu g/\ell$. It would take approximately 30 years for the concentration of the leachate to be reduced so that its concentration after mixing with the top 10 feet of the surficial aquifer would not exceed the Federal and State drinking water criterion of 5 $\mu g/\ell$. These estimates assume that all TCE in the soil above and below the water table will migrate and is not present as an NAPL.

The highest groundwater concentrations of TCE were detected in an Aquaprobe™ sample at the source area. The highest of these detections was 1,500,000 $\mu g/\ell$ in the 28 to 32 feet bls interval. Based on the USEPA batch model, it is estimated to take approximately 20 years for the flow of groundwater to reduce the TCE concentration at this location to 5 $\mu g/\ell$. This estimate also assumes the TCE present in soil will respond as adsorbed and dissolved TCE.

The leading edge of the TCE plume has migrated approximately 1,000 feet downgradient of the source in the 35 years since the discharge to the seepage pit began, roughly 300 feet farther than would be expected based on the estimated groundwater seepage velocity of 21 feet per year. This observation is interpreted to be the result of longitudinal dispersion.

The projected path of the TCE plume is to the southeast, ultimately discharging into a drainage ditch and wetlands that are, in turn, drained by Sal Taylor Creek. Using a two dimensional contaminant transport model (which takes into account longitudinal and lateral dispersion) it is estimated that the plume will reach the drainage ditch in approximately 105 years (2099). Assuming a constant, continuing release of TCE at the seepage pit, the concentration of the TCE plume would reach a maximum discharge concentration of 730 $\mu g/\ell$ approximately 195 years from now (2189). However, based on the previous estimate that the TCE concentration beneath the source would be 5.0 $\mu g/\ell$ 20 years from now (55 years since the discharge to the seepage pit began and 39 years since the discharge ceased) the TCE concentration of the discharge from the plume to the wetlands (drainage ditch) should actually begin to decrease approximately 55 years after the leading edge arrives at the wetlands, or 160 years from now (2154).

Because no transformation products of TCE were observed in the monitoring wells downgradient of the source area, no degradation factor was included in the transport model, nor was any TCE loss by volatilization from the water table considered. As a result, the estimated future concentrations are considered very conservative (i.e., overestimated). In addition, as the plume discharges and mixes with surface water, some dilution is expected to occur. Upon discharging to and mixing with the water in the drainage ditch, TCE concentrations are interpreted to be diluted by a factor of approximately 17. Upon discharging to and mixing with the water in Sal Taylor Creek, the TCE plume is expected to be diluted by a factor of approximately 4,400. Water in the drainage ditch would

be expected to be diluted by a factor of approximately 270 upon discharging to and mixing with the water in Sal Taylor Creek.

All dissolved groundwater contaminants originating from the source area would be expected to follow the same hydrologic transport as estimated for TCE. Of the other risk-related groundwater contaminants, bis(2-ethylhexyl)phthalate, antimony, and zinc appear to originate in the intermediate aquifer and flow up into the surficial aquifer downgradient of the OU 7 source area. Aluminum and iron appear at concentrations above background screening criteria at the source area, but if transport is occurring, their migratory concentration distribution is being masked by widespread detections of these inorganics below the background screening concentrations. Thallium is detected at three scattered locations in the surficial aquifer, and there is no indication of its origin. Groundwater in both the surficial and intermediate aquifers is interpreted to flow toward discharge points in the wetlands and Sal Taylor Creek. Dilution on the order of that calculated for the TCE plume is assumed for these other risk-related groundwater contaminants upon their discharge to and mixing with surface water in the drainage ditch and/or Sal Taylor Creek.

The only other contaminants that appear to originate from OU 7 are the TCE and 1,2-DCE detected in the surface water of the drainage ditch (east of the runways) downgradient of the outfall of a storm sewer line that runs along the west side of Building 313 and intersects the TCE plume southeast of the source area. These detections are interpreted to be the result of TCE contaminated groundwater entering the storm sewer line through joints or cracks. The water in the ditch would be diluted by a factor of approximately 270 upon discharging to, and mixing with, water in Sal Taylor Creek. TCE was not detected in the sediments or surface water of the drainage ditch that may have occasionally received discharge from the seepage pit and holding tank for several years.

7.1.3 **Baseline Risk Assessment** A BRA was completed at OU 7 to characterize the risks associated with exposures to site-related contaminants at OU 7 for human health and ecological receptors (ABB-ES, 1995). In addition, a review of available guidance was presented.

7.1.3.1 **Human Health Risk Assessment** The purpose of the HHRA was to characterize the risks associated with possible exposures to site-related contaminants for human health receptors. Potential health risks were evaluated under current and assumed future land use conditions for a subset of contaminants detected in surface soil, subsurface soil, surface water, sediment, and groundwater (surficial and intermediate aquifers).

Under current land use, all estimated cancer and noncancer risks are considered acceptable according to regulations established in the NCP. These regulations establish acceptable as the excess lifetime cancer risk, due to exposure to the HHCPCs at a site by each complete exposure pathway, of 1 in a million to 1 in 10,000 (USEPA, 1990) or a non-cancer hazard index of 1.

The assumed future land use is residential, including use of groundwater at OU 7 as a potable water supply (ingestion of groundwater and inhalation of volatile organic compounds while showering by an adult resident). Cancer and noncancer risks under these assumed conditions in surface soil, subsurface soil, surface water, sediment, and the intermediate aquifer are consistent with USEPA acceptable risks. Only risks for the surficial aquifer exceed the USEPA acceptable risks.

The cancer risk estimate for the surficial aquifer under the assumed use of groundwater as a potable water supply is 3 in 1,000. The major contaminant contributing to the cancer risk is 1,1-dichloroethene. The noncancer risk estimate (HI) for the surficial aquifer (adult resident) is 50. Major contributors to this HI are 1,2-dichloroethene, 1,1-dichloroethene, trichloroethene, antimony, and thallium. Because current plans are to continue to use the area of OU 7 for industrial purpose when NAS Cecil Field closes, and OU 7 is served with a potable water supply, the estimated future risks may never occur.

7.1.3.2 **Ecological Assessment** The purpose of the ecological risk assessment (ERA) was to characterize the risks associated with potential exposures to site-related contaminants at OU 7 for ecological receptors. Potential risks for ecological receptors were evaluated for selected contaminants detected in surface water, sediment, and groundwater at OU 7.

Sediment toxicity testing results indicate that risks may be present for certain types of macroinvertebrate receptors at two of the three sampling stations in the drainage ditches. Comparison of the adverse responses with the measurements of selected contaminants in surface water or sediment revealed that risks to aquatic receptors may be associated with elevated concentrations of TPH in sediment. TPH was not identified as a contaminant associated with OU 7 but would be expected to enter the storm sewers as a result of fuel spills or runoff from runways and parking lots.

Risks were not identified for terrestrial wildlife resulting from exposures to selected contaminants in surface water and sediment at the drainage ditches.

Potential risks for aquatic receptors were evaluated for exposures to selected contaminants in groundwater. The maximum concentrations of selected contaminants in unfiltered groundwater were estimated as they are discharged to both the wetlands and Sal Taylor Creek. The risk characterization did not identify risks for aquatic receptors in Sal Taylor Creek associated with selected contaminants in groundwater. However, risks associated with exposures to bis(2-ethylhexyl)phthalate, aluminum, iron, and zinc are possible for aquatic receptors in the wetlands.

7.1.3.3 **Comparison to Available Criteria** Available criteria for groundwater (USEPA, 1994d; FDEP, 1994a), surface soil (FDEP, 1994b), and subsurface soil (FDEP, 1994b) were considered in the BRA. The maximum detected concentration for each chemical detected in the surficial aquifer (Table P-1), intermediate aquifer (Table P-2), surface soil (Table P-3), and subsurface soil (Table P-4) was compared to available criteria.

<u>Groundwater</u>. In the surficial aquifer, the maximum detected concentrations of 1,1,1-trichloroethane, 1,1-dichloroethene, 1,2-dichloroethene, trichloroethene, bis(2-ethylhexyl)phthalate, aluminum, antimony, arsenic, iron, manganese, and thallium exceeded drinking water criteria (Appendix P, Table P-1)).

In the intermediate aquifer, the maximum concentrations of bis(2-ethylhexyl)phthalate (a common laboratory contaminant), antimony, iron, and manganese also exceeded respective drinking water criteria (Appendix P, Table P-2)).

Soil. The concentrations of contaminants detected in surface soil did not exceed any of the available FDEP guidance concentrations for direct contact and inhalation exposures (Appendix P, Table P-3).

In subsurface soil, the maximum concentrations of acetone, methylene chloride, and trichloroethene exceed available FDEP guidance concentrations for leaching to groundwater (Appendix P, Table P-4). This comparison was conducted because subsurface soil may be contributing to contamination in the surficial aquifer. It is noted that acetone and methylene chloride are both common laboratory contaminants.

TPH. TPH data were collected in surface and subsurface soil at OU 7 as well as in sediment at the drainage ditches east of the runways. The TPH value for each sample location was compared to the available Florida guidance value of 50 mg/kg developed for treated petroleum-contaminated soil (Florida Legislation, 1992) in Table P-5 of Appendix P.

Surface and subsurface soil near the holding tank and seepage pit and sediment in the drainage ditches east of the runways exceed the 50 mg/kg guidance value at one or more sample locations. However, the source of the TPH in surface soil may not be the result of wastes placed in the holding tank or seepage pit. The source may be the result of fuel or lubricants from vehicular activity in the vicinity of OU 7. TPH in sediment east of the runways may result from sources other than OU 7 such as runway, parking lot, and industrial operations that discharge surface runoff to the storm drains that discharge to the drainage ditches.

7.2 CONCLUSIONS.

Several conclusions can be made regarding the physical characteristics of the OU 7 study area and the contaminants detected in surface water, sediment, surface soil, subsurface soil, and groundwater.

- Sufficient information was collected in the field or compiled from historical records to identify and assess human and ecological risks, extent and nature of contamination, and remedial alternatives.

- Contaminant distribution from the seepage pit is well defined in surface and subsurface soil at OU 7 and does not pose a risk to current human or ecological receptors.

- Waste disposed in the former seepage pit has contaminated underlying groundwater at OU 7 sufficiently to pose a health risk if groundwater is used as a future drinking water supply. Use of unfiltered groundwater as a water supply exceeds the carcinogenic risk range (1 in 10,000 to 1 in 1 million) and non-carcinogenic threshold (HI of 1) based on the presence of TCE, DCE, bis(2-ethylhexyl)phthalate, antimony, and thallium. 1,1-Dichloroethene contributes the majority of the estimated cancer risks.

- There are no unacceptable human health risks associated with drainage ditch surface water and sediment.

- OU 7 is located in a highly industrialized area and is expected to remain industrialized after base closure. The site is served by potable water and utilities.

- Assuming the maximum concentrations detected in groundwater are unaffected by dispersion and other processes, as groundwater migrates to and discharges to the wetlands east of the runways, risks are possible for aquatic receptors. No such risks are estimated for discharge to Sal Taylor Creek.

- Based on bioassay and chemical analytical results, risks to certain types of macroinvertebrates in the drainage ditches east of the runways are interpreted to be related to TPH in the sediment.

- Based on assumptions that did not consider contaminant degradation or losses along the flowpath from the former seepage pit area to the wetlands and did consider continued leaching at the former seepage pit area, contaminated groundwater is estimated to begin discharging in about 105 years and may reach a maximum TCE concentration of 730 $\mu g/\ell$ in approximately 195 years.

- Contaminants detected in the shallow soil (0 to 2 feet bls) are interpreted to be related to surface activity (i.e., soil excavation and drilling operations) rather than the former underground waste disposal operations.

- Several risk-related groundwater contaminants are not believed to be associated with the source area at OU 7 because they appear to enter the OU 7 area from the underlying intermediate aquifer or in a deeper part of the surficial aquifer. These contaminants include: bis(2-ethylhexyl)-phthalate, antimony, and zinc.

7.2.1 Data Limitations and Recommendations for Future Work The purpose of the data limitations section is to outline the limits within which the conclusions of the RI are made and to identify areas for which use of the data, findings, and conclusions developed during the RI may be inappropriate. This information will assist in the evaluation of RI data during the FS and will assist the Navy and regulatory agencies during the selection of the final remedy for OU 7.

7.2.1.1 Data limitations Based on the evaluation of data gathered during the OU 7 RI, the following data limitations were identified.

- Contaminants in surface water and sediments in the drainage ditches east of the north-south runways may not all be attributable to OU 7 operations and existing soil and groundwater contamination in the source area. Based on the nature of the contaminants (i.e., petroleum related and inorganics) several other industrial activities (i.e., former and current runway and hangar operations) appear to be the major contaminant contributors (e.g. TPH) to ecological risks identified in surface water and sediment.

7.2.2 Data Gaps Based on the evaluation of data gathered during the OU 7 RI, the following data gaps were identified.

- The volume of contaminated groundwater entering the storm sewer has not been quantified.

- The distribution of TCE in vadose and phreatic soil on the west side of Building 313 (in the area of Aquaprobe™ groundwater screening locations GS-16-1 and GS-16-43) is not known.

- None of these data gaps prevented the development and selection of a remedial action for OU 7.

7.2.3 **Recommendations** Based on the evaluation of data gathered during the OU 7 RI, the following recommendations are presented.

- A control program should be instituted for contaminants in groundwater at OU 7 to prevent risks associated with possible future use of groundwater as a potable water supply.

- An investigation of the contaminants present in surface water and sediment in the storm sewer network should be conducted to identify sources of contamination in the drainage ditches that discharge to Sal Taylor Creek.

- An assessment of contamination in soil and groundwater west of Building 313 should be included as part of any subsequent remedial activity.

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DISTANCE ACROSS(M)

DISTANCE DOWN(M)	.0	10.0	20.0	30.0	40.0	50.0	75.0	100.0	125.0	150.0	200.0
.0	******	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000
40.0	.00399	.00062	.00003	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000
100.0	.00236	.00115	.00019	.00001	.00000	.00000	.00000	.00000	.00000	.00000	.00000
150.0	.00189	.00120	.00034	.00004	.00001	.00000	.00000	.00000	.00000	.00000	.00000
300.0	.00131	.00107	.00058	.00017	.00006	.00001	.00000	.00000	.00000	.00000	.00000
400.0	.00113	.00098	.00063	.00024	.00011	.00003	.00000	.00000	.00000	.00000	.00000
500.0	.00101	.00090	.00064	.00028	.00017	.00005	.00000	.00000	.00000	.00000	.00000
700.0	.00085	.00079	.00063	.00033	.00025	.00010	.00001	.00000	.00000	.00000	.00000
900.0	.00074	.00070	.00059	.00035	.00030	.00014	.00002	.00000	.00000	.00000	.00000
1100.0	.00055	.00053	.00046	.00029	.00027	.00014	.00003	.00000	.00000	.00000	.00000
1300.0	.00017	.00016	.00014	.00009	.00009	.00005	.00001	.00000	.00000	.00000	.00000

Y

X

TIME = 60225.000 DAYS

165 (130) 2124

Table O-1
Comparison with Criteria
Surficial Aquifer

Remedial Investigation
NAS Cecil Field
Jacksonville, Florida

Analyte	Frequency of Detection [1]	Range of Detected Concentrations	Mean of Detected Concentrations [2]	Analyte HHCPC? [3] (Yes/No)	Federal Primary MCL [4]	Florida Primary Standard [5]	Florida Guidance Concentration [6]	Exceedance? [7] (Yes/No)
Volatiles (µg/l)								
1,1,1-Trichloroethane	1/21	[8] 3,000 - [8] 3,000	3,000	Yes	200	200	200	Yes [13,14,15]
1,1-Dichloroethane	1/21	1 - 1	1	No	NA	NA	700	No
1,1-Dichloroethene	1/21	[8] 400 - [8] 400	400	Yes	7	7	7	Yes [13,14,15]
1,2-Dichloroethene (total)	2/21	270 - [8] 12,450	6,360	Yes	[9] 70	[9] 70	[9] 70	Yes [13,14,15]
4-Methyl-2-pentanone	1/16	1 - 1	1	No	NA	NA	350	No
Trichloroethene	7/21	12 - [8] 630	238	Yes	5	3	3	Yes [13,14,15]
Semivolatiles (µg/l)								
2-Methylnaphthalene	1/21	[8] 2.75 - [8] 2.75	2.8	No	NA	NA	NA	NA
Diethylphthalate	2/21	1 - 1	1	No	NA	NA	5,600	No
Naphthalene	1/21	[8] 3.5 - [8] 3.5	3.5	No	NA	NA	6.8	No
Phenanthrene	1/21	3 - 3	3	No	NA	NA	10	No
Phenol	3/21	0.8 - [8] 1.45	1.1	No	NA	NA	10	No
bis(2-Ethylhexyl) phthalate	17/21	0.5 - [8] 20.5	5.7	Yes	6	6	6	Yes [13,14,15]
Pesticides/PCBs (µg/l)								
Endrin	1/20	0.02 - 0.02	0.02	No	2	2	2	No
Inorganics (µg/l)								
Aluminum	12/21	[8] 175.5 - [8] 7,965	1,483	No	[10] 200	[11] 200	200	Yes [13,14,15]
Antimony	3/21	2.2 - [8] 16.05	7.3	Yes	6	6	6	Yes [13,14,15]
Arsenic	10/21	3.6 - 56.2	13.2	Yes	50	50	50	Yes [13,14,15]
Barium	21/21	6.5 - 108	27.5	No	2,000	2,000	2,000	No
Cadmium	1/21	[8] 3.3 - [8] 3.3	3.3	No	5	5	5	No
Calcium	21/21	603 - [8] 58,450	19,819	No	NA	NA	NA	NA
Chromium	4/21	2 2 - 7.9	4.8	No	100	100	100	No
Cobalt	3/21	[8] 2.3 - 5.9	4.6	Yes	NA	NA	NA	NA

See notes at end of table.

Table O-1 (Continued)
Comparison with Criteria
Surficial Aquifer

Remedial Investigation
NAS Cecil Field
Jacksonville, Florida

Analyte	Frequency of Detection [1]	Range of Detected Concentrations	Mean of Detected Concentrations [2]	Analyte HHCPC? [3] (Yes/No)	Federal Primary MCL [4]	Florida Primary Standard [5]	Florida Guidance Concentration [6]	Exceedance? [7] (Yes/No)
Copper	5/21	[8] 2.1 - 3.8	3	No	[10] 1,000	[11] 1,000	1,000	No
Iron	20/20	[8] 260 - 9,150	1,828	Yes	[10] 300	[11] 300	300	Yes [13,14,15]
Lead	1/21	[8] 2.55 - [8] 2.55	2.6	No	[12] 15	15	15	No
Magnesium	21/21	254 - 28,000	8,188	Yes	NA	NA	NA	NA
Manganese	18/20	[8] 4.9 - 56.8	27.4	Yes	[10] 50	[11] 50	50	Yes [13,14,15]
Mercury	1/21	1 - 1	1	No	2	2	2	No
Nickel	2/21	[8] 11 - 12.5	11.8	No	100	100	100	No
Potassium	21/21	125 - [9] 4,470	806	No	NA	NA	NA	NA
Sodium	21/21	[9] 2,665 - [9] 31,700	7,506	No	NA	NA	NA	NA
Thallium	3/21	6 - 6.3	6.2	Yes	2	2	2	Yes [13,14,15]
Vanadium	13/21	1.1 - 14.3	4.1	No	NA	NA	49	No
Zinc	8/21	[8] 15.95 - 89.5	40.4	No	[10] 5,000	[11] 5,000	5,000	No

See notes at end of table.

Table O-1 (Continued)
Comparison with Criteria
Surficial Aquifer

Remedial Investigation
NAS Cecil Field
Jacksonville, Florida

Notes from previous pages.

[1] Frequency of detection is the number of samples in which the analyte was detected divided by the total number of samples analyzed.
[2] The average of detected concentrations is the arithmetic mean of all samples in which the analyte was detected. It does not include those samples in which the analyte was not detected.
[3] HHCPCs were selected for groundwater associated with Site 16 Surficial Aquifer as described in the baseline risk assessment (ABB-ES, 1995a).
[4] Federal Primary MCLs are taken from USEPA Drinking Water Regulations and Health Advisories (May 1994).
[5] Florida Primary Standards are taken from Chapter 1 (Primary Standards) of the FDEP Groundwater Guidance Concentrations (June 1994).
[6] Florida Guidance Concentrations are taken from Chapter 6 (Guidance Concentrations Index) of the FDEP Groundwater Guidance Concentrations (June 1994).
[7] An exceedance of the available critieria is identified when the maximum detected site concentration is greater than one or more of the criteria.
[8] Value is the average of a sample and its duplicate(s).
[9] Primary MCL is for cis-1,2-Dichloroethylene.
[10] Value is a Federal Secondary MCL.
[11] Value is a Florida Secondary MCL.
[12] Treatment technology action limit for lead in drinking water distribution system identified in the USEPA Drinking Water Standards and Health Advisories (May, 1994).
[13] The maximum detected concentration of the contaminant exceeds the Federal Primary MCL.
[14] The maximum detected concentration of the contaminant exceeds the Florida Primary Standard.
[15] The maximum detected concentration of the contaminant exceeds the Florida Guidance Concentration.

Notes: HHCPC = human health chemical of potential concern.
μg/l = micrograms per liter
DDD = dichlorodiphenyldichloroethane.
DDT = dichlorodiphenyltrichloroethane.
MCL = Maximum Contaminant Level.
NA = not available.
DDE = dichlorodiphenyldichloroethylene.

Table O-2
Comparison with Criteria
Intermediate Aquifier

Remedial Investigation
NAS Cecil Field
Jacksonville, Florida

Analyte	Frequency of Detection [1]	Range of Detected Concentrations	Mean of Detected Concentrations [2]	Analyte HHCPC? [3] (Yes/No)	Federal Primary MCL [4]	Florida Primary MCL [5]	Florida Guidance Concentration [6]	Exceedance? [7] (Yes/No)
Semivolatiles (µg/l)								
Di-n-butylphthalate	1/4	1 - 1	1	No	NA	NA	700	No
bis(2-Ethylhexyl) phthalate	4/4	1 - 10	5.5	Yes	6	6	6	Yes [10,11,12]
Inorganics (µg/l)								
Antimony	2/4	3.1 - 10.3	6.7	Yes	6	6	6	Yes [10,11,12]
Barium	4/4	7 - 41.8	27.3	No	2,000	2,000	2,000	No
Calcium	4/4	9,160 - 63,400	49,290	No	NA	NA	NA	NA
Chromium	1/4	9.8 - 9.8	9.8	No	100	100	100	No
Copper	2/4	8 - 8 2	8.1	No	[8] 1,000	[9] 1,000	1,000	No
Iron	4/4	69.6 - 444	250	No	[8] 300	[9] 300	300	Yes [10,11,12]
Magnesium	4/4	16,000 - 28,700	24,525	No	NA	NA	NA	NA
Manganese	4/4	6.7 - 57.5	40.5	Yes	[8] 50	[9] 50	50	Yes [10,11,12]
Potassium	4/4	853 - 39,900	10,721	No	NA	NA	NA	NA
Sodium	4/4	8,050 - 30,600	14,798	No	NA	NA	NA	NA
Zinc	3/4	48.6 - 98 5	75.7	No	[8] 5,000	[9] 5,000	5,000	No

[1] Frequency of detection is the number of samples in which the analyte was detected divided by the total number of samples analyzed.
[2] The average of detected concentrations is the arithmetic mean of all samples in which the analyte was detected. It does not include those samples in which the analyte was not detected.
[3] HHCPCs were selected for groundwater associated with Site 16 Intermediate Aquifier in the baseline risk assessment (ABB-ES, 1995a).
[4] Federal Primary MCLs are taken from USEPA Drinking Water Regulations and Health Advisories (May 1994).
[5] Florida Primary Standards are taken from Chapter 1 (Primary Standards) of the FDEP Groundwater Guidance Concentrations (June 1994).
[6] Florida Guidance Concentrations are taken from Chapter 6 (Guidance Concentrations Index) of the FDEP Groundwater Guidance Concentrations (June 1994).
[7] An exceedance of the criteria is identified when the maximum detected site concentration is greater than one or more criteria.
[8] Value is a Federal Secondary MCL.
[9] Value is a Florida Secondary MCL.
[10] The maximum detected concentration of the contaminant exceeds the Federal Primary MCL.
[11] The maximum detected concentration of the contaminant exceeds the Florida Primary Standard.
[12] The maximum detected concentration of the contaminant exceeds the Florida Guidance Concentration.

Notes: HHCPC = human health chemical of potential concern.
µg/l = micrograms per liter.
MCL = Maximum Contaminant Level.
NA = not available.

Table O-3
Comparison with Criteria
Surface Soil

Remedial Investigation
NAS Cecil Field
Jacksonville, Florida

Analyte	Frequency of Detection [1]	Range of Detected Concentrations	Range of Reporting Limits	Mean of Detected Concentrations [2]	Analyte HHCPC? [3] (Yes/No)	Background Screening Concentration [4]	FDEP Clean-up Goals [5]	Exceedance? (Yes/No) [6]
Volatiles (µg/kg)								
1,2-Dichloroethene (total)	1/10	[7] 6.5	5 - 11	6 5	No	NA	NP	NA
Trichloroethene	6/10	3 - 150	5 - 12	43 2	No	NA	12,000	No
Semivolatiles (µg/kg)								
Acenaphthene	3/10	32 - 82	360 - 380	55	No	NA	4,000,000	No
Acenaphthylene	1/10	31	360 - 380	31	No	NA	ND	NA
Anthracene	3/10	46 - 170	360 - 380	102	No	NA	18,300,000	No
Benzo (a) anthracene	3/10	200 - 420	360 - 380	340	Yes	NA	1,480	No
Benzo (a) pyrene	5/10	[7] 29 - 310	360 - 380	178	Yes	NA	148	No
Benzo (b) fluoranthene	9/10	23 - 620	360 - 380	193	Yes	NA	1,480	No
Benzo (g,h,i) perylene	5/10	82 - 140	360 - 380	110	No	NA	ND	NA
Benzo (k) fluoranthene	5/10	[7] 20 - 180	360 - 380	103	Yes	NA	1,470	No
Butylbenzylphthalate	6/10	32 - 140	360 - 380	78.2	No	NA	15,300,000	No
Carbazole	3/10	65 - 140	360 - 380	94.7	No	NA	58,100	No
Chrysene	7/10	26 - 360	360 - 380	150	Yes	NA	14,800	No
Dibenz (a,h) anthracene	3/10	29 - 52	360 - 380	41.7	Yes	NA	148	No
Dibenzofuran	1/10	44	360 - 380	44	Yes	NA	290,000	No
Fluoranthene	7/10	41 - 870	360 - 380	351	No	NA	2,990,000	No
Fluorene	3/10	26 - 97	360 - 380	55.3	No	NA	2,760,000	No
Indeno (1,2,3-cd) pyrene	5/10	62 - 190	360 - 380	125	Yes	NA	1,480	No
Naphthalene	1/10	28	360 - 380	28	No	NA	2,290,000	No
Phenanthrene	6/10	[7] 39 - 740	360 - 380	288	No	NA	ND	NA
Pyrene	8/10	24 - 600	360 - 380	203	No	NA	2,224,000	No

See notes at end of table.

Table O-3 (Continued)
Comparison with Criteria
Surface Soil

Remedial Investigation
NAS Cecil Field
Jacksonville, Florida

Analyte	Frequency of Detection [1]	Range of Detected Concentrations	Range of Reporting Limits	Mean of Detected Concentrations [2]	Analyte HHCPC? [3] (Yes/No)	Background Screening Concentration [4]	FDEP Clean-up Goals [5]	Exceedance? (Yes/No) [6]
Pesticides/PCBs (µg/kg)								
4,4-DDD	1/10	[7] 5.85	3.6 - 4	5.9	No	NA	4,740	No
4,4-DDE	7/10	0.32 - 3.1	3.6 - 4	0.97	No	NA	3,340	No
Aroclor-1260	4/10	5 5 - 33	36 - 38	21.1	No	NA	NP	NA
Endosulfan sulfate	1/10	0.27	3.6 - 4	0.27	No	NA	NP	NA
alpha-Chlordane	4/10	0.6 - [7] 26	1.9 - 2	7.4	No	NA	869	No
gamma-Chlordane	1/10	[7] 30	1.9 - 2	30	No	NA	869	No
Inorganics (mg/kg)								
Aluminum	10/10	932 - [7] 5,950	40 - 40	2,774	No	29,000	ND	No [8]
Barium	10/10	1 7 - 8 7	40 - 40	5.8	No	21	NP	No [8]
Cadmium	5/10	[7] 0.35 - 0.94	1 - 1	0.69	No	-	37.5	No
Calcium	10/10	994 - 13,000	1,000 - 1,000	4,035	Yes	-	NP	NA
Chromium	10/10	1.8 - [7] 13	2 - 2	6.5	No	31.2	[9] 201	No [8]
Cobalt	4/10	0.49 - 0.71	10 - 10	0.61	Yes	-	ND	No
Copper	9/10	0.81 - 3.1	5 - 5	1.7	No	-	2,880	No
Iron	10/10	207 - 1,030	20 - 20	603	No	8,060	ND	No [8]
Lead	10/10	3.9 - 32.1	0.6 - 0.6	16.1	No	15.6	ND	No
Magnesium	10/10	66 - [7] 172 5	1,000 - 1,000	114	No	474	NP	No [8]
Manganese	10/10	2.9 - 14	3 - 3	7.7	No	18	5,710	No [8]
Nickel	9/10	0.81 - 2.6	8 - 8	1.6	No	8	1,510	No [8]
Potassium	9/10	21.7 - 93 7	1,000 - 1,000	45.3	No	310	NP	No [8]
Silver	1/10	0.4	2 - 2	0.4	No	-	NP	No
Sodium	10/10	143 - 192	1,000 - 1,000	164	Yes	-	NP	No
Inorganics (mg/kg)								
Vanadium	10/10	1.2 - 5	10 - 10	2.9	No	34.2	501	No [8]
Zinc	8/10	9.4 - 25.2	4 - 4	14.2	No	-	23,330	No

See notes at end of table.

Table O-3 (Continued)
Comparison with Criteria
Surface Soil

Remedial Investigation
NAS Cecil Field
Jacksonville, Florida

Notes from previous pages

[1] Frequency of detection is the number of samples in which the analyte was detected divided by the total number of samples analyzed (16SS01, 16SS02, 16SS03, 16SS04, 16SS05, 16SS06, 16SS07, 16SS08, 16SS09, and 16SS10, including a duplicate at 16SS08).
[2] The average of detected concentrations is the arithmetic mean of all samples in which the analyte was detected. It does not include those samples in which the analyte was not detected.
[3] HHCPCs were selected for surface soil as described in the baseline risk assessment (ABB-ES, 1995a).
[4] Twice the average of detected concentrations for inorganic analytes at BSS01, BSS02, BSS03, and BSS04, including a duplicate at BSS02 (Arents soil unit).
[5] Florida Department of Environmental Protection (FDEP) memorandum dated July 5, 1994. Values presented are the lesser of the Clean-up Goals based on the hazard index for the child resident or the cancer risk for the aggregate resident.
[6] An exceedance of the FDEP clean-up goal is identified when the maximum detected anlalyte concentration is greater than the Clean-up goal concentration. Pursuant to FDEP guidance (July, 1994), an analyte that has a maximum detected concentration that is less than the background concentration is not listed as exceeding the FDEP Clean-up goal.
[7] Value is the average of a sample and its duplicate.
[8] This analyte is not listed as exceeding the FDEP Clean-up Goal because the maximum detected concentration of the analyte is less than the background soil screening concentration
[9] Value is for chromium VI.

Notes: HHCPC = human health chemical of potential concern.
mg/kg = milligrams per kilogram.
ND = analayte is presented in FDEP guidance but no data is provided.
DDD = dichlorodiphenyldichloroethane
- = not detected in any background samples.
µg/kg = micrograms per kilogram.
NP = analyte is not presented in FDEP guidance.
DDE = dichlorodiphenyldichloroethylene.
NA = not applicable.

Table O-4
Comparison with Criteria
Subsurface Soil

Remedial Investigation
NAS Cecil Field
Jacksonville, Florida

Analyte	Frequency of Detection [1]	Range of Detected Concentrations	Range of Reporting Limits	Mean of Detected Concentrations [2]	Analyte HHCPC? [3] (Yes/No)	Background Screening Concentration [4]	FDEP Clean-up Goals Based on Leachability [5]	Exceedance? [6] (Yes/No)
Volatiles (µg/kg)								
1,2-Dichloroethene (total)	3/24	[7] 3 - [7] 350	5 - 28	145	No	NA	NP	NA
2-Butanone	1/24	6	11 - 54	6	No	NA	878	No
Acetone	4/24	46 - 220	11 - 150	169	No	NA	143	Yes
Methylene chloride	10/24	[7] 2.5 - 10	5 - 28	6	No	NA	1.13	Yes
Trichloroethene	9/24	3 - 650	5 - 54	146	No	NA	1.46	Yes
Semivolatiles (µg/kg)								
2-Methylnaphthalene	1/24	21	360 - 410	21	No	NA	ND	NA
Benzo (a) pyrene	2/24	20 - 21	360 - 410	20.5	No	NA	2,200	No
Benzo (b) fluoranthene	6/24	23 - 49	360 - 410	32.4	No	NA	4,400	No
Benzo (g,h,i) perylene	2/24	19 - 21	360 - 410	20	No	NA	32,000	No
Butylbenzylphthalate	4/24	21 - 750	360 - 410	244	No	NA	24,200	No
Chrysene	1/24	46	360 - 410	46	No	NA	2,000	No
Diethylphthalate	1/24	23	360 - 410	23	No	NA	NP	NA
Dimethylphthalate	1/24	29	360 - 410	29	No	NA	NP	NA
Fluoranthene	2/24	[7] 23.5 - 28	360 - 410	25.8	No	NA	21,300	No
Indeno (1,2,3-cd) pyrene	1/24	20	360 - 410	20	No	NA	24,000	No
Phenol	2/24	20 - 33	360 - 410	26.5	No	NA	NP	NA
Pyrene	2/24	21 - [7] 23	360 - 410	22	No	NA	16,000	No
bis(2-Ethylhexyl) phthalate	8/24	23 - 600	360 - 410	108	No	NA	NP	NA
Pesticides/PCBs (µg/kg)								
4,4-DDD	2/24	0.99 - 3.1	0.6 - 4.1	2	No	NA	154	No
4,4-DDE	8/24	0.27 - [7] 4.2	3.6 - 4.1	1.2	No	NA	880	No

See notes at end of table.

Table O-4 (Continued)
Comparison with Criteria
Subsurface Soil

Remedial Investigation
NAS Cecil Field
Jacksonville, Florida

Analyte	Frequency of Detection [1]	Range of Detected Concentrations	Range of Reporting Limits	Mean of Detected Concentrations [2]	Analyte HHCPC? [3] (Yes/No)	Background Screening Concentration [4]	FDEP Clean-up Goals Based on Leachability [5]	Exceedance? [6] (Yes/No)
Pesticides/PCBs (µg/kg)								
4,4-DDT	1/24	0.31	2.25 - 4.1	0.31	No	NA	48.6	No
Aroclor-1248	2/24	[7] 15.8 - 30	33 - 41	22.9	No	NA	NP	NA
Aroclor-1254	3/24	[7] 15 - 66	36 - 41	43.3	No	NA	NP	NA
Aroclor-1260	4/24	3.1 - 49	36 - 41	16.5	No	NA	NP	NA
Heptachlor epoxide	1/24	1 5	0.4 - 2 1	1.5	No	NA	0.128	No
alpha-Chlordane	5/24	[7] 1 25 - 19	1.8 - 2.1	6.8	No	NA	560	No
gamma-Chlordane	7/24	1 - 22	1.8 - 2.1	5.9	No	NA	560	No
Inorganics (mg/kg)								
Aluminum	24/24	882 - 15,300	40 - 140	6,150	No	11,200	ND	NA
Arsenic	5/24	0 75 - 1.9	2 - 2	1.1	Yes	1.64	ND	NA
Barium	22/24	1 6 - 15.6	40 - 40	7.1	No	16	NP	NA
Cadmium	1/24	0 93	1 - 1	0.93	No	-	ND	NA
Calcium	18/24	304 - 45,500	1,000 - 1,000	4,370	Yes	320	NP	NA
Chromium	24/24	[7] 1.4 - 19.5	2 - 2	8.3	No	16	ND	NA
Cobalt	14/24	0.49 - [7] 2 85	10 - 10	1	Yes	-	ND	NA
Copper	16/24	[7] 0.525 - 2.1	5 - 5	0.84	No	1.16	ND	NA
Cyanide	2/23	1.7 - 2	0.5 - 0.5	1.9	No	-	NP	NA
Iron	24/24	191 - 4,420	20 - 20	1,030	No	2,840	ND	NA
Lead	24/24	1.6 - 55	0.6 - 0.6	7.6	No	14	ND	NA
Magnesium	18/24	39.7 - 339	1,000 - 1,000	189	No	268	NP	NA
Manganese	24/24	2 8 - 8	3 - 3	4.8	No	7 8	ND	NA
Mercury	4/24	0.12 - [7] 0.13	0.1 - 0.1	0.13	No	1.1	NP	NA

See notes at end of table.

Table O-4 (Continued)
Comparison with Criteria
Subsurface Soil

Remedial Investigation
NAS Cecil Field
Jacksonville, Florida

Analyte	Frequency of Detection [1]	Range of Detected Concentrations	Range of Reporting Limits	Mean of Detected Concentrations [2]	Analyte HHCPC? [3] (Yes/No)	Background Screening Concentration [4]	FDEP Clean-up Goals Based on Leachability [5]	Exceedance? [6] (Yes/No)
Inorganics (mg/kg)								
Nickel	22/24	0.48 - 5	8 - 8	2.2	No	5.4	ND	NA
Potassium	18/24	33.6 - [7] 277	1,000 - 1,000	103	No	152	NP	NA
Sodium	8/24	142 - 781	1,000 - 1,000	239	No	312	NP	NA
Thallium	2/24	2.1 - 2.6	2 - 2	2.4	Yes	-	NP	NA
Vanadium	24/24	[7] 1.1 - 17	10 - 10	5.7	No	16	ND	NA
Zinc	2/24	9.4 - 25.8	4 - 4	17.6	No	-	ND	NA

[1] Frequency of detection is the number of samples in which the analyte was detected divided by the total number of samples analyzed (16SB10S2, 16SB10S4, 16SB11S2, 16SB11S6, 16SB12S2, 16SB12S6, 16SB1S0, 16SB1S6, 16SB2S2, 16SB2S4, 16SB3S0, 16SB3S6, 16SB4S2, 16SB4S6, 16SB5S2, 16SB5S6, 16SB6S2, 16SB6S4, 16SB7S2, 16SB7S4, 16SB8S2, 16SB8S4, 16SB9S4, 16SB9S6, including duplicates at 16SB10S2, 16SB5S2, and 16SB7S2).

[2] The average of detected concentrations is the arithmetic mean of all samples in which the analyte was detected. It does not include those samples in which the analyte was not detected.

[3] HHCPCs were selected for subsurface soil as described in the baseline risk assessment (ABB-ES, 1995a).

[4] Twice the average of detected concentrations for inorganic analytes at CEFBBMS1S0, CEFBBMS1S6, CEFBBMS2S2, CEFBBMS2S6, CEFBBMS312, CEFBBMS316, CEFBBMS4S2, CEFBBMS4S4, CEFBBMS5S2, CEFBBMS5S6, CEFBBMS610, CEFBBMS616, CEFBBMS7S0, CEFBBMS7S4, CEFBBMS8S2, CEFBBMS8S6, CEFBBMS910, and CEFBBMS916, including a duplicate at CEFBBMS7S0 (background).

[5] Florida Department of Environmental Protection (FDEP) memorandum dated July 5, 1994. Values presented are the Clean-up Goals based on Leachablity

[6] An exceedance of the FDEP clean-up goal is identified when the maximum detected anlalyte concentration is greater than the Clean-up goal concentration. Pursuant to FDEP guidance (July, 1994), an analyte that has a maximum detected concentration that is less than the background concentration is not listed as exceeding the FDEP Clean-up goal.

[7] Value is the average of a sample and its duplicate.

Notes: HHCPC = human health chemical of potential concern. NA = not applicable.
mg/kg = milligrams per kilogram. µg/kg = micrograms per kilogram.
ND = analyte is presented in FDEP guidance but no criterion is provided. DDD = dichlorodiphenyldichloroethane.
DDE = dichlorodiphenyldichloroethylene. DDT = dichlorodiphenyltrichloroethane.
NP = FDEP clean-up criterion for this analyte not presented in guidance - = not detected in any background samples.