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REMEDIAL INVESTIGATION REPORT FOR SITE 15 SOUTHWEST LANDFILL NAS WHITING FIELD FL

12/1/1999

HARDING LAWSON ASSOCIATES

REMEDIAL INVESTIGATION REPORT

SITE 15, SOUTHWEST LANDFILL

NAVAL AIR STATION WHITING FIELD
MILTON, FLORIDA

UNIT IDENTIFICATION CODE: N60508
CONTRACT NO.: N62467-89-D-0317/116

DECEMBER 1999

SOUTHERN DIVISION
NAVAL FACILITIES ENGINEERING COMMAND
NORTH CHARLESTON, SOUTH CAROLINA 29418

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December 1999

CERTIFICATION OF TECHNICAL
DATA CONFORMITY (MAY 1987)

The Contractor, Harding Lawson Associates (formerly 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-0317/116 are complete and accurate and comply with all requirements of this contract.

DATE: December 20, 1999

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(DFAR 252.227-7036)

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FOREWORD

To meet its mission objectives, the U.S. Navy performs a variety of operations, some requiring the use, handling, storage, or disposal of hazardous materials. Through accidental spills and leaks and conventional methods of past disposal, hazardous materials may have entered the environment in ways unacceptable by today's standards. With growing knowledge of the long-term effects of hazardous materials on the environment, the Department of Defense (DOD) initiated various programs to investigate and remediate conditions related to suspected past releases of hazardous materials at their facilities.

One of these programs is the Installation Restoration (IR) program. This program complies with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) as amended by the Superfund Amendments and Reauthorization Act, the Resource Conservation and Recovery Act and the Hazardous and Solid Waste Amendments of 1984. These acts establish the means to assess and clean up hazardous waste sites for both private-sector and Federal facilities. The CERCLA and SARA acts form the basis for what is commonly known as the Superfund program.

Originally, the Navy's part of this program was called the Naval Assessment and Control of Installation Pollutants (NACIP) program. Early reports reflect the NACIP process and terminology. The Navy eventually adopted the program structure and terminology of the standard IR program.

The IR program is conducted in several stages as follows:

- preliminary assessment (PA),
- site inspection (SI) (formerly the PA and SI steps were called the initial assessment study under the NACIP program),
- remedial investigation and feasibility study, and
- remedial design and remedial action.

The Southern Division, Naval Facilities Engineering Command manages and the U.S. Environmental Protection Agency and the Florida Department of Environmental

Protection (formerly Florida Department of Environmental Regulation) oversee the Navy environmental program at NAS Whiting Field. All aspects of the program are conducted in compliance with State and Federal regulations, as ensured by the participation of these regulatory agencies.

Questions regarding the CERCLA program at NAS Whiting Field should be addressed to Ms. Linda Martin, Code 1859, at (843) 820-5574.

EXECUTIVE SUMMARY

A remedial investigation and feasibility study (RI/FS) is being conducted at Naval Air Station (NAS) Whiting Field in Milton, Florida, by Southern Division, Naval Facilities Engineering Command (SOUTHNAVFACENGCOM) as part of the Department of Defense Installation Restoration (IR) program. The IR program was designed to identify and abate or control contaminant migration resulting from past operations at naval installations.

A phased approach was implemented to conduct the RI. Phase I was completed in August 1992. The subsequent phases of the RI were designated as Phase IIA and Phase IIB. Fieldwork for Phase IIA was completed in March 1994. RI Phase IIB was completed in November 1996.

This RI report contains the results of assessment activities used to characterize site-specific chemicals detected in environmental media (surface soil, subsurface soil, and groundwater) at Site 15, Southwest Landfill at NAS Whiting Field. Data obtained from these activities were used to evaluate the nature and extent of contamination at the site and support feasibility studies (if required) and baseline risk assessments. Human health and ecological baseline risk assessments are included with the RI report.

The fieldwork conducted during the RI included the following tasks:

- geophysical survey,
- soil gas survey,
- test pit investigations,
- surface soil sampling,
- subsurface soil sampling,
- monitoring well installation,
- groundwater sampling, and
- hydrogeologic investigations.

Soil gas samples were analyzed for methane and other volatile organic compounds (VOCs). Soil and groundwater samples were analyzed for target compound list organic analytes, and target analyte list inorganic analytes.

The following conclusions are based on results of the RI investigation activities at Site 15, Southwest Landfill, NAS Whiting Field.

- Geophysical surveys results suggested the presence of geophysical anomalies indicating buried ferromagnetic debris in a series of trenches covering approximately 15 of the 21 acres of the site.

- Ten test pits were excavated at the locations of geophysical anomalies at Site 15. Materials encountered during test pit excavations include construction debris, metallic debris, and aircraft parts.

- Methane and VOCs were detected during the soil gas survey conducted at Site 15. The highest soil gas concentrations (exceeding 5,000 parts per million [ppm] total VOCs and 5,000 ppm methane) were reported near the western boundary of the site.

- Three VOCs, three semivolatile organic compound (SVOCs), and three pesticide compounds were detected in Site 15 surface soil samples. Detected concentrations in all VOCs, SVOCs, and pesticides are lower than the U.S. Environmental Protection Agency (USEPA) Region III risk-based concentrations (RBCs) and Florida residential cleanup target levels for surface soil.

- Twenty inorganic analytes and cyanide were detected in the 30 surface soil samples. Ten inorganic analytes exceeded the background screening values for surface soil. Arsenic exceeded the USEPA Region III RBC and the Florida residential soil cleanup target level in 28 surface soil samples. The detected concentrations of arsenic also exceeded the Florida Department of Environmental Protection (FDEP)-approved site-specific nonresidential soil cleanup target level of 4.62 $\mu g/\ell$ in one sample. The arsenic concentration exceeded the USEPA Region III industrial RBC screening criterion in one surface soil sample.

- Three VOCs, seven SVOCs, and one pesticide compound were detected in Site 15 subsurface soil samples. None of the detected concentrations of VOCs, SVOCs, or pesticides exceeded the USEPA Region III RBCs for industrial-use soils. The polychlorinated biphenyl Aroclor-1242 was detected in one subsurface sample. Aroclor-1242 exceeded the Florida industrial-use soil cleanup target level and the USEPA Region III RBC industrial soil screening criterion in this sample. Phenol and 4-methylphenol were detected at concentrations exceeding the Florida cleanup target level for leaching to groundwater.

- Twenty inorganic analytes were detected in the five subsurface soil samples. Eight analytes (calcium, chromium, iron, manganese, potassium, vanadium, zinc, and cyanide) were detected at concentrations exceeding the background screening values. None of the detected concentrations exceeded industrial standards for either the Florida soil cleanup target levels or USEPA Region III RBCs.

- The pH values of the groundwater samples collected from monitoring wells were below the lower range for the Federal and State secondary MCLs of 6.5 Standard Units but were within the range of pH values observed in background groundwater samples collected at NAS Whiting Field.

- Five VOCs and four SVOCs were detected in groundwater samples collected from the shallow monitoring wells at Site 15. None of the compounds with the exception of bis(2-ethylhexyl)phthalate, were detected in the background groundwater samples and none of the detected concentrations exceeded their Federal or Florida MCLs. The pesticide compound 4,4'-DDT was detected at a concentration exceeding the Florida groundwater guidance concentration.

- Eighteen inorganic analytes were detected in groundwater samples from shallow monitoring wells. Nine inorganic analytes, (aluminum, arsenic, cyanide, iron, magnesium, potassium, thallium, vanadium, and zinc) were detected at concentrations exceeding the background

screening concentration. Concentrations of aluminum, iron, and manganese were reported to exceed Federal MCLs and Florida groundwater guidance concentrations.

- Five VOCs (1,1-dichloroethene, 1,2-dichloroethene, trichloroethene, benzene, and xylene) and one SVOC (bis(2-ethylhexyl)phthalate) were detected in groundwater samples collected from intermediate depth monitoring wells. Bis(2-ethylhexyl)phthalate was the only compound detected in the background sample. Trichloroethene and benzene were both detected at concentrations exceeding Federal MCLs and Florida groundwater guidance concentrations.

- Fifteen inorganic analytes were detected in groundwater samples from intermediate depth wells. Seven analytes (arsenic, calcium, iron, lead, manganese, sodium, and zinc) were detected at concentrating exceeding the background screening criteria. Aluminum, iron, and manganese were detected at concentrations exceeding Federal MCLs and the Florida groundwater guidance concentrations.

- Five VOCs, two SVOCs, and one pesticide compound were detected in groundwater samples collected from the deep monitoring wells at Site 15. One SVOC (bis[2-ethylhexyl]phthalate) was the only organic compound detected in the background groundwater samples. Two compounds (1,1-dichloroethene and trichloroethene) were detected at concentrations that either equaled or exceeded Federal MCLs and Florida groundwater guidance concentrations.

- Sixteen inorganic analytes were detected in the groundwater samples from the Site 15 deep monitoring wells. Nine of the compounds including: antimony, arsenic, calcium, cobalt, copper, lead, manganese, potassium, and sodium were detected at concentrations exceeding the background screening concentration (Table 5-21). Three of the analytes, antimony, iron, and manganese, were detected at concentrations exceeding the Federal MCLs and Florida groundwater guidance concentrations.

- The extent of groundwater contamination downgradient of Site 15 has not been defined. Benzene and trichloroethene were detected in groundwater at concentrations above cleanup target levels and Federal MCLs between Site 15 and the base boundary.

- The groundwater flow direction is toward the southwest and likely discharges to Clear Creek. Clear Creek is located approximately 1,200 feet southwest of the site. The average horizontal hydraulic gradient for the site is 0.0066 feet per foot. The geometric mean for the hydraulic conductivity data for monitoring wells in the site area is 10.8 feet per day (ft/day) and the average seepage velocity value is 0.38 ft/day.

- The human health risk assessment identified three inorganic analytes as human health chemical of potential concern (HHCPCs) for surface soils at Site 15. Aroclor-1260 was identified as an HHCPC for subsurface soil. Thirteen analytes including 1,1-dichloroethene, 1,2-dichloroethene, benzene, chlorobenzene, trichloroethene, 1,4-

dichlorobenzene, bis(2-ethylhexyl)phthalate, 4,4'-DDT, aluminum, arsenic, iron, manganese, and thallium were identified as HHCPCs for groundwater at Site 15.

- The HHCPCs detected in surface soil do not pose unacceptable carcinogenic risks to the receptors evaluated based on evaluation of the samples using USEPA guidelines and target risk range.

- The total ELCR of 4×10^{-6} at Site 15, associated with exposure to soil by a hypothetical future resident, exceeds Florida's target risk level of concern 1×10^{-6} due to arsenic. The background levels of arsenic at Site 15 exceed the Florida residential soil cleanup target level and may result in an unacceptable carcinogenic risk. It is likely that naturally occurring arsenic contributes to the FDEP target risk-level exceedance.

- The ELCR for groundwater exceeds the USEPA acceptable risk range and the FDEP cancer level of concern due to 1,1-dichloroethene, arsenic, benzene, trichlorobenzene, and 1,4-dichlorobenzene; however, groundwater contamination is being addressed as a separate RI site under a facilitywide investigation.

- The ecological risk assessment (ERA) selected three VOCs (acetone, methylene chloride, and xylene) two SVOCs (di-*n*-butylphthalate and bis[2-ethylhexyl]phthalate) and five inorganic analytes (cyanide, lead, silver, vanadium, and zinc) as ecological chemicals of potential concern (ECPCs) for surface soil at Site 15. In addition, four VOCs (acetone, benzene, trichloroethene, xylene), two SVOCs (1,4-dichlorobenzene and bis[2-ethylhexyl]phthalate), one pesticide (4,4'-DDT), and nine inorganic analytes (aluminum, cobalt, iron, lead, manganese, mercury, silver, vanadium, and zinc) were identified as ECPCs in groundwater at the site.

- Risks were not identified for terrestrial wildlife resulting from exposure to ECPCs in surface soil; therefore, reductions in the survivability, growth, and reproduction of wildlife receptor populations at Site 15 are not expected to occur.

- Reduction in terrestrial plant and soil invertebrate biomass used as forage material was evaluated by comparing exposure concentrations for surface soil with toxicity benchmarks. Based on this comparison it is unlikely that plant and invertebrate biomass or plant cover availability would be reduced such that small mammal and bird populations at Site 15 would be affected.

- Potential risks for aquatic receptors were evaluated for exposures to ECPCs in groundwater. The concentrations of ECPCs in groundwater as they discharge to Clear Creek 1,200 feet downgradient of Site 15 were estimated based on application of a 10-fold attenuation factor to the RME concentration. Based on the screening evaluation of groundwater, risks to aquatic receptors in Clear Creek associated with exposure to groundwater ECPCs from Site 15 are not expected. The ERA for Site 39, Clear Creek Flood Plain, will provide additional information regarding potential risks to aquatic receptors in Clear Creek based on actual site-related surface water and sediment data.

- In summary, the results of the ERA suggest that risks are not predicted for ecological receptor populations at Site 15.

Based upon the interpretation of findings from the RI activities, a FS is recommended for Site 15 to evaluate potential strategies for the reduction in human health risks associated with surface and subsurface soil at the site. In addition, the presence of organic and inorganic analytes in Site 15 groundwater samples at concentration exceeding Florida's target risk levels indicates that additional sampling and remedial measures may be required. Leaching of contaminants phenol and 4-methylphenol from subsurface soil to groundwater will also need to be addressed. However, all groundwater contamination issues will be addressed as part of the ongoing RI for the Site 40, facilitywide groundwater study.

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GLOSSARY

ABB-ES	ABB Environmental Services, Inc.
AQUIRE	Aquatic Information Retrieval
ATSDR	Agency for Toxic Substances and Disease Registry
AWQC	ambient water quality criteria
BAF	bioaccumulation factor
BAT	Bengt-Arne-Torstensson
bls	below land surface
°C	degrees Celsius
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CLP	Contract Laboratory Program
cm/sec	centimeters per second
DDD	dichlorodiphenyldichloroethane
DDE	dichlorodiphenyldichloroethene
DDT	dichlorodiphenyltrichloroethane
DQO	data quality objective
ECPC	ecological chemical of potential concern
ELCR	excess lifetime cancer risk
EM	electromagnetic
EPC	exposure point concentration
ERA	ecological risk assessment
ft/day	feet per day
ft/ft	feet per foot
ft/yr	feet per year
FS	feasibility study
GIR	General Information Report
HHCPC	human health chemical of potential concern
HHRA	human health risk assessment
HI	hazard index
HQ	hazard quotient
HRS	Hazard Ranking System
IAS	initial assessment study
IDL	instrument detection limit
IR	installation restoration
k_{oc}	carbon partitioning coefficient
LD_{50}	lethal dose to 50 percent of test population
LDC	Laboratory Data Consultants, Inc.
LOAEL	lowest observed adverse effects level

MAG	magnetometer
MCL	maximum contaminant level
mm Hg	millimeters mercury
MS/MSD	matrix spike and matrix spike duplicate
mg/kg	milligrams per kilogram
μg/kg	micrograms per kilogram
μg/ℓ	micrograms per liter
NAS	Naval Air Station
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NEESA	Naval Energy and Environmental Support Activity
NOAEL	no observable adverse effects level
NPL	National Priority List
NTU	nephelometric turbidity unit
OVA	organic vapor analyzer
PA	preliminary assessment
PARCC	precision, accuracy, representativeness, completeness, and comparability
PCB	polychlorinated biphenyl
PCPT	piezocone penetrometer test
PDE	potential dietary exposure
ppm	parts per million
PVC	polyvinyl chloride
%D	percent difference
%RPD	relative percent difference
%RSD	relative standard deviation
QA/QC	quality assurance and quality control
QAPP	quality assurance project plan
RBC	risk-based concentration
RGO	remedial goal option
RI	remedial investigation
RI/FS	remedial investigation and feasibility study
RME	reasonable maximum exposure
RRF	relative response factor
RTV	reference toxicity value
SARA	Superfund Amendment and Reauthorization Act
SDG	sample delivery group
SFF	site foraging frequency
SOUTHNAV-FACENGCOM	Southern Division, Naval Facilities Engineering Command
SPCCs	system performance check compounds
SQL	sample quantitation limit
SU	standard unit
SVOC	semivolatile organic compound

GLOSSARY (Continued)

TAL	target analyte list
TCL	target compound list
TM	trademark
TRPH	total recoverable petroleum hydrocarbons
UCL	upper confidence limit
USDA	U.S. Department of Agriculture
USEPA	U.S. Environmental Protection Agency
UST	underground storage tank
UXB	UXB International, Inc.
VOC	volatile organic compound

CHAPTER 1.0

1.0 INTRODUCTION

Harding Lawson Associates (HLA) (formerly ABB Environmental Services, Inc. [ABB-ES]), under contract to the Department of Navy, Southern Division, Naval Facilities Engineering Command (SOUTHNAVFACENGCOM) is submitting the Remedial Investigation (RI) Report for Site 15, Southwest Landfill, at Naval Air Station (NAS) Whiting Field located in Milton, Florida. The RI Report for Site 15 is one in a series of site-specific reports being completed in conjunction with the NAS Whiting Field General Information Report (GIR) (ABB-ES, 1998) to summarize the previous investigations and to present the results of the RI.

The Remedial Investigation and Feasibility Study (RI/FS) is being conducted on behalf of the Navy at NAS Whiting Field under contract No. N62467-89-D-0317. The RI was conducted in three phases. The Phase I RI field program was completed in May 1992. The Phase IIA RI field program was conducted between May 1992 and March 1994. The Phase IIB RI field program was completed in November 1996.

Installation Location and Description. NAS Whiting Field is located in Santa Rosa County, in Florida's northwest coastal area, approximately 5.5 miles north of Milton and 25 miles northeast of Pensacola (Figure 1-1). NAS Whiting Field presently consists of two air fields separated by an industrial area. The installation is approximately 3,842 acres. Figure 1-2 presents the installation layout and locations of RI/FS sites at NAS Whiting Field. A complete description of historic operations at the facility is presented in Section 1.3 and Appendix A of the NAS Whiting Field GIR (ABB-ES, 1998).

1.1 PURPOSE OF THE RI/FS. The purpose of the NAS Whiting Field RI is to identify and characterize the nature and extent of chemicals in environmental media and potential risks to human and ecological receptors that might be posed by toxic or hazardous chemicals present on site. The chemicals were potentially released to the environment during past waste disposal practices or spills. The data collected during the RI field program will also be used in an feasibility study (FS) (if necessary) to screen, evaluate, and select remedial alternatives to provide permanent, feasible solutions to environmental impacts that may be a result of past waste disposal practices or spills.

1.2 SITE DESCRIPTION. Site 15 is a 21-acre parcel located along the southwestern facility boundary near the South Air Field (Figure 1-2). The site is currently forested with pine trees that exceed 20 feet in height and is surrounded by taller pine trees. The site typography slopes at about 5 percent to the southwest towards Clear Creek, which is located approximately 1,200 feet southwest of the site. The initial assessment study (IAS) report indicated that erosion had uncovered numerous areas where buried waste were exposed (Envirodyne Engineers, Inc., 1985).

Site 15 was an operational landfill from 1965 to 1979 and consisted of approximately seven trenches trending north-northeast, which covered 15 of the 21 acres. The landfill reportedly received the majority of waste generated at NAS Whiting Field, which included general refuse, waste paints, oils, solvents, thinner, hydraulic fluid, bagged asbestos, and potentially polychlorinated biphenyl (PCB)-contaminated transformer oil (Envirodyne Engineers, Inc., 1985).

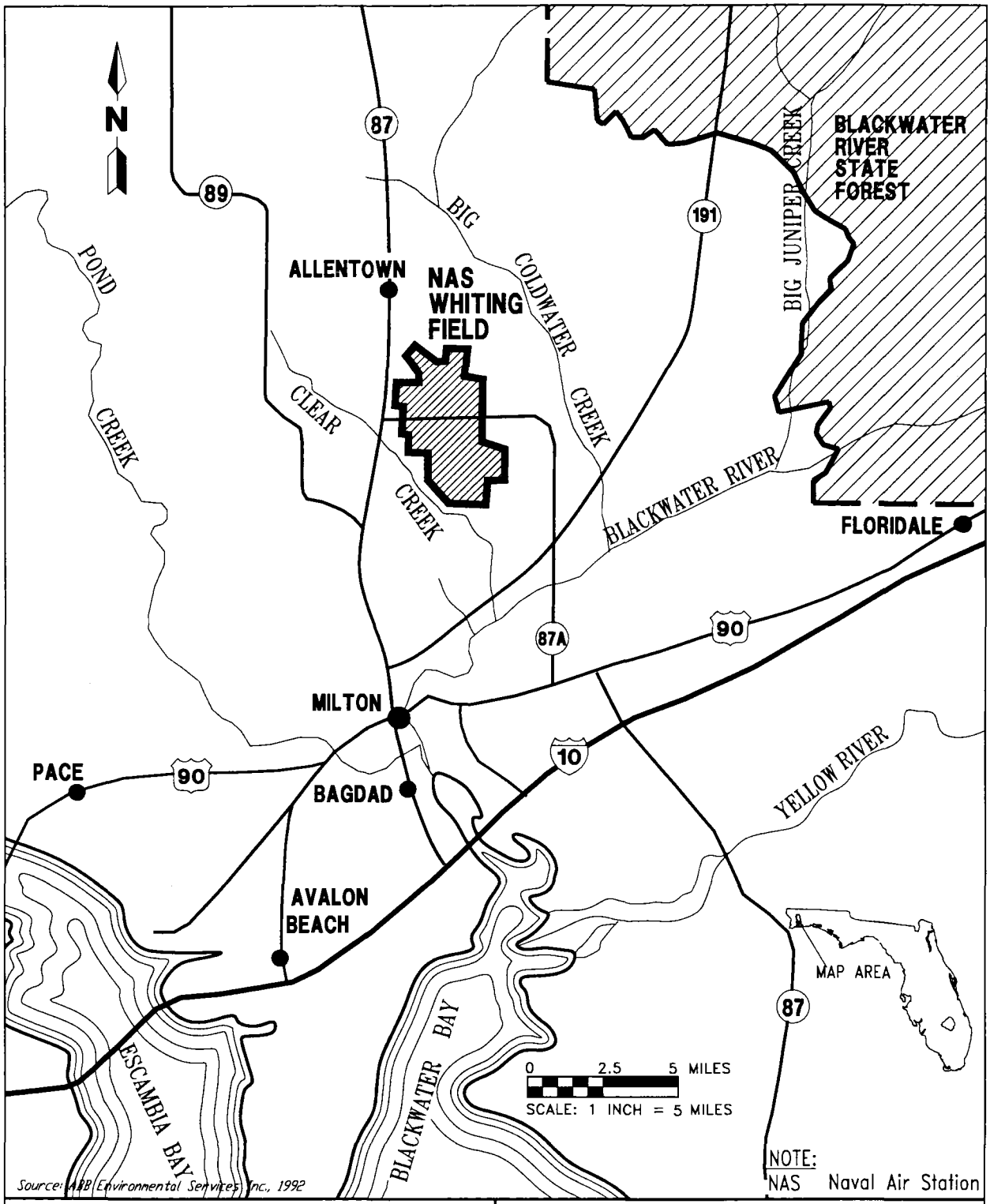

FIGURE 1-1
FACILITY LOCATION MAP

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REMEDIAL INVESTIGATION REPORT
SITE 15, SOUTHWEST LANDFILL

NAS WHITING FIELD
MILTON, FLORIDA

Figure 1-2 Location of RI/FS Sites at NAS Whiting Field

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It was estimated that approximately 3,000 to 4,500 tons of waste were disposed of at the site annually. Burning of waste material was not conducted and waste was covered on a daily basis (Envirodyne Engineers, Inc., 1985). Buried wastes are not typically exposed at the land surface nor are there indications (e.g., stained soil or stressed vegetation) of other past waste disposal practices.

According to the U.S. Department of Agriculture (USDA) (USDA, 1980), the soil at Site 15 is classified as Troup loamy sand and Dothan/Lucy/Bonifay soil types (ABB-ES, 1998). There is no evidence of a clay soil cap over the site area. Because the soil at the site is predominantly silty sand, much of the on-site rainfall directly infiltrates the soil.

1.3 REGULATORY SETTING. The Navy Installation Restoration (IR) program was designed to identify and abate or control contaminant migration resulting from past operations at naval installations. The IR program is the Navy response authority under Section 120 of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980 as amended by the Superfund Amendments and Reauthorization Act (SARA) of 1986 and Executive Order 12580. CERCLA requires that Federal facilities comply with the act, both procedurally and substantively. SOUTHNAVFACENGCOM is the agency responsible for the Navy IR program in the southeastern United States. Therefore, SOUTHNAVFACENGCOM has the responsibility to process NAS Whiting Field through preliminary assessment, site inspection, RI/FS, and remedial response selection in compliance with the guidelines of the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) (40 Code of Federal Regulations [CFR] 300).

Section 105(a)(8)(A) of SARA requires the U.S. Environmental Protection Agency (USEPA) to develop criteria to set priorities for remedial action for chemicals detected in environmental media based on relative risk to human health and the environment. To meet this requirement, USEPA has established the Hazard Ranking System (HRS) as Appendix A to the NCP. First promulgated in 1982, the HRS was amended in December 1990, effective March 14, 1991 (55 Federal Register No. 241:51532-51667), to comply with requirements of Section 105(c)(1) of SARA to increase the accuracy of the assessment of relative risk. The HRS has been substantially revised and is designed to prioritize sites after the SI phase of the CERCLA process.

The HRS score for NAS Whiting Field was generated in 1993. The score was sufficient to place NAS Whiting Field on the National Priority List (NPL).

In January 1994, the USEPA placed NAS Whiting Field on a proposed list of sites to be included on the NPL (40 CFR 300, Federal Register, January 18, 1994), and on May 31, 1994, NAS Whiting Field was placed on the NPL effective June 30, 1994 (40 CFR 300, Federal Register, May 31, 1994). As a result, the RI/FS for NAS Whiting Field must follow the requirements of the NCP, as amended by SARA, and regulatory guidance for conducting RI/FS programs under CERCLA.

1.4 REPORT ORGANIZATION. The RI Report is organized into ten chapters (Chapters 1.0 to 10.0). Chapter 1.0 presents the purpose, site description, and regulatory setting for the RI at NAS Whiting Field. Chapter 2.0 summarizes previous investigations. Chapter 3.0 presents the investigative methodology for conducting the assessment. Chapter 4.0 presents the site-specific data quality assessment. Chapter 5.0 discusses the investigative results of the assessment. Chapter 6.0 presents the Human Health Risk Assessment (HHRA), and Chapter 7.0

presents the Ecological Risk Assessment (ERA). Chapter 8.0 discusses the fate and transport of chemicals determined to be human and/or ecological chemicals of potential concern (ECPC). Chapter 9.0 provides a summary of the conclusions and recommendations. Chapter 10.0 presents professional review certification.

CHAPTER 2.0

2.0 PREVIOUS INVESTIGATIONS

This chapter summarizes the previous investigations at Site 15, Southwest Landfill, at NAS Whiting Field.

2.1 INITIAL ASSESSMENT STUDY. Background information was gathered for the IAS (Envirodyne Engineers, Inc., 1985) by conducting a record search, performing an on-site survey, and conducting interviews with long-time employees and retired personnel familiar with the site.

From 1965 until 1979, general refuse and wastes associated with operation and maintenance of aircraft may have been disposed of at this site. Anecdotal evidence suggests this may include unknown quantities of waste paints, paint thinners, solvents, waste oils, hydraulic fluids, and asbestos. Access to the site was uncontrolled, and there were no available written records of the types of wastes disposed of at the site (Envirodyne Engineers, Inc., 1985).

Envirodyne Engineers, Inc., recommended in the IAS that a confirmation study be completed based on the types of wastes possibly disposed of at the site, the potential for off-site migration, and the presence of human and ecological receptors. The confirmation study would typically consist of two parts: verification and characterization; however, only the verification phase was conducted.

2.2 VERIFICATION STUDY. The Verification Study (Geraghty & Miller, 1986) at Site 15 included installing one monitoring well (WHF-15-1) and collecting a groundwater sample. The monitoring well was installed to a depth of 72.5 feet below land surface (bls) along the southwestern edge of the site.

Groundwater elevation data collected in 1993 and 1994 (ABB-ES, 1995a) for the area suggest that the well was located hydraulically downgradient from the site. The groundwater sample was analyzed for USEPA priority pollutants, which includes volatile organic compound (VOCs), semivolatile organic compound (SVOCs), pesticides, and inorganic analytes. No organic compounds were detected. One inorganic analyte (lead) was detected.

CHAPTER 3.0

3.0 FIELD INVESTIGATIVE METHODS

Field investigative techniques used during the RI to collect the data are described in the RI/FS Sampling and Analysis Plan, Volume II (E.C. Jordan, 1990), which provides descriptions of sampling methods, field personnel responsibilities, sample management, chain of custody, project documentation, change in field methods, protocols on corrective actions, decontamination procedures, waste management handling, and other general project standards and procedures in Section 3.1, General Site Operations.

Field and laboratory quality assurance and quality control (QA/QC) requirements for the RI activities comply with the RI/FS Quality Assurance Project Plan (QAPP) located in Appendix A of the RI/FS Work Plan, Volume II (E.C. Jordan, 1990). Health and safety requirements were in general accordance with the Health and Safety Plan, Volume III (E.C. Jordan, 1990).

Field investigative methods not covered in the documents identified above are described in Technical Memorandum No. 7, RI Phase IIB Workplan (ABB-ES, 1995b) and in the NAS Whiting Field GIR (ABB-ES, 1998).

These field and laboratory investigation techniques are in general conformance with USEPA standard operating procedure (USEPA, 1991a and 1996a) and were followed during the RI sampling and analysis program.

The RI Phase I investigation at Site 15 consisted of generating lithologic logs and collecting four groundwater samples using a piezocone penetrometer (PCPT) and Bengt-Arne Torstensson (BAT) sampler (ABB-ES, 1992a). The Phase IIA investigation included completion of a geophysical survey, collection of five surface soil samples and five subsurface soil samples from five test pits, installation of 10 additional monitoring wells, and collection of 11 groundwater samples (ABB-ES, 1995a, 1995b, and 1995c). The Phase IIB investigation consisted an active soil gas survey, collection of twenty-five additional surface soil samples, collecting five groundwater screening samples using a hydrocone penetrometer (similar to a BAT device), installation of six additional monitoring wells, and collection of two rounds of groundwater samples from the 16 monitoring wells.

The samples collected during Phase IIA and IIB were analyzed for target compound list (TCL) VOCs, SVOCs, pesticides and PCBs, and target analyte list (TAL) inorganic analytes. Additional sampling events during 1997 were limited to analyses for TCL, VOCs, and TAL inorganic analytes.

The following provides a brief description of the number and types of environmental samples and the analytical methodology for the RI for Site 15, Southwest Landfill.

3.1 SOIL GAS FIELD SCREENING. Soil gas field screening was conducted in September 1995 at Site 15 to assess the presence of VOCs or methane in soil gas potentially emanating from the site. Soil gas samples were collected throughout the site and up to 300 feet beyond the site boundary. Sample locations were determined based on an approximate 100- by 100-foot grid. Figure 3-1 presents the locations of the active soil gas sample points.

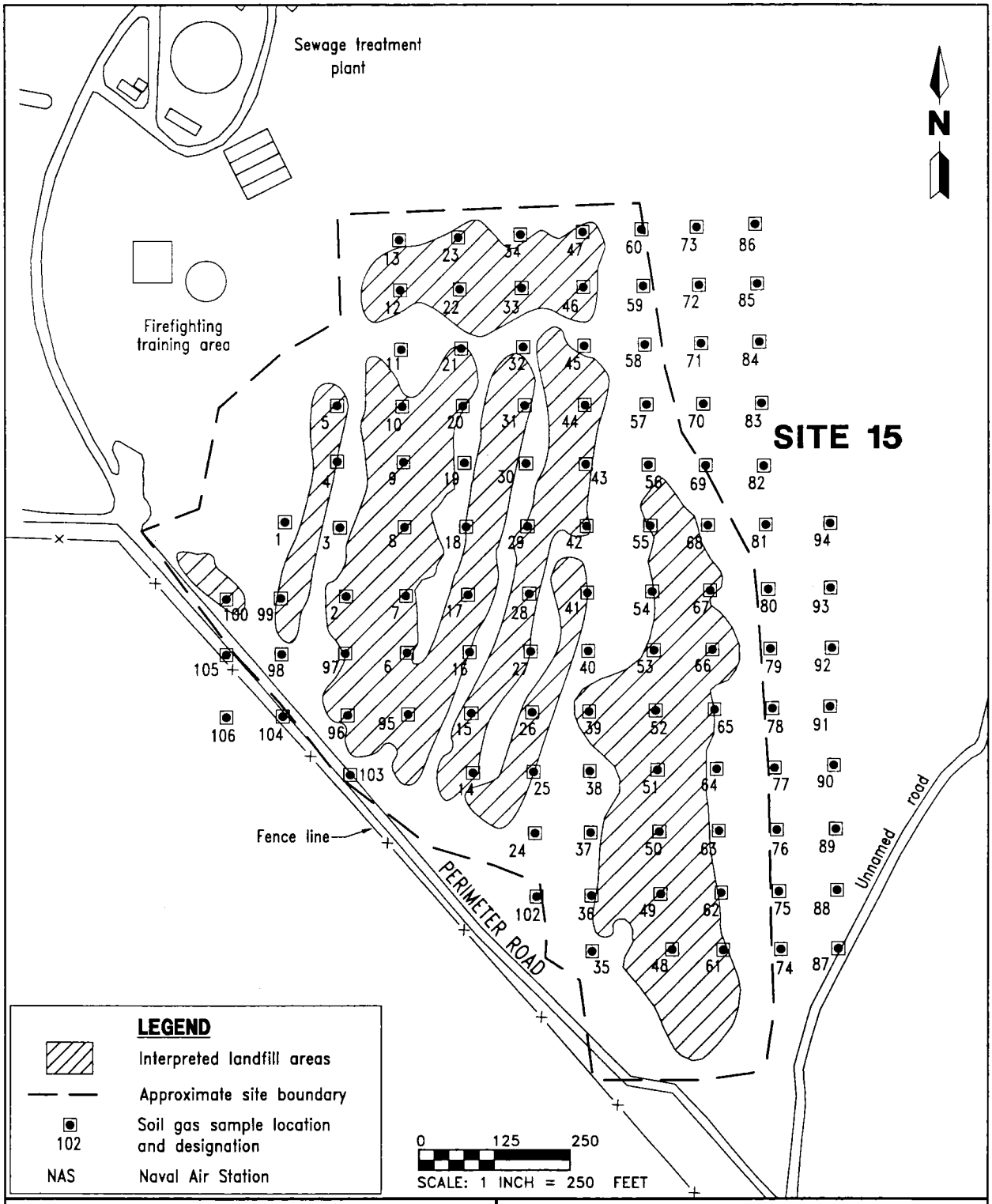

FIGURE 3-1
ACTIVE SOIL GAS SAMPLING LOCATIONS

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At each location, an open-ended stainless-steel tube was pushed or manually driven to the proposed sampling depths of 1.5 feet and 3.0 feet bls. Organic vapor measurements were made at the two sampling depths. The air within the stainless-steel tube was purged with a vacuum pump to obtain a representative sample of soil gas. The soil gas sample was analyzed for total VOCs and methane. Organic vapor concentrations were measured in the field with either a Portafid II™ or a Foxboro 128™ organic vapor analyzer (OVA) and recorded. Total VOCs readings were a direct measure of soil gas, however, methane analysis required filtration of VOCs by granulated charcoal filter, which adsorbs the VOCs allowing only the methane to pass through to the detector. A comparison of the two measurements allowed for a qualitative analysis of the presence of methane gas. Soil gas samples were not submitted for laboratory analysis.

Soil gas sample results are typically contoured to evaluate the soil gas measurements. The results of the soil gas survey are presented in Section 5.1.

3.2 GEOPHYSICAL SURVEY. Geophysical surveys at Site 15 were conducted between May 26, 1992, and June 14, 1992. The purpose of the geophysical surveys was to assess the lateral and vertical extent of the waste disposal area and locate buried metallic or nonmetallic objects that may indicate a potential waste disposal area.

Geophysical methods used at the site include electromagnetic (EM) induction and magnetometry (MAG). Blackhawk Geosciences, Inc., Golden, Colorado, was subcontracted by ABB-ES (presently HLA) to conduct the geophysical tasks. A technical report describing the methodology, results, and conclusions of the geophysical survey was prepared in February 1993 (ABB-ES, 1993). The following paragraph presents a brief description of the geophysical field program.

Data from the EM and MAG surveys were collected along parallel east to west lines spaced 40 feet apart. The survey lines were oriented with a magnetic compass and measuring tape. Data were collected at stations located along each survey line at 10-foot intervals. These lines were later surveyed by a Florida-licensed surveyor. The location of the lines and the plotted geophysical data are presented on Figures A-1 through A-4 in Appendix A. The results of the geophysical survey are presented in Section 5.3.

3.3 SURFACE SOIL ASSESSMENT. The surface soil assessment included the collection of five surface soil samples during Phase IIA and twenty-five surface soil samples during Phase IIB of the RI.

The five Phase I soil samples (15-SL-01 through 15-SL-05) were collected in August 1992 at locations where surface geophysical anomalies were interpreted to be present (Figure 3-2). Because these surface soil sample locations were biased locations based on geophysical anomalies, additional surface soil samples (Phase IIB) from other random locations were required to confirm the presence or absence of chemicals detected during Phase IIB and to characterize the nature and extent of contamination.

Twenty-five Phase IIB surface soil samples (15S001 through 15S025) were collected in December 1995 at locations shown on Figure 3-2. In addition to providing unbiased sampling locations, these samples also support the ecological (potential

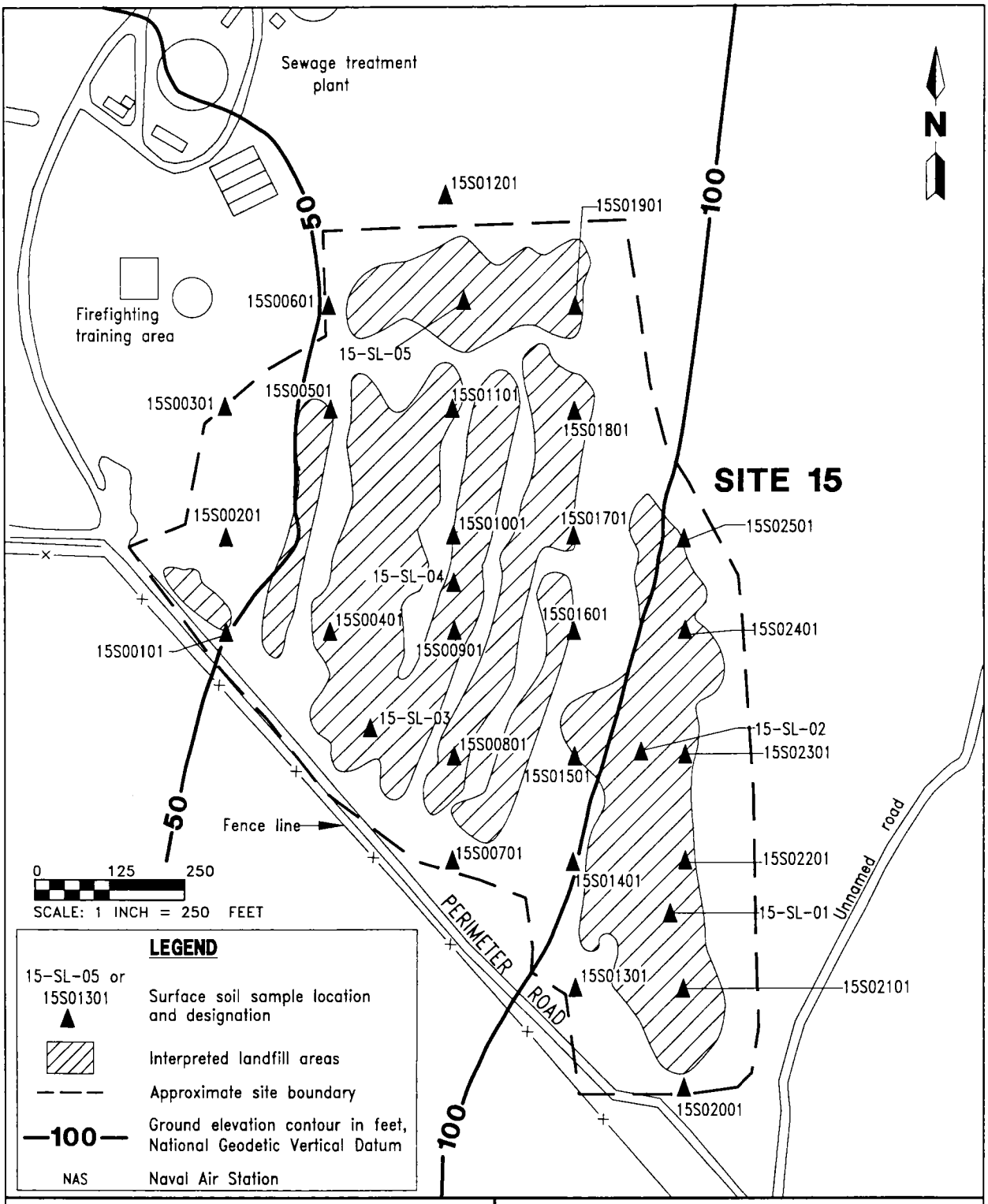

FIGURE 3-2
SURFACE SOIL SAMPLING LOCATIONS

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SITE 15, SOUTHWEST LANDFILL

NAS WHITING FIELD
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exposure to terrestrial wildlife) and human health (exposure of transient persons to site soil) risk assessments. Locations were determined using the systematic sampling method where a point is chosen at random along a transect, and then samples are collected at equidistant intervals thereafter (Gilbert, 1987; USEPA, 1989a). Surface soil samples were collected from the land surface to a maximum depth of 12 inches bls using a decontaminated stainless-steel auger. Soil samples were described using the Unified Soil Classification System and recorded in a bound field logbook by ABB-ES (presently HLA) personnel.

The surface soil samples were analyzed for Contract Laboratory Program (CLP) (Naval Energy and Environmental Support Activity [NEESA] Level D) TCL VOCs, SVOCs, pesticides and PCBs, and TAL inorganic analytes.

Background screening criteria were established by collecting background surface soil samples across the installation from each USDA soil type identified at NAS Whiting Field. These surface soil background data are presented in Subsection 3.3.1 of the GIR (ABB-ES, 1998). The arithmetic mean of analytes detected in the background soil samples was calculated by summing individual analyte concentrations and then dividing the sum by the number of samples from which the analytes were detected. Samples were then compared to twice the arithmetic mean of analyte concentrations detected in background surface soil samples associated with the Troup loamy sand soil type. The surface soil sampling results are discussed in Section 5.3 of this report.

3.4 SUBSURFACE SOIL ASSESSMENT. The subsurface RI at Site 15 included a PCPT investigation, split-spoon sampling conducted during monitoring well installations, and test pit excavation and sampling. Lithologic descriptions for the PCPT soundings are presented in Phase I Technical Memorandum No. 1, Geological Assessment (ABB-ES, 1992c). Lithologic descriptions generated during the installation of monitoring wells during Phase IIA are presented in Phase IIA Technical Memorandum No. 2, Geological Assessment (ABB-ES, 1995a). Additional lithologic descriptions for selected monitoring wells generated during Phase IIB, as well as all lithologic data described above and the monitoring well associated with Site 16, are presented in Appendix D of this report. A summary of the Site 15 lithology is presented in Section 5.6 of this report.

3.4.1 PCPT Screening Two PCPT explorations (1991 and 1995) were performed at Site 15. The location of the PCPT explorations are presented on Figure 3-3.

The PCPT exploration conducted in April 1991 consisted of using a stainless-steel cone tip (equipped with electronic sensors) connected to stainless-steel rods that was hydraulically pressed into the ground. Measurements of end-bearing resistance, friction resistance, and pore pressure were recorded from the sensors throughout each exploration. The analog signals from the cone tip sensors were digitized for data logging, and analysis of the digital data was completed in the field using a data acquisition software system. Based on the cone readings, a lithologic description of the soil was computed with the aid of the software package.

The cone tip was advanced until the friction resistance of the soil exceeded the power of the hydraulic system (refusal); the exploration was then terminated. The primary purpose of extending the boring explorations was to collect *in situ*

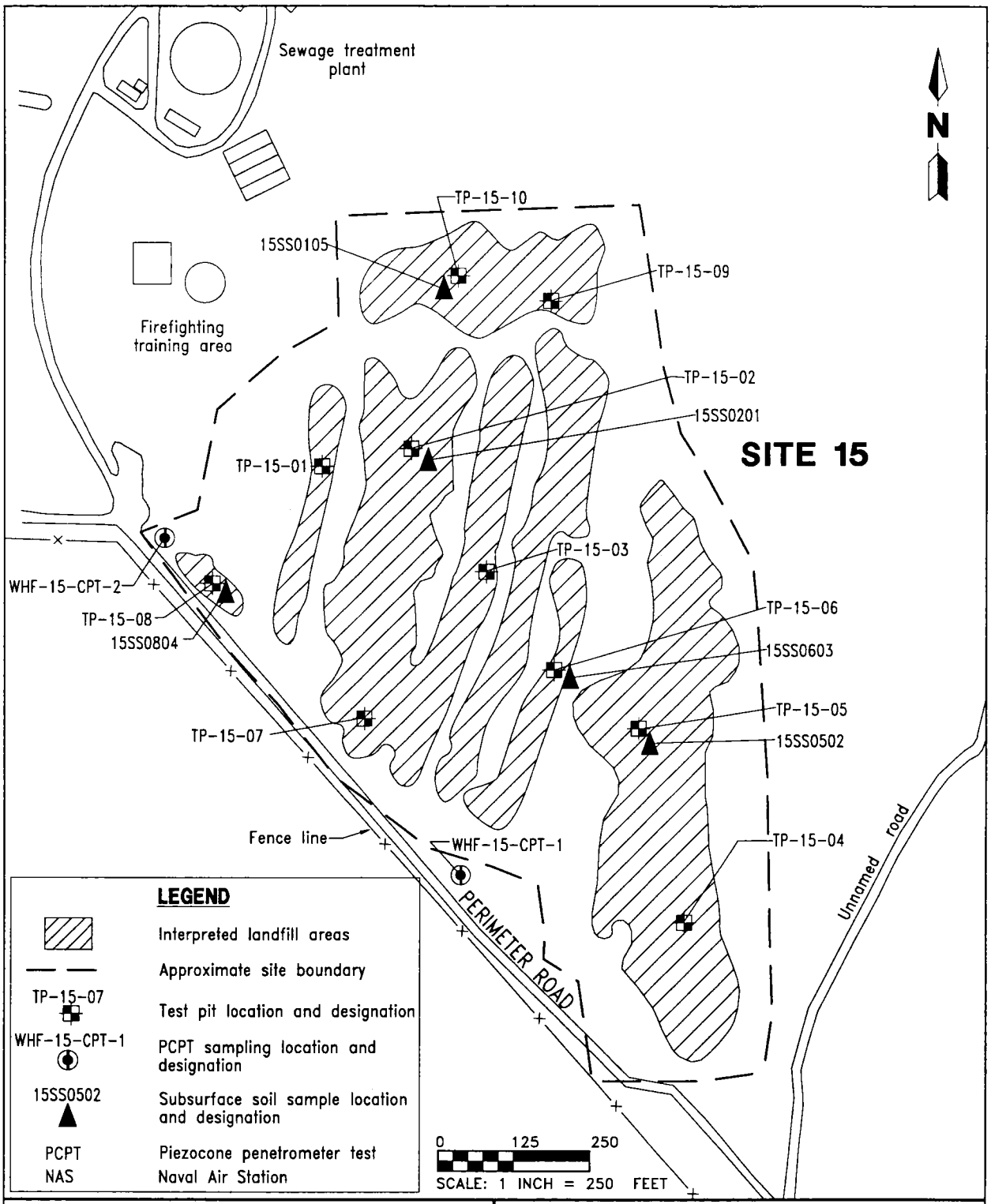

FIGURE 3-3
PCPT, TEST PIT, AND SUBSURFACE SOIL SAMPLING LOCATIONS

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groundwater samples as described in Phase I Technical Memorandum No. 5, Groundwater Assessment (ABB-ES, 1992a). A summary of the exploration designations, completion dates, proposed and actual depths, and the lithologic descriptions for the explorations are presented in Phase IIA Technical Memorandum No. 2, Geological Assessment (ABB-ES, 1995a).

3.4.2 Split-Spoon Sampling Lithologic data were also recorded during monitoring well installation. A 2-foot split-spoon sample was collected for visual inspection by an ABB-ES (presently HLA) geologist. All data were entered into a bound logbook. Detailed soil descriptions and other pertinent data are presented in the boring logs for the soil boring investigation located in Phase IIA Technical Memorandum No. 2, Geological Assessment (ABB-ES, 1995a) and Appendix D of this report. Split-spoon samples were generally collected at 5-foot intervals during drilling of the monitoring wells. Monitoring well installations for Phase IIB were conducted in conjunction with the previous hydrogeologic and groundwater investigations (summarized in Phase IIA Technical Memoranda Nos. 4 [ABB-ES, 1995d] and 5 [ABB-ES, 1995c], respectively).

3.4.3 Test Pitting Ten test pits were excavated at Site 15 during the period of September 31 through August 4, 1992, following the completion of the geophysical survey. UXB International, Inc. (UXB), from Chantilly, Virginia, was subcontracted by ABB-ES (presently HLA) to conduct the test pit excavation.

The test pits were excavated at locations where a geophysical anomaly indicated the potential for buried materials (Figure 3-3). The purpose of conducting the test pits was to characterize waste materials, if present, by description of the waste present, and chemical analysis of subsurface soil samples. Test pit logs are located in Appendix D of this report.

Prior to excavating the test pits, vegetation was cleared, then the proposed test pit area was surveyed by UXB with a hand-held MAG, a terrain conductivity meter (FEREX™ 4.021), and a metal detector. The four corners of each test pit were staked. The staked locations were referenced to grid coordinates defined for the geophysical survey. A backhoe was used to excavate a rectangular pit. During the excavation the physical description of each soil layer and waste type was recorded in the field logbook. A subsurface soil sample was collected directly from the backhoe bucket during the excavation. Following sample collection, the test pit was backfilled with the excavated soil.

Five subsurface soil samples (15SS0201, 15SS0502, 15SS0603, 15SS0804, and 15SS1005) were collected from five of the ten test pits excavated. Sample depths ranged from 5 to 6 feet bls to deeper 10 to 12 feet bls intervals within the test pits. The locations of the test pits are presented on Figure 3-3. Sampling results are discussed in Section 5.6 of this report.

3.5 HYDROGEOLOGIC ASSESSMENT. The hydrogeologic assessment of Southwest Disposal Area included Site 15 (Southwest Landfill), Site 16 (Open Disposal and Burning Area), an adjacent site, and utilized groundwater monitoring wells associated with underground storage tank (UST) Site 1466, the South Aviation Gasoline Tank Sludge Disposal Area (identified in IR program as Site 7), an upgradient UST site. Sites 31A (Sludge Drying Beds) and 31B (Sludge Disposal Area) are also adjacent sites; however, hydrologic data from these sites have not been included. Hydrogeologic data from Sites 15, 16, and 1466 were combined to provide a larger data set for a better understanding of the hydrogeologic conditions at Site 15 and other sites in the area.

The hydrogeologic field investigation activities included collecting water-level data from 42 monitoring wells (Figure 3-4) and conducting slug test analyses on seven monitoring wells. Monitoring well construction details for these sites are presented in Table 3-1. Results of the hydrogeologic assessment are presented in Section 5.2 of this report.

3.6 GROUNDWATER ASSESSMENT. Groundwater assessment activities included collecting groundwater samples with a PCPT sampler during Phases I and IIB as well as collecting groundwater samples from monitoring wells installed in Phases IIA and IIB.

The PCPT groundwater sampling program for Site 15 was conducted in April 1991 during the Phase I investigation in conjunction with the PCPT subsurface exploration to verify the potential contamination of groundwater downgradient of the site. Four groundwater samples were collected from locations WHF-15-CPT-01, WHF-15-CPT-02, WHF-15-CPT-03, and WHF-15-CPT-04 using the PCPT sampling technique (ABB-ES, 1995c). Groundwater sample depth was determined based on subsurface exploration data (lithology and pore pressure) collected from the PCPT soundings. The PCPT groundwater sample was analyzed for VOCs and TAL metals.

In September of 1995, an *in situ* groundwater sampling program using PCPT technology was conducted to screen for contaminants hydrogeologically downgradient of Site 15 to aid in the placement of additional monitoring wells to be installed during the Phase IIB field program. Five locations were investigated at Site 15 (Figure 3-4). The PCPT exploration consisted of pushing a hollow stainless-steel rod to depth to collect groundwater samples in an integral sampling chamber. The sample chamber was hermetically sealed at depth and brought to the surface where the sample was transferred to appropriate sample containers placed on ice and shipped to an off-site analytical laboratory.

Groundwater samples were collected from four intervals at each location. The initial sample was collected near the potentiometric surface of groundwater and subsequent samples were collected at 20-foot intervals below the initial sample point. Samples were collected and analyzed for selected VOCs. The location of the PCPT sample is presented on Figure 3-3, and the analytical results of the PCPT sampling are presented in Section 5.7 of this report and in the Phase I Technical Memorandum No. 1, Geological Assessment (ABB-ES, 1992c).

The groundwater monitoring well WHF-15-1 was installed during the Verification Study (Geraghty & Miller, 1986). During the Phase IIA investigation (in 1993), ten additional groundwater monitoring wells (WHF-15-2I, WHF-15-2S, WHF-15-2D, WHF-15-3D, WHF-15-3I, WHF-15-3S, WHF-15-4S, WHF-15-5S, WHF-15-6D, and WHF-15-6S) were installed. Groundwater samples were collected from the 11 existing monitoring wells at Site 15 between November 3 and December 3, 1993. Based on the analytical results from these groundwater samples, eight additional monitoring wells (WHF-15-5I, WHF-15-5D, WHF-15-7S, WHF-15-7I, WHF-15-7D, WHF-15-8S, WHF-15-8I, and WHF-15-8D) were installed. The monitoring well locations are presented on Figure 3-4, and the groundwater analytical data are discussed in Section 5.7.

Generally, shallow monitoring wells are identified with an "S" at the end of the well number (e.g., WHF-15-7S). These wells have been screened at the water table and well vary in depth from 30 to 107 feet deep. The intermediate monitoring wells, identified with an "I" at the end of the well number, are clustered with the shallow and deep wells and are screened from 63 to 121 feet

Figure 3-4 Monitoring Well Location Map

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Table 3-1
Summary of Monitoring Well Construction Details

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Site 15, Southwest Landfill
Naval Air Station Whiting Field
Milton, Florida

Monitoring Well Designation	RI Phase of Well Completion	Well Size (inches)	Land Surface Elevation (feet msl)	TOC Elevation (feet msl)	Total Well Depth (feet BTOC)	Approximate Screen Interval (feet BTOC)
Southwest Landfill and Adjacent Areas						
Site 15, Southwest Landfill						
WHF-15-1	VS	4	64.17	66.35	73.60	63 to 73
WHF-15-2S	IIA	2	57.18	59.58	32.90	17 to 32
WHF-15-2I	IIA	2	57.24	60.10	63.20	53 to 63
WHF-15-2D	IIA	2	57.05	59.39	112.44	107 to 112
WHF-15-3S	IIA	2	67.35	69.29	37.94	22 to 37
WHF-15-3I	IIA	2	67.26	69.69	87.83	77 to 87
WHF-15-3D	IIA	2	67.84	69.44	119.48	109 to 119
WHF-15-4S	IIA	2	140.62	143.29	109.15	94 to 109
WHF-15-5S	IIA	2	101.73	104.14	68.18	58 to 68
WHF-15-5I	IIA	2	102.05	105.17	98	88 to 98
WHF-15-5D	IIA	2	102.81	106.11	128.38	118 to 128
WHF-15-6S	IIA	2	71.87	74.29	43.73	28 to 43
WHF-15-6D	IIA	2	72.56	75.08	123.36	113 to 123
WHF-15-7S	IIB	2	116.96	120.18	88.85	73 to 88
WHF-15-7I	IIB	2	116.59	119.85	121.5	111 to 121
WHF-15-7D	IIB	2	116.36	119.49	147.53	137 to 147
WHF-15-8S	IIB	2	77.03	79.67	55	40 to 55
WHF-15-8I	IIB	2	76.69	79.48	85.2	75 to 85
WHF-15-8D	IIB	2	76.19	79.08	115	105 to 115
Site 16, Open Disposal Burning Area						
WHF-16-1	VS	4	47.47	50.04	43.00	33 to 43
WHF-16-2	I	4	79.38	82.19	74.20	69 to 74
WHF-16-2S	IIA	2	80.77	83.66	49.80	34 to 49
WHF-16-2I	IIA	2	78.02	80.60	130.14	120 to 130
WHF-16-3S	IIA	2	48.60	51.69	23.25	8 to 23
WHF-16-3I	IIA	2	48.73	51.31	52.87	47 to 52
WHF-16-3II	IIA	2	48.60	51.22	78.91	73 to 78
WHF-16-3D	IIA	2	48.64	51.40	118.08	108 to 118
WHF-16-4S	IIA	2	52.19	54.79	22.38	7 to 22
WHF-16-4II	IIA	2	50.62	53.01	64.80	54 to 64
WHF-16-4D	IIA	2	49.88	52.87	122.54	112 to 122
WHF-16-5	IIA	2	--	37.54	13.50	3 to 13
WHF-16-6S	IIB	2	53.67	56.57	26	11 to 26

See notes at end of table.

Table 3-1 (Continued)
Summary of Monitoring Well Construction Details

Remedial Investigation Report
Site 15, Southwest Landfill
Naval Air Station Whiting Field
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Monitoring Well Designation	RI Phase of Well Completion	Well Size (inches)	Land Surface Elevation (feet msl)	TOC Elevation (feet msl)	Total Well Depth (feet BTOC)	Approximate Screen Interval (feet BTOC)
Southwest Landfill and Adjacent Areas						
Site 16, Open Disposal Burning Area (Continued)						
WHF-16-6D	IIB	2	53.58	56.77	62.1	52 to 62
WHF-16-7S	IIB	2	35.05	38.27	14	4 to 14
WHF-16-7I	IIB	2	35.14	38.17	46.5	36 to 46
WHF-16-7D	IIB	2	35.19	38.05	75.2	65 to 75
Site 1466						
WHF-1466-6S	IIB	2	173.40	173.09	131	121 to 131
WHF-1466-6I	IIB	2	173.01	173.06	160	150 to 160
WHF-1466-6D	IIB	2	173.21	173.05	190.5	180 to 190
WHF-1466-6DD	IIB	2	172.86	172.90	220	210 to 220

Notes: RI = remedial investigation.
msl = mean sea level.
TOC = top of casing.
BTOC = below top of casing.
VS = Verification Study.
I = Remedial Investigation Phase I.
IIA = Remedial Investigation Phase IIA.
IIB = Remedial Investigation Phase IIB.
-- = not available.

bls. The deep wells identified with a "D" at the end of the well number are the deepest wells in the cluster and range from 112 to 147 feet bls. A summary of the monitoring well classification is presented in Table 3-2.

Table 3-2
Classification of Monitoring Wells

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	Location Identifier	Total Depth
Shallow	WHF-15-2S	32
	WHF-15-3S	37
	WHF-15-4S	109
	WHF-15-5S	68
	WHF-15-6S	43
	WHF-15-7S	88
	WHF-15-8S	55
Intermediate	WHF-15-2I	6
	WHF-15-3I	87
	WHF-15-5I	98
	WHF-15-7I	121
	WHF-15-8I	85
Deep	WHF-15-2D	112
	WHF-15-3D	119
	WHF-15-5D	128
	WHF-15-6D	123
	WHF-15-7D	147
	WHF-15-8D	115

During the Phase IIA investigation, groundwater samples were collected from monitoring wells using a Teflon™ bailer after purging the monitoring wells with either a submersible or bladder pump. The groundwater samples were analyzed for CLP (NEESA Level C) TCL VOCs, SVOCs, pesticides and PCBs, and TAL inorganics.

Groundwater samples were collected during Phase IIB of the RI (July 31 and November 20, 1996) from 18 monitoring wells at Site 15. The groundwater samples were collected using low-flow sampling techniques and were analyzed for CLP (NEESA Level D) TCL VOCs, SVOCs, pesticides and PCBs, and TAL inorganic analytes. Samples for TAL inorganic analysis were unfiltered (total analysis) if turbidity was below 10 nephelometric turbidity units (NTUs). If turbidity was greater than 10 NTUs, an additional groundwater sample was collected and filtered (dissolved-phase inorganics) using a 45-micron filter. The purpose of the additional groundwater sample was to assess uncertainty associated with a turbid unfiltered groundwater sample.

Analyses were also conducted to assess secondary water quality parameters and provide data for assessing remedial alternatives in the FS. The analyses included alkalinity, chloride, sulfates, color, hardness, ammonia nitrates, total Kjeldahl nitrogen, nitrate and nitrite, pH, phosphorous, total dissolved solids, and sulfides.

CHAPTER 4.0

4.0 SITE-SPECIFIC DATA QUALITY ASSESSMENT

This chapter describes how the data generated during Phase IIB of the RI at Site 15 were managed and evaluated. Section 4.1 describes the analytical program and data management for the RI at Site 15. Section 4.2 summarizes the precision, accuracy, representativeness, comparability, and completeness (PARCC) report on the data. Section 4.3 presents a summary of the Data Quality Assessment.

The soil and groundwater samples collected during Phase IIA of the RI were qualified according to USEPA functional guidelines for evaluation of organic (USEPA, 1991b) and inorganic (USEPA, 1988) analytical data analyzed using USEPA CLP protocol. The Data Quality Objective (DQO) assessment for the Phase IIA soil samples is presented in detail in RI Phase IIA Technical Memorandum No. 3 (ABB-ES, 1994). The DQO assessment for the Phase IIA groundwater samples is presented in detail in RI Phase IIA Technical Memorandum No. 5 (ABB-ES, 1995c).

4.1 ANALYTICAL PROGRAM. Environmental and quality control samples collected during the Phase IIB of the RI at Site 15 were analyzed using field screening methods and laboratory analytical methods. Site 15 analytical results and quality control data is included with sample delivery groups (SDGs) WF008, WF009, WF024, WF025, WF026, WF037, WF053, and WF054. The field QC data are presented in Appendix B of this report. Sampling locations are presented in Chapter 3.0 and sample results are presented in Chapter 5.0 of this report. The analytical data are presented in Appendix E (soil data) and Appendix F (groundwater data).

Environmental samples (surface soil and groundwater) were collected and analyzed at an off-site laboratory using CLP methodology (USEPA, 1986a) for analysis of VOCs, SVOCs, pesticides and PCBs, total recoverable petroleum hydrocarbons (TRPH), metals and cyanide. Some groundwater samples were also analyzed for wet chemistry analyses. The laboratory analytical program is described in more detail in Section 2.2 of the NAS Whiting Field GIR (ABB-ES, 1998).

Analytical results obtained for all environmental samples during the RI sampling events were submitted as NEESA Level D (USEPA Level IV) analytical packages for VOCs, SVOCs, pesticides, PCBs, TRPH, metals, cyanide, and wet chemistry.

4.2 DATA REVIEW. Data validation is the technical review of individual analytical results relative to the following criteria:

- DQOs and the QAPP in the NAS Whiting Field Work Plan (E. C. Jordan Co., Inc., 1990 and ABB-ES, 1995b).
- NEESA guidance document 20.2-047B, Sampling and Chemical Analysis Quality Assurance Requirements for the Navy Installation Program (NEESA, 1988).
- USEPA, CLP National Functional Guidelines for Organic Data Review, February 1994 (USEPA, 1994a).
- USEPA, CLP National Functional Guidelines for Inorganic Data Review, February 1994 (USEPA, 1994b).

The data validation process is described in Section 2.3 of the NAS Whiting Field GIR (ABB-ES, 1998).

The data were reviewed, validated, and evaluated using the PARCC criteria specified in the DQOs. PARCC criteria are described in Section 2.3 of the NAS Whiting Field GIR (ABB-ES, 1998). The Site 15 Phase IIB soil and groundwater analytical data was validated by Laboratory Data Consultants, Inc. (LDC), of Carlsbad, California, in 1996-97. The subsections below summarize the PARCC criteria evaluation of the analytical data.

4.2.1 Precision Precision is a measure of the agreement or repeatability of a set of replicate results (relative percent difference [RPD]) obtained from duplicate laboratory analyses of samples collected from the same location and depth interval. Precision for analytical data collected during the RI sampling events was evaluated using results of field duplicate samples, laboratory duplicate samples, matrix spike and matrix spike duplicate (MS/MSD) samples, and/or consecutive laboratory control samples. The evaluation of precision for the field duplicate samples at Site 15 are presented in Table 4-1 and summarized below.

Organic Analytes. The RPD criteria for four organic analytes (acetone, bis(2-ethylhexyl)phthalate, 4,4'-dichlorodiphenyltrichloroethane [DDT], and 1,2-trichloroethene) did not meet the 30 percent control limit for at least one SDG as shown in Table 4-1. All other organic analytes were within the control limit for RPD. Since acetone is widely recognized as a laboratory contaminant, the acetone spike in the sample and duplicate may not have been introduced in the field. Furthermore, the high imprecision of acetone (as high as 133 percent RPD) may be the result of poor laboratory instrument stability rather than improper sample collection and handling.

Inorganic Analytes. The RPD criteria for six inorganic analytes (chromium, copper, iron, lead, and nickel) in at least one groundwater SDG did not meet the 30 percent control limit (Table 4-1). The RPD criteria for one inorganic analyte (nickel) in one surface soil sample (15S02001) did not meet the 50 percent control limit (Table 4-1). According to the data validation (LDC, 1996), the exceedances in the inorganic analytes are considered moderately imprecise. Exceedances of RPD values may have been due to sample heterogeneity or poor laboratory instrument stability.

4.2.2 Accuracy Accuracy is a measure of the agreement between the true value and the value measured using an analytical method (percent recovery). Accuracy also is evaluated during data validation by assessing initial and continuing calibration data for the analytical instrument. Accuracy for analytical data collected during the RI sampling events was assessed by evaluating percentage recoveries for MS/MSD samples, surrogate recoveries, laboratory control samples, and initial and continuing calibration standard results. A summary of accuracy exceedances for MS/MSD samples at Site 15 is presented in Table 4-2 and summarized below.

The percent recovery for some of the MS/MSD samples was above or below the target range; therefore, some analytical results may be biased high or low. Some of the analytical results for SVOCs and inorganic analytes were qualified based on the evaluation of percent recovery. According to the data validation (LDC, 1996), the results of organic and inorganic MS/MSD analyses indicate that an acceptable level of accuracy was attained.

Table 4-1
Precision Summary for Soil and Groundwater Field Duplicate Samples

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SDG Number	Sample ID	Compound	Sample Concentration (D_1)	Duplicate Concentration (D_2)	RPD (%)	Control Limit (%)
Soil						
WF008						
Organics (µg/kg)	15S02001	Acetone	5	ND	NC	50
		Methylene chloride	ND	5	NC	50
TAL Metals (mg/kg)	15S02001	Aluminum	4,630	5,470	17	50
		Arsenic	1.2	1.1	9	50
		Barium	5.6	6.6	16	30
		Beryllium	0.13	0.13	0	50
		Calcium	22.2	25.2	13	50
		Chromium	3.0	3.7	21	50
		Copper	1.9	2.4	23	50
		Iron	2,500	2,950	17	50
		Lead	5.9	5.9	0	50
		Magnesium	85.0	107	23	50
		Manganese	75.2	87.1	15	50
		Mercury	0.02	0.02	0	50
		Nickel	2.4	9.1	117	50
		Selenium	0.33	ND	NC	50
		Vanadium	5.7	7.1	22	50
		Zinc	3.0	4.1	31	50
		Cyanide	ND	ND	NC	50
		TRPH	ND	ND	NC	50
Organics (µg/kg)	15S01701	Acetone	6	4	40	50
TAL Metals (mg/kg)	15S01701	Aluminum	13,700	9,290	38	50
		Arsenic	3.7	4.3	15	50
		Barium	4.4	3.8	15	50
		Beryllium	0.11	0.11	0	50
		Calcium	23.7	20.4	15	50
		Chromium	14.8	14.0	6	50
		Copper	2.6	2.5	4	50
		Iron	11,900	10,400	13	50

See notes at end of table.

Table 4-1 (Continued)
Precision Summary for Soil and Groundwater Field Duplicate Samples

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SDG Number	Sample ID	Compound	Sample Concentration (D_1)	Duplicate Concentration (D_2)	RPD (%)	Control Limit (%)
TAL Metals (mg/kg) (Continued)						
		Lead	4.7	4.1	14	50
		Magnesium	51.2	41.8	20	50
		Manganese	10.8	6.8	45	50
		Nickel	ND	3.0	NC	50
		Selenium	ND	0.25	NC	50
		Vanadium	35.9	31.8	12	50
		Zinc	1.5	1.1	31	50
WF009						
Organics (µg/kg)	15S00101	Acetone	6	7	15	50
		bis(2-Ethylhexyl)phthalate	ND	1,700	NC	50
TAL Metals (mg/kg)	15S00101	Aluminum	9,280	10,800	15	50
		Arsenic	2.0	1.9	5	50
		Barium	6.6	7.8	17	50
		Beryllium	0.12	0.13	8	50
		Calcium	21.6	23.9	10	50
		Chromium	8.4	8.0	5	50
		Copper	3.4	3.9	14	50
		Iron	5,120	5,700	11	50
		Lead	4.7	3.6	26	50
		Magnesium	109	132	19	50
		Manganese	36.4	39.9	9	50
		Mercury	0.02	0.02	0	50
		Nickel	5.0	2.4	70	50
		Potassium	169	ND	NC	50
		Vanadium	13.3	15.1	13	50
		Zinc	4.1	5.0	22	50
		Cyanide	ND	ND	NC	50

See notes at end of table.

Table 4-1 (Continued)
Precision Summary for Soil and Groundwater Field Duplicate Samples

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SDG Number	Sample ID	Compound	Sample Concentration (D_1)	Duplicate Concentration (D_2)	RPD (%)	Control Limit (%)
Groundwater						
WF024						
Organics (µg/kg)	15G00701	Acetone	2	ND	NC	30
TAL Metals (mg/kg)	15G00701	Aluminum	161	173	7	30
		Barium	15.6	19.3	21	30
		Calcium	356	360	1	30
		Chromium	2.9	2.0	37	30
		Iron	183	202	10	30
		Lead	0.70	0.60	15	30
		Magnesium	433	422	3	30
		Manganese	2.8	2.6	7	30
		Sodium	1,530	1,610	5	30
		Vanadium	ND	1.2	NC	30
		Zinc	3.4	3.6	6	30
		Cyanide	2.6	3.2	21	30
WF025						
Organics (µg/kg)	15G00601	Acetone	5	8	46	30
		1,2-Dichloroethene	1	1	0	30
		Chlorobenzene	5	5	0	30
		Ethylbenzene	ND	1	NC	30
		1,4-Dichlorobenzene	12	12	0	30
		Naphthalene	4	4	0	30
		Diethylphthalate	1	1	0	30
TAL Metals (mg/kg)	15G00601	Aluminum	89.4	55.8	46	30
		Arsenic	8.0	7.8	2	30
		Barium	67.6	63.7	6	30
		Calcium	3,690	3,620	2	30
		Iron	31,000	30,500	2	30
		Lead	0.90	ND	NC	30
		Magnesium	1,940	1900	2	30
		Manganese	139	136	2	30
		Potassium	2460	2340	5	30

See notes at end of table.

Table 4-1 (Continued)
Precision Summary for Soil and Groundwater Field Duplicate Samples

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SDG Number	Sample ID	Compound	Sample Concentration (D_1)	Duplicate Concentration (D_2)	RPD (%)	Control Limit (%)
TAL Metals (mg/kg) (Continued)						
		Sodium	2,630	2,590	2	30
		Zinc	3.4	3.3	3	30
		Cyanide	ND	8.1	NC	30
WF026						
Organics (µg/kg)	15G00803	Acetone	25	5	133	30
		2-Butanone	7	ND	NC	30
		Trichloroethene	4	4	0	30
		bis(2-Ethylhexyl)phthalate	2	1	67	30
		4,4'-DDT	0.16	0.079	68	30
TAL Metals (mg/kg)	15G00803	Aluminum	187	146	25	30
		Barium	10.6	10.8	2	30
		Calcium	1,440	1,170	21	30
		Chromium	2.9	ND	NC	30
		Cobalt	ND	2.4	NC	30
		Copper	4.0	2.4	50	30
		Iron	194	175	10	30
		Lead	0.80	0.50	46	30
		Magnesium	322	296	8	30
		Manganese	33.1	32.9	0.6	30
		Potassium	522	ND	NC	30
		Sodium	5,350	5,380	0.6	30
		Vanadium	2.0	1.5	29	30
		Zinc	176	178	1	30
		Cyanide	1.6	4.2	90	30
WF037						
Organics (µg/kg)	15G00803	Trichloroethene	5	5	0	30

See notes at end of table.

Table 4-1 (Continued)
Precision Summary for Soil and Groundwater Field Duplicate Samples

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SDG Number	Sample ID	Compound	Sample Concentration (D_1)	Duplicate Concentration (D_2)	RPD (%)	Control Limit (%)
WF053						
Organics (µg/kg)	15G00602	Trichloroethene	2	2	0	30
TAL Metals (mg/kg)	15G00602	Aluminum	ND	29.9	NC	30
		Barium	13.0	13.0	0	30
		Calcium	676	675	0.1	30
		Chromium	3.3	4.2	24	30
		Iron	33.8	92.6	93	30
		Magnesium	504	490	3	30
		Manganese	2.3	2.7	16	30
		Sodium	2,870	2,740	5	30
		Zinc	3.1	3.4	9	30
Organics (µg/kg)	15G00703	1,2-Trichloroethene	1	2	67	30
		Trichloroethene	36	38	5	30
		1,1-Dichloroethene	2	ND	NC	30
TAL Metals (mg/kg)	15G00703	Aluminum	43.6	108	14	30
		Antimony	ND	21.2	NC	30
		Barium	6.6	6.2	6	30
		Calcium	587	549	7	30
		Chromium	10.6	13.4	23	30
		Copper	2.9	4.5	43	30
		Iron	107	115	7	30
		Lead	ND	5.1	NC	30
		Magnesium	280	266	5	30
		Manganese	6.9	6.5	6	30
		Nickel	10.9	20.3	60	30
		Sodium	2,040	1,820	11	30
		Zinc	5.2	6.1	16	30

See notes at end of table.

Table 4-1 (Continued)
Precision Summary for Soil and Groundwater Field Duplicate Samples

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SDG Number	Sample ID	Compound	Sample Concentration (D_1)	Duplicate Concentration (D_2)	RPD (%)	Control Limit (%)
WF054						
Organics (µg/kg)	15G00801	Chlorobenzene	4	4	0	30
TAL Metals (mg/kg)	15G00801	Aluminum	143	116	21	30
		Arsenic	2.0	ND	NC	30
		Barium	34.7	37.3	7	30
		Calcium	1,870	2,010	7	30
		Copper	5.2	2.6	67	30
		Iron	4,760	4,940	4	30
		Magnesium	1,370	1,470	7	30
		Manganese	84.6	91.4	8	30
		Mercury	ND	0.07	NC	30
		Sodium	1,830	1,960	7	30
		Thallium	ND	0.90	NC	30
		Zinc	8.5	6.6	25	30

Notes: SDG = sample delivery group.
ID = identification.
RPD = relative percent difference.
% = percent.
µg/kg = micrograms per kilogram.
ND = not detected.
NC = not calculable.
TAL = target analyte list.
mg/kg = milligrams per kilogram.
TRPH = total recoverable petroleum hydrocarbons.

$$RPD = 100 \times \frac{|D_1 - D_2|}{0.5\,(D_1 + D_2)} \qquad (1)$$

Table 4-2
Accuracy Exceedances for MS/MSD Samples

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SDG Number	MS/MSD Sample ID	Analyte	% Recovery MS/MSD	Control Limits (%)
Surface Soil				
WF008				
Organics (µg/kg)	15S02001	1,4-Dichlorobenzene	--/14	28 to 104
		1,2,4-Trichlorobenzene	--/12	38 to 107
		Acenaphthene	--/--	--
		2,4-Dinitrotoluene	100/94	28 to 89
		Pyrene	--/6	35 to 142
WF009				
Organics (µg/kg)	15S00101	2-Chlorophenol	16/--	25 to 102
		1,4-Dichlorobenzene	0/0	28 to 104
		1,2,4-Trichlorobenzene	0/3	38 to 107
		Acenaphthene	0/9	31 to 137
		Pentachlorophenol	10/--	17 to 109
		Pyrene	0/0	35 to 142
Groundwater				
WF024	15G00701	4-Nitrophenol	100/102	10 to 80
		2,4-Dinitrotoluene	102/106	24 to 96
		Pentachlorophenol	9/103	9 to 103
WF025	15G00601	4-Nitrophenol	99/102	10 to 80
		2,4-Dinitrotoluene	101/103	24 to 96
		Pentachlorophenol	124/130	9 to 103
WF026	15G00803	4-Chloro-3-methylphenol	99/--	23 to 97
		4-Nitrophenol	108/114	10 to 80
		Pentachlorophenol	104/104	9 to 103
		2,4-Dinitrotoluene	--/100	24 to 96
WF037	15G00803	--	--	--
WF053	15G00602	--	--	--
WF054	15G00801	--	--	--

Notes: MS/MSD = matrix spike and matrix spike duplicate.
SDG = sample delivery group.
ID = identification.
% = percent.
-- = not detected.

A summary of the surrogate spike samples and the surrogate compounds that were outside control limits for the Phase IIB samples collected at Site 15 is presented in Table 4-3. The required control limits were also identified for each surrogate compound. All the samples associated with these surrogates were qualified in accordance with the USEPA functional guidelines as presented in Subsection 3.3.4 of the GIR (ABB-ES, 1998).

Initial calibrations were performed to ensure that the instrument was capable of producing acceptable qualitative and quantitative data for TCL VOCs. Initial calibration demonstrates that the instrument is capable of acceptable performance in the beginning of the analytical run and of producing a linear calibration curve. Continuing calibrations were performed to ensure that the instrument was capable of reproducing acceptable qualitative and quantitative data.

Continuing calibration establishes the 12-hour relative response factor (RRF) on which the quantitations are based and checks satisfactory performance of the instrument on a day-to-day basis. Initial and continuing calibrations for organic analytes are measured by the percent relative standard deviation (%RSD) for initial calibrations and the percent difference (%D) for continuing calibrations. Table 4-4 summarizes the organic compounds that exceeded the initial or continuing calibrations for surface soil and groundwater samples collected at Sites 15.

The evaluation of the %RSD for the initial calibrations and the %D for the continuing calibrations indicate that the response factors for the system performance check compounds generally met the required criteria for VOCs, SVOCs, pesticides, and PCBs. Samples associated with those SDGs in which certain VOCs, SVOCs, pesticides, and PCBs exhibiting an RRF which does not meet the minimum requirements were qualified as J/UJ.

<u>4.2.3 Representativeness</u> Representativeness is the degree to which the data obtained from an environmental sample accurately reflects the presence or absence of contamination at a site. Field quality control samples (including source water blanks, equipment rinse blanks, and trip blanks) and laboratory quality control samples (including method blanks [organic analyses] and preparation blanks [inorganic analysis]) were used to assess representativeness. Representativeness also is assessed by review of the adherence to extraction and analysis holding times. The evaluation of representativeness in field quality control samples for Site 15 SDGs is presented in Table 4-5 and summarized below.

Trip Blanks. Acetone and methylene chloride were detected in trip blanks with a concentration ranging from 2 to 19 micrograms per liter ($\mu g/\ell$) for acetone and 1 to 2 $\mu g/\ell$ for methylene chloride. Both acetone and methylene chloride are widely recognized as laboratory contaminants commonly introduced during the calibration or cleaning of equipment.

Environmental samples associated with the trip blanks with results greater than the instrument detection limit (IDL) but less than 10 times the amount detected in the trip blank were appropriately annotated with a J or UJ qualifier (LDC, 1996).

Rinsate Blanks. One VOC (acetone) was detected at concentrations ranging from 6-12 $\mu g/\ell$ in surface soil and groundwater rinsate blanks. One SVOC (di-*n*-butylphthalate) was detected at concentrations ranging from 3 to 6 $\mu g/\ell$.

Table 4-3
Accuracy Summary for Surrogate Recoveries Outside QC Criteria

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SDG Number	Sample ID	Spiked Analyte	Surrogate Recovery (%R)	QC Limits (percent)
WF008	15S02501	Decachlorobiphenyl	54	60 to 150
WF024	BKG00203	Decachlorobiphenyl	52/48	60 to 150
WF025	15G00101	Decachlorobiphenyl	21/20	60 to 150
	15G00303	Tetrachloro-m-xylene	57/58	60 to 150
	15G00502	Tetrachloro-m-xylene	155/162	60 to 150
	15R01301	Decachlorobiphenyl	59	60 to 150
	15G00502RE	Decachlorobiphenyl	53/54	60 to 150
WF026	15G00802	2-Fluorobiphenyl	161	43 to 116
		Terphenyl-d14	163	33 to 141
	15G00802R	2-Fluorobiphenyl	182	43 to 116
		Terphenyl-d14	153	33 to 141
	15G00201	Decachlorobiphenyl	52/50	60 to 150
	15G00202	Decachlorobiphenyl	58/58	60 to 150
	15G00801	Decachlorobiphenyl	43/38	60 to 150
	15G00803	Decachlorobiphenyl	58/58	60 to 150
	16G00201	Decachlorobiphenyl	43/37	60 to 150
	16G00203	Decachlorobiphenyl	44/43	60 to 150
	16G00403	Decachlorobiphenyl	40/39	60 to 150
	16G00403D	Decachlorobiphenyl	47/46	60 to 150
	16G00601	Decachlorobiphenyl	25/25	60 to 150

Notes: QC = quality control.
% = percent recovery.
SDG = sample delivery group.
ID = identification.

Table 4-4
Summary of Compounds Exceeding Instrument Calibration for Site 15 SDGs

Remedial Investigation Report
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SDG	Compound	Initial Calibration (%RSD)	Continuing Calibration (%D)	Qualifier
WF008	Nitrobenzene	--	25.6	UJ
	Pentachlorophenol	--	29.6	UJ
	2,4-Dinitrophenol	--	42.0	UJ
	4-Nitrophenol	--	27.3	UJ
	Pentachlorophenol	--	34.8	UJ
	3,3'-Dichlorobenzidine	--	25.9	UJ
	Benzo(b)fluoranthene	--	27.7	UJ
	Delta-BHC	21.7	--	UJ
	Alpha-BHC	20.3	--	UJ
WF009	Nitrobenzene	--	25.6	UJ
	Pentachlorophenol	--	29.6	UJ
	2,4-Dinitrophenol	--	42.0	UJ
	4-Nitrophenol	--	27.3	UJ
	Pentachlorophenol	--	34.8	UJ
	3,3'-Dichlorobenzidine	--	25.9	UJ
	Benzo(b)fluoranthene	--	27.7	UJ
WF024	Acetone	30.2	--	J
	Acetone	33.8	--	J
	Chloroethane	--	29.5	J
	Carbon disulfide	--	30.8	J
	Methylene chloride	--	41.0	J
	4-Nitroaniline	--	28.7	J
	Chrysene	--	29.5	J
	Indeno(1,2,3-cd)pyrene	--	28.1	J
	Dibenz(a,h)anthracene	--	34.0	J
	Benzo(g,h,i)perylene	--	37.6	J
WF025	Acetone	33.8	--	J
	Chloromethane	26.7	--	J
	Chloroethane	28.5	--	J

See notes at end of table.

Table 4-4 (Continued)
Summary of Compounds Exceeding Instrument Calibration for Site 15 SDGs

Remedial Investigation Report
Site 15, Southwest Landfill
Naval Air Station Whiting Field
Milton, Florida

SDG	Compound	Initial Calibration (%RSD)	Continuing Calibration (%D)	Qualifier
WF025 (Continued)				
	Acetone	29.7	--	J
	2,4-Dinitrophenol	--	29.9	J
	4-Nitroaniline	--	27.6	J
	4,6-Dinitro-2-methylphenol	--	30.7	J
	Pyrene	--	30.0	J
	3,3'-Dichlorobenzidine	--	37.0	J
	2,4-Dinitrophenol	--	35.6	J
	4-Nitroaniline	--	29.4	J
	4,6-Dinitro-2-methylphenol	--	32.0	J
	Pentachlorophenol	--	27.8	J
	3,3'-Dichlorobenzidine	--	27.8	J
	4,4'-DDT	23.6	--	J
WF026	Acetone	33.8	--	J
	Chloromethane	--	46.5	J
	Chloroethane	--	77.1	J
	1,1-Dichloroethane	--	28.6	J
	2-Butanone	--	30.3	J
	Chloromethane	--	32.5	J
	Chloroethane	--	32.4	J
	Acetone	--	37.9	J
	Carbon disulfide	--	28.0	J
	2-Butanone	--	27.8	J
	2,4-Dinitrophenol	--	35.6	J
	4-Nitroaniline	--	29.4	J
	4,6-Dinitro-2-methylphenol	--	32.0	J
	Pentachlorophenol	--	27.8	J
	3,3'-Dichlorobenzidine	--	27.8	J
	4-Chloroaniline	--	36.8	J

See notes at end of table.

Table 4-4 (Continued)
Summary of Compounds Exceeding Instrument Calibration for Site 15 SDGs

Remedial Investigation Report
Site 15, Southwest Landfill
Naval Air Station Whiting Field
Milton, Florida

SDG	Compound	Initial Calibration (%RSD)	Continuing Calibration (%D)	Qualifier
WF026 (Continued)				
	3-Nitroaniline	--	37.9	J
	2,4-Dinitrophenol	--	29.3	J
	4-Nitroaniline	--	49.5	J
	4,6-Dinitro-2-methylphenol	--	29.4	J
	Pentachlorophenol	--	29.6	J
	3,3'-Dichlorobenzidine	--	54.1	J
	alpha-BHC	22.2	--	J
	delta-BHC	22.1	--	J
WF037	Di-*n*-octylphthalate	--	25.3	J
	alpha-BHC	23.9	--	J
WF053	Acetone	--	36.4	J
	Acetone	39.1	--	J
	Acetone	--	36.4	J
	Acetone	--	30.3	J

Notes: SDG = sample delivery group.
%RSD = percent relative standard deviation for initial calibrations.
%D = percent difference for continuing calibrations.
-- = not detected.
UJ = analyte was not detected above the reported sample instrument detection limit (IDL); however, the reported concentration is approximate and may not reliably be presumed to be less than the IDL value.
BHC = benzene hexachloride.
J = analyte was positively identified and is reported as an approximate concentration.
DDT = dichlorodiphenyltrichloroethane.

Table 4-5
Representativeness Summary for Field QC Samples for Site 15 SDGs

Remedial Investigation Report
Site 15, Southwest Landfill
Naval Air Station Whiting Field
Milton, Florida

SDG:	WF008		WF009		WF024	WF025			WF026	
Sample ID:	15T00101	15R00101	15T00201	15R00201	15R01201	15T01501	15T01601	15R01301	15T01701	15R01401
Collect Date:	12-09-95	12-11-95	12-11-95	12-11-95	7-31-96	8-5-96	8-8-96	8-7-96	8-12-96	8-14-96
Sample Type:	Trip Blank	Rinsate Blank	Trip Blank	Rinsate Blank	Rinsate Blank	Trip Blank	Trip Blank	Rinsate Blank	Trip Blank	Rinsate Blank
Volatile Organic Compounds (µg/ℓ)										
Acetone	8	--	19	12	6	4	2	--	--	6
Xylene (total)	--	--	--	--	--	--	--	--	--	--
Methylene chloride	--	--	--	--	--	2	1	--	1	--
Semivolatile Organic Compounds (µg/ℓ)										
Di-*n*-butylphthalate	NA	3	NA	4	6	NA	NA	6	NA	6
bis(2-Ethylhexyl)phthalate	NA	--	NA	--	--	NA	NA	--	NA	--
Pesticides and PCBs (µg/ℓ)										
None detected										
Inorganic Analytes (µg/ℓ)										
Aluminum	NA	54.6 UJ	NA	69.8 UJ	13.8 U	NA	NA	--	NA	--
Barium	NA	1.0 J	NA	1.0 J	--	NA	NA	--	NA	--
Beryllium	NA	0.21 UJ	NA	0.29 UJ	--	NA	NA	--	NA	--
Calcium	NA	22.6 UJ	NA	58.5 UJ	--	NA	NA	--	NA	--
Cadmium	--	--	--	--	--	--	--	--	--	--
Chromium	--	--	--	--	--	--	--	--	--	--
Copper	NA	5.0 UJ	NA	6.5 UJ	--	NA	NA	--	NA	--
Iron	NA	45.4 UJ	NA	29.2 UJ	10.5 U	NA	NA	5.3 U	NA	14.8 U
Lead	--	--	--	--	--	--	--	--	--	--
Manganese	NA	--	NA	--	--	NA	NA	--	NA	--
Mercury	--	--	--	--	--	--	--	--	--	--
Nickel	NA	--	NA	48.7 U	--	NA	NA	--	NA	--
Sodium	NA	--	NA	--	55.4 U	NA	NA	26.6	NA	--
Zinc	NA	1.5 UJ	NA	2.7 J	--	NA	NA	1.8 U	NA	1.1
TRPH	NA	--	NA	--	--	NA	NA	--	NA	--
Cyanide	NA	--	NA	--	2.6	NA	NA	--	NA	1.8

See notes at end of table.

Table 4-5 (Continued)
Representativeness Summary for Field QC Samples for Site 15 SDGs

Remedial Investigation Report
Site 15, Southwest Landfill
Naval Air Station Whiting Field
Milton, Florida

SDG:	WF037	WF053					WF054	
Sample ID:	15F00201	15T07201	15T07301	15T07401	15T07501	15R03701	15T07601	15R03801
Collect Date:	11-20-96	7-27-97	7-28-97	7-29-97	7-30-97	7-27-97	8-4-96	8-5-97
Sample Type:	Field Blank	Trip Blank	Trip Blank	Trip Blank	Trip Blank	Rinsate Blank	Trip Blank	Rinsate Blank
Volatile Organic Compounds (μg/ℓ)								
Acetone	--	--	--	--	--	--	--	--
Xylene (total)	2	--	--	--	--	--	--	--
Methylene chloride	--	--	--	--	--	--	--	--
Semivolatile Organic Compounds (μg/ℓ)								
Di-*n*-butylphthalate	4	--	--	--	--	--	--	--
bis(2-Ethylhexyl)phthalate	--	--	--	--	--	--	--	--
Pesticides and PCBs (μg/ℓ)								
None detected								
Inorganic Analytes (μg/ℓ)								
Aluminum	--	--	--	--	--	--	--	--
Barium	1.2	NA	NA	NA	NA	1.6	NA	--
Beryllium	--	--	--	--	--	--	--	--
Cadmium	--	NA	NA	NA	NA	--	NA	4.7
Calcium	111	NA	NA	NA	NA	134	NA	159
Chromium	--	NA	NA	NA	NA	4.2	NA	--
Copper	6.8	NA	NA	NA	NA	2.1	NA	1.3
Iron	--	NA	NA	NA	NA	18.4	NA	13.3
Lead	--	NA	NA	NA	NA	--	NA	--
Manganese	0.43	NA	NA	NA	NA	0.69	NA	0.48
Mercury	--	NA	NA	NA	NA	--	NA	0.05
Nickel	--	NA	NA	NA	NA	--	NA	--
Sodium	2.6	NA	NA	NA	NA	83.0	NA	20.0

See notes at end of table.

Table 4-5 (Continued)
Representativeness Summary for Field QC Samples for Site 15 SDGs

Remedial Investigation Report
Site 15, Southwest Landfill
Naval Air Station Whiting Field
Milton, Florida

SDG:	WF037	WF053					WF054	
Sample ID:	15F00201	15T07201	15T07301	15T07401	15T07501	15R03701	15T07601	15R03801
Collect Date:	11-20-96	7-27-97	7-28-97	7-29-97	7-30-97	7-27-97	8-4-96	8-5-97
Sample Type:	Field Blank	Trip Blank	Trip Blank	Trip Blank	Trip Blank	Rinsate Blank	Trip Blank	Rinsate Blank
Inorganic Analytes (Continued)								
Zinc	2.6	NA	NA	NA	NA	5.0	NA	1.8
TRPH	--	--	--	--	--	--	--	--
Cyanide	--	NA	NA	NA	NA	--	NA	--

Notes: QC = quality control.
SDG = sample delivery group.
ID = identification.
$\mu g/\ell$ = microgram per kilogram.
-- = analyte not detected.
NA = not analyzed.
PCB = polychlorinated biphenyl.
UJ = estimated detection value.
J = estimated value.
U = instrument detection value.
TRPH = total recoverable petroleum hydrocarbons.

Inorganics detected at concentrations exceeding the IDL but less than the contract-required detection limits are aluminum, beryllium, calcium, copper, iron, and zinc. Barium was detected at an estimated 1.0 $\mu g/\ell$ in two rinsate blanks. Cyanide was detected in two groundwater rinsate blanks at concentrations of 1.8 and 2.6 $\mu g/\ell$. TRPH was not detected in any of the rinsate blanks.

Field Blank. One VOC (xylene) was detected in field blank (15F00201) at a concentration of 2 $\mu g/\ell$. One SVOC (di-*n*-butylphthalate) was detected at a concentration of 4 $\mu g/\ell$ in field blank 15F00201). Environmental samples associated with the field blank that reported results greater than the IDL but less than 10 times the amount detected in the field blank were appropriately annotated with a UJ qualifier.

Six inorganic analytes (barium, calcium, copper, manganese, sodium, and zinc) were detected in field blank 15F00201. TRPH and cyanide were not detected in the Site 15 field blank.

Laboratory Method and Preparation Blanks. Concentrations of VOCs, SVOCs and metals were detected in the laboratory method blanks associated with SDGs WF008, WF009, WF024, WF025, WF026, WF037, WF053, and WF054.

Environmental samples associated with method blanks that contained methylene chloride and acetone with results greater than IDL but less than 10 times the amount detected in the laboratory preparation blanks were annotated with UJ qualifier (LDC, 1996). For metals, sample results greater than IDL but less than 5 times the amount detected in the laboratory preparation blanks were appropriately annotated with a J or UJ qualifier (LDC, 1996).

Sampling and analysis holding times for each analytical fraction were met in all samples.

Qualification of the environmental samples were required because of the detection of target analytes in laboratory and field blanks. Qualification of the RI data, based on blank contamination, were performed according to USEPA data validation guidelines (USEPA, 1994a and 1994b). According to the data validation (LDC, 1996), the analytes detected in the QA/QC blanks are considered common contaminants and were found at typical concentrations; therefore, the analytical results are considered to be representative.

4.2.4 Comparability Comparability is the confidence with which one data set can be compared with another and the degree to which the environmental data from each sampling event are considered equivalent. Comparability of the analytical data was assured by using standard operating procedures for sample collection, by using standard chemical analytical methods, and by reporting the analytical results in standard units (SUs). The sampling, shipment, and analytical protocols were consistent with USEPA standard operation procedures and methodologies described in workplans for NAS Whiting Field throughout the period of the RI.

4.2.5 Completeness Completeness is the percentage of useable data reported and validated compared with the total number of measurements made. Useable data are those measurements that were not rejected (qualified with an "R") during the

validation process. None of the analytical data were rejected. The goal for analytical completeness for the RI sampling event was 85 percent useable data. The completeness goal of 85 percent was met for all matrices and all parameters.

4.3 SUMMARY. Based on the results of the QC sample analyses, the established precision, accuracy, and representativeness goals of the project were achieved (Table 4-6). Some field and/or laboratory-derived contamination was present in some of the QC samples, which required the results of some environmental samples to be amended. QC sample results and data validation criteria indicate that a 99 - 100 percent completeness goal was achieved; thus, satisfying the 85 percent goal. Standard methods of analyses and units of measure were used throughout the project; therefore, the QC criteria and the DQOs presented in the workplan were achieved.

Table 4-6
Summary of DQO Assessment - PARCC Parameters

Remedial Investigation Report
Site 15, Southwest Landfill
Naval Air Station Whiting Field
Milton, Florida

Sample Type	Precision[1]	Accuracy[2]	Representativeness	Completeness (%)	Comparability
Surface Soil Samples - Site 15					
SDG WF008 and WF009					
TCL VOC	Acceptable	Acceptable	Acceptable	100	Acceptable
TCL SVOCs	Acceptable	Acceptable	Acceptable	[4]99.5	Acceptable
Pesticides and PCBs	Acceptable	Acceptable	Acceptable	100	Acceptable
TAL metals and total cyanide	Acceptable	Acceptable	Acceptable	100	Acceptable
TRPH	Acceptable	Acceptable	Acceptable	100	Acceptable
Groundwater Samples - Site 15					
SDG WF024, WF025, WF026, WF037, WF053, and WF054					
TCL VOC	Acceptable	Acceptable	Acceptable	100	Acceptable
TCL SVOCs	Acceptable	Acceptable	Acceptable	100	Acceptable
Pesticides and PCBs	Acceptable	Acceptable	Acceptable	100	Acceptable
TAL metals and total cyanides	Acceptable	Acceptable[3]	Acceptable	100	Acceptable

[1] Cumulative of sampling and analytical components.
[2] Analytical component.
[3] The accuracy for cyanide measurements associated with SDG WF037 was found to be unacceptable.
[4] A few samples have results whose concentrations were rejected.

Notes: All the units are expressed as the ratio of number of analytes meeting the quality control criteria to the total number of analytes.

DQO = data quality objective.
PARCC = precision, accuracy, reproducibility, completeness, and comparability.
% = percent.
SDG = sample delivery group.
TCL VOCs = target compound list volatile organic compounds.
TCL SVOCs = target compound list semivolatile organic compounds.
PCB = polychlorinated biphenyl.
TAL = target analyte list.
TRPH = total recoverable petroleum hydrocarbons.

CHAPTER 5.0

5.0 INVESTIGATIVE RESULTS

The following sections present the interpretation of geology and hydrogeology for the southwest disposal area, which includes Sites 15 and 16. Geophysical survey data, as well as analytical results of soil gas, surface soil, subsurface soil, and groundwater sampling events are presented for Site 15.

5.1 GEOLOGIC RESULTS. This section presents the summarized results of the Phase IIA and IIB geologic investigations of Sites 15 and 16, which are in close proximity and share similar geologic characteristics.

Surface soil at the sites is generally described in test pit logs (Appendix D-1) as red-orange to yellowish orange (fine- to very fine-grained) clayey sand or light tan (fine- to very fine-grained) silty sand. The shallow soil (2 to 7 feet bls) tended to be red-orange to light tan in color and contained thin interbedded sand silt and clay layers.

The subsurface lithology (greater then 7 feet bls) of Sites 15 and 16 consists of poorly graded (very fine- to fine- to medium-grained) sand displaying various shades of yellow, brown, and gray. Layers of well-graded sand, clay, and silt are common to the deep borings at both sites (Appendix D). The soil from shallow depths (referred to as interbedded sands, silts, and clays on cross sections) tends to be darker in color and contain significant amounts of clay and silt.

A plan view of Site 15 and 16 is provided on Figure 5-1 and a description of the geology of the two sites is depicted in cross sections shown on Figures 5-2, 5-3, and 5-4. These cross sections show that a continuous clay layer is not present immediately beneath the southwest disposal area. A 3-foot-thick clay layer was encountered sporadically during drilling but is likely discontinuous across the area. Clay was detected at Site 15 in monitoring wells WHF-15-3D and WHF-15-5. These layers are relatively thin and discontinuous. Clay detected at Site 16 occurs beneath the northern area of the landfill (WHF-16-4D) and is not found in the southern area of the landfill. Clay exceeding 30 feet in thickness is present at a depth of approximately 65 feet bls at monitoring well WHF-16-2D (ABB-ES, 1995e). The horizontal extent of this layer is not known.

Detailed lithologic descriptions can be found in the boring and monitoring well logs included in Appendix D of this report. A general discussion of the geology at NAS Whiting Field is presented in Subsection 1.4.5 of the GIR (ABB-ES, 1998).

5.2 HYDROGEOLOGIC RESULTS. The hydrogeologic assessment included determining horizontal and vertical hydraulic gradients, hydraulic conductivities, and seepage velocities.

Water table elevations were measured twice, September 30 through October 1, 1993, and February 8 through 9, 1994, during the RI Phase IIA investigation. Beginning in June 1994, quarterly water table elevations were measured as part the RI Phase IIB investigation. Groundwater measurements were recorded in all available monitoring wells, and the measured water elevation data through January 1996 are provided in Appendix E of the GIR. Measurements recorded since January 1996 are included in this report. Because the groundwater measurement data between the

Figure 5-1 Plan View, Southwest Disposal Area

11 X 17
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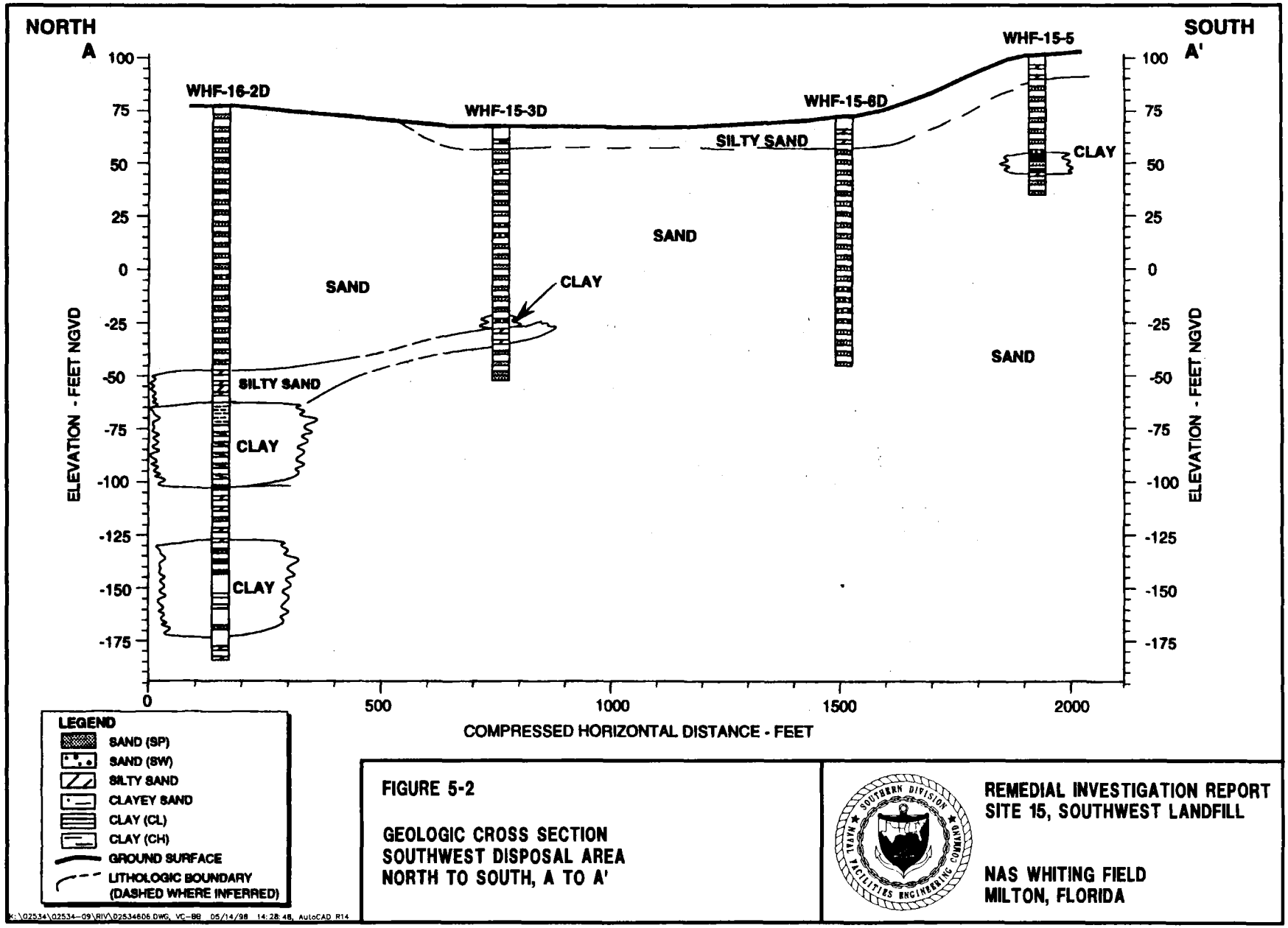

FIGURE 5-2

GEOLOGIC CROSS SECTION
SOUTHWEST DISPOSAL AREA
NORTH TO SOUTH, A TO A'

REMEDIAL INVESTIGATION REPORT
SITE 15, SOUTHWEST LANDFILL

NAS WHITING FIELD
MILTON, FLORIDA

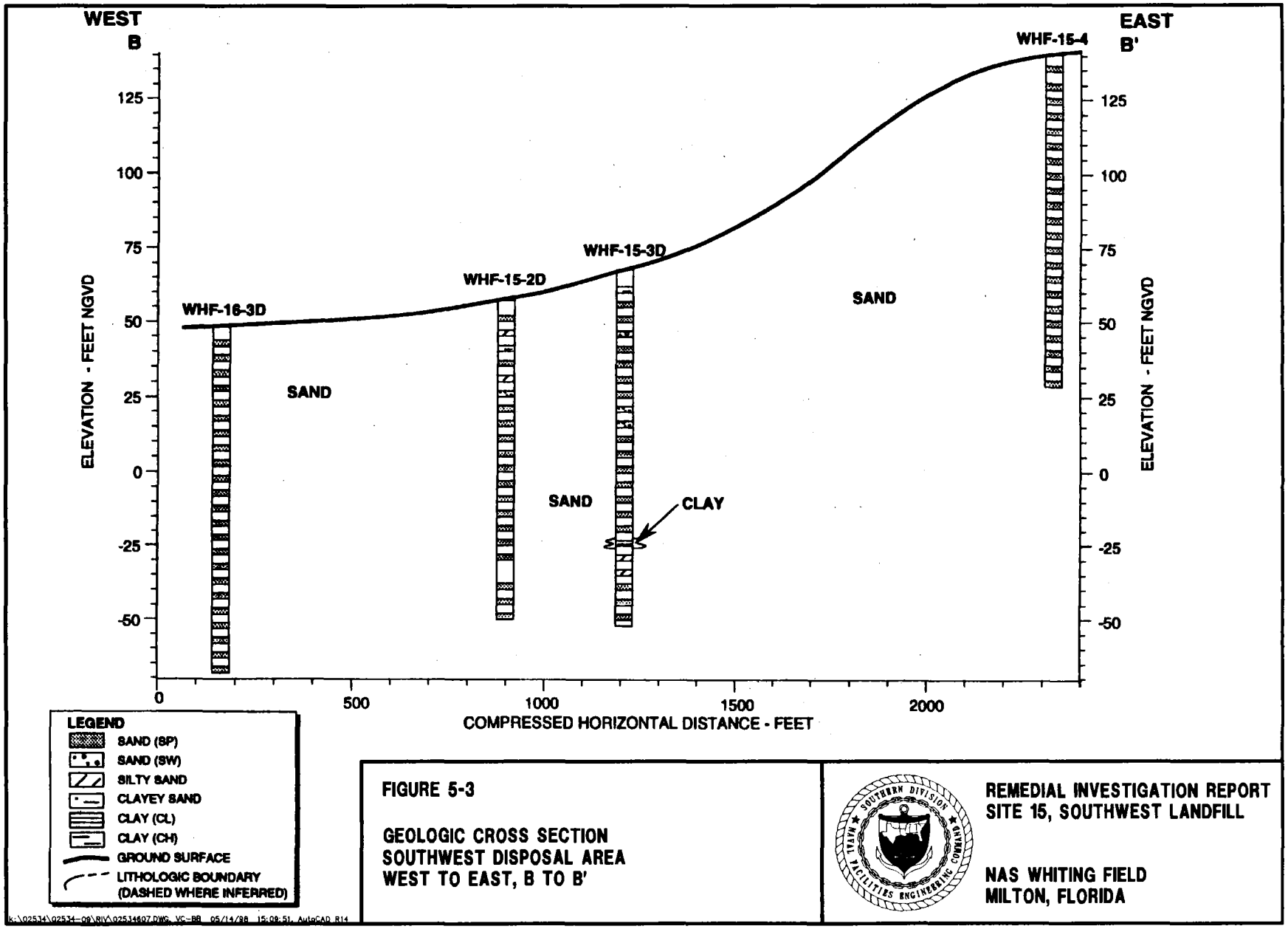

FIGURE 5-3

GEOLOGIC CROSS SECTION
SOUTHWEST DISPOSAL AREA
WEST TO EAST, B TO B'

REMEDIAL INVESTIGATION REPORT
SITE 15, SOUTHWEST LANDFILL

NAS WHITING FIELD
MILTON, FLORIDA

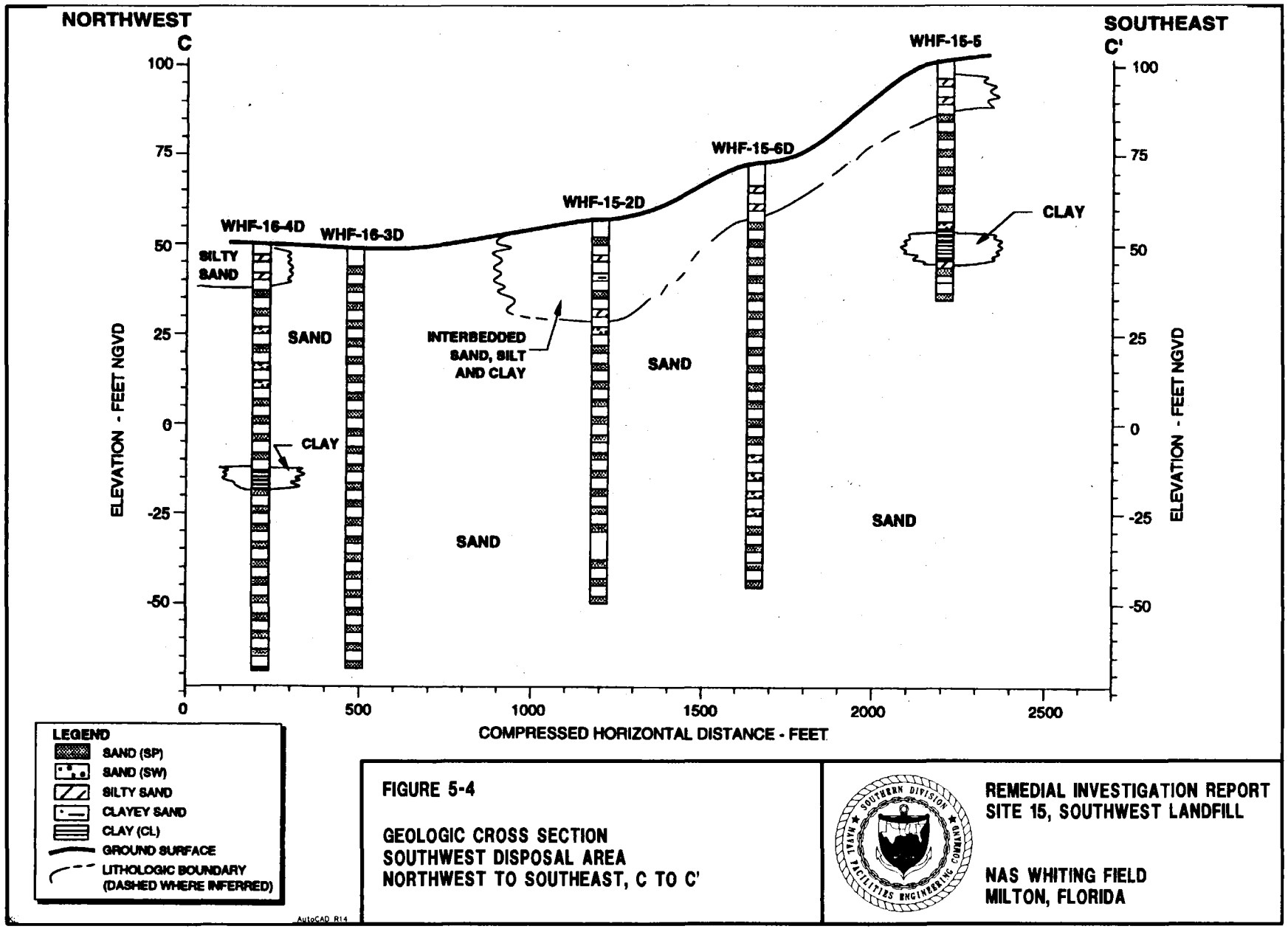

FIGURE 5-4

GEOLOGIC CROSS SECTION
SOUTHWEST DISPOSAL AREA
NORTHWEST TO SOUTHEAST, C TO C'

REMEDIAL INVESTIGATION REPORT
SITE 15, SOUTHWEST LANDFILL

NAS WHITING FIELD
MILTON, FLORIDA

multiple measurement events are similar, a discussion and figures for only the two most recent events (January 16 and 18, 1997, and August 7 and 9, 1997) are presented in this report.

The hydrogeologic assessment results are used to evaluate the transport of human health and ECPC from the site by groundwater flow. Chapter 8.0 of this report covers contaminant fate and transport for human health and ECPC at Site 15.

Groundwater Flow Direction. Table 5-1 summarizes the results of the water-level measurements recorded for the RI/FS sites in the southwest disposal area (i.e., Sites 15 and 16) during the RI field program. Figures 5-5 and 5-6 show groundwater flow patterns as potentiometric surface maps for the periods of January 16 through 18, 1997, and August 7 through 9, 1997. The data from the measurement events indicated a groundwater flow direction to the southwest. Facilitywide water table elevation data are provided in Appendix D of the GIR (ABB-ES, 1998).

Horizontal and Vertical Gradients. Table 5-2 provides a summary of the horizontal hydraulic gradients calculated for the southwest disposal area in January and August 1997. The horizontal hydraulic gradients at Site 15 ranged from 0.0057 foot per foot (ft/ft) (monitoring wells WHF-16-3S and WHF-15-2S) to 0.0082 ft/ft (monitoring wells WHF-15-7S and WHF-15-6S). The horizontal hydraulic gradients at Site 16 ranged from 0.0063 ft/ft (monitoring wells WHF-16-6S and WHF-16-3S) to 0.0069 ft/ft (monitoring wells WHF-16-2S and WHF-16-4S). The average hydraulic gradients for the southwest disposal area in each measurement event were 0.0067 ft/ft for January 1997 and 0.0064 ft/ft for August 1997. The overall average horizontal hydraulic gradient for all measurement events was 0.0066 ft/ft.

Table 5-3 presents a summary of the vertical hydraulic gradients calculated for the southwest disposal area. The vertical hydraulic gradients were calculated using nine well pairs at Site 15 and six well pairs at Site 16 in January and August of 1997. Values calculated for the paired monitoring wells in January ranged from -0.0015 ft/ft (upward movement) to 0.023 ft/ft (downward movement). Vertical hydraulic gradients were mostly in a downward direction.

Hydraulic Conductivity and Seepage Velocity. Slug tests were conducted on 13 monitoring wells during the RI and the hydraulic conductivity values calculated from slug test data are summarized in Table 5-4. A minimum of three trials of rising head slug tests were conducted for each monitoring well in the southwest disposal area. A more detailed presentation of the evaluation of hydraulic conductivity data is presented in Section 2.3 (Table 2-2) of Technical Memorandum No. 4, Hydrogeologic Assessment, January 1995 (ABB-ES, 1995d).

The average hydraulic conductivity values for individual monitoring wells at Site 15 ranged from 0.73 feet per day (ft/day) (2.58×10^{-3} centimeters per second [cm/sec]) for WHF-15-2D to 28 ft/day (9.88×10^{-4} cm/sec) for WHF-15-2I. The geometric mean of the hydraulic conductivity values for Site 15 is 10.8 ft/day (3.81×10^{-4} cm/sec) or approximately 4,000 feet per year (ft/yr).

The average hydraulic conductivity values for individual monitoring wells at Site 16 ranged from 0.27 ft/day (9.5×10^{-2} cm/sec) for WHF-16-3D to 46.5 ft/day

Table 5-1
Summary of Water-Level Elevations

Remedial Investigation Report
Site 15, Southwest Disposal Area
Naval Air Station Whiting Field
Milton, Florida

Monitoring Well Designation	Well TOC Elevation (feet msl)	Well Depth (feet BTOC)	April 25 to 27, 1996		July 25 to 27, 1996	
			Depth to Groundwater (feet BTOC)	Groundwater Elevation (feet above msl)	Depth to Groundwater (feet BTOC)	Groundwater Elevation (feet above msl)
Southwest Disposal Area						
Site 15, Southwest Landfill						
WHF-15-1	66.35	73.60	21.82	44.53	--	--
WHF-15-2S	59.58	32.90	13.45	46.13	14.39	45.19
WHF-15-2I	60.10	63.20	15.33	44.77	16.19	43.91
WHF-15-2D	59.39	112.44	14.68	44.71	15.52	43.87
WHF-15-3S	69.29	37.94	20.17	49.12	21.39	47.90
WHF-15-3I	69.69	87.83	21.41	48.28	22.16	47.53
WHF-15-3D	69.44	119.48	20.68	48.76	21.36	48.08
WHF-15-4S	143.29	109.15	92.11	51.18	92.53	50.76
WHF-15-5S	104.14	68.18	59.38	44.76	60.22	43.92
WHF-15-5I	105.17	98	--	--	61.28	43.89
WHF-15-5D	106.11	128.38	--	--	62.22	43.89
WHF-15-6S	74.29	43.73	29.23	45.06	30.15	44.14
WHF-15-6D	75.08	123.36	30.37	44.71	31.27	43.81
WHF-15-7S	120.18	88.85	--	--	70.76	49.69
WHF-15-7I	119.85	121.5	--	--	70.46	49.71
WHF-15-7D	119.49	147.53	--	--	70.03	49.15
WHF-15-8S	79.67	55	--	--	40.15	39.52
WHF-15-8I	79.48	85.2	--	--	39.98	39.50
WHF-15-8D	79.08	115	--	--	39.57	39.51
Site 16, Open Disposal Burning Area						
WHF-16-1	50.04	43.00	8.94	41.10	9.29	40.75
WHF-16-2	82.19	74.20	33.93	49.73	33.20	48.99
WHF-16-2S	83.66	49.80	32.53	49.66	34.63	49.03
WHF-16-2I	80.60	130.14	31.23	49.37	31.89	48.71
WHF-16-3S	51.69	23.25	10.83	40.86	11.14	40.55
WHF-16-3I	51.31	52.87	10.49	40.82	10.93	40.38
WHF-16-3II	51.22	78.91	10.60	40.62	11.04	40.18
WHF-16-3D	51.40	118.08	6.57	44.83	6.92	44.48
WHF-16-4S	54.79	22.38	10.67	44.12	12.74	42.05
WHF-16-4II	53.01	64.80	11.58	41.43	11.75	41.26
WHF-16-4D	52.87	122.54	11.43	41.44	11.75	41.12
WHF-16-5	37.54	10.00	3.09	34.45	3.16	34.38

See notes at end of table.

Table 5-1 (Continued)
Summary of Water-Level Elevations

Remedial Investigation Report
Site 15, Southwest Disposal Area
Naval Air Station Whiting Field
Milton, Florida

Monitoring Well Designation	Well TOC Elevation (feet msl)	Well Depth (feet BTOC)	April 25 to 27, 1996		July 25 to 27, 1996	
			Depth to Groundwater (feet BTOC)	Groundwater Elevation (feet above msl)	Depth to Groundwater (feet BTOC)	Groundwater Elevation (feet above msl)
Site 16, Open Disposal Burning Area (Continued)						
WHF-16-6S	56.57	26	--	--	12.16	44.41
WHF-16-6D	56.77	62.1	--	--	--	--
WHF-16-7S	38.27	14	--	--	2.96	35.31
WHF-16-7I	38.17	46.5	--	--	1.44	36.73
WHF-16-7D	38.05	75.2	--	--	1.31	36.74
Site 1466, Aviation Gas Disposal Area						
WHF-1466-6S	173.09	131	115.54	57.55	115.54	57.55
WHF-1466-6I	173.06	160	115.52	57.54	115.52	57.54
WHF-1466-6D	173.05	190.5	115.58	57.47	115.58	57.47
WHF-1466-6DD	173.90	220	--	--	--	--

See notes at end of table.

Table 5-1 (Continued)
Summary of Water-Level Elevations

Remedial Investigation Report
Site 15, Southwest Disposal Area
Naval Air Station Whiting Field
Milton, Florida

Monitoring Well Designation	Well TOC Elevation (feet msl)	Well Depth (feet BTOC)	November 7 to 9, 1996	
			Depth to Groundwater (feet BTOC)	Groundwater Elevation (feet above msl)
Southwest Disposal Area				
Site 15, Southwest Landfill				
WHF-15-1	66.35	73.60	23.90	42.45
WHF-15-2S	59.58	32.90	16.10	43.48
WHF-15-2I	60.10	63.20	17.37	42.73
WHF-15-2D	59.39	112.44	15.70	43.69
WHF-15-3S	69.29	37.94	22.77	46.52
WHF-15-3I	69.69	87.83	23.53	46.12
WHF-15-3D	69.44	119.48	22.75	46.69
WHF-15-4S	143.29	109.15	94.45	48.84
WHF-15-5S	104.14	68.18	61.54	42.60
WHF-15-5I	105.17	98	62.63	42.54
WHF-15-5D	106.11	128.38	63.54	42.57
WHF-15-6S	74.29	43.73	31.40	42.89
WHF-15-6D	75.08	123.36	32.45	42.63
WHF-15-7S	120.18	88.85	72.35	48.10
WHF-15-7I	119.85	121.5	72.03	48.14
WHF-15-7D	119.49	147.53	71.63	47.55
WHF-15-8S	79.67	55	41.11	38.56
WHF-15-8I	79.48	85.2	40.95	38.53
WHF-15-8D	79.08	115	40.54	38.54
Site 16, Open Disposal Burning Area				
WHF-16-1	50.04	43.00	9.06	40.98
WHF-16-2	82.19	74.20	34.47	47.72
WHF-16-2S	83.66	49.80	35.87	47.79
WHF-16-2I	80.60	130.14	33.13	47.47
WHF-16-3S	51.69	23.25	12.01	39.68
WHF-16-3I	51.31	52.87	11.71	39.60
WHF-16-3II	51.22	78.91	11.80	39.42
WHF-16-3D	51.40	118.08	7.86	43.54
WHF-16-4S	54.79	22.38	13.81	40.98
WHF-16-4II	53.01	64.80	12.48	40.53
WHF-16-4D	52.87	122.54	12.46	40.41
WHF-16-5	37.54	10.00	3.35	34.19

See notes at end of table.

Table 5-1 (Continued)
Summary of Water-Level Elevations

Remedial Investigation Report
Site 15, Southwest Disposal Area
Naval Air Station Whiting Field
Milton, Florida

Monitoring Well Designation	Well TOC Elevation (feet msl)	Well Depth (feet BTOC)	November 7 to 9, 1996	
			Depth to Groundwater (feet BTOC)	Groundwater Elevation (feet above msl)
Site 16, Open Disposal Burning Area (Continued)				
WHF-16-6S	56.57	26	13.46	43.11
WHF-16-6D	56.77	62.1	13.59	43.18
WHF-16-7S	38.27	14	3.68	34.59
WHF-16-7I	38.17	46.5	1.93	36.24
WHF-16-7D	38.05	75.2	1.79	36.26
Site 1466, Aviation Gas Disposal Area				
WHF-1466-6S	173.09	131	117.20	55.89
WHF-1466-6I	173.06	160.06	117.20	55.86
WHF-1466-6D	173.05	190.5	117.22	55.83
WHF-1466-6DD	172.90	220	117.09	55.77

See notes at end of table.

Table 5-1 (Continued)
Summary of Water-Level Elevations

Remedial Investigation Report
Site 15, Southwest Disposal Area
Naval Air Station Whiting Field
Milton, Florida

Monitoring Well Designation	Well TOC Elevation (msl)	Well Depth (feet BTOC)	January 16 to 18, 1997		August 7 to 9, 1997	
			Depth to Groundwater (feet BTOC)	Groundwater Elevation (feet above msl)	Depth to Groundwater (feet BTOC)	Groundwater Elevation (feet above msl)
Southwest Disposal Area						
Site 15, Southwest Landfill						
WHF-15-1	66.35	73.60	24.54	41.81	25.51	40.84
WHF-15-2S	59.58	32.90	16.79	42.79	18.09	41.49
WHF-15-2I	60.10	63.20	18.01	42.09	18.93	41.17
WHF-15-2D	59.39	112.44	17.33	42.06	18.24	41.15
WHF-15-3S	69.29	37.94	23.63	45.66	24.80	44.49
WHF-15-3I	69.69	87.83	24.25	45.44	25.57	44.12
WHF-15-3D	69.44	119.48	23.59	45.85	24.85	44.59
WHF-15-4S	143.29	109.15	95.55	47.74	97.24	46.05
WHF-15-5S	104.14	68.18	62.34	41.80	63.40	40.74
WHF-15-5I	105.17	98	63.40	41.77	64.46	40.71
WHF-15-5D	106.11	128.38	64.34	41.77	65.40	40.71
WHF-15-6S	74.29	43.73	32.14	42.15	33.12	41.17
WHF-15-6D	75.08	123.36	33.19	41.89	34.15	40.93
WHF-15-7S	120.18	88.85	73.36	47.09	74.90	45.55
WHF-15-7I	119.85	121.5	73.03	47.14	74.56	45.61
WHF-15-7D	119.49	147.53	72.63	47.18	74.17	45.64
WHF-15-8S	79.67	55	41.67	38.00	41.79	37.88
WHF-15-8I	79.48	85.2	41.48	38.00	42.24	37.24
WHF-15-8D	79.08	115	41.09	37.99	42.35	36.73
Site 16, Open Disposal Burning Area						
WHF-16-1	50.04	43.00	10.26	39.76	10.87	39.17
WHF-16-2	82.19	74.20	--	--	--	--
WHF-16-2S	83.66	49.80	35.26	46.93	36.49	45.70
WHF-16-2I	80.60	130.14	33.88	46.72	35.11	45.49
WHF-16-3S	51.69	23.25	12.23	39.46	12.92	38.77
WHF-16-3I	51.31	52.87	12.04	39.27	12.67	38.64
WHF-16-3II	51.22	78.91	12.12	39.10	12.75	38.47
WHF-16-3D	51.40	118.08	8.34	43.06	9.28	42.12
WHF-16-4S	54.79	22.38	14.15	40.64	14.86	39.93
WHF-16-4II	53.01	64.80	12.81	40.20	13.47	39.54
WHF-16-4D	52.87	122.54	12.80	40.07	13.45	39.42
WHF-16-5	37.54	13.5	3.35	34.19	3.67	33.87

See notes at end of table.

Table 5-1 (Continued)
Summary of Water-Level Elevations

Remedial Investigation Report
Site 15, Southwest Disposal Area
Naval Air Station Whiting Field
Milton, Florida

Monitoring Well Designation	Well TOC Elevation (msl)	Well Depth (feet BTOC)	January 16 to 18, 1997		August 7 to 9, 1997	
			Depth to Groundwater (feet BTOC)	Groundwater Elevation (feet above msl)	Depth to Groundwater (feet BTOC)	Groundwater Elevation (feet above msl)
Site 16, Open Disposal Burning Area (Continued)						
WHF-16-6S	56.57	26	13.96	42.61	14.73	41.84
WHF-16-6D	56.77	62.1	14.18	42.61	15.09	41.68
WHF-16-7S	38.27	14	3.53	34.74	4.00	34.27
WHF-16-7I	38.17	46.5	2.11	36.06	2.50	35.67
WHF-16-7D	38.05	75.2	1.99	36.06	2.39	35.66
Site 1466, Aviation Gas Disposal Area						
WHF-1466-6S	173.09	131	118.48	54.61	120.63	52.46
WHF-1466-6I	173.06	160	118.43	54.63	120.61	52.45
WHF-1466-6D	173.05	190.5	118.50	54.55	120.62	52.43
WHF-1466-6DD	172.90	220	118.37	54.49	120.49	52.37

Notes: TOC = top of casing.
msl = mean sea level.
BTOC = below top of casing.
-- = not available.

Figure 5-5 Groundwater Contour Map of the Water Table in the Sand-and-Gravel Aquifer Southwest Disposal Area, January 1997

11 X 17
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from file

Figure 5-6 Groundwater Contour Map of the Water Table in the Sand-and-Gravel Aquifer Southwest Disposal Area, August 1997

11 x 17
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from file

Table 5-2
Summary of Horizontal Hydraulic Gradients

Remedial Investigation Report
Site 15, Southwest Disposal Area
Naval Air Station Whiting Field
Milton, Florida

Well Designation	Distance Between Wells (feet)	January 16 to 18, 1997		August 7 to 9, 1997	
		Water Level (msl)	Horizontal Gradient (ft/ft)	Water Level (msl)	Horizontal Gradient (ft/ft)
Southwest Disposal Area					
Site 16, Open Disposal Burning Area					
WHF-16-2S	900	46.93	0.0069	45.70	0.0064
WHF-16-4S		40.64		39.93	
WHF-16-6S	495	42.61	0.0063	41.84	0.0062
WHF-16-3S		39.46		38.77	
Site 15, Southwest Landfill					
WHF-15-3S	500	45.66	0.0057	44.49	0.0061
WHF-15-2S		42.79		41.44	
WHF-15-7S	600	47.09	0.0082	45.55	0.0073
WHF-15-6S		42.15		41.17	
WHF-15-4S	900	47.74	0.0066	46.05	0.0059
WHF-15-5S		41.80		40.74	
	Average gradient		0.0067		0.0064

Notes: msl = mean sea level.
ft/ft = feet per foot.

Table 5-3
Summary of Vertical Hydraulic Gradients

Remedial Investigation Report
Site 15, Southwest Disposal Area
Naval Air Station Whiting Field
Milton, Florida

Well Number	Bottom of Well Elevation (msl)	Vertical Distance Between Screens (feet)	January 16 to 18, 1997			August 7 and 9, 1997		
			Groundwater Elevation (msl)	Vertical Gradient (ft/ft)[1]	Vertical Flow Direction	Groundwater Elevation (msl)	Vertical Gradient (ft/ft)	Vertical Flow Direction
Southwest Disposal Area								
Site 15, Southwest Landfill								
WHF-15-2S	32.90	30.3	42.79	0.023	Downward	41.49	0.0106	Downward
WHF-15-2I	63.20	49.74	42.09	0.0006	Downward	41.17	-0.056	Upward
WHF-15-2D	112.44		42.06			44.15		
WHF-15-3S	37.94	49.89	45.66	0.004	Downward	44.49	0.0074	Downward
WHF-15-3I	87.83	31.6	45.44	-0.013	Upward	44.12	0.1117	Downward
WHF-15-3D	119.48		45.85			40.59		
WHF-15-5S	68.18	29.82	41.80	0.001	Downward	40.74	0.001	Downward
WHF-15-5I	98	30.38	41.77	0.0	Stagnant	40.71	0.0009	Downward
WHF-15-5D	128.38		41.77			40.71		
WHF-15-6S	43.73	79.63	42.15	0.003	Downward	41.17	0.003	Downward
WHF-15-6D	123.36		41.89			40.93		
WHF-15-7S	88.85	32.65	47.09	-0.0015	Upward	45.55	-0.0018	Upward
WHF-15-7I	121.5	26.03	47.14	-0.0015	Upward	45.61	-0.0011	Upward
WHF-15-7D	147.53		47.18			45.64		
WHF-15-8S	55	32.5	38.00	0	Stagnant	37.88	0.0197	Downward
WHF-15-8I	85	30	38.00	0.003	Downward	37.24	0.017	Downward
WHF-15-8D	115		37.99			36.73		
Site 16, Open Disposal Burning Area								
WHF-16-3S	23.25	29.12	39.46	0.006	Downward	38.77	0.0045	Downward
WHF-16-3I	52.87	26.54	39.27	0.006	Downward	38.64	0.006	Downward
WHF-16-3II	78.91	39.17	39.10	0.101	Upward	38.47	-0.093	Upward
WHF-16-3D	118.08		43.06			42.12		

See notes at end of table.

Table 5-3 (Continued)
Summary of Vertical Hydraulic Gradients

Remedial Investigation Report
Site 15, Southwest Disposal Area
Naval Air Station Whiting Field
Milton, Florida

Well Number	Bottom of Well Elevation (msl)	Vertical Distance Between Screens (feet)	January 16 to 18, 1997			August 7 and 9, 1997		
			Groundwater Elevation (msl)	Vertical Gradient (ft/ft)[1]	Vertical Flow Direction	Groundwater Elevation (msl)	Vertical Gradient (ft/ft)	Vertical Flow Direction
Site 16, Open Disposal Burning Area (Continued)								
WHF-16-4S	22.38	41.42	40.64	0.0106	Downward	39.93	0.009	Downward
WHF-16-4II	64.80	47.74	40.20	0.0027	Downward	39.54	0.0025	Downward
WHF-16-4D	122.54		40.07			39.42		
WHF-16-6S	26	36.1	42.61	0.0	Stagnant	41.84	0.0044	Downward
WHF-16-6D	62.1		42.61			41.68		
WHF-16-7S	15	29.8	34.74	0.0443	Upward	34.27	0.047	Upward
WHF-16-7I	45	29.2	36.06	0	Stagnant	35.67	0.00034	Downward
WHF-16-7D	75		36.06			35.66		

[1] Vertical gradients are computed as follows: the difference between groundwater elevations of associated monitoring wells is divided by the vertical distance between screened intervals.

Notes: msl = mean sea level.
ft/ft = feet per foot.

Table 5-4
Summary of Hydraulic Conductivity (K) Data from Slug Tests

Remedial Investigation Report
Site 15, Southwest Disposal Area
Naval Air Station Whiting Field
Milton, Florida

Well Number	Range of K (ft/day)	Number of Usable Runs	Average K (ft/min)	Average K (ft/day)	Average K (cm/sec)
Site 15, Southwest Landfill					
WHF-15-2S	6.65 to 6.86	3	0.00469	6.75	2.38×10^{-4}
WHF-15-2I	22.4 to 28.87	5	0.01938	28	9.88×10^{-4}
WHF-15-2D	0.96 to 1.04	6	0.00051	0.73	2.58×10^{-3}
WHF-15-3S	8.88 to 8.95	3	0.0062	8.9	3.14×10^{-4}
WHF-15-3I	20.28 to 23.44	4	0.01533	22	7.76×10^{-4}
WHF-15-3D	4.80 to 5.13	6	0.00393	5.66	1.9×10^{-4}
WHF-15-6S	3.5 to 3.79	3	0.00255	3.6	1.27×10^{-4}
			Geometric Mean	10.8	3.81×10^{-4}
Site 16, Open Disposal Burning Area					
WHF-16-2S	27.20 to 30.96	4	0.020015	28.8	1.01×10^{-5}
WHF-16-2I	9.18 to 10.39	4	0.00676	9.7	3.4×10^{-4}
WHF-16-3S	3.99 to 4.55	3	0.0298	42.9	1.51×10^{-5}
WHF-16-3I	4.92 to 5.28	5	0.00352	5.06	1.78×10^{-4}
WHF-16-3II	43.9 to 49.1	3	0.03228	46.5	1.64×10^{-5}
WHF-16-3D	0.27 to 0.29	3	0.00019	0.27	9.5×10^{-2}
			Geometric Mean	22.2	7.8×10^{-4}

Notes: Average is the arithmetic mean.

ft/day = feet per day.
ft/min = feet per minute.
cm/sec = centimeters per second.

(1.64×10^{-5} cm/sec) for WHF-16-3II. The geometric mean of the hydraulic conductivity values for Site 16 is 22.2 ft/day (7.8×10^{-4} cm/sec) or approximately 8,000 ft/yr.

Seepage Velocity. Table 5-5 summarizes the average linear pore water velocity (seepage velocities) for the water table zone of the sand-and-gravel aquifer for sites in the southwest disposal area. The calculations used an assumed effective porosity (n) of 0.35 for the site. The value represents silty through poorly graded sands (Fetter, 1988). Seepage velocities for Site 15 ranged from 0.02 to 0.08 ft/day and at Site 16 from 0.56 to 0.77 ft/day. The average of the seepage velocity values for the two sites was 0.38 ft/day or approximately 139 (ft/yr).

5.3 GEOPHYSICAL SURVEY. A geophysical survey was conducted of Site 15 by Blackhawk Geosciences in the summer of 1992 (ABB-ES, 1993). Maps of the survey results referred to below are presented as figures and are located in Appendix A. Anomalies observed during the Site 15 survey are described below.

The Site 15 geophysical survey identified five major features: (1) seven linear anomalies oriented north-northeast located centrally in the landfill that appear to be parallel landfill trenches (Figure C-2), (2) three possible anomalies are interpreted to be present at the northern boundary of the site that appear to be buried metal(s) (Figure C-2), (3) an 80-by-40-foot oval shaped area that appears to be buried metal(s) (Figure C-2), (4) an area at the western edge of the site appears to be buried metal(s) (Figure C-3), and (5) two anomalies on the eastern and western perimeters near the southern perimeter that coincide with large steel drainage culverts (Figure C-2). Corresponding anomalies are observed in the EM-31 quadrature (Figure C-3) or in-phase (Figure C-4) conductivity data. The geophysical survey results support evidence of a general disposal area at Site 15. Landfill materials were encountered within the explored depths in 9 of the 10 test pits excavated at or near various geophysical anomalies described above.

5.4 SOIL GAS SCREENING RESULTS. The soil gas screening program consisted of sampling 106 locations at Site 15 to determine if measurable concentrations of total VOCs or methane were present (Figure 3-1). The soil gas samples were measured in the field with either a Portafid II™ or a Foxboro OVA-128™ OVA and recorded. The methodology is described in Section 3.1 of this report. Table 5-6 presents the analytical results obtained from the soil gas survey including total VOCs and methane (filtered reading) from depths of 1.5 and 3.0 feet bls. Figures 5-7 through 5-10 present these analytical results as isopleth maps that were prepared using the data generated by the soil gas screening event. These figures show that soil gas samples collected near the western boundary of the site have measurable concentrations of total VOCs and methane. This suggests that landfilled materials are generating the organic vapors.

5.5 SURFACE SOIL ANALYTICAL RESULTS. Tables 5-7 and 5-8 summarize the analytical results for organic and inorganic analytes respectively detected in 30 surface soil samples and three duplicates at Site 15. Table 5-9 and 5-10 summarize the frequency of detection, range of detection limits, range of detection concentrations, and a comparison to background screening values obtained from the USEPA Region III risk-based concentrations (RBCs) (USEPA, 1998)

Table 5-5
Summary of Seepage Velocities

Remedial Investigation Report
Site 15, Southwest Landfill
Naval Air Station Whiting Field
Milton, Florida

Investigation Area	Monitoring Well Pair	Horizontal Gradient (ft/ft)[1]	K (ft/day)[2]	Effective Porosity (n)	Seepage Velocity (ft/day)[3]
Site 15, Southwest Landfill	WHF-15-3S and WHF-15-2S	0.0057	7.82	0.35	0.02
	WHF-15-7S and WHF-15-6S	0.0082	3.6	0.35	0.08
Site 16, Open Disposal Burning Area	WHF-16-4S and WHF-16-2S	0.0069	28.8	0.35	0.56
	WHF-16-6S and WHF-16-3S	0.0063	42.9	0.35	0.77
				Arithmetic average	0.38

[1] Horizontal gradients are the average value for all groundwater measurements performed between September 30, 1993, and November 9, 1996.
[2] The K is averaged where values are available for both wells in the well pair.
[3] The seepage velocity is computed as follows: seepage velocity = (horizontal gradient) X (K)/(effective porosity).

Notes: ft/ft = feet per foot.
K = hydraulic conductivity.
ft/day = feet per day.

Table 5-6
Summary of Active Soil Gas Survey, August 9 and 26, 1995

Remedial Investigation Report
Site 15, Southwest Disposal Area
Naval Air Station Whiting Field
Milton, Florida

Sample ID	Depth (feet)	Total VOC (ppm)	Methane (ppm)	Methane/VOC (percent)	Rinsate Blank (ppm)
15V001	1.5	0	0	NA	1
	3.0	0	0	NA	
15V002	1.5	>1,000	>1,000	NA	0
	3.0	>1,000	>1,000	NA	
15V003	1.5	0	0	NA	0
	3.0	W	W	NA	
15V004	1.5	97	83	86	0
	3.0	120	98	82	
15V005	1.5	0	0	NA	0
	3.0	0	0	NA	
15V006	1.5	>5,000	>5,000	NA	0
	3.0	>5,000	>5,000	NA	
15V007	1.5	>1,000	>1,000	NA	1
	3.0	>1,000	>1,000	NA	
15V008	1.5	>1,000	>1,000	NA	1
	3.0	>1,000	>1,000	NA	
15V009	1.5	0	0	NA	0
	3.0	0	0	NA	
15V010	1.5	0	0	NA	0
	3.0	0	0	NA	
15V011	1.5	0	0	NA	0
	3.0	0	0	NA	
15V012	1.5	0	0	NA	0
	3.0	0	0	NA	
15V013	1.5	0	0	NA	0
	3.0	0	0	NA	
15V014	1.5	0	0	NA	2.5
	3.0	0	0	NA	
15V015	1.5	0	0	NA	0
	3.0	0	0	NA	

See notes at end of table.

Table 5-6 (Continued)
Summary of Active Soil Gas Survey, August 9 and 26, 1995

Remedial Investigation Report
Site 15, Southwest Disposal Area
Naval Air Station Whiting Field
Milton, Florida

Sample ID	Depth (feet)	Total VOC (ppm)	Methane (ppm)	Methane/VOC (percent)	Rinsate Blank (ppm)
15V016	1.5	0	0	NA	0
	3.0	W	W	NA	
	4.5	>5,000	>5,000	NA	0
	6.0	>5,000	>1,800	NA	
15V017	1.5	>5,000	>5,000	NA	0
	3.0	>3,000	>3,000	NA	
15V018	1.5	4	4	100	0
	3.0	>1,000	>1,000	NA	
15V019	1.5	>1,000	>1,000	NA	0
	3.0	>1,000	>1,000	NA	
15V020	1.5	0	0	NA	0
	3.0	0	0	NA	
15V021	1.5	0	0	NA	0
	3.0	0	0	NA	
15V022	1.5	3	3	100	0
	3.0	3	3	NA	
15V023	1.5	0	0	NA	0
	3.0	0	0	NA	
15V024	1.5	0	0	NA	3
	3.0	0	0	NA	
15V025	1.5	0	0	NA	2
	3.0	0	0	NA	
15V026	1.5	0	0	NA	2
	3.0	0	0	NA	
15V027	1.5	0	0	NA	2
	3.0	>1,000	>1,000	NA	
15V027D	1.5	300	300	97	0
	3.0	>1,000	>5,000	NA	
15V028	1.5	0	0	NA	0
	3.0	35	18	NA	

See notes at end of table.

Table 5-6 (Continued)
Summary of Active Soil Gas Survey, August 9 and 26, 1995

Remedial Investigation Report
Site 15, Southwest Disposal Area
Naval Air Station Whiting Field
Milton, Florida

Sample ID	Depth (feet)	Total VOC (ppm)	Methane (ppm)	Methane/VOC (percent)	Rinsate Blank (ppm)
15V029	1.5	35	28	80	0
	3.0	0	0	NA	
15V030	1.5	W	W	NA	0
	3.0	W	W	NA	
15V031	1.5	W	W	NA	2
	3.0	NS	NS	NA	
15V032	1.5	0	0	NA	0
	3.0	0	0	NA	
15V033	1.5	0	0	NA	0
	3.0	0	0	NA	
15V034	1.5	0	0	NA	0
	3.0	0	0	NA	
15V035	1.5	0	0	NA	0
	3.0	0	0	NA	
15V036	1.5	W	W	NA	2
	3.0	NS	NS	NA	
15V037	1.5	0	0	NA	0
	3.0	0	0	NA	
15V038	1.5	0	0	NA	0
	3.0	0	0	NA	
15V039	1.5	0	0	NA	0
	3.0	0	0	NA	
15V040	1.5	0	0	NA	2.4
	3.0	0	0	NA	
15V041	1.5	0	0	NA	0
	3.0	0	NS	NA	
15V042	1.5	0	0	NA	2
	3.0	0	0	NA	
15V043	1.5	W	W	NA	0
	3.0	W	W	NA	

See notes at end of table.

Table 5-6 (Continued)
Summary of Active Soil Gas Survey, August 9 and 26, 1995

Remedial Investigation Report
Site 15, Southwest Disposal Area
Naval Air Station Whiting Field
Milton, Florida

Sample ID	Depth (feet)	Total VOC (ppm)	Methane (ppm)	Methane/VOC (percent)	Rinsate Blank (ppm)
15V043D	1.5	4	0	87	0
	3.0	W	W	NA	
15V044	1.5	0	0	NA	1
	3.0	NA	NA	NA	
15V045	1.5	0	0	NA	0
	3.0	0	0	NA	
15V046	1.5	0	0	NA	1
	3.0	0	0	NA	
15V047	1.5	0	0	NA	0
	3.0	0	0	NA	
15V048	1.5	0	0	NA	2
	3.0	NA	NA	NA	
15V049	1.5	0	0	NA	1
	3.0	0	0	NA	
15V050	1.5	0	0	NA	2
	3.0	0	0	NA	
15V051	1.5	0	0	NA	4
	3.0	0	0	NA	
15V052	1.5	3,000	2,600	87	0
	3.0	>5,000	>5,000	NA	
15V053	1.5	0	0	NA	2
	3.0	1	1	NA	
15V054	1.5	0	0	NA	0
	3.0	0	0	NA	
15V055	1.5	450	400	89	0
	3.0	>1,000	>1,000	NA	
15V056	1.5	0	0	NA	0
	3.0	0	0	NA	
15V057	1.5	0	0	NA	0
	3.0	0	0	NA	

See notes at end of table.

Table 5-6 (Continued)
Summary of Active Soil Gas Survey, August 9 and 26, 1995

Remedial Investigation Report
Site 15, Southwest Disposal Area
Naval Air Station Whiting Field
Milton, Florida

Sample ID	Depth (feet)	Total VOC (ppm)	Methane (ppm)	Methane/VOC (percent)	Rinsate Blank (ppm)
15V058	1.5	0	0	NA	0
	3.0	0	0	NA	
15V059	1.5	0	0	NA	1
	3.0	0	0	NA	
15V060	1.5	0	0	NA	0
	3.0	0	0	NA	
15V061	1.5	0	0	NA	2
	3.0	0	0	NA	
15V062	1.5	0	0	NA	3
	3.0	NA	NA	NA	
15V063	1.5	0	0	NA	2
	3.0	0	0	NA	
15V064	1.5	0	0	NA	2
	3.0	0	0	NA	
15V065	1.5	0	0	NA	0
	3.0	0	0	NA	
15V066	1.5	0	0	NA	2
	3.0	0	0	NA	
15V067	1.5	0	0	NA	0
	3.0	0	0	NA	
15V068	1.5	0	0	NA	0
	3.0	0	0	NA	
15V069	1.5	0	0	NA	0
	3.0	0	0	NA	
15V070	1.5	0	0	NA	1
	3.0	0	0	NA	
15V071	1.5	0	0	NA	1
	3.0	0	0	NA	
15V072	1.5	0	0	NA	0
	3.0	0	0	NA	

See notes at end of table.

Table 5-6 (Continued)
Summary of Active Soil Gas Survey, August 9 and 26, 1995

Remedial Investigation Report
Site 15, Southwest Disposal Area
Naval Air Station Whiting Field
Milton, Florida

Sample ID	Depth (feet)	Total VOC (ppm)	Methane (ppm)	Methane/VOC (percent)	Rinsate Blank (ppm)
15V073	1.5	0	0	NA	0
	3.0	0	0	NA	
15V074	1.5	0	0	NA	2
	3.0	0	0	NA	
15V075	1.5	0	0	NA	2
	3.0	0	0	NA	
15V076	1.5	0	0	NA	1
	3.0	0	0	NA	
15V077	1.5	0	0	NA	2
	3.0	0	0	NA	
15V078	1.5	0	0	NA	2
	3.0	0	0	NA	
15V079	1.5	0	0	NA	2
	3.0	0	0	NA	
15V080	1.5	0	0	NA	2
	3.0	0	0	NA	
15V081	1.5	0	0	NA	3
	3.0	0	0	NA	
15V082	1.5	0	0	NA	0
	3.0	0	0	NA	
15V083	1.5	0	0	NA	0
	3.0	0	0	NA	
15V084	1.5	0	0	NA	0
	3.0	0	0	NA	
15V085	1.5	0	0	NA	0
	3.0	0	0	NA	
15V086	1.5	0	0	NA	1
	3.0	0	0	NA	
15V087	1.5	0	0	NA	1
	3.0	0	0	NA	

See notes at end of table.

Table 5-6 (Continued)
Summary of Active Soil Gas Survey, August 9 and 26, 1995

Remedial Investigation Report
Site 15, Southwest Disposal Area
Naval Air Station Whiting Field
Milton, Florida

Sample ID	Depth (feet)	Total VOC (ppm)	Methane (ppm)	Methane/VOC (percent)	Rinsate Blank (ppm)
15V088	1.5	0	0	NA	0
	3.0	0	0	NA	
15V089	1.5	0	0	NA	2
	3.0	0	0	NA	
15V090	1.5	0	0	NA	0
	3.0	0	0	NA	
15V091	1.5	0	0	NA	2
	3.0	0	0	NA	
15V092	1.5	0	0	NA	3
	3.0	0	0	NA	
15V093	1.5	0	0	NA	7
	3.0	0	0	NA	
15V094	1.5	0	0	NA	2
	3.0	0	0	NA	
15V095	1.5	0	0	NA	0
	3.0	W	W	NA	
15V096	1.5	>1,000	>1,000	NA	0
	3.0	>1,000	>1,000	NA	
15V097	1.5	>5,000	>5,000	NA	0
	3.0	>5,000	>5,000	NA	
15V098	1.5	>5,000	>5,000	NA	0
	3.0	>5,000	>5,000	NA	
15V099	1.5	1	W	NA	0
	3.0	NA	NA	NA	
15V100	1.5	0	0	NA	0
	3.0	0	0	NA	
15V101	1.5	0	0	NA	0
	3.0	0	0	NA	
15V102	1.5	0	0	NA	0
	3.0	0	0	NA	

See notes at end of table.

Table 5-6 (Continued)
Summary of Active Soil Gas Survey, August 9 and 26, 1995

Remedial Investigation Report
Site 15, Southwest Disposal Area
Naval Air Station Whiting Field
Milton, Florida

Sample ID	Depth (feet)	Total VOC (ppm)	Methane (ppm)	Methane/VOC (percent)	Rinsate Blank (ppm)
15V103	1.5	0	0	NA	0
	3.0	0	0	NA	
15V104	1.5	0	NA	NA	0
	3.0	>1,000	>1,000	NA	
15V105	1.5	0	0	NA	0
	3.0	0	0	NA	
15V106	1.5	0	0	NA	0
	3.0	0	0	NA	

Notes: ID = identification.
VOC = volatile organic compound.
ppm = parts per million.
NA = not available; calculation cannot be made.
> = greater than.
W = water-saturated soil.
NS = not sampled.

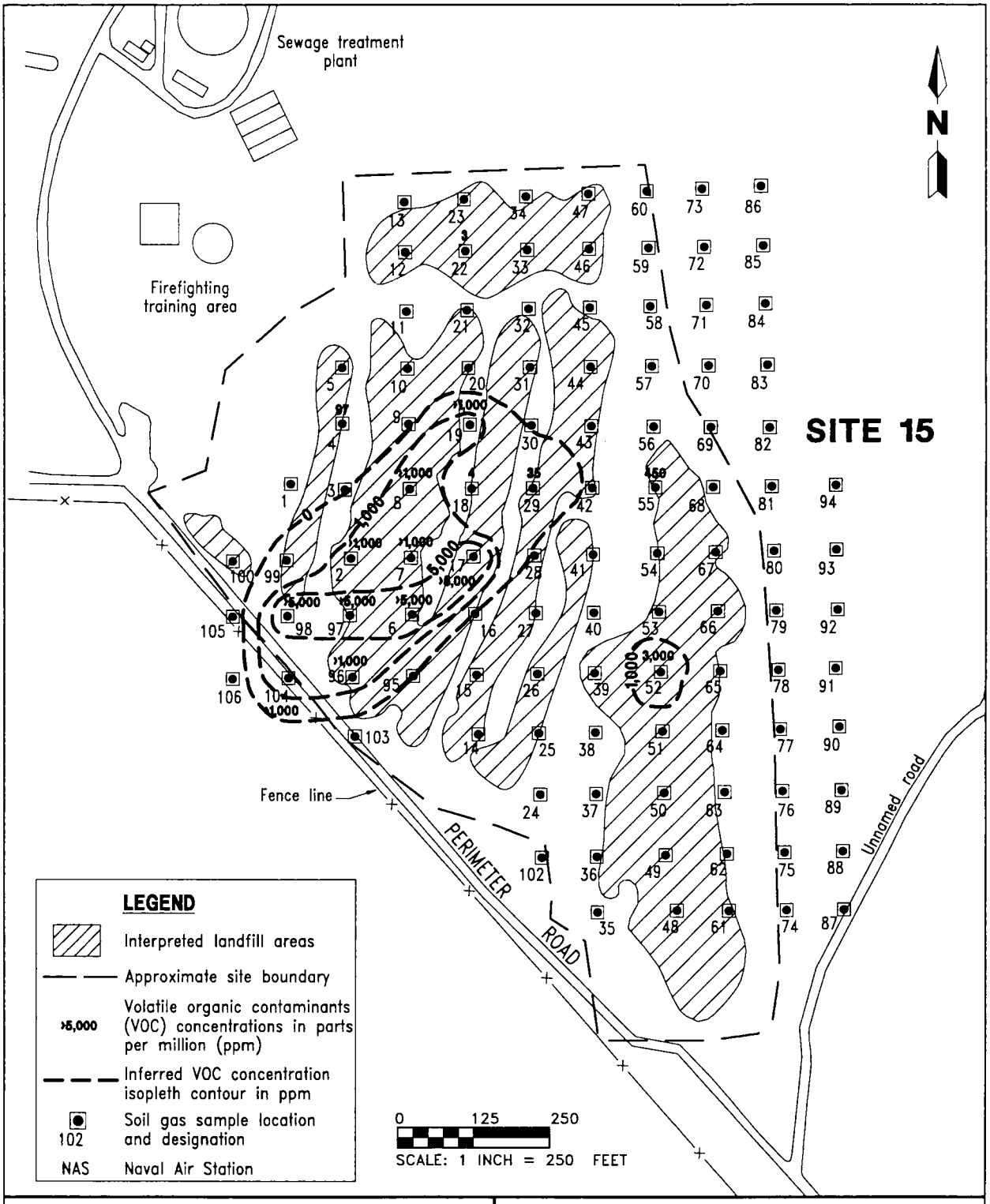

FIGURE 5-7
DISTRIBUTION OF INTERPRETED TOTAL VOC CONCENTRATIONS DETECTED AT 1.5 FEET BELOW LAND SURFACE IN SOIL GAS FIELD SCREENING SAMPLES

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REMEDIAL INVESTIGATION REPORT
SITE 15, SOUTHWEST LANDFILL

NAS WHITING FIELD
MILTON, FLORIDA

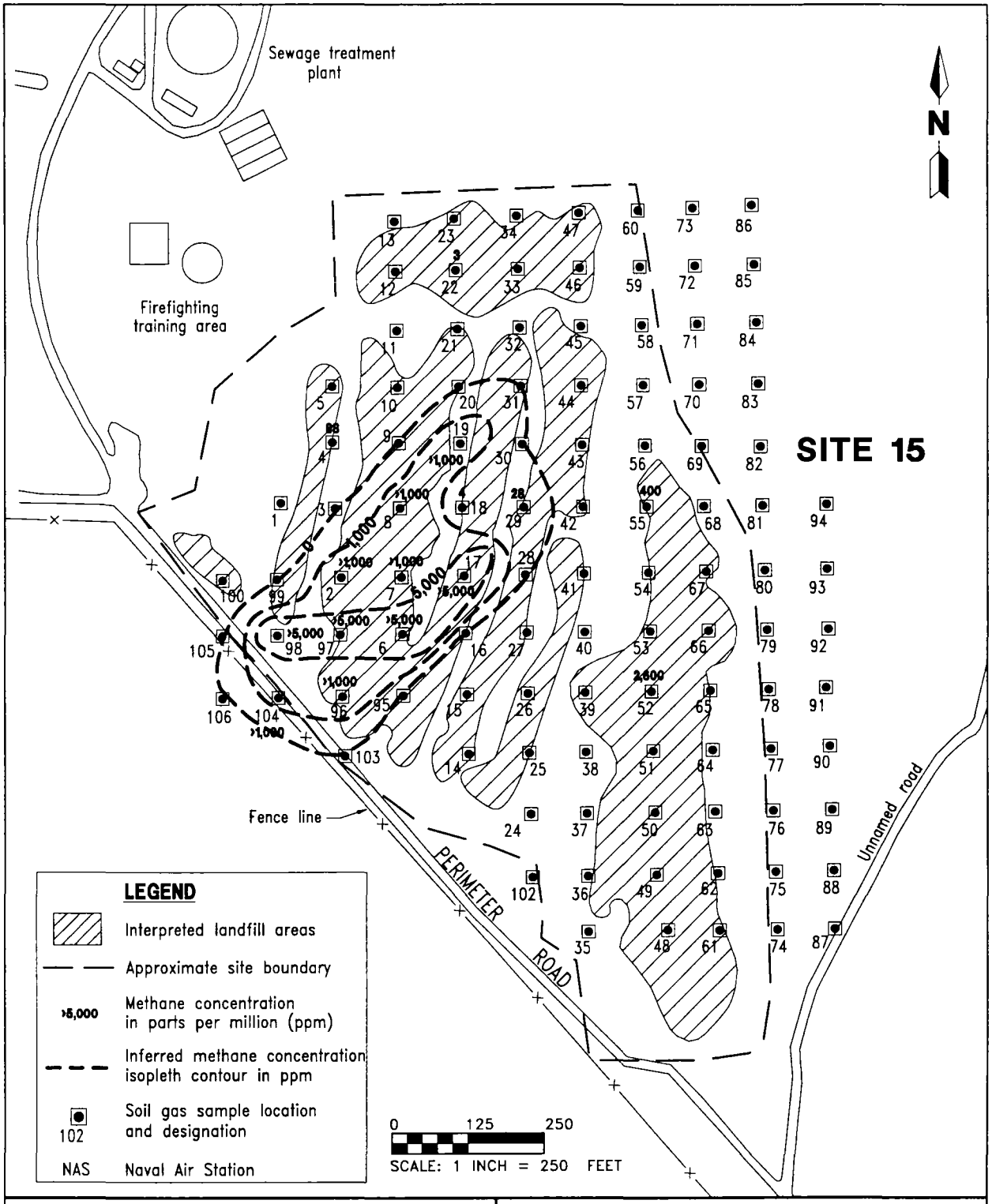

FIGURE 5-8
DISTRIBUTION OF INTERPRETED METHANE CONCENTRATIONS DETECTED AT 1.5 FEET BELOW LAND SURFACE IN SOIL GAS FIELD SCREENING SAMPLES

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REMEDIAL INVESTIGATION REPORT
SITE 15, SOUTHWEST LANDFILL

NAS WHITING FIELD
MILTON, FLORIDA

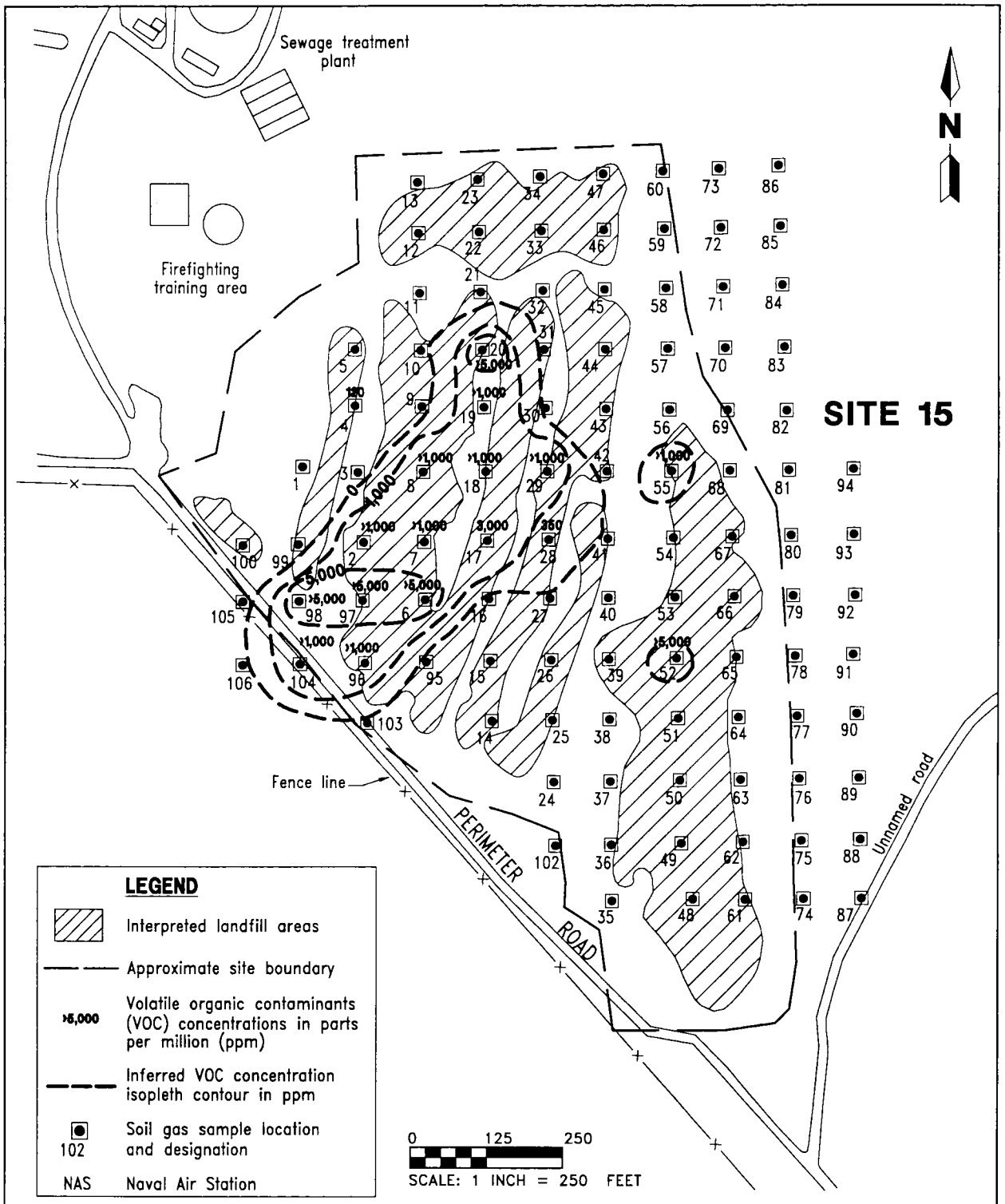

FIGURE 5-9
DISTRIBUTION OF INTERPRETED TOTAL VOC CONCENTRATIONS DETECTED AT 3.0 FEET BELOW LAND SURFACE IN SOIL GAS FIELD SCREENING SAMPLES

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REMEDIAL INVESTIGATION REPORT
SITE 15, SOUTHWEST LANDFILL

NAS WHITING FIELD
MILTON, FLORIDA

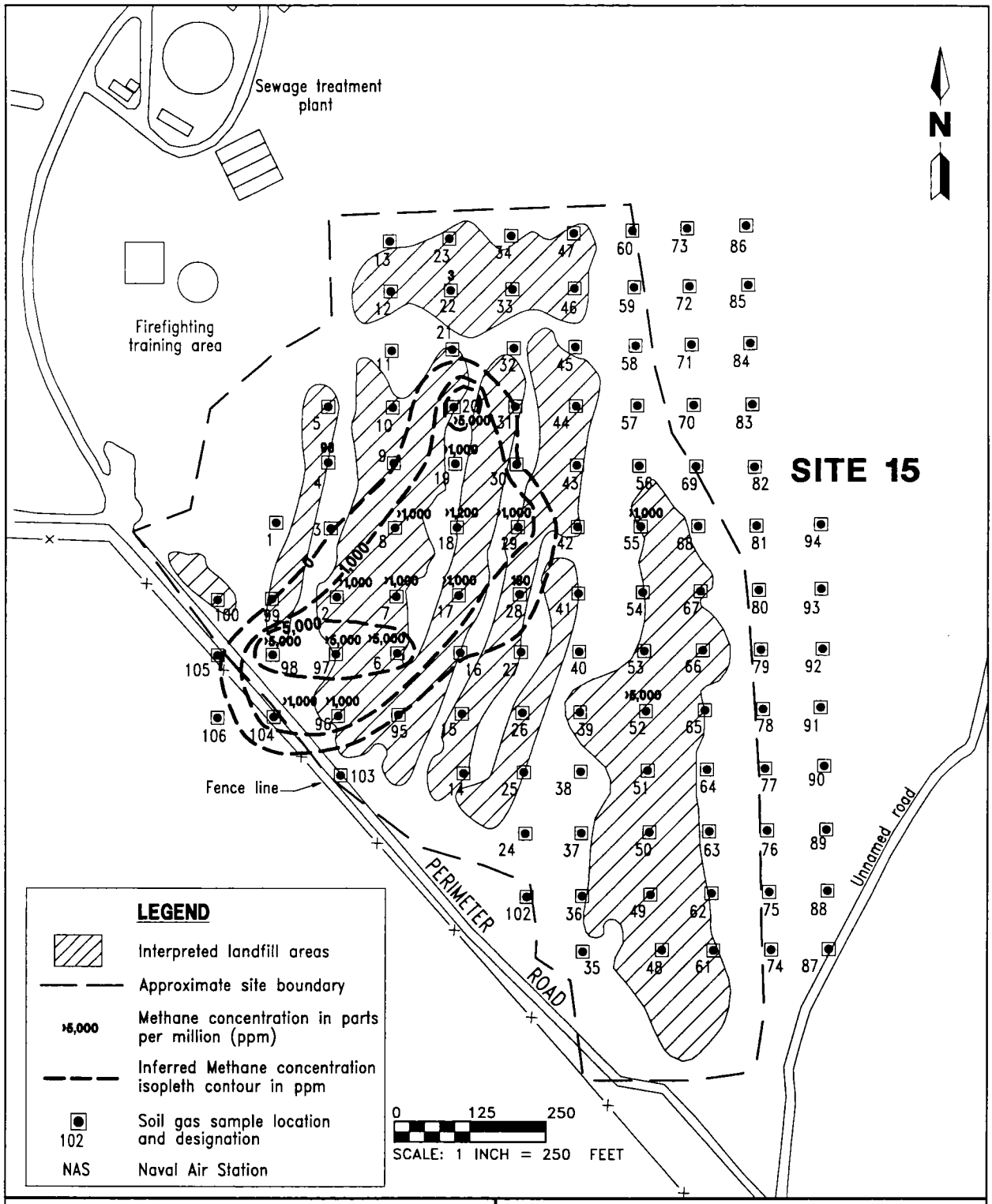

FIGURE 5-10
DISTRIBUTION OF INTERPRETED METHANE CONCENTRATIONS DETECTED AT 3.0 FEET BELOW LAND SURFACE IN SOIL GAS FIELD SCREENING SAMPLES

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REMEDIAL INVESTIGATION REPORT
SITE 15, SOUTHWEST LANDFILL

NAS WHITING FIELD
MILTON, FLORIDA

Table 5-7
Summary of Analytical Results for Organic Compounds Detected in Site 15 Surface Soil Samples

Remedial Investigation Report
Site 15, Southwest Landfill
Naval Air Station Whiting Field
Milton, Florida

Sample Identifier:	15-SL-01	15-SL-02	15-SL-03	15-SL-04	15-SL-05	15S00101	15S00101(DUP)	15S00201
Laboratory Sample No:	S22454005	S22454006	S22454007	S22454008	S22454009	G8914002	G8914003	G8914004
Collection Date:	11-AUG-92	11-AUG-92	11-AUG-92	11-AUG-92	11-AUG-92	11-DEC-95	11-DEC-95	11-DEC-95
Sample Depth (inches bls):	0 to 12	0 to 12	0 to 12	0 to 12	0 to 12	0 to 12	0 to 12	0 to 12
Volatile Organic Compounds (µg/kg)								
Acetone	--	--	--	--	--	--	--	--
Methylene chloride	--	--	--	--	--	--	--	--
Xylenes (total)	--	1.0 J	2.0 J	4 J	--	--	--	--
Semivolatile Organic Compounds (µg/kg)								
Di-*n*-butylphthalate	--	--	--	--	--	--	--	1,100
Butylbenzylphthalate	--	--	--	--	--	--	--	240 J
bis(2-Ethylhexyl)phthalate	39 J	--	41 J	--	--	--	1,700	--
Pesticides and PCBs (µg/kg)								
4,4'-DDE	--	--	--	--	--	--	--	--
4,4'-DDD	--	--	--	--	--	--	--	--
4,4'-DDT	--	--	--	--	--	--	--	--

See notes at end of table.

Table 5-7 (Continued)
Summary of Analytical Results for Organic Compounds Detected in Site 15 Surface Soil Samples

Remedial Investigation Report
Site 15, Southwest Landfill
Naval Air Station Whiting Field
Milton, Florida

Sample Identifier:	15S00301	15S00401	15S00501	15S00601	15S00701	15S00801	15S00901	15S01001
Laboratory Sample No:	G8914005	G8914007	G8914006	G8914008	G8914009	G8914010	G8913017	G8914014
Collection Date:	11-DEC-95	11-DEC-95	11-DEC-95	11-DEC-95	11-DEC-95	11-DEC-95	11-DEC-95	10-DEC-95
Sample Depth (inches bls):	0 to 12	0 to 12	0 to 12	0 to 12	0 to 12	0 to 12	0 to 12	0 to 12
Volatile Organic Compounds (µg/kg)								
Acetone	--	--	--	--	--	--	--	--
Methylene chloride	--	--	--	--	--	--	--	--
Xylenes (total)	--	--	--	--	--	--	--	--
Semivolatile Organic Compounds (µg/kg)								
Di-*n*-butylphthalate	790	730	770	850	560	--	--	--
Butylbenzylphthalate	--	--	--	--	--	--	--	--
bis(2-Ethylhexyl)phthalate	--	--	--	--	--	--	--	--
Pesticides and PCBs (µg/kg)								
4,4'-DDE	--	--	--	--	--	--	--	3.1 J
4,4'-DDD	--	--	--	--	--	--	--	--
4,4'-DDT	--	--	--	--	--	--	--	--

See notes at end of table.

Table 5-7 (Continued)
Summary of Analytical Results for Organic Compounds Detected in Site 15 Surface Soil Samples

Remedial Investigation Report
Site 15, Southwest Landfill
Naval Air Station Whiting Field
Milton, Florida

Sample Identifier:	15S01101	15S01201	15S01301	15S01401	15S01501	15S01601	15S01701	15S01701(DUP)
Laboratory Sample No:	G8914013	G8914011	G8913011	G8913010	G8913009	G8913012	G8913013	G8913014
Collection Date:	10-DEC-95	10-DEC-95	09-DEC-95	09-DEC-95	09-DEC-95	09-DEC-92	10-DEC-92	10-DEC-92
Sample Depth (inches bls):	0 to 12	0 to 12	0 to 12	0 to 12	0 to 12	0 to 12	0 to 12	0 to 12
Volatile Organic Compounds (µg/kg)								
Acetone	--	--	--	--	--	--	--	--
Methylene chloride	3.0 J	4.0 J	--	--	--	--	--	--
Xylenes (total)	--	--	--	--	--	--	--	--
Semivolatile Organic Compounds (µg/kg)								
Di-*n*-butylphthalate	--	--	--	--	--	--	--	--
Butylbenzylphthalate	--	--	--	--	--	--	--	--
bis(2-Ethylhexyl)phthalate	--	--	--	170 J	--	--	--	--
Pesticides and PCBs (µg/kg)								
4,4'-DDE	50	--	--	--	--	--	--	--
4,4'-DDD	3.8	--	--	--	--	--	--	--
4,4'-DDT	14	--	4.4	--	--	--	--	--

See notes at end of table.

Table 5-7 (Continued)
Summary of Analytical Results for Organic Compounds Detected in Site 15 Surface Soil Samples

Remedial Investigation Report
Site 15, Southwest Landfill
Naval Air Station Whiting Field
Milton, Florida

Sample Identifier:	15S01801	15S01901	15S02001	15S02001(DUP)	15S02101	15S02201	15S02301	15S02401	15S02501
Laboratory Sample No:	G8913015	G8913016	G8913002	G8913003	G8913004	G8913005	G8913006	G8913007	G8913008
Collection Date:	10-DEC-92	10-DEC-92	09-DEC-92	09-DEC-92	09-DEC-95	09-DEC-95	09-DEC-95	09-DEC-95	09-DEC-95
Sample Depth (inches bls):	0 to 12	0 to 12	0 to 12	0 to 12	0 to 12	0 to 12	0 to 12	0 to 12	0 to 12
Volatile Organic Compounds (μg/kg)									
Acetone	--	--	--	--	11 J	--	--	--	--
Methylene chloride	--	--	--	5.0 J	9.0	--	--	--	--
Xylenes (total)	--	--	--	--	--	--	--	--	--
Semivolatile Organic Compounds (μg/kg)									
Di-*n*-butylphthalate	--	--	--	--	--	--	--	--	--
Butylbenzylphthalate	--	--	--	--	--	--	--	--	--
bis(2-Ethylhexyl)phthalate	--	--	--	--	--	--	--	--	--
Pesticides and PCBs (μg/kg)									
4,4'-DDE	--	--	--	--	1.9 J	--	--	--	--
4,4'-DDD	--	--	--	--	--	--	--	--	--
4,4'-DDT	--	--	--	--	--	--	--	--	--

Notes: DUP = duplicate.
bls = below land surface.
μg/kg = microgram per kilogram.
-- = Concentration of analyte, if present, was less than detection limit.
J = estimated value.
PCB = polychlorinated biphenyl.
DDE = dichlorodiphenyldichloroethene.
DDD = dichlorodiphenyldichloroethane.
DDT = dichlorodiphenyltrichloroethane.

Table 5-8
Summary of Analytical Results for Inorganic Analytes Detected in Site 15 Surface Soil Samples

Remedial Investigation Report
Site 15, Southwest Landfill
Naval Air Station Whiting Field
Milton, Florida

Sample Identifier:	15-SL-01	15-SL-02	15-SL-03	15-SL-04	15-SL-05	15S00101	15S00101(DUP)	15S00201
Laboratory Sample No:	S22454005	S22454006	S22454007	S22454008	S22454009	G8914002	G8914003	G8914004
Collection Date:	11-AUG-92	11-AUG-92	11-AUG-92	11-AUG-92	11-AUG-92	11-DEC-95	11-DEC-95	11-DEC-95
Sample Depth (inches bls):	0 to 12	0 to 12	0 to 12	0 to 12	0 to 12	0 to 12	0 to 12	0 to 12
Inorganic Analytes (mg/kg)								
Aluminum	11,800	5,160	7,450	6,790	4,940	9,280	10,800	6,210
Arsenic	1.6 J	0.93 J	2.2 J	1.0 J	0.98 J	2.0 J	1.9 J	1.3 J
Barium	5.3 J	7.0 J	4.3 J	9.0 J	3.2 J	6.6 J	7.8 J	4.7 J
Beryllium	0.07 J	--	0.08 J	0.09 J	--	--	--	--
Calcium	75.6 J	137 J	79.6 J	78.9 J	136 J	--	--	--
Chromium	10.8	3.3	6.3	3.9	3.8	8.4	8.0	8.1
Cobalt	1.2 J	0.73 J	0.85 J	1.0 J	--	--	--	--
Copper	4.1 J	4.2 J	1.6 J	5.1 J	12.5	--	--	--
Iron	7,760	3,040	4,980	3.460	2,810	5,120	5,700	3,760
Lead	2.8 J	4.4 J	4.4 J	10.7 J	59.9	4.7	3.6	2.8
Magnesium	54.3 J	74.3 J	43 J	93.9 J	57.8 J	109 J	132 J	72.2 J
Manganese	23.1	25.7	9.3	143	13.7	36.4	39.9	35.7
Mercury	--	--	--	--	--	0.02 J	0.02 J	0.01 J
Nickel	--	--	--	--	--	--	--	--
Potassium	--	--	--	--	--	169 J	--	--
Selenium	--	--	--	--	--	--	--	--
Silver	--	--	--	--	--	--	--	0.74 J
Sodium	170 J	174 J	172 J	174 J	179 J	--	--	--
Vanadium	20.6	6.8 J	12.6	8.3 J	7.2 J	13.3	15.1	9.6 J
Zinc	11.3	6.8 J	5.4 J	7.4 J	8.8	4.1 J	5.0	2.8 J
Cyanide	--	--	--	--	--	--	--	0.16 J

See notes at end of table.

Table 5-8 (Continued)
Summary of Analytical Results for Inorganic Analytes Detected in Site 15 Surface Soil Samples

Remedial Investigation Report
Site 15, Southwest Landfill
Naval Air Station Whiting Field
Milton, Florida

Sample Identifier:	15S00301	15S00401	15S00501	15S00601	15S00701	15S00801	15S00901	15S01001
Laboratory Sample No:	G8914005	G8914007	G8914006	G8914008	G8914009	G8914010	G8913017	G8914014
Collection Date:	11-DEC-95	11-DEC-95	11-DEC-95	11-DEC-95	11-DEC-95	11-DEC-95	11-DEC-95	10-DEC-95
Sample Depth (inches bls):	0 to 12	0 to 12	0 to 12	0 to 12	0 to 12	0 to 12	0 to 12	0 to 12
Inorganic Analytes (mg/kg)								
Aluminum	10,200	12,400	5,290	11,900	5,590	10,200	8,400	5,810
Arsenic	2.0 J	2.7	1.2 J	2.1 J	1.0 J	1.8 J	1.7 J	1.5 J
Barium	6.9 J	7.4 J	5.5 J	7.3 J	8.1 J	9.2 J	9.4 J	6.5 J
Beryllium	--	--	--	--	--	--	--	--
Calcium	--	--	--	--	--	89 J	--	--
Chromium	6.9	9.1	4.6	8.5	5.8	8.8	6.1	5.2
Cobalt	--	--	0.55 J	0.49 J	0.58 J	--	0.56 J	--
Copper	--	--	--	--	--	--	--	--
Iron	5,100	6,570	3,490	6,400	2,900	6,700	4,510 J	3,440
Lead	6.0	3.6	3.2	5.5	3.3	4.9	4.4	4.7
Magnesium	133 J	121 J	84.9 J	135 J	121 J	124 J	156 J	85.7 J
Manganese	12.9	34.4	43.3	30.8	112	53.2	35.3	10.9
Mercury	0.01	0.01 J	0.01 J	0.01 J	0.02 J	0.01 J	--	0.01 J
Nickel	--	--	--	--	--	--	--	--
Potassium	131	--	--	--	--	--	137 J	--
Selenium	--	--	--	--	--	0.27 J	--	--
Silver	--	--	0.66 J	--	--	--	--	--
Sodium	--	--	--	--	--	--	--	--
Vanadium	14.5	17.8	7.5 J	17	7.2 J	17.5	11.5	8.6 J
Zinc	6.3	4.9	3.7 J	7.1	3.9 J	5.5	5.4	3.3 J
Cyanide	--	--	--	--	0.31 J	--	--	--

See notes at end of table.

Table 5-8 (Continued)
Summary of Analytical Results for Inorganic Analytes Detected in Site 15 Surface Soil Samples

Remedial Investigation Report
Site 15, Southwest Landfill
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Sample Identifier:	15S01101	15S01201	15S01301	15S01401	15S01501	15S01601	15S01701	15S01701(DUP)
Laboratory Sample No:	G8914013	G8914011	G8913011	G8913010	G8913009	G8913012	G8913013	G8913014
Collection Date:	10-DEC-95	10-DEC-95	09-DEC-95	09-DEC-95	09-DEC-95	09-DEC-92	10-DEC-92	10-DEC-92
Sample Depth (inches bls):	0 to 12	0 to 12	0 to 12	0 to 12	0 to 12	0 to 12	0 to 12	0 to 12
Inorganic Analytes (mg/kg)								
Aluminum	5,060	4,190	5,860	6,220	13,400	7,190	13,700	9,290
Arsenic	0.75 J	0.84 J	1.6 J	1.5 J	6.8	1.5 J	3.7	4.3
Barium	7.4 J	11.4 J	5.5 J	7.0 J	11.8 J	4.9 J	4.4 J	3.8 J
Beryllium	--	--	--	--	--	--	--	--
Calcium	--	115 J	29.3 J	23.3 J	189 J	25.1 J	23.7 J	20.4 J
Chromium	3.7	4.7	4.3	10.2	12.4	5.4	14.8	14
Cobalt	--	0.57 J	--	--	--	--	--	--
Copper	--	7.1	--	--	4.2 J	--	--	--
Iron	2,780	2,500	3,520 J	3,620 J	9,790 J	4,610 J	11,900 J	10,400 J
Lead	3.0	13.8	3.6	3.2	9.7	3.6	4.7	4.1
Magnesium	94.4 J	99 J	74.8 J	84.2 J	114 J	63.6 J	51.2 J	41.8 J
Manganese	52.4	55.3	51.9	56.3	44.3	23.1	10.8	6.8
Mercury	0.02 J	0.19	0.01 J	0.01 J	0.02 J	--	--	--
Nickel	--	--	--	--	--	--	--	--
Potassium	--	--	--	--	--	--	--	--
Selenium	--	--	--	--	0.41 J	--	--	0.25 J
Silver	--	2.0 J	--	--	--	--	--	--
Sodium	--	--	--	--	--	--	--	--
Vanadium	6.8 J	5.6 J	8.5 J	8.6 J	26.2	11.4	35.9	31.8
Zinc	3.2 J	15.9	3.1 J	11.2	5.3	2.7 J	--	--
Cyanide	--	--	--	--	0.09 J	--	--	--

See notes at end of table.

Table 5-8 (Continued)
Summary of Analytical Results for Inorganic Analytes Detected in Site 15 Surface Soil Samples

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Sample Identifier:	15S01801	15S01901	15S02001	15S02001(DUP)	15S02101	15S02201	15S02301	15S02401	15S02501
Laboratory Sample No:	G8913015	G8913016	G8913002	G8913003	G8913004	G8913005	G8913006	G8913007	G8913008
Collection Date:	10-DEC-92	10-DEC-92	09-DEC-92	09-DEC-92	09-DEC-92	09-DEC-92	09-DEC-92	09-DEC-92	09-DEC-92
Sample Depth (inches bls):	0 to 12	0 to 12	0 to 12	0 to 12	0 to 12	0 to 12	0 to 12	0 to 12	0 to 12
Inorganic Analytes (mg/kg)									
Aluminum	6,020	6,040	4,630	5,470	4,050	3,910	3,280	5,410	5,420
Arsenic	1.0 J	1.2 J	1.2 J	1.1 J	1.1 J	0.85 J	0.77 J	1.1 J	1.1 J
Barium	7.7 J	8.4 J	5.6 J	6.6 J	4.4 J	5.2 J	4.5 J	7.3 J	6.9 J
Beryllium	--	--	--	--	--	--	--	--	--
Calcium	--	40.3 J	--	25.2 J	--	27.3 J	27.9 J	36.9 J	36.9 J
Chromium	3.8	5.2	3.0	3.7	2.8	2.8	4.4	3.9	3.3
Cobalt	0.53	0.88 J	--	--	--	--	--	--	--
Copper	--	--	--	--	--	--	--	4.4 J	--
Iron	3,040 J	3,220 J	2,500 J	2,950 J	2,090 J	1,940 J	1,610 J	2,620 J	2,800 J
Lead	3.9	4.2	5.9	5.9	2.8	2.7	2.3	3.7	6.1
Magnesium	108 J	99.1 J	85 J	107 J	74.3 J	81.1 J	65.7 J	106 J	85.7 J
Manganese	116	139	75.2	87.1	43.3	52.1	52.8	86.3	122
Mercury	0.01 J	0.04 J	0.02 J	0.02 J	0.01 J	0.01 J	0.01 J	0.02 J	0.02 J
Nickel	--	--	--	--	--	3.3 J	--	--	--
Potassium	201 J	--	--	--	146 J	--	--	--	--
Selenium	0.24 J	0.3 J	0.26 J	--	--	--	--	--	--
Silver	--	--	--	--	0.67 J	--	--	--	--
Sodium	--	--	--	--	--	--	--	--	--
Vanadium	7.4 J	7.7 J	5.7 J	7.1 J	4.8 J	4.7 J	4.1 J	6.7 J	6.6 J
Zinc	3.5 J	3.7 J	3.0 J	4.1 J	2.7 J	--	2.4 J	4.0 J	3.6 J
Cyanide	--	--	--	--	--	--	--	--	--

Notes: DUP = duplicate sample.
bls = below land surface.
mg/kg = milligrams per kilogram.
J = estimated value.
-- = concentration of analyte, if present, was less than detection limit.

Table 5-9
Summary of Organic Analytes Detected in Surface Soil Samples

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Naval Air Station Whiting Field
Milton, Florida

Analyte	Frequency of Detection[1]	Reporting Limit Range	Detected Concentration Range[2]	Background Screening Concentration[3]	USEPA Region III RBCs[4] Residential/ Industrial	Soil Cleanup Target Levels for Florida Residential/Industrial/Leachability[5]
Volatile Organic Compounds (µg/kg)						
Acetone	1/30	10 to 22	11	NA	[7]780,000/20,000,000	780,000/5,500,000/2,800
Methylene chloride	4/30	5 to 12	3 to 9	NA	[6]85,000/760,000	16,000/23,000/20
Xylenes (total)	3/30	5 to 12	1 to 4	NA	[7]16,000,000/410,000,000	5,900,000/40,000,000/200
Semivolatile Organic Compounds (µg/kg)						
Butylbenzylphthalate	1/30	350 to 430	240	NA	[7]1,600,000/410,000,000	15,000,000/320,000,000/310,000
Dibutylphthalate	6/30	350 to 420	560 to 1,100	NA	[7]780,000/200,000,000	7,300,000/140,000,000/47,000
bis(2-Ethylhexyl)phthalate	4/30	350 to 430	39 to 947.5*	NA	[6]46,000/410,000	76,000/280,000/3,600,000
Pesticides and PCBs (µg/kg)						
4,4'-DDD	1/30	3.5 to 18	3.8	NA	[6]2,700/24,000	4,600/18,000/4,000
4,4'-DDE	3/30	3.5 to 18	1.9 to 50	NA	[6]1,900/17,000	3,300/13,000/18,000
4,4'-DDT	2/30	3.5 to 18	4.4 to 14	NA	[6]1,900/17,000	3,300/13,000/11,000

[1] Frequency of detection is the number of samples in which the analyte was detected over the total number of samples analyzed (excluding rejected values).
[2] The value indicated by an asterisk is the average of a sample and its duplicate. For duplicate samples having one nondetect value, one-half of the contract-required quantification limit/contract-required detection limit is used as a surrogate concentration for the nondetected concentration.
[3] The background screening value is twice the average of detected concentrations for inorganic analytes in background samples. Organic values are one times the mean of the detected concentration. Organic values are included for comparison purposes only.
[4] USEPA Region III RBC Table (October 1, 1998).
[5] Chapter 62-777, Florida Administrative Code, June 1999.
[6] The values correspond to a human cancer risk level of 1 in 1,000,000.
[7] The values correspond to a noncancer hazard quotient of 0.1.

Notes: Samples: 15-SL-01 through 15-SL-05 and 15S00101 through 15S02501.
Duplicate samples: 15S00101D, 15S01701D, and 15S02001D.
Background samples: BKG-SL-02, BKG-SL-06, BKG-SL-07, BKG-SL-08, BKS00101, BKS00201, BKS00301, BKS00401, and BKS00501.
Background duplicate samples: BKS00201D.

µg/kg = micrograms per kilogram.
NA = not applicable.
* = average of sample and duplicate.
PCB = polychlorinated biphenyl.
DDD = dichlorodiphenyldichloroethane.
DDE = dichlorodiphenyldichloroethene.
DDT = dichlorodiphenyltrichloroethane.

Table 5-10
Summary of Inorganic Analytes Detected in Surface Soil Samples

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Analyte	Frequency of Detection[1]	Reporting Limit Range	Detected Concentration Range[2]	Background Screening Concentration[3]	USEPA Region III RBCs[4] Residential/ Industrial	Soil Cleanup Target Levels for Florida Residential/Industrial/Leachability[5]
Inorganic Analytes (mg/kg)						
Aluminum	30/30	40	3,280 to 13,400	15,334	[9]7,800/200,000	72,000/--/SPLP[11]
Arsenic	30/30	2	0.75 to 6.8	4.6	[8]0.43/3.8	0.8/[10]4.62/29
Barium	30/30	40	3.2 to 11.8	23.8	[8]550/14,000	110/87,000/1,600
Beryllium	3/30	0.5 to 1	0.07 to 0.09	0.36	[8]16/410	120/800/63
Calcium	18/30	1,000	22.05* to 262.6*	402	--/--	--/--/--
Chromium[6]	30/30	2	2.8 to 14.4*	10.8	23/610	[8]210/420/38
Cobalt	11/30	0.33 to 10	0.49 to 1.2	3.0	[9]470/12,000	4,700/110,000/SPLP[11]
Copper	8/30	5	1.6 to 12.5	9.4	[9]310/8,200	110/76,000/SPLP[11]
Iron	30/30	20	1,610 to 11,150*	8,588	[9]2,300/61,000	23,000/480,000/SPLP[11]
Lead	30/30	0.6 to 1	2.3 to 59.9	11.4	[7]400	400/920/SPLP[11]
Magnesium	30/30	1,000	43 to 156	258	--/--	--/--/--
Manganese	30/30	3	8.8* to 143	404	[9]160/4,100	1,600/22,000/SPLP[11]
Mercury	22/30	0.06 to 0.1	0.01 to 0.19	0.12	[9]2.3/61	3.4/26/2.1
Nickel	1/30	2.3 to 8	3.3	7.2	[9]160/4,100	110/28,000/130
Potassium	5/30	128 to 1,000	131 to 334.5*	177	--/--	--/--/--
Selenium	6/30	0.39 to1	0.24 to 0.41	0.44	[9]39/1,000	390/10,000/5
Silver	4/30	0.32 to 2	0.66 to 2	0.7	[9]39/1,000	390/9,100/17
Sodium	5/30	1,000	170 to 179	388	--/--	--/--/--
Vanadium	30/30	10	4.1 to 33.85*	21.2	[9]55/1,400	15/7,400/980
Zinc	28/30	4	2.4 to 15.9	15.4	[9]2,300/61,000	23,000/560,000/6,000
Cyanide	3/30	0.24 to 0.5	0.09 to 0.31	0.26	[9]160/4,100	30/28,000/40

See notes at end of table.

Table 5-10
Summary of Inorganic Analytes Detected in Surface Soil Samples

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[1] Frequency of detection is the number of samples in which the analyte was detected over the total number of samples analyzed (excluding rejected values).
[2] The value indicated by an asterisk is the average of a sample and its duplicate. For duplicate samples having one nondetect value, one-half of the contract-required quantification limit/contract-required detection limit is used as a surrogate concentration for the nondetected concentration.
[3] The background screening value is twice the average of detected concentrations for inorganic analytes in background samples.
[4] USEPA Region III RBC Table (October 1, 1998).
[5] Chapter 62-777, Florida Administrative Code, June 1999.
[6] The value is based on hexavalent chromium form.
[7] The value for lead is based on the USEPA Office of Solid Waste and Emergency Response Directive No. 9355.4-12, "Revised Interim Soil Lead Guidance for CERCLA Sites and RCRA Corrective Action Facilities" (USEPA, 1994c).
[8] The values correspond to a human cancer risk level of 1 in 1,000,000
[9] The values correspond to a noncancer hazard quotient of 0.1.
[10] Value is an FDEP-approved site-specific soil cleanup target level for arsenic at covered landfill sites (ABB-ES, 1998, Appendix I; FDEP, 1998)
[11] Leachability values may be derived using the SPLP test to calculate site-specific target levels or may be determined using toxicity characteristic leaching procedure in the event oily wastes are present.

Notes: The average of a sample and its duplicate is used for all table calculations.
Samples: 15-SL-01, 15-SL-02, 15-SL-03, 15-SL-04, 15-SL-05, 15S00101, 15S00201, 15S00301, 15S00401, 15S00501, 15S00601, 15S00701, 15S00801, 15S00901, 15S01001, 15S01101, 15S01201, 15S01301, 15S01401, 15S01501, 15S01601, 15S01701, 15S01801, 15S01901, 15S02001, 15S02101, 15S02201, 15S02301, 15S02401, and 15S02501.
Duplicate samples: 15S00101D, 15S01701D, and 15S02001D.
Background samples: BKG-SL-02, BKG-SL06, BKG-SL-07, BKG-SL-08, BKS00101, BKS00201, BKS00301, BKS00401, and BKS00501.
Background duplicate samples: BKS00201D.
Bold indicates analyte exceeded screening criteria.

mg/kg = milligrams per kilogram.
-- = not applicable.
* = average of sample and duplicate.

and residential, industrial, and leachability soil Cleanup Target Levels (Florida Department of Environmental Protection [FDEP], 1999) for Site 15 surface soil samples. The sample locations are shown on Figure 3-2.

VOCs. Acetone, methylene chloride, and xylenes (total) were the only VOCs detected in the 30 surface soil samples (and three duplicates) collected at Site 15. Detected concentrations of the three VOCs are lower than the USEPA Region III RBCs and the Florida cleanup target levels.

TCL SVOCs. Bis(2-ethylhexyl)phthalate, butylbenzylphthalate, and dibutylphthalate were detected in surface soil samples. Detected concentrations of all three SVOCs are lower than the USEPA Region III RBCs and the Florida soil cleanup target levels.

Pesticides and PCBs. Three pesticides 4,4'-dichlorodiphenyldichloroethene (4,4'-DDE), 4,4'-dichlorodiphenyldichloroethane (4,4'-DDD), and 4,4'-DDT, were detected in surface soil samples. Detected concentrations of all three pesticides are lower than the USEPA Region III RBCs and the Florida soil cleanup target levels. No PCBs were detected in the surface soil samples.

Inorganic Analytes. Twenty-one inorganic analytes were detected in the surface soil samples. Eleven analytes (arsenic, chromium, copper, iron, lead, mercury, potassium, silver, vanadium, zinc, and cyanide) exceeded the background screening values in one or more samples (Table 5-10). Arsenic and vanadium were the only inorganic analytes detected at concentrations exceeding the Florida residential soil cleanup target levels and USEPA Region III RBC residential soil screening criteria, as described below.

Arsenic was detected at concentrations exceeding the Florida residential soil cleanup target level of 0.8 milligrams per kilogram (mg/kg) in 28 surface soil samples and three duplicate samples. Arsenic exceeded the USEPA Region III residential soil screening criteria (0.43 mg/kg) in all surface soil samples and duplicate samples. Arsenic exceeded the USEPA Region III industrial soil screening criteria (3.8 mg/kg) and the FDEP-approved site-specific soil cleanup target level of 4.62 mg/kg (FDEP, 1998) in surface soil sample 15S01501.

Vanadium was detected at concentrations exceeding the Florida residential soil cleanup target level of 15 mg/kg in six surface soil samples and two duplicate samples.

5.6 SUBSURFACE SOIL ANALYTICAL RESULTS. Five subsurface soil samples were collected from 10 of the test pits excavated at Site 15. Samples 15SS0201, 15SS0502, 15SS0603, and 15SS0804 were collected from depths ranging from 10 to 12 feet bls and sample 15SS1005 was collected from a depth of 5 to 6 feet bls. Tables 5-11 and 5-12 summarize the analytical results for organic and inorganic analytes detected in the five subsurface soil samples. Tables 5-13 and 5-14 summarize the frequency of detection, range of detection limits, range of detected concentrations, and comparison to background screening values, USEPA Region III RBCs for industrial-use screening criteria (USEPA, 1998), and FDEP residential, industrial, and leachability soil cleanup target levels (FDEP, 1999). The location of the subsurface soil samples are shown on Figure 3-3.

Table 5-11
Summary of Analytical Results for Organic Compounds Detected in Site 15 Subsurface Soil Samples

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Sample Identifier:	15SS0201	15SS0502	15SS0603	15SS0804	15SS1005
Laboratory Sample No:	22883001	22889004	22889005	228891002	22883001
Collection Date:	02-OCT-92	03-OCT-92	03-OCT-92	04-OCT-92	02-OCT-92
Sample Depth (ft bls):	10 to 11	10 to 12	10 to 12	10 to 11	5 to 6
Volatile Organic Compounds (μg/kg)					
2-Hexanone	3.0 J	--	--	--	--
Chlorobenzene	--	--	--	2.0 J	--
Xylenes (total)	4.0 J	--	5.0 J	5.0 J	6.0 J
Semivolatile Organic Compounds (μg/kg)					
Phenol	53 J	--	--	--	--
1,4-Dichlorobenzene	--	--	--	110 J	--
4-Methylphenol	42 J	--	77 J	--	--
Naphthalene	--	--	140 J	92 J	--
2-Methylnaphthalene	--	--	68 J	76 J	--
Diethylphthalate	41 J	--	--	--	--
bis(2-Ethylhexyl)phthalate	42 J	--	230 J	--	--
Pesticides and PCBs (μg/kg)					
4,4'-DDE	--	--	--	--	2.3 J
Aroclor-1242	--	--	--	2,200	--

Notes: ft bls = feet below land surface.
μg/kg = micrograms per kilogram.
J = estimated value.
-- = concentration of analyte, if present, was less than detection limit.
PCB = polychlorinated biphenyl.
DDE = dichlorodiphenyldichloroethene.

Table 5-12
Summary of Analytical Results for Inorganic Analytes Detected in Site 15 Subsurface Soil Samples

Remedial Investigation Report
Site 15, Southwest Landfill
Naval Air Station Whiting Field
Milton, Florida

Sample Identifier:	15SS0201	15SS0502	15SS0603	15SS0804	15SS1005
Laboratory Sample No:	22883001	22889004	22889005	228891002	22883001
Collection Date:	02-OCT-92	03-OCT-92	03-OCT-92	04-OCT-92	02-OCT-92
Sample Depth (ft bls):	10 to 11	10 to 12	10 to 12	10 to 11	5 to 6
Inorganic Analytes (mg/kg)					
Aluminum	13,900	3,520	7,250	15,100	7,760
Arsenic	2.6	0.63 J	1.5 J	2.6	1.9 J
Barium	5.0 J	1.6 J	9.6 J	13.2 J	6.5 J
Beryllium	0.17 J	--	0.11 J	0.16 J	0.09 J
Cadmium	--	--	2.1	--	--
Calcium	131 J	72.7 J	148 J	267 J	264 J
Chromium	11	3.8	6.6	12.7	6.5
Cobalt	0.71 J	--	--	--	--
Copper	5.9	0.86 J	3.5 J	6.8	3.6 J
Iron	7,520	2,100	3,650	9,640	4,530
Lead	4.3	2.8	5.7	8.4	86.2
Magnesium	78.9 J	18.8 J	109 J	96 J	70.7 J
Manganese	21.4	10	22.9	44.2	28.1
Mercury	0.44 J	0.09 J	0.44 J	0.59	0.43 J
Nickel	2.3 J	--	2.1 J	--	3.0 J
Potassium	137 J	--	157 J	154 J	--
Silver	0.51 J	--	0.48 J	0.62 J	--
Sodium	175 J	165 J	175 J	191 J	182 J
Vanadium	22.5	6.5 J	11.1	25	13.9
Zinc	9.9 J	3.1 J	12.9	19.1	7.4 J
Cyanide	--	0.53 J	0.55 J	--	--

Notes: ft bls = feet below land surface.
mg/kg = milligrams per kilogram.
J = estimated value.
-- = concentration of analyte, if present, was less than detection limit.

Table 5-13
Summary of Organic Subsurface Soil Analytical Results

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Site 15, Southwest Landfill
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Milton, Florida

Analyte	Frequency of Detection[1]	Reporting Limit Range	Detected Concentration Range[2]	Background Screening Concentration[3]	USEPA Region III RBCs (Industrial)[4]	Florida Soil Cleanup Target Levels Residential/Industrial/Leachability[5]
Volatile Organic Compounds (µg/kg)						
2-Hexanone	1/5	11	3	ND	[7]8,200,000	5,100/34,000/1,400
Chlorobenzene	1/5	11	2	ND	[7]4,100,000	30,000/200,000/1,300
Xylenes (total)	4/5	11	4 to 6	ND	[7]410,000,000	5,900,000/40,000,000/200
Semivolatile Organic Compounds (µg/kg)						
Phenol	1/5	350 to 370	53	ND	[7]120,000,000	900,000/390,000,000/50
1,4-Dichlorobenzene	1/5	350 to 370	110	ND	[6]240,000	6,000/9,000/2,200
4-Methylphenol	2/5	350 to 370	42 to 77	ND	[7]1,000,000	250,000/3,000,000/30
Naphthalene	2/5	350 to 370	92 to 140	ND	[7]4,100,000	40,000/270,000/1,700
2-Methylnaphthalene	2/5	350 to 370	68 to 76	ND	[7]4,100,000	80,000/560,000/6,100
Diethylphthalate	1/5	350 to 370	41	ND	160,000,000	54,000,000/920,000,000/86,000
bis(2-Ethylhexyl) phthalate	2/5	350 to 370	42 to 230	80.3	[6]410,000	76,000/280,000/3,600,000
Pesticides and PCBs (µg/kg)						
4,4'-DDE	1/5	3.5 to 37	2.3	ND	[6]17,000	3,300/13,000/18,000
Aroclor-1242	1/5	35 to 370	2,200	ND	[6]2,900	500/2,100/17,000

See notes at end of table.

Table 5-13 (Continued)
Summary of Organic Subsurface Soil Analytical Results

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Milton, Florida

[1] Frequency of detection is the number of samples in which the analyte was detected over the total number of samples analyzed (excluding rejected values).
[2] The value indicated by an asterisk is the average of a sample and its duplicate. For duplicate samples having one nondetect value, one-half of the contract-required quantification limit/contract-required detection limit is used as a surrogate concentration for the nondetected concentration.
[3] The background screening value is twice the average of detected concentrations for inorganic analytes in background samples. Organic values are one times the mean of detected concentration. Organic values are included for comparison purposes only.
[4] USEPA Region III RBC Table (October 1, 1998).
[5] Chapter 62-777, Florida Administrative Code, June 1999.
[6] The values correspond to a human cancer risk level of 1 in 1,000,000.
[7] The values correspond to a noncancer hazard quotient of 0.1.

Notes: The average of a sample and its duplicate is used for all table calculations.
Samples: 15-SL-01, 15-SL-02, 15-SL-03, 15-SL-04, 15-SL-05, 15S00101, 15S00201, 15S00301, 15S00401, 15S00501, 15S00601, 15S00701, 15S00801, 15S00901, 15S01001, 15S01101, 15S01201, 15S01301, 15S01401, 15S01501, 15S01601, 15S01701, 15S01801, 15S01901, 15S02001, 15S02101, 15S02201, 15S02301, 15S02401, and 15S02501.
Duplicate samples: 15S00101D, 15S01701D, and 15S02001D.
Background samples: BKG-SL-02, BKG-SL06, BKG-SL-07, BKG-SL-08, BKS00101, BKS00201, BKS00301, BKS00401, and BKS00501.
Background duplicate samples: BKS00201D.

Bold indicates analyte exceeded screening criteria.
μg/kg = micrograms per kilogram.
PCB = polychlorinated biphenyl.
DDE = dichlorodiphenyldichloroethene.

Table 5-14
Summary of Inorganic Analytes Detected in Subsurface Soil Samples

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Naval Air Station Whiting Field
Milton, Florida

Analyte	Frequency of Detection[1]	Reporting Limit Range	Detected Concentration Range	Background Screening Concentration[2]	USEPA Region III RBCs (Industrial)[3]	Florida Soil Cleanup Target Levels Residential/Industrial/-Leachability[4]
Inorganic Analytes (mg/kg)						
Aluminum	5/5	40	3,520 to 15,100	27,834	[9]200,000	72,000/--/SPLP[10]
Arsenic	5/5	2	0.63 to 2.6	6.2	[8]3.8	0.8/[6]4.62/29
Barium	5/5	40	1.6 to 13.2	15.8	[9]14,000	110/87,000/1,600
Beryllium	4/5	1	0.09 to 0.17	0.26	[8]410	120/800/63
Cadmium	1/5	1	2.1 to 2.1	0.92	[9]100	75/1,300/8
Calcium	5/5	1,000	72.7 to 267	444	--	--/--/--
Chromium[5]	5/5	2	3.8 to 12.7	22.8	[9]610	210/420/38
Cobalt	1/5	10	0.71 to 0.71	1.5	[9]12,000	4,700/110,000/SPLP[10]
Copper	5/5	5	0.86 to 6.8	8.8	[9]8,200	110/76,000/SPLP[10]
Iron	5/5	20	2,100 to 9,640	18,100	[9]61,000	23,000/480,000/SPLP[10]
Lead	5/5	1	2.8 to 86.2	8.4	[7]400	400/920/SPLP[10]
Magnesium	5/5	1,000	18.8 to 109	272	--	--/--/--
Manganese	5/5	3	10 to 44.2	42.6	[9]4,100	1,600/22,000/SPLP[10]
Mercury	5/5	0.1	0.09 to 0.59	ND	[9]61	3.4/26/2.1
Nickel	3/5	8	2.1 to 3	5.0	[9]4,100	110/28,000/130
Potassium	3/5	1,000	137 to 157	181	--	--/--/--
Silver	3/5	2	0.48 to 0.62	1.2	[9]1,000	390/9,100/17
Sodium	5/5	1,000	165 to 191	ND	--	--/--/--
Vanadium	5/5	10	6.5 to 25	45	[9]1,400	15/7,400/980
Zinc	5/5	4	3.1 to 19.1	15.6	[9]61,000	23,000/560,000/6,000
Cyanide	2/5	1	0.53 to 0.55	ND	[9]4,100	30/28,000/40

See notes at end of table.

Table 5-14 (Continued)
Summary of Inorganic Analytes Detected in Subsurface Soil Samples

Remedial Investigation Report
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[1] Frequency of detection is the number of samples in which the analyte was detected over the total number of samples analyzed (excluding rejected values).
[2] The background screening value is twice the average of detected concentrations for inorganic analytes in background samples. Organic values are one times the mean of detected concentration. Organic values are included for comparison purposes only.
[3] USEPA Region III RBC Table (October 1, 1998).
[4] Chapter 62-777, Florida Administrative Code, June 1999.
[5] The value is based on hexavalent chromium form.
[6] Value is an FDEP-approved site-specific soil cleanup target level for arsenic at covered landfill sites (ABB-ES, 1998; FDEP, 1998).
[7] The value for lead is based on the USEPA Office of Solid Waste and Emergency Response Directive No. 9355.4-12 "Revised Interim Soil Lead Guidance for CERCLA Sites and RCRA Corrective Action Facilities" (USEPA, 1994c).
[8] Values correspond to a human cancer risk level of 1 in 1,000,000.
[9] The calculated values correspond to a noncancer hazard quotient of 1.
[10] Leachability values may be derived using the SPLP test to calculate site specific target levels or may be determined using toxicity characteristic leaching procedure in the event oily wastes are present.

Notes: The average of a sample and its duplicate is used for all table calculations.
Samples: 15-SL-01, 15-SL-02, 15-SL-03, 15-SL-04, 15-SL-05, 15S00101, 15S00201, 15S00301, 15S00401, 15S00501, 15S00601, 15S00701, 15S00801, 15S00901, 15S01001, 15S01101, 15S01201, 15S01301, 15S01401, 15S01501, 15S01601, 15S01701, 15S01801, 15S01901, 15S02001, 15S02101, 15S02201, 15S02301, 15S02401, and 15S02501.
Duplicate samples: 15S00101D, 15S01701D, and 15S02001D.
Background samples: BKG-SL-02, BKG-SL06, BKG-SL-07, BKG-SL-08, BKS00101, BKS00201, BKS00301, BKS00401, and BKS00501.
Background duplicate samples: BKS00201D.

mg/kg = milligrams per kilogram.
NA = not applicable.

Organic analytes detected in subsurface soil samples include three VOCs, seven SVOCs, one pesticide, and one PCB. No TRPH were detected above IDLs in the subsurface soil samples collected from Site 15.

VOCs. Three VOCs including 2-hexanone, chlorobenzene, and xylenes (total) were detected in the five subsurface soil samples collected at Site 15. Detected concentrations of 2-hexanone, chlorobenzene and xylenes (total) are below the Florida soil cleanup target levels and USEPA Region III industrial RBC.

SVOCs. Seven SVOCs including phenol, 1,4-dichlorobenzene, 4-methylphenol, naphthalene, 2-methylnaphthalene, diethylphthalate, and bis(2-ethylhexyl)phthalate were detected in subsurface soil samples. Phenol and 4-Methylphenol were detected at concentrations above the Florida soil cleanup target level for leaching. Detected concentrations of all other SVOCs were below the Florida soil cleanup target levels and USEPA Region III industrial RBC.

Pesticides and PCBs. The pesticides 4,4'-DDE and Aroclor-1242 were detected in subsurface soil samples. The detected concentration of 4,4'-DDE was less than the Florida soil cleanup target levels and USEPA Region III industrial RBC. Aroclor-1242 was detected in sample 15SS0804 at a concentration of 2,200 μg/kg. The detected concentration of Aroclor-1242 exceeded the Florida residential and industrial soil cleanup target levels of 500 and 2,100 μg/kg, respectively, but was below the USEPA Region III industrial-use RBC of 2,900 μg/kg. TRPH was not detected in the subsurface soil samples.

Inorganics and Cyanide. Twenty inorganic analytes were detected in the five subsurface soil samples collected at Site 15. Eight of the analytes (calcium, chromium, iron, manganese, potassium, vanadium, zinc, and cyanide) were detected at concentrations exceeding the background screening concentrations (Table 5-14). Arsenic and vanadium were detected at concentrations above the Florida residential soil cleanup target levels. No other inorganic detections in the Site 15 subsurface soil samples exceeded either the Florida soil cleanup target levels or the USEPA Region III RBCs.

5.7 GROUNDWATER ANALYTICAL RESULTS. The groundwater assessment at Site 15 consisted of collecting groundwater screening samples using PCPT during Phases I and IIA as well as sampling of all on-site monitoring wells installed at Site 15.

5.7.1 Phase I Groundwater Samples The RI Phase I investigation at Site 15 consisted of an initial series of PCPT soundings to better define lithology in the interpreted hydrogeologically downgradient southern perimeter (Figure 5-1) and collecting groundwater samples for screening purposes. The VOCs detected in the groundwater screening samples included benzene, 1,1-dichloroethane, 1,2-dichloroethane, 1,2-dichloroethene, toluene, trichloroethene, and xylenes. Trichloroethene was detected in at least one sample from each PCPT sounding location. The highest detected concentration of trichloroethene (161 μg/ℓ) was at location 15Q001. Daughter products of trichloroethene including 1,1-dichloroethane, 1,2-dichloroethane, and 1,2-dichloroethene were detected in groundwater samples from all of the Site 15 locations. Groundwater samples collected using the PCPT or BAT samplers are considered appropriate for preliminary screening but are not used to support risk assessment conclusions or decision making relative to response actions.

5.7.2 Phase II Groundwater Samples Groundwater samples were collected at Site 15 during the Phase IIA event (November to December 1993) and two Phase IIB events in July to November 1996 and July to August 1997. The locations of the Site 15 monitoring wells are shown on Figure 3-4.

Concentrations of inorganic analytes detected in groundwater samples collected during the Phase IIB sampling event (1996 and 1997) are generally lower than the corresponding samples collected during the Phase IIA sampling event (1993). This change is attributed to a modification in the sampling method. Phase IIB groundwater samples were collected using the low-flow sampling process. The low-flow sampling method produces less turbid samples that are more representative of the surficial aquifer. Because the samples are less turbid and more representative of the groundwater conditions, they represent the preferred data set. Therefore, only the Phase IIB groundwater sample data are summarized in this section and used in the HHRAs. It should be noted that reporting limit ranges for 1,1-dichloroethene, 1,2-dichloroethane, benzene, trichloroethene, naphthalene, and bis(2-ethylhexyl)phthalate exceeded the screening criteria.

Field Parameters. Groundwater field parameter results are presented in Table 5-15. The pH values for groundwater samples collected at Site 15 ranged from 3.68 to 6.62 SUs. With the exception of one monitoring well (WHF-15-3D), all of the pH values reported were below the lower range for the Florida secondary drinking water requirements of 6.5 SUs. However, the values were within the range observed in background samples collected at NAS Whiting Field (ABB-ES, 1998).

The temperature measurements ranged from 21.7 to 26.8 degrees Celsius (°C), and the specific conductance ranged from 17 to 177 micromhos per centimeter.

Turbidity measurements for the Site 15 Phase IIA groundwater sampling event ranged from 1.05 NTUs to 1,348 NTUs. Turbidity measurements for Site 15 Phase IIB groundwater samples ranged from 0.13 to 98.6 NTUs. With one exception (WHF-15-5S that was measured at 98.6 NTU), all the Phase IIB groundwater samples collected at Site 15 had turbidity measurements below 10 NTUs.

Phase IIA Sampling Event. Tables 5-16 and 5-17 present organic and inorganic analytical results for groundwater samples collected from 11 monitoring wells located at Site 15 during the Phase IIA (1993) sampling event. Five VOCs including chloromethane, 1-2,dichloroethene, toluene, chlorobenzene, and ethylbenzene were detected in the Phase IIA groundwater samples. None of the detected VOCs exceeded the Federal or State maximum contaminant levels (MCLs). Four SVOCs including 1,4-dichlorobenzene, naphthalene, diethylphthalate, and bis(2-ethylhexyl)phthalate were detected in the groundwater samples. All detected concentrations were below the Federal and State MCLs. No pesticides, PCBs, or TRPH were detected (Table 5-16) in the groundwater samples.

Twenty-one inorganic analytes and cyanide were detected in groundwater samples from Site 15 monitoring wells (Table 5-17). Five of the analytes (aluminum, cadmium, iron, manganese, and vanadium) were detected at concentrations exceeding either the Federal or State MCLs.

Phase IIB Sampling Events. Tables 5-18 and 5-19 present organic and inorganic analytical results, respectively for groundwater samples collected at Site 15

Table 5-15
Summary of Groundwater Quality Field Parameters

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Monitoring Well Identification	Date	pH (SU)	Temperature (°C)	Specific Conductance (μmhos/cm)	Turbidity (NTUs)	Dissolved Oxygen (mg/ℓ) (1)(2)	Hydrogen Sulfide (mg/ℓ)	Ferrous Iron (mg/ℓ)	Redox (mV)
Phase IIA									
WHF-15-1	12-03-93	4.87	22.5	33	1.81	NA	NA	NA	NA
WHF-15-2D	11-09-93	5.67	22.1	34	17.1	NA	NA	NA	NA
WHF-15-21	11-09-93	4.92	21.1	22	6.53	NA	NA	NA	NA
WHF-15-2S	11-09-93	5.39	21.5	40	1,348	NA	NA	NA	NA
WHF-15-3D	11-03-93	6.15	22.9	81	1.79	NA	NA	NA	NA
WHF-15-31	11-03-93	4.80	23.4	20	10.6	NA	NA	NA	NA
WHF-15-3S	11-04-93	5.15	22.4	27	1,025	NA	NA	NA	NA
WHF-15-4	11-03-93	6.07	22.7	36.5	534	NA	NA	NA	NA
WHF-15-5	12-03-93	4.94	24.8	34	44.2	NA	NA	NA	NA
WHF-15-6D	11-10-93	5.04	22.1	24	1.05	NA	NA	NA	NA
WHF-15-6S	11-10-93	6.06	22.2	270	7.86	NA	NA	NA	NA
Phase IIB									
WHF-15-1	8-8-96	5.25	23.2	30	2.2	0.77/NA	NA	NA	NA
	7-28-97	5.07	25.0	30	0.13	1.8/5	0	0	375.4
WHF-15-2S	8-13-96	4.92	25.6	21	21	0.12/NA	NA	NA	NA
	7-28-97	5.14	25.0	32	9.42	1.2/3.6	0	0.67	337.4
WHF-15-2I	8-12-96	4.86	26.4	25	12	8.4/NA	NA	NA	NA
	7-28-97	4.91	23.0	31	1.23	2.7/7.6	0	0	408.9
WHF-15-2D	8-9-96	5.53	25.2	35	25	2.56/NA	NA	NA	NA
	7-29-97	5.88	24.0	42	5.77	2.0/5.5	0	0.02	350.2
WHF-15-3S	8-8-96	5.24	25.4	25	11.9	5.24/NA	NA	NA	NA
	7-29-97	5.19	25.0	27	5.20	1.9/5.2	0	0.01	368.9
WHF-15-3I	8-8-96	5.01	24.8	22	2.6	3.21/NA	NA	NA	NA
	7-29-97	5.02	25.0	28	1.16	3.0/7.5	0	0.03	382.5
WHF-15-3D	8-8-96	6.59	23.1	100	14	5.84/NR	NR	NR	NR
	8-4-97	6.62	25.0	92	5.0	2.0/3.1	0	0	277.3

See notes at end of table.

Table 5-15 (Continued)
Summary of Groundwater Quality Field Parameters

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Monitoring Well Identification	Date	pH (SU)	Temperature (°C)	Specific Conductance (μmhos/cm)	Turbidity (NTUs)	Dissolved Oxygen (mg/ℓ) (1)/(2)	Hydrogen Sulfide (mg/ℓ)	Ferrous Iron (mg/ℓ)	Redox (mV)
Phase IIB (Continued)									
WHF-15-4	7-30-96	5.25	26.8	28	6	4.5/NR	NR	NR	NR
	7-30-97	5.81	26.0	29	4.91	3.5/7.8	0	0	411.9
WHF-15-5S	8-6-96	5.06	25.5	37	.07	2.35/NR	NR	NR	NR
	7-31-97	5.21	22.0	57	48.6	0.4/3.6	0	4.51	212.5
WHF-15-5I	8-6-96	5.38	21.7	41	14	2.54/NA	NA	NA	NA
	7-31-97	5.05	23.0	20	5.00	0.5/2.9	0	0.12	333.8
WHF-15-5D	8-6-96	5.35	24.3	29	1	2.36/NA	NA	NA	NA
	7-31-97	4.86	24.0	23	3.48	1.6/4.3	0	0.04	392.3
WHF-15-6S	8-6-96	6.37	22.7	177	10	3.91/NA	NA	NA	NA
	7-27-97	6.13	27.0	170	0.63	0.8/4.5	0.7	5.10	-70.8
WHF-15-6D	8-7-96	5.11	26.3	21	8	3.57/NA	NA	NA	NA
	7-27-97	5.11	25.5	27	4.00	3.2/7.2	0	0	376.3
WHF-15-7S	7-31-96	5.92	23.9	17	2.2	5.70/NA	NA	NA	NA
	7-30-97	4.79	22.0	19	0.64	4.4/9.7	0	0	441.7
WHF-15-7I	7-31-96	3.68	23.1	30	3.7	2.9/NA	NA	NA	NA
	7-30-97	5.14	23.0	30	7.76	0.7/3.6	0	0.20	366.6
WHF-15-7D	8-5-96	3.95	24.3	24	6	7.62/NA	NA	NA	NA
	7-30-97	5.23	25.0	20	7.31	3.6/8.2	0	0	422.5
WHF-15-8S	8-13-96	5.42	24.3	100	7.0	0.02/NA	NA	NA	NA
	8-4-97	5.50	23.5	40	3.31	2.0/4.8	0	3.44	176.8
WHF-15-8I	8-13-96	6.02	24.4	96	3.4	0.05/NA	NA	NA	NA
	8-4-97	5.34	23.0	34	9.63	0.9/4.4	0	0.06	272.8
WHF-15-8D	8-14-96	5.58	25.7	26	123	0.20/NA	NA	NA	NA
	8-4-97	5.34	26.0	20	0.35	7.3/8.0	0	0	338.9

[1] Dissolved oxygen measured with a Horiba U10™.
[2] Dissolved oxygen measured with a Hach DR/700 Colorimeter 0-10 mg/ℓ ± 0.1.

Notes: SU = standard units.
°C = degrees Celsius.
μmhos/cm = micromhos per centimeter.
NTU = nephelometric turbidity units.
mg/ℓ = milligrams per liter.
mV = millivolt.
NA = not analyzed.
± = plus or minus.
™ = trademark.

Table 5-16
Summary of Analytical Results for Organic Compounds Detected in Site 15 Groundwater Samples - Phase IIA

Remedial Investigation Report
Site 15, Southwest Landfill
Naval Air Station Whiting Field
Milton, Florida

Location Identifier:	WHF-15-1	WHF-15-2S	WHF-15-2S	WHF-15-2I	WHF-15-2D	WHF-15-3S
Sample Identifier:	WHF-15-1	WHF-15-2B	WHF-15-2BDUP	WHF-15-2C	WHF-15-2D	WHF-15-3B
Laboratory Sample Number:	90271002	90271003	90271004	90210002	90210001	90203001
Date Sampled:	03-DEC-93	09-NOV-93	09-NOV-93	09-NOV-93	09-NOV-93	14-NOV-93
Volatile Organic Compounds (µg/ℓ)						
Chloromethane	--	1.0 J	--	--	--	--
1,2-Dichloroethene (total)	--	--	--	--	--	--
Toluene	--	--	--	--	--	--
Chlorobenzene	--	--	--	--	--	--
Ethylbenzene	--	--	--	--	--	--
Semivolatile Organic Compounds (µg/ℓ)						
1,4-Dichlorobenzene	--	--	--	--	--	--
Naphthalene	--	--	--	--	--	--
Diethylphthalate	--	--	--	--	--	--
bis(2-Ethylhexyl)phthalate	--	--	--	--	--	--

See notes at end of table.

Table 5-16 (Continued)
Summary of Analytical Results for Organic Compounds Detected in Site 15 Groundwater Samples - Phase IIA

Remedial Investigation Report
Site 15, Southwest Landfill
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Milton, Florida

Location Identifier:	WHF-15-3I	WHF-15-3D	WHF-15-4S	WHF-15-5S	WHF-15-6S	WHF-15-6D
Sample Identifier:	WHF-15-3C	WHF-15-3D	WHF-15-4	WHF-15-5	WHF-15-6B	WHF-15-6D
Laboratory Sample Number:	90199005	90199004	90199003	90271001	90214004	90214004
Date Sampled:	03-NOV-93	03-NOV-93	03-NOV-93	03-DEC-93	24-NOV-93	24-NOV-93
Volatile Organic Compounds (μg/ℓ)						
Chloromethane	--	--	--	--	--	--
1,2-Dichloroethene (total)	--	--	--	--	3.0 J	--
Toluene	--	--	7.0 J	--	--	--
Chlorobenzene	--	--	--	--	5.0 J	--
Ethylbenzene	--	--	--	--	7.0 J	--
Semivolatile Organic Compounds (μg/ℓ)						
1,4-Dichlorobenzene	--	--	--	--	42	--
Naphthalene	--	--	--	--	7.0 J	--
Diethylphthalate	--	--	--	--	2.0 J	--
bis(2-Ethylhexyl)phthalate	--	--	10	21	--	--

Notes: μg/ℓ = micrograms per liter.
-- = concentration of analyte, if present, was less than detection limit.
J = estimated value.

Table 5-17
Summary of Analytical Results for Inorganic Analytes Detected in Site 15 Groundwater Samples - Phase IIA

Remedial Investigation Report
Site 15, Southwest Landfill
Naval Air Station Whiting Field
Milton, Florida

Location Identifier:	WHF-15-1	WHF-15-2S	WHF-15-2S	WHF-15-2I	WHF-15-2D	WHF-15-3S
Sample Identifier:	WHF-15-1	WHF-15-2B	WHF-15-2BDUP	WHF-15-2C	WHF-15-2D	WHF-15-3B
Laboratory Sample Number:	90271002	90271003	90271004	90210002	90210001	90203001
Date Sampled:	03-DEC-93	09-NOV-93	09-NOV-93	09-NOV-93	09-NOV-93	14-NOV-93
Inorganic Analytes (µg/ℓ)						
Aluminum	24.5 J	76,400	45,600	39.2 J	77.2	10,600
Arsenic	--	--	--	--	--	2.1 J
Barium	24.3 J	75.8 J	56.1 J	15.9 J	8.5 J	--
Beryllium	--	0.71 J	0.52 J	--	--	--
Cadmium	7.6	--	5.0	--	23.3	--
Calcium	8,710	2,430 J	2,570 J	801 J	2,090 J	1,080 J
Chromium	3.4 J	71.5	46.9	--	--	22.1
Cobalt	4.3 J	--	--	--	--	--
Copper	2.2 J	30.6	23.2 J	--	2.6 J	13.3 J
Iron	22.6 J	94,500	78,000	46 J	180	33,000
Lead	--	12	6.8	--	--	6.0
Magnesium	670 J	1,240 J	1,070 J	581 J	491 J	1,010 J
Manganese	2.5 J	1,270	1,260	14.1 J	11.6 J	39.6
Mercury	1.0	--	0.16 J	--	0.17 J	0.15 J
Nickel	--	20.5 J	--	--	10.0 J	--
Potassium	870 J	1,110 J	1,020 J	--	2,240 J	916 J
Silver	--	3.8 J	2.7 J	--	--	--
Sodium	4,850	1,080 J	1,040 J	2,670 J	3,860 J	1,810 J
Thallium	--	1.0 J	--	0.93 J	--	--
Vanadium	--	136	102	--	--	69
Zinc	4.9 J	51.6	39.5	14.7 J	16.8 J	48.4
Cyanide	--	1.9 J	2.5 J	--	--	--

See notes at end of table.

Table 5-17 (Continued)
Summary of Analytical Results for Inorganic Analytes Detected in Site 15 Groundwater Samples - Phase IIA

Remedial Investigation Report
Site 15, Southwest Landfill
Naval Air Station Whiting Field
Milton, Florida

Location Identifier:	WHF-15-3I	WHF-15-3D	WHF-15-4	WHF-15-5	WHF-15-6S	WHF-15-6D
Sample Identifier:	WHF-15-3C	WHF-15-3D	WHF-15-4	WHF-15-5	WHF-15-6B	WHF-15-6D
Laboratory Sample Number:	90199005	90199004	90199003	90271001	90214004	90214004
Date Sampled:	03-NOV-93	03-NOV-93	03-NOV-93	03-DEC-93	24-NOV-93	24-NOV-93
Inorganic Analytes (μg/ℓ)						
Aluminum	--	--	3,350	519	9,990	43 J
Arsenic	--	--	--	2.3 J	2.1 J	--
Barium	8.4 J	7.8 J	23 J	34.4 J	126 J	14.2 J
Beryllium	--	--	--	--	0.39 J	0.26 J
Cadmium	--	--	--	--	--	12.7
Calcium	605 J	2,280 J	4,360 J	1,320 J	7,430	802 J
Chromium	--	--	32.2	11.2	13	--
Cobalt	--	--	--	--	--	--
Copper	8.8 J	--	5.0 J	7.6 J	19.9 J	2.6 J
Iron	75.2 J	66 J	4,700	3,390	65,600	198
Lead	--	--	--	3.6	3.9 J	1.1 J
Magnesium	423 J	1,430 J	628 J	1,340 J	3,590 J	540 J
Manganese	8.0 J	1.6 J	16.5	41	291	10.8 J
Mercury	--	--	--	--	--	--
Nickel	--	--	14 J	--	11.7 J	--
Potassium	--	1,100 J	3,250 J	949 J	2,680 J	641 J
Silver	--	--	--	4.6 J	--	--
Sodium	2,360 J	13,300	3,540 J	1,540 J	3,800 J	2,890 J
Thallium	--	--	--	--	0.92 J	0.91 J
Vanadium	--	--	29.1 J	--	17.6 J	--
Zinc	35.9	10.8 J	16.9 J	52.7	43.7	17.1 J
Cyanide	--	--	--	--	2.1 J	--

Notes: μg/ℓ = micrograms per liter.
J = estimated value.
-- = concentration of analyte, if present, was less than detection limit.
DUP = duplicate

Table 5-18
Summary of Analytical Results for Organic Compounds Detected in Site 15 Groundwater Samples - Phase IIB

Remedial Investigation Report
Site 15, Southwest Landfill
Naval Air Station Whiting Field
Milton, Florida

	Shallow Monitoring Wells									
Location Identifier:	WHF-15-1S	WHF-15-1S	WHF-15-2S	WHF-15-2S	WHF-15-3S	WHF-15-3S	WHF-15-4	WHF-15-4	WHF-15-5S	WHF-15-5S
Sample Identifier:	15G00101	15G00101	15G00201	15G00201	15G00301	15G00301	15G00401	15G00401	15G00501	15G00501
Laboratory Sample Number:	RB956016	ME377003	RB980003	ME377002	RB956013	ME390002	RB920003	ME404002	RB956005	ME404005
Date Sampled:	08-AUG-96	28-JUL-97	13-AUG-96	28-JUL-97	08-AUG-96	29-JUL-97	30-JUL-96	30-JUL-97	06-AUG-96	31-JUL-97
Volatile Organic Compounds (µg/ℓ)										
1,1-Dichloroethene	--	--	--	--	--	--	--	--	--	--
1,2-Dichloroethane	--	--	--	--	--	--	--	--	--	--
1,2-Dichloroethene (total)	--	--	--	--	--	--	--	--	2.0 J	--
Acetone	--	--	--	--	--	--	--	--	--	--
Benzene	--	--	--	--	--	--	--	--	--	--
2-Butanone	--	--	--	--	--	--	--	--	--	--
Chlorobenzene	--	--	--	--	--	--	--	--	--	--
Ethylbenzene	--	--	--	--	--	--	--	--	--	--
Trichloroethene	2.0 J	3.0 J	--	--	--	--	--	--	--	--
Xylenes (total)	--	--	--	--	--	--	--	--	--	--
Semivolatile Organic Compounds (µg/ℓ)										
1,4-Dichlorobenzene	--	NA	--	NA	--	NA	--	NA	1.0 J	--
Diethylphthalate	--	NA	--	NA	--	NA	--	NA	--	--
Naphthalene	--	NA	--	NA	--	NA	--	NA	1.0 J	--
bis(2-Ethylhexyl)phthalate	--	NA	2.0 J	NA	--	NA	--	NA	2.0 J	--
Pesticides and PCBs (µg/ℓ)										
4,4'-DDT	--	NA	0.12 J	NA	--	NA	--	NA	--	--

See notes at end of table.

Table 5-18 (Continued)
Summary of Analytical Results for Organic Compounds Detected in Site 15 Groundwater Samples - Phase IIB

Remedial Investigation Report
Site 15, Southwest Landfill
Naval Air Station Whiting Field
Milton, Florida

	Shallow Monitoring Wells								
Location Identifier:	WHF-15-6S	WHF-15-6S	WHF-15-6S	WHF-15-7S	WHF-15-7S	WHF-15-7S	WHF-15-8S	WHF-15-8S	WHF-15-8S
Sample Identifier:	15G00601	15G00601D Duplicate	15G00601	15G00701	15G00701D Duplicate	15G00701	15G00801	15G00801	15G00801D Duplicate
Laboratory Sample Number:	RB956006	RB956008	ME367003	RB920009	RB920010	ME390004	RB980005	ME441002	ME441003
Date Sampled:	07-AUG-96	07-AUG-96	27-JUL-97	31-JUL-96	31-JUL-96	30-JUL-97	13-AUG-96	04-AUG-97	04-AUG-97
Volatile Organic Compounds (µg/ℓ)									
1,1-Dichloroethene	--	--	--	--	--	--	--	--	--
1,2-Dichloroethane	--	--	--	--	--	--	--	--	--
1,2-Dichloroethene (total)	1.0 J	1.0 J	3.0 J	--	--	--	1.0 J	--	--
Acetone	--	--	--	--	--	--	--	--	--
Benzene	--	--	1.0 J	--	--	--	--	--	--
2-Butanone	--	--	--	--	--	--	--	--	--
Chlorobenzene	5.0 J	5.0 J	12	--	--	--	3.0 J	4.0 J	4.0 J
Ethylbenzene	--	1.0 J	2.0 J	--	--	--	--	--	--
Trichloroethene	--	--	--	--	--	--	--	--	--
Xylenes (total)	--	--	--	--	--	--	--	--	--
Semivolatile Organic Compounds (µg/ℓ)									
1,4-Dichlorobenzene	12	12	NA	--	--	NA	8.0 J	NA	NA
Diethylphthalate	1.0 J	1.0 J	NA	--	--	NA	1.0 J	NA	NA
Naphthalene	4.0 J	4.0 J	NA	--	--	NA	--	NA	NA
bis(2-Ethylhexyl)phthalate	--	--	NA	--	--	NA	--	NA	NA
Pesticides and PCBs (µg/ℓ)									
4,4'-DDT	--	--	NA	--	--	NA	--	NA	NA

See notes at end of table.

Table 5-18 (Continued)
Summary of Analytical Results for Organic Compounds Detected in Site 15 Groundwater Samples - Phase IIB

Remedial Investigation Report
Site 15, Southwest Landfill
Naval Air Station Whiting Field
Milton, Florida

	Intermediate Monitoring Wells							
Location Identifier:	WHF-15-2I	WHF-15-2I	WHF-15-3I	WHF-15-3I	WHF-15-5I	WHF-15-5I	WHF-15-5I	WHF-15-6I
Sample Identifier:	15G00202	15G00202	15G00302	15G00302	15G00502	15G00502	15G00502	15G00602
Laboratory Sample Number:	RB98002	ME377004	RB956014	ME390003	RB956004	MC424002	ME404007	ME367004
Date Sampled:	12-AUG-96	29-JUL-97	08-AUG-96	29-JUL-97	06-AUG-96	18-NOV-96	31-JUL-97	27-JUL-97
Volatile Organic Compounds (µg/ℓ)								
1,1-Dichloroethene	--	--	--	--	2.0 J	--	--	--
1,2-Dichloroethane	--	--	--	--	--	--	--	--
1,2-Dichloroethene (total)	--	--	--	--	38	21	7.0 J	--
Acetone	--	--	--	--	--	--	--	--
Benzene	--	--	--	--	130	66	9.0 J	--
2-Butanone	--	--	--	--	--	--	--	--
Chlorobenzene	--	--	--	--	--	--	--	--
Ethylbenzene	--	--	--	--	--	--	--	--
Trichloroethene	1.0 J	2.0 J	1.0 J	3.0 J	29	21	7.0 J	2.0 J
Xylenes (total)	--	--	--	--	--	--	--	--
Semivolatile Organic Compounds (µg/ℓ)								
1,4-Dichlorobenzene	--	NA	--	NA	--	NA	NA	NA
Diethylphthalate	--	NA	--	NA	--	NA	NA	NA
Naphthalene	--	NA	--	NA	--	NA	NA	NA
bis(2-Ethylhexyl)phthalate	2.0 J	NA	3.0 J	NA	--	NA	NA	NA
Pesticides and PCBs (µg/ℓ)								
4,4'-DDT	--	NA	--	NA	--	NA	NA	NA

See notes at end of table.

Table 5-18 (Continued)
Summary of Analytical Results for Organic Compounds Detected in Site 15 Groundwater Samples - Phase IIB

Remedial Investigation Report
Site 15, Southwest Landfill
Naval Air Station Whiting Field
Milton, Florida

	Intermediate Monitoring Wells						Deep Monitoring Wells	
Location Identifier:	WHF-15-6I	WHF-15-7I	WHF-15-7I	WHF-15-8I	WHF-15-8I	WHF-15-8I	WHF-15-2D	WHF-15-2D
Sample Identifier:	15G00602D Duplicate	15G00702	15G00702	15G00802	15G00802	15G00802	15G00203	15G00203
Laboratory Sample Number:	ME367005	RB920007	ME390005	RB980004	MC424006	ME441004	RB956017	ME377005
Date Sampled:	27-JUL-97	31-JUL-96	30-JUL-97	13-AUG-96	20-NOV-96	04-AUG-97	09-AUG-96	29-JUL-97
Volatile Organic Compounds (µg/ℓ)								
1,1-Dichloroethene	--	--	--	--	--	--	--	--
1,2-Dichloroethane	--	--	--	--	--	--	--	--
1,2-Dichloroethene (total)	--	--	14	--	--	1.0 J	--	--
Acetone	--	--	--	--	--	--	--	--
Benzene	--	--	100	5.0 J	84	19	--	--
2-Butanone	--	--	--	--	--	--	--	--
Chlorobenzene	--	--	--	--	--	--	--	--
Ethylbenzene	--	--	--	--	--	--	--	--
Trichloroethene	2.0 J	1.0 J	5.0 J	5.0 J	15	11	--	1.0 J
Xylenes (total)	--	--	1.0 J	--	--	--	--	--
Semivolatile Organic Compounds (µg/ℓ)								
1,4-Dichlorobenzene	NA	--	NA	--	NA	NA	--	NA
Diethylphthalate	NA	--	NA	--	NA	NA	2.0 J	NA
Naphthalene	NA	--	NA	--	NA	NA	--	NA
bis(2-Ethylhexyl)phthalate	NA	--	NA	5.0 J	NA	NA	1.0 J	NA
Pesticides and PCBs (µg/ℓ)								
4,4'-DDT	NA	--	NA	--	NA	NA	--	NA

See notes at end of table.

Table 5-18 (Continued)
Summary of Analytical Results for Organic Compounds Detected in Site 15 Groundwater Samples - Phase IIB

Remedial Investigation Report
Site 15, Southwest Landfill
Naval Air Station Whiting Field
Milton, Florida

	Deep Monitoring Wells						
Location Identifier:	WHF-15-3D	WHF-15-3D	WHF-15-5D	WHF-15-5D	WHF-15-5D	WHF-15-6D	WHF-15-7D
Sample Identifier:	15G00303	15G00303	15G00503	15G00503	15G00503	15G00603	15G00703
Laboratory Sample Number:	RB956015	ME441007	RB956003	MC424003	ME404008	RB956007	RB956002
Date Sampled:	09-AUG-96	05-AUG-97	06-AUG-96	18-NOV-96	31-JUL-97	07-AUG-96	05-AUG-96
Volatile Organic Compounds (µg/ℓ)							
1,1-Dichloroethene	--	--	11	10 J	10 J	--	5.0 J
1,2-Dichloroethane	--	--	2.0 J	--	--	--	4.0 J
1,2-Dichloroethene (total)	--	--	16	22 J	14 J	--	--
Acetone	--	--	170 J	--	--	--	140 J
Benzene	--	--	--	--	--	--	--
2-Butanone	--	--	--	--	--	--	--
Chlorobenzene	--	--	--	--	--	--	--
Ethylbenzene	--	--	--	--	--	--	--
Trichloroethene	--	--	230	350	330	--	150
Xylenes (total)	--	--	--	--	--	--	--
Semivolatile Organic Compounds (µg/ℓ)							
1,4-Dichlorobenzene	--	NA	--	NA	NA	--	NA
Diethylphthalate	--	NA	--	NA	NA	--	NA
Naphthalene	--	NA	--	NA	NA	--	NA
bis(2-Ethylhexyl)phthalate	--	NA	--	NA	NA	--	NA
Pesticides and PCBs (µg/ℓ)							
4,4'-DDT	--	NA	--	NA	NA	--	NA

See notes at end of table.

Table 5-18 (Continued)
Summary of Analytical Results for Organic Compounds Detected in Site 15 Groundwater Samples - Phase IIB

Remedial Investigation Report
Site 15, Southwest Landfill
Naval Air Station Whiting Field
Milton, Florida

	Deep Monitoring Wells						
Location Identifier:	WHF-15-7D	WHF-15-7D	WHF-15-8D	WHF-15-8D	WHF-15-8D	WHF-15-8D	WHF-15-8D
Sample Identifier:	15G00703	15G00703D Duplicate	15G00803	15G00803D Duplicate	15G00803	15G00803D Duplicate	15G00803
Laboratory Sample Number:	ME404003	ME404004	RB980007	RB980008	MC424007	MC424008	ME441006
Date Sampled:	30-JUL-97	30-JUL-97	14-AUG-96	14-AUG-96	20-NOV-96	20-NOV-96	05-AUG-97
Volatile Organic Compounds (µg/ℓ)							
1,1-Dichloroethene	2.0 J	--	--	--	--	--	--
1,2-Dichloroethane	1.0 J	2.0 J	--	--	--	--	--
1,2-Dichloroethene (total)	--	--	--	--	--	--	--
Acetone	--	--	--	--	--	--	--
Benzene	--	--	--	--	--	--	--
2-Butanone	--	--	7.0 J	--	--	--	--
Chlorobenzene	--	--	--	--	--	--	--
Ethylbenzene	--	--	--	--	--	--	--
Trichloroethene	36	38	4.0 J	4.0 J	5.0 J	5.0 J	7.0 J
Xylenes (total)	--	--	--	--	--	--	--
Semivolatile Organic Compounds (µg/ℓ)							
1,4-Dichlorobenzene	NA	NA	--	--	NA	NA	NA
Diethylphthalate	NA	NA	--	--	NA	NA	NA
Naphthalene	NA	NA	--	--	NA	NA	NA
bis(2-Ethylhexyl)phthalate	NA	NA	2.0 J	1.0 J	NA	NA	NA
Pesticides and PCBs (µg/ℓ)							
4,4'-DDT	NA	NA	0.16 J	0.79 J	NA	NA	NA

Notes: µg/ℓ = micrograms per liter.
-- = concentration of analyte, if present, was less than detection limit.
J = estimated value.
NA = not analyzed.
PCB = polychlorinated biphenyl.
DDT = dichlorodiphenyltrichloroethene.
DUP = duplicate sample.

Table 5-19
Summary of Analytical Results for Inorganic Analytes Detected in Site 15 Groundwater Samples - Phase IIB

Remedial Investigation Report
Site 15, Southwest Landfill
Naval Air Station Whiting Field
Milton, Florida

	Shallow Monitoring Wells							
Location Identifier:	WHF-15-1S	WHF-15-1S	WHF-15-2S	WHF-15-2S	WHF-15-2S	WHF-15-3S	WHF-15-3S	WHF-15-3S
Sample Identifier:	15G00101	15G00101	15G00201	15G00201F Filtered Sample	15G00201	15G00301	15G00301F Filtered Sample	15G00301
Laboratory Sample Number:	RB956016	ME377003	RB980003	RB980010	ME377002	RB956013	RB956018	ME390002
Date Sampled:	08-AUG-96	28-JUL-97	13-AUG-96	13-AUG-96	28-JUL-97	08-AUG-96	08-AUG-96	29-JUL-97
Inorganic Analytes (μg/ℓ)								
Aluminum	153 J	--	1,030	--	--	--	--	--
Antimony	--	--	--	--	--	--	--	--
Arsenic	--	--	2.2 J	--	--	--	--	--
Barium	26 J	16.7 J	34.6 J	30.2 J	27.1 J	21.7 J	21.2 J	14.2 J
Cadmium	--	--	--	1.3 J	--	--	--	--
Calcium	15,000	--	1,470 J	1,480 J	1,810 J	830 J	795 J	2,240 J
Chromium	--	--	2.8 J	--	--	--	--	--
Cobalt	--	--	--	--	--	--	--	--
Copper	--	--	1.3 J	--	--	--	--	--
Iron	--	--	4,250	98.8 J	923	447	331	324
Lead	1.1 J	--	1.5 J	--	--	1.2 J	0.9 J	0.98 J
Magnesium	612 J	506 J	283 J	283 J	533 J	606 J	603 J	404 J
Manganese	8.1 J	--	141	131	553	9.0 J	9.8 J	9.0 J
Mercury	--	--	--	--	--	--	--	--
Nickel	--	--	--	--	--	--	--	--
Potassium	1,680 J	--	1,600 J	1,440 J	1,080 J	946 J	743 J	--
Silver	--	--	--	--	--	--	--	--
Sodium	3,420 J	4,370 J	978 J	969 J	1,390 J	1,800 J	1,790 J	2,080 J
Thallium	--	--	--	--	--	--	--	--
Vanadium	--	--	5.2 J	--	--	--	--	--
Zinc	--	--	--	--	--	--	--	--
Cyanide	2.5 J	--	--	NA	NA	1.9 J	NA	NA

See notes at end of table.

Table 5-19 (Continued)
Summary of Analytical Results for Inorganic Analytes Detected in Site 15 Groundwater Samples - Phase IIB

Remedial Investigation Report
Site 15, Southwest Landfill
Naval Air Station Whiting Field
Milton, Florida

	Shallow Monitoring Wells							
Location Identifier:	WHF-15-4S	WHF-14-4S	WHF-15-5S	WHF-15-5S	WHF-15-5S	WHF-15-5S	WHF-15-6S	WHF-15-6S
Sample Identifier:	15G00401	15G00401	15G00501	15G00501F Filtered Sample	15G00501	15G00501F Filtered Sample	15G00601	15G00601
Laboratory Sample Number:	RB920003	ME404002	RB956005	RB956010	ME404005	ME404006	RB956006	ME367003
Date Sampled:	30-JUL-96	30-JUL-97	06-AUG-96	06-AUG-96	31-JUL-97	31-JUL-97	07-AUG-96	27-JUL-97
Inorganic Analytes (μg/ℓ)								
Aluminum	102 J	--	174 J	--	481	--	89.4	--
Antimony	--	--	--	--	--	--	--	--
Arsenic	--	--	1.8 J	1.7 J	--	--	8.0 J	14.2
Barium	11.5 J	14.2 J	31.9 J	37.3 J	41.5 J	36.9 J	67.6 J	68.3 J
Cadmium	--	--	--	--	--	--	--	--
Calcium	936 J	2,640 J	1,110 J	1,480 J	2,650 J	2,510 J	3,690 J	4,170 J
Chromium	--	--	2.1 J	--	--	--	--	--
Cobalt	--	--	--	--	--	--	--	--
Copper	--	--	--	--	--	--	--	--
Iron	--	--	3,730	2,180	5,150	3,550	31,000	40,200
Lead	--	--	0.6 J	0.8 J	1.7 J	--	0.9 J	--
Magnesium	354 J	--	1,160 J	1,190 J	1,470 J	1,450 J	1,940 J	2,140 J
Manganese	1.8 J	--	38.1	61.5	92.2	83	139	164
Mercury	--	--	--	--	--	--	--	--
Nickel	--	--	--	7.8 J	--	--	--	--
Potassium	978 J	--	792 J	630 J	--	--	2,460 J	2,190 J
Silver	2.9 J	--	--	--	--	--	--	--
Sodium	3,280 J	2,000 J	1,480 J	1,500 J	1,070 J	1,300 J	2,630 J	2,210 J
Thallium	--	--	--	--	0.98 J	--	--	--
Vanadium	--	1.7 J	1.9 J	--	--	--	--	--
Zinc	1.6 J	--	306	112	--	--	--	--
Cyanide	--	NA	5.0 J	NA	--	NA	--	NA

See notes at end of table.

Table 5-19 (Continued)
Summary of Analytical Results for Inorganic Analytes Detected in Site 15 Groundwater Samples - Phase IIB

Remedial Investigation Report
Site 15, Southwest Landfill
Naval Air Station Whiting Field
Milton, Florida

	Shallow Monitoring Wells						
Location Identifier:	WHF15-6S	WHF-15-7S	WHF-15-7S	WHF-15-7S	WHF-15-8S	WHF-15-8S	WHF-15-8S
Sample Identifier:	15G00601D Duplicate	15G00701	15G00701D Duplicate	15G00701	15G00801	15G00801	15G00801D Duplicate
Laboratory Sample Number:	RB956008	RB920009	RB92001	ME390004	RB980005	ME441002	ME441003
Date Sampled:	07-AUG-96	31-JUL-96	31-JUL-96	30-JUL-97	13-AUG-96	04-AUG-97	04-AUG-97
Inorganic Analytes (μg/ℓ)							
Aluminum	--	162 J	173 J	--	--	143 J	116 J
Antimony	--	--	--	--	--	--	--
Arsenic	7.8 J	--	--	--	1.2 J	2.0 J	--
Barium	63.7 J	15.6 J	19.3 J	20.4 J	69.8 J	34.7 J	37.3 J
Cadmium	--	--	--	--	--	--	--
Calcium	3,620 J	356 J	360 J	--	2,570 J	1,870 J	2,010 J
Chromium	--	2.9 J	2.0 J	--	--	--	--
Cobalt	--	--	--	--	--	--	--
Copper	--	--	--	--	--	--	--
Iron	30,500	183	20	155	22,100	4,760	4,940
Lead	--	--	--	--	--	--	--
Magnesium	1,900 J	433 J	422 J	482 J	2,330 J	1,370 J	1,470 J
Manganese	136	2.8 J	2.6 J	--	150	84.6	91.4
Mercury	--	--	--	--	--	--	--
Nickel	--	--	--	--	--	--	--
Potassium	2,340 J	--	--	--	1,080 J	--	--
Silver	--	--	--	--	--	--	--
Sodium	2,590 J	1,530 J	1,610 J	1,840 J	2,160 J	1,830 J	1,960 J
Thallium	--	--	--	--	--	--	0.9 J
Vanadium	--	--	1.2 J	--	--	--	--
Zinc	--	3.4 J	3.6 J	--	--	--	--
Cyanide	8.1 J	--	--	NA	--	NA	NA

See notes at end of table.

Table 5-19 (Continued)
Summary of Analytical Results for Inorganic Analytes Detected in Site 15 Groundwater Samples - Phase IIB

Remedial Investigation Report
Site 15, Southwest Landfill
Naval Air Station Whiting Field
Milton, Florida

	Intermediate Monitoring Wells							
Location Identifier:	WHF-15-2I	WHF-15-2I	WHF-15-2I	WHF-15-3I	WHF-15-3I	WHF-15-5I	WHF-15-5I	WHF-15-6I
Sample Identifier:	15G00202	15G00202F Filtered Sample	15G00202	15G00302	15G00302	15G00502	15G00502	15G00602
Laboratory Sample Number:	RB980002	RB980009	ME377004	RB956014	ME390003	RB956004	ME404007	ME367004
Date Sampled:	12-AUG-96	12-AUG-96	29-JUL-97	08-AUG-96	29-JUL-97	06-AUG-96	31-JUL-97	27-JUL-97
Inorganic Analytes (μg/ℓ)								
Aluminum	204	--	--	--	--	--	--	--
Antimony	--	--	--	--	--	--	--	--
Arsenic	--	--	--	--	--	--	--	--
Barium	23.2 J	17.4 J	24.6 J	15.1 J	17.3 J	28.5 J	14.3 J	13 J
Cadmium	--	1.3 J	--	2.3 J	--	--	--	--
Calcium	892 J	1,370 J	--	735 J	--	2,260 J	--	--
Chromium	--	--	--	2.2 J	--	--	--	--
Cobalt	--	--	--	--	--	--	--	--
Copper	1.5 J	1.1 J	--	--	--	--	--	--
Iron	462	--	--	67.7 J	--	2,190	1,060	--
Lead	0.5 J	--	--	0.5 J	--	1.8 J	--	--
Magnesium	751 J	695 J	758 J	508 J	598 J	1,130 J	516 J	504 J
Manganese	6.1 J	7.0 J	5.4 J	3.4 J	--	114	29.9	--
Mercury	--	--	--	--	--	--	--	--
Nickel	--	--	--	--	--	--	--	--
Potassium	431 J	--	--	338 J	--	--	--	--
Silver	--	--	--	--	--	--	--	--
Sodium	3,500 J	3,510 J	4,030 J	2,300 J	3.150 J	2,120 J	1,700 J	2,870 J
Thallium	--	--	--	--	--	--	--	--
Vanadium	--	--	--	--	--	--	--	--
Zinc	86.6	123	--	127	--	--	--	--
Cyanide	--	NA	NA	2.5 J	NA	--	NA	NA

See notes at end of table.

Table 5-19 (Continued)
Summary Analytical Results for Inorganic Analytes Detected in Site 15 Groundwater Samples - Phase IIB

Remedial Investigation Report
Site 15, Southwest Landfill
Naval Air Station Whiting Field
Milton, Florida

	Intermediate Monitoring Wells						
Location Identifier:	WHF-15-6I	WHF-15-7I	WHF-15-7I	WHF-15-7I	WHF-15-8I	WHF-15-8I	WHF-15-8I
Sample Identifier:	15G00602D Duplicate	15G00702	15G00702F Filtered Sample	15G00702	15G00802	15G00802F Filtered Sample	15G00802
Laboratory Sample Number:	ME367005	RB920007	RB920008	ME390005	RB980004	RB980011	ME441004
Date Sampled:	27-JUL-97	31-JUL-96	31-JUL-96	30-JUL-97	13-AUG-96	13-AUG-96	04-AUG-97
Inorganic Analytes (µg/ℓ)							
Aluminum	--	500	--	538	127 J	--	--
Antimony	--	--	--	--	--	--	--
Arsenic	--	0.6 J	--	--	--	--	--
Barium	13 J	15.5 J	11.8 J	15.4 J	21.9	22.8 J	9.3 J
Cadmium	--	--	--	--	--	--	--
Calcium	--	2,460 J	1,900 J	1,350 J	5,760	6,270	1,760 J
Chromium	--	--	--	--	--	--	--
Cobalt	--	--	--	--	--	--	--
Copper	--	3.3 J	1.5 J	--	1.8 J	1.5 J	--
Iron	92.6 J	380	--	388	118	--	75 J
Lead	--	--	--	--	--	--	--
Magnesium	490 J	474 J	386 J	501 J	796 J	839 J	381 J
Manganese	--	70.4	62.3	50.7	215	226	106
Mercury	--	--	--	--	--	--	--
Nickel	--	--	--	--	--	--	--
Potassium	--	698 J	714 J	--	649 J	740 J	--
Silver	--	--	--	--	--	--	--
Sodium	2,740 J	9,090	7,340	4,130 J	18,600	19,800	4,890 J
Thallium	--	--	--	--	--	--	--
Vanadium	--	1.9 J	--	--	--	--	--
Zinc	--	65.1	38.6	--	197	232	--
Cyanide	NA	--	NA	NA	--	NA	NA

See notes at end of table.

Table 5-19 (Continued)
Summary Analytical Results for Inorganic Analytes Detected in Site 15 Groundwater Samples - Phase IIB

Remedial Investigation Report
Site 15, Southwest Landfill
Naval Air Station Whiting Field
Milton, Florida

	Deep Monitoring Wells							
Location Identifier:	WHF-15-2D	WHF-15-2D	WHF-15-2D	WHF-15-3D	WHF-15-3D	WHF-15-3D	WHF-15-5D	WHF-15-5D
Sample Identifier:	15G00203	15G00203F Filtered Sample	15G00203	15G00303	15G00303	15G00503	15G00503F Filtered Sample	15G00503
Laboratory Sample Number:	RB956017	RB956019	ME377005	RB956015	ME441007	RB956003	RB956009	ME404008
Date Sampled:	09-AUG-96	09-AUG-96	29-JUL-97	09-AUG-96	05-AUG-97	06-AUG-96	06-AUG-96	31-JUL-97
Inorganic Analytes (μg/ℓ)								
Aluminum	156 J	193 J	--	--	171 J	103 J	--	--
Antimony	--	9.4 J	--	--	--	--	--	--
Arsenic	--	--	--	--	--	--	--	17.2
Barium	8.2 J	8.0 J	--	13.7 J	13.3 J	10.2 J	8.7 J	9.8 J
Cadmium	--	--	--	--	--	--	--	--
Calcium	1,600 J	1,660 J	1,760 J	3,470 J	3,570 J	2,000 J	2,080 J	--
Chromium	--	--	--	--	--	--	--	--
Cobalt	--	--	--	--	--	--	--	--
Copper	--	--	--	--	--	2.0 J	1.7 J	--
Iron	314	321	111	43.8 J	136	134	--	--
Lead	--	0.7 J	--	--	--	--	0.7 J	--
Magnesium	651 J	695 J	840 J	1,720 J	1,810 J	232 J	227 J	361 J
Manganese	25.9	23	12.4 J	--	--	71	69.3	18.5
Mercury	--	--	--	--	--	--	--	0.06 J
Nickel	--	--	--	--	--	--	--	--
Potassium	1,250 J	1,600 J	--	1,550 J	1,280 J	460 J	403 J	--
Silver	--	--	--	--	--	--	--	--
Sodium	5,750	6,610	6,310 J	16,800	18,300 J	3250 J	3,260 J	2,480 J
Thallium	--	--	--	--	--	--	--	--
Vanadium	--	1.4 J	--	--	--	1.7 J	--	--
Zinc	30.5	30.5	--	--	--	49	88.3	--
Cyanide	1.9 J	NA	NA	2.5 J	NA	--	NA	NA

See notes at end of table.

Table 5-19 (Continued)
Summary Analytical Results for Inorganic Analytes Detected in Site 15 Groundwater Samples - Phase IIB

Remedial Investigation Report
Site 15, Southwest Landfill
Naval Air Station Whiting Field
Milton, Florida

	Deep Monitoring Wells							
Location Identifier:	WHF-15-6D	WHF-15-7D	WHF-15-7D	WHF-15-7D	WHF-15-8D	WHF-15-8D	WHF-15-8D	WHF-15-8D
Sample Identifier:	15G00603	15G00703	15G00703	15G00703D Duplicate	15G00803	15G00803D Duplicate	15G00803F Filtered Sample	15G00803
Laboratory Sample Number:	RB956007	RB956002	ME404003	ME404004	RB980007	RB980008	RB980013	ME441006
Date Sampled:	07-AUG-96	05-AUG-96	30-JUL-97	30-JUL-97	14-AUG-96	14-AUG-96	13-AUG-96	05-AUG-97
Inorganic Analytes (μg/ℓ)								
Aluminum	--	--	--	--	187 J	146 J	--	110 J
Antimony	--	--	--	21.2 J	--	--	11 J	--
Arsenic	--	--	--	--	--	--	--	--
Barium	13.7 J	7.8 J	--	--	10.6 J	10.8 J	7.9 J	8.9 J
Cadmium	--	--	--	--	--	--	--	--
Calcium	826 J	738 J	--	--	1,440 J	1,170 J	1,130 J	--
Chromium	--	2.6 J	--	--	2.9 J	--	--	--
Cobalt	--	--	--	--	--	2.4 J	--	--
Copper	--	--	--	--	4.0 J	2.4 J	--	--
Iron	56.7 J	63.6 J	107	115	194	175	--	91.4 J
Lead	--	--	--	5.1	0.8 J	0.5 J	--	--
Magnesium	500 J	279 J	280 J	266 J	322 J	296 J	268 J	361 J
Manganese	3.0 J	14.5 J	6.9 J	6.5 J	33.1	32.9	32	14.7 J
Mercury	--	--	--	--	--	--	--	--
Nickel	--	7.4 J	--	--	--	--	--	--
Potassium	354 J	451 J	--	--	522 J	--	485 J	--
Silver	--	--	--	--	--	--	--	--
Sodium	2,540 J	2,890 J	2,040 J	1,820 J	5,350	5,380	4,650 J	2,270 J
Thallium	--	--	--	--	--	--	0.6 J	--
Vanadium	--	--	--	--	2.0 J	1.5 J	1.8 J	--
Zinc	173	66.3	--	--	176	178	40.2	--
Cyanide	--	--	NA	NA	--	--	NA	NA

Notes: F = filtered sample.
DUP = duplicate sample.
μg/ℓ = micrograms per liter.
-- = concentration of analyte, if present, was less than detection limit.
NA = not analyzed.
J = estimated value.

during the Phase IIB sampling events (1996 and 1997). Tables 5-20 and 5-21 summarize the frequency of detection, reporting range limits, detected concentration range, background screening concentrations and Federal and State regulatory limits of the 1997 sampling event for the organic and inorganic analytes, respectively. The distribution of organic contaminants exceeding Florida cleanup target levels and Federal MCLs is shown in Figure 5-11.

Shallow Groundwater Samples. Five VOCs (1,2-dichloroethene, trichloroethene, benzene, chlorobenzene, and ethylbenzene) were detected in groundwater samples collected from the shallow monitoring wells at Site 15. None of the detected VOCs were identified in the facility background groundwater samples. None of the detected concentrations exceeded either the Federal MCLs or Florida groundwater cleanup target levels. However, the detected concentrations of benzene in sample 15G00601 and trichloroethene in sample 15G00101 equaled the Florida cleanup target levels of 1 $\mu g/\ell$ and 3.0 $\mu g/\ell$, respectively.

Four SVOCs, including 1,4-dichlorobenzene, diethylphthalate, naphthalene, and bis(2-ethylhexyl)phthalate, were detected in groundwater samples from the shallow depth monitoring wells. The SVOCs were only detected in the groundwater samples from four of the shallow monitoring wells (WHF-15-2S, WHF-15-5S, WHF-15-6S and WHF-15-8S) at the site. All of the detected concentrations of SVOCs were below the Federal MCLs and the Florida groundwater cleanup target levels.

One pesticide compound, 4,4'-DDT, was detected in the groundwater samples from the shallow monitoring wells at Site 15. 4,4'-DDT was detected in the groundwater sample from monitoring well WHF-14-2S at a concentration of 0.12 $\mu g/\ell$, which exceeded the Florida groundwater guidance concentration of 0.1 $\mu g/\ell$. Currently, there is no Federal MCL for this compound.

Eighteen inorganic analytes were detected in the groundwater samples from shallow monitoring wells. Nine of the inorganic analytes including aluminum, arsenic, cyanide, iron, magnesium, potassium, thallium, vanadium, and zinc were detected at concentrations exceeding the background screening concentration (Table 5-21). Concentrations of aluminum, iron, and manganese were reported to exceed the Federal MCLs and Florida groundwater guidance concentrations.

Intermediate Groundwater Samples. Five VOCs (1,1-dichloroethene, 1,2-dichloroethene, trichloroethene, benzene, and xylene) were detected in groundwater samples collected from intermediate depth monitoring wells.

Trichloroethene was detected in every monitoring well sampled at concentrations ranging from an estimated 1 $\mu g/\ell$ to 29 $\mu g/\ell$. The concentrations detected in groundwater samples from three monitoring wells (WHF-15-5I, WHF-15-7I, and WHF-15-8I) exceeded the Florida groundwater guidance concentration of 3 $\mu g/\ell$ and either met or exceeded the Federal MCL of 5 $\mu g/\ell$.

Benzene was detected in the groundwater samples from intermediate depth wells WHF-15-5I, WHF-15-7I, and WHF-15-8I at concentrations ranging from 5 $\mu g/\ell$ to 130 $\mu g/\ell$. All of the detected concentrations exceeded the Florida groundwater guidance concentration of 1 $\mu g/\ell$ and either met or exceeded the Federal MCL of 5 $\mu g/\ell$.

None of the remaining VOCs were detected at concentrations exceeding the Federal or State regulatory limits.

Table 5-20
Summary of Groundwater Analytical Results for Organic Compounds - 1997 Data

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Site 15, Southwest Landfill
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Milton, Florida

Analyte	Frequency of Detection[1]	Reporting Limit Range	Detected Concentration Range	Background Screening Concentration[2]	Federal MCLs[3]	Florida Groundwater Cleanup Target Levels[4]
Volatile Organic Compounds (μg/ℓ)						
1,1-Dichloroethene	2/20	10 to 25	3.5 to 10	ND	7	7
1,2-Dichloroethane	1/20	10 to 25	2	ND	[5]5	3
1,2-Dichloroethene (total)	8/20	10 to 25	1 to 14	ND	70	[5]70
Acetone	1/20	10 to 25	140	ND	NA	700
Benzene	4/20	10 to 25	1 to 100	ND	5	1
2-Butanone	1/20	10 to 25	7	ND	NA	4,200
Chlorobenzene	2/20	10 to 25	4 to 12	ND	100	100
Ethylbenzene	1/20	10 to 25	2	ND	700	30
Trichloroethene	11/20	10 to 25	1 to 330	ND	5	3
Xylenes (total)	1/20	10 to 25	1	ND	10,000	20
Semivolatile Organic Compounds (μg/ℓ)						
1,4-Dichlorobenzene	3/19	10 to 10	1 to 12	ND	76	75
Diethylphthalate	3/19	10 to 10	1 to 2	ND	NA	5,600
Naphthalene	2/19	10 to 10	1 to 4	ND	NA	20
bis(2-Ethylhexyl)phthalate	8/19	10 to 10	1 to 5	4	6	6
Pesticides and PCBs (μg/ℓ)						
4,4'-DDT	2/19	0.1 to 0.1	0.16 to 0.79	ND	NA	0.1

[1] Frequency of detection is the number of samples in which the analyte was detected divided by the total number of samples analyzed (excluding rejected values).
[2] The background screening value is twice the average of detected concentrations for inorganic analytes in background samples. Background screening values for organic analyte values are one times the average of detected concentrations. Organic values are included for comparison purposes only (i.e., not used to select ECPCs).
[3] Federal MCLs are the maximum permissible concentration of contaminants in the water that are delivered to a user by a public water system.
[4] Chapter 62-777, Florida Administrative Code, Groundwater Cleanup Target Levels.
[5] Value is for cis-1,2-dichloroethene.

Notes: The average of a sample and its duplicate is used for all table calculations.

Bold indicates analyte exceeded screening criteria.
Samples: 15G00101, 15G00201, 15G00202, 15G00203, 15G00301, 15G00302, 15G00303, 15G00401, 15G00501, 15G00502, 15G00503, 15G00601, 15G00602, 15G00603, 15G00701, 15G00702, 15G00703, 15G00801, 15G00802, and 15G00803.
Duplicate samples: 15G00601D, 15G00602D, 15G00701D, 15GOO703D, 15G00703D, 15G00801D, 15G00803D.
Background samples: BKG00101 through BKG00103, BKG00201 through BKG00203, and BKG00301.
Background duplicate samples: BKG00101D.

MCL = maximum contaminant level.
ND = not detected in any background sample.
PCB = polychlorinated biphenyl.
μg/ℓ = micrograms per liter.
NA = not available.
DDT = dichlorodiphenyltrichloroethane.

Table 5-21
Summary of Groundwater Analytical Results for Inorganic Analytes - 1997 Data

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Site 15, Southwest Landfill
Naval Air Station Whiting Field
Milton, Florida

Analyte	Frequency of Detection[1]	Reporting Limit Range[2]	Detected Concentration Range	Background Screening Concentration[3]	Federal MCLs[4]	Florida Groundwater Cleanup Target Levels[5]
Inorganic Analytes (mg/ℓ)						
Aluminum	14/20	35.8 to 200	58.65 to 1,030	654	[6]200	[8]200
Antimony	1/20	8.6 to 60	25.6	20.4	6	[7]6
Arsenic	6/20	0.5 to 10	0.6 to 17.2	ND	50	[7]50
Barium	20/20	200 to 200	7.8 to 68.3	72.6	2,000	[7]2,000
Cadmium	1/20	1.2 to 5	2.3	4.4	5	[7]5
Calcium	19/20	5,000 to 5,000	358 to 15,000	3,316	NA	NA
Chromium	6/20	2 to 10	1.95 to 2.8	30	100	[7]100
Cobalt	1/20	2.3 to 50	1.78	ND	NA	420
Copper	6/20	1.1 to 25	1.3 to 3.3	10.8	[6]1,000	[8]1,000
Cyanide	7/19	1.5 to 7.6	1.9 to 5	7	200	[7]200
Iron	18/20	100 to 100	56.7 to 40,200	964	[6]300	[8]300
Lead	10/20	0.5 to 3	0.5 to 4.05	ND	[10]15	[7]15
Magnesium	20/20	5,000 to 5,000	273 to 2,140	2,426	NA	NA
Manganese	18/20	15 to 15	1.8 to 553	42.8	[6]50	[8]50
Mercury	1/20	0.1 to 0.2	0.06	ND	2	[7]2
Nickel	1/20	7.3 to 40	7.4	42.8	100	[7]100
Potassium	17/20	5,000 to 5,000	338 to 2,190	1,528	NA	NA
Silver	1/20	2.5 to 10	2.9	ND	[6]100	[8]100
Sodium	20/20	5,000 to 5,000	1,070 to 18,300	4,772	[7]NA	[7]160,000
Thallium	2/20	0.6 to 10	0.98 to 2.95	ND	2	[7]2
Vanadium	7/20	1.2 to 50	0.9 to 5.2	3.8	NA	[9]49
Zinc	12/20	20 to 20	1.6 to 306	200	[6]5,000	[8]5,000

See notes on following page.

Table 5-21 (Continued)
Summary of Groundwater Analytical Results for Inorganic Analytes - 1997 Data

Remedial Investigation Report
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Milton, Florida

[1] Frequency of detection is the number of samples in which the analyte was detected divided by the total number of samples analyzed (excluding rejected values).
[2] For duplicate samples having one nondetect value, one-half of the detection limit is used as a surrogate for the nondetect value.
[3] The background screening value is twice the average of detected concentrations for inorganic analytes in background samples. Background screening values for organic analyte values are one times the average of detected concentrations. Organic values are included for comparison purposes only (i.e., not used to select ecological contaminant of potential concerns).
[4] Federal MCLs are maximum permissible concentration of contaminants in the water that are delivered to a user by a public water system.
[5] Chapter 62-777, Florida Administrative Code, Groundwater Cleanup Target Levels.
[6] Secondary MCL.
[7] Primary drinking water standard based on Florida Administrative Code (FAC) Rule 17-550.310.320.
[8] Secondary drinking water standard based on FAC Rule 17-550.310.320.
[9] Systemic toxicants based on FAC rule 17-520.400(1)d.
[10] Treatment technique.

Notes: The average of a sample and its duplicate is used for all table calculations.

Bold indicates analyte exceeded screening criteria.
Samples: 15G00101, 15G00201, 15G00202, 15G00203, 15G00301, 15G00302, 15G00303, 15G00401, 15G00501, 15G00502, 15G00503, 15G00601, 15G00602, 15G00603, 15G00701, 15G00702, 15G00703, 15G00801, 15G00802, and 15G00803.
Duplicate samples: 15G00601D, 15G00602D, 15G00701D, 15G00703D, 15G00801D, 15G00803D.
Background samples: BKG00101 through BKG00103, BKG00201 through BKG00203, and BKG00301.
Background duplicate samples: BKG00101D.

MCL = maximum contaminant level.
mg/ℓ = milligrams per liter.
ND = not detected in any background sample.
NA = not available.

Bis(2-ethylhexyl)phthalate was the only SVOC detected in the groundwater samples from intermediate depth monitoring wells at Site 15. The compound was detected in samples from monitoring wells WHF-15-2I, WHF-15-3I, and WHF-15-8I at concentrations ranging from an estimated 2.0 to 5.0 $\mu g/\ell$. All detected concentrations were below the Federal MCL and Florida groundwater guidance concentration of 6 $\mu g/\ell$.

No pesticides or PCB compounds were detected in the groundwater samples from the intermediate depth monitoring wells.

Fifteen inorganic analytes were detected in the groundwater samples from intermediate monitoring wells at Site 15. Seven of the analytes (arsenic, calcium, iron, lead, manganese, sodium, and zinc) were detected at concentrations exceeding the background water screening criteria. Concentrations of aluminum, iron, and manganese were detected in one or more samples at levels exceeding the Federal MCLs and Florida groundwater guidance concentrations.

Deep Groundwater Samples. Five VOCs (acetone, 1,1-dichloroethene, 1,2-dichloroethene, 1,2-dichloroethane, and trichloroethene) were detected in groundwater samples collected from deep monitoring wells. 1,1-Dichloroethene exceeded the Federal and State MCLs (3 $\mu g/\ell$ and 5 $\mu g/\ell$ respectively) in groundwater samples from monitoring well 15G00503 where concentrations ranged from 10 to 11 $\mu g/\ell$. Trichloroethene either equals or exceeds the Federal and State MCLs (5 and 3 $\mu g/\ell$ respectively) in groundwater samples from three monitoring wells (15G00503 [230 to 350 $\mu g/\ell$], 15G00703 [36 to 150 $\mu g/\ell$], and 15G00803 [4 to 7 $\mu g/\ell$]).

Two SVOCs (diethylphthalate and bis(2-ethylhexyl)phthalate) were detected in the groundwater samples from the deep monitoring wells at Site 15. The compounds were detected in groundwater samples from monitoring wells WHF-15-2D, WHF-15-7D, and WHF-15-8D. All detected concentrations were less than the Federal MCLs and Florida groundwater guidance concentrations.

4,4'-DDT, which was detected at estimated concentrations of 0.16 and 0.79 $\mu g/\ell$ in the groundwater samples from monitoring well WHF-15-8D, was the only pesticide compound reported in the deep monitoring wells. The detected concentrations exceeded the Florida groundwater guidance concentration of 0.1 $\mu g/\ell$. There is currently no Federal MCL for this compound.

Sixteen inorganic analytes were detected in the groundwater samples from the Site 15 deep monitoring wells. Nine of the compounds including antimony, arsenic, calcium, cobalt, copper, lead, manganese, potassium, and sodium were detected at concentrations exceeding the background screening concentration (Table 5-21). Three of the analytes antimony, iron, and manganese, were detected at concentrations exceeding the Federal MCLs and Florida groundwater guidance concentrations.

Filtered Groundwater Samples. Filtered samples for inorganics (metals only) were collected from monitoring wells WHF-15-2S, WHF-15-2I, WHF-15-2D, WHF-15-3S, WHF-15-5S, WHF-15-5D, WHF-15-7I, WHF-15-8I, and WHF-15-8D, for comparison purposes only during the Phase IIB RI (denoted with "F" suffix, Table 5-19). Comparison of the analytical results between the filtered sample and the corresponding unfiltered sample indicates that, in general, fewer analytes are detected in the filtered samples. In addition, analyte concentrations in the filtered sample are typically lower than the corresponding concentrations in the unfiltered sample.

However, there were several filtered samples which contained higher concentrations of analytes than in the unfiltered samples. It should be noted that only unfiltered sample data was used in the RI decision making process, including the risk assessment.

CHAPTER 6.0

6.0 HUMAN HEALTH RISK ASSESSMENT

An HHRA has been conducted as part of the RI for Site 15 at NAS Whiting Field. The purpose of the HHRA is to characterize the risks associated with the hypothetical exposures to site-related chemicals. This HHRA is conducted in accordance with the following guidance documents:

- USEPA's Risk Assessment Guidance for Superfund, Volume 1, Human Health Evaluation Manual (Part A) (USEPA, 1989b),
- Guidance for Data Useability in Risk Assessment (Part A), Final (USEPA, 1992a), and
- Region IV Risk Assessment Guidance (USEPA, 1995a).

Additionally, the HHRA will consider the following FDEP guidance:

- Soil and Groundwater Cleanup Target Levels for Florida (FDEP, 1999).

The methodology for the HHRA is described in Chapter 2.0 of the GIR (ABB-ES, 1998). The HHRA methodology presented in the GIR (ABB-ES, 1998) consists of the following steps:

- data evaluation,
- selection of chemicals of potential concern,
- exposure assessment,
- toxicity assessment, and
- risk characterization.

Site 15 is a 21-acre parcel located along the southwestern facility bound near the South Air Field at NAS Whiting Field. The location, physical description, and history associated with Site 15 are described in Chapter 1.0 of this report. Surface soil, subsurface soil, and groundwater were collected from Site 15 during the RI. Sampling locations and the sampling rationale are presented in Chapters 3.0 and 5.0 of this report.

6.1 DATA EVALUATION. The data evaluation involves numerous activities, including sorting data by medium, evaluating sample quantitation limits (SQLs), and evaluating quality of data with respect to qualifiers.

The data for Site 15 was categorized into surface soil, subsurface soil, groundwater, and background for each medium.

SQLs are compared to USEPA Region III RBCs (USEPA, 1998), and Florida screening values (FDEP, 1999). Surface soil and subsurface soil SQLs were compared to USEPA Region III RBCs (USEPA, 1998) and Florida Soil Cleanup Target Levels (FDEP, 1999) for residential and industrial use, respectively. Groundwater SQLs were compared to Florida Groundwater Cleanup Target Levels (FDEP, 1999) and USEPA Region III Tap Water RBCs (USEPA, 1998). Analyte-specific SQLs that are above RBCs and Florida screening values are identified and discussed in the uncertainty analysis.

The quality of the data was evaluated with respect to the data qualifiers. Only data of sufficient quality were retained for evaluation in the HHRA. The HHRA considers data with "J", "U", and "UJ" qualifiers as well as data with no qualifier.

6.2 SELECTION OF HUMAN HEALTH CHEMICALS OF POTENTIAL CONCERN (HHCPCs). The HHCPCs were selected per the methodology described in Section 2.5 of the GIR (ABB-ES, 1998). This HHCPC methodology considers (1) frequency of detection, (2) consistency with background conditions, (3) a comparison with regulatory and risk-based screening values (screening values are presented in Appendix C, Tables C-1 through C-3), and (4) a comparison to essential nutrient levels.

USEPA Region IV criteria were used in selecting HHCPCs (USEPA, 1995a). For each medium, the following criteria were employed to exclude detected analytes from the list of HHCPCs. Each criterion by itself is justification for excluding the analyte.

Less than 5 Percent Frequency of Detection. An analyte is not selected as a HHCPC if it has a frequency of detection (number of samples in which the analyte is detected divided by the number of samples analyzed for that analyte) less than 5 percent (USEPA, 1995a) and is not selected as an HHCPC in another medium. This criterion is not used if there are less than 20 environmental samples for a specific media.

Less than Background Screening Concentrations. If the maximum detected concentration of an analyte is less than twice the arithmetic mean of the background concentration (inorganics only), the analyte is not selected as an HHCPC (USEPA, 1995a). Development of background screening values for surface soil, groundwater, and subsurface soil are discussed below.

- A representative surface soil background data set consisting of Troup loamy sand and Dothan/Lucy/Bonifay soil is used for background screening of Site 15 surface soil samples. Sample locations are identified on Figure 3-10 and are discussed in Subsection 3.3.1 of the GIR (ABB-ES, 1998). The background surface soil data used for screening Site 15 surface soil are presented in Tables 3-9 and 3-14 of the GIR (ABB-ES, 1998).

- Background subsurface soil locations are identified on Figure 3-10 and discussed in Subsection 3.3.2 of the GIR (ABB-ES, 1998). Tables 3-15 through 3-17 in the GIR present background sample data for various types of subsurface soil. Table 3-18 of the GIR (ABB-ES, 1998) presents summary statistics and background screening data value used in the Site 15 HHRA subsurface soil evaluation.

- Background groundwater sample locations are identified on Figure 3-12 and discussed in Subsection 3.3.3 of the GIR (ABB-ES, 1998). Tables 3-21 through 3-23 of the GIR (ABB-ES, 1998) presents background screening data for groundwater. Table 3-24 of the GIR (ABB-ES, 1998) present the summary statistics used for screening the groundwater at Site 15.

Less than Risk-Based Screening Concentrations, Standards, and Guidelines. If the maximum detected concentration of the analyte in a medium is less than its corresponding adjusted USEPA Region III RBC (USEPA, 1998), and less than FDEP standards and guidelines, the analyte is not selected as a HHCPC (USEPA, 1995a). The target hazard quotient (HQ) in the USEPA Region III RBC table is 1 and the target cancer risk is 1×10^{-6}. All RBCs based on noncarcinogenic effects are adjusted for a target HQ of 0.1 per Region IV guidance (USEPA, 1995a).

The residential soil RBCs are used for screening surface soil. The industrial soil RBCs are used for screening subsurface soil. No RBC is available for lead in soil due to a lack of toxicity data. Based on an USEPA recommendation, a screening level of 400 mg/kg for lead under residential land use is used as the RBC for lead in soil (USEPA, 1994c). The maximum detected concentrations of analytes in surface soil and subsurface soil are also compared to residential and industrial Florida Soil Cleanup Target Levels (FDEP, 1999), respectively.

Tap water RBCs (USEPA, 1998), Federal MCLs (USEPA, 1996c) and Florida Cleanup Target Levels (FDEP, 1999) are used for screening HHCPCs in groundwater.

Less than Essential Nutrient Screening Values. If the maximum detected concentration of an essential nutrient in a medium is below a toxic level and consistent with or only slightly above its background concentration, the essential nutrient is not selected as an HHCPC. The derivation of essential nutrient screening values is presented in the GIR (Appendix C).

HHCPCs were not screened using the essential nutrient value for iron; the RBC for iron was used instead. However, if iron is determined to be a risk driver, a comparison of the exposure concentrations against the essential nutrient level for iron will be presented in the uncertainty analysis section for that medium.

If the analyte meets any of the above criteria, is not a member of the same chemical class as other HHCPCs in the medium, and is not a breakdown product of other HHCPCs in the medium, then the analyte is not selected as a HHCPC. In situations where multiple screening values are available, a chemical is excluded only if its maximum screening concentration is less than all of the corresponding screening values. Appendix C of this report presents the RBCs, regulatory guidance values, and ARARs that are used in HHCPC selection. After applying these criteria with professional judgment, HHCPCs are identified for each medium. HHCPC selection for each medium is presented below in Subsections 6.2.1 through 6.2.3.

6.2.1 Surface Soil Thirty samples (15-SL-01 through 15-SL-05, 15S00101, 15S00201, 15S00301, 15S00401, 15S00501, 15S00601, 15S00701, 15S00801, 15S00901 [and a reanalysis, 15S00901RE], 15S01001, 15S01101, 15S01201, 15S01301, 15S01401, 15S01501, 15S01601, 15S01701, 15S01801, 15S01901 [and a reanalysis, 15S01901RE], 15S02001, 15S02101, 15S02201, 15S02301, 15S02401, and 15S02501 as well as three duplicates 15S00101D, 15S01701D, and 15S02001D) were considered in the Site 15 HHRA. Sample 15S00901RE only had data for SVOCs. The SVOC data for 15S00901 was all rejected. Samples 15-SL-01, 15-SL-02, 15-SL-03, 15-SL-04, and 15-SL-05 did not have data for endrin aldehyde and carbazole.

VOCs, SVOCs, pesticides, PCBs, and inorganic analyte data from all of these samples are evaluated in this HHRA. Tables 5-9 and 5-10 present the analytes and concentrations detected in surface soil samples. Table 6-1 presents summary

Table 6-1
Selection of Human Health Chemicals of Potential Concern for Surface Soil

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Naval Air Station Whiting Field
Milton, Florida

Analyte	Frequency of Detection[1]	Range of Reporting Limit	Range of Detected Concentrations[2]	Mean of Detected Concentrations[3]	Background Screening Concentration[4]	Selected Screening Concentration[5]	Analyte HHCPC? (Yes/No)	Reason[6]
Volatile Organic Compounds (μg/kg)								
Acetone	1/30	10 to 22	11	11	NA	780,000	No	S, F
Methylene chloride	4/30	5 to 12	3 to 9	5.3	NA	16,000	No	S
Xylenes (total)	3/30	5 to 12	1 to 4	2.3	NA	5,900,000	No	S
Semivolatile Organic Compounds (μg/kg)								
Butylbenzylphthalate	1/30	350 to 430	240	240	NA	1,600,000	No	S, F
Di-*n*-butylphthalate	6/30	350 to 420	560 to 1,100	800	NA	780,000	No	S
bis(2-Ethylhexyl)phthalate	4/30	350 to 430	39 to 947.5*	299	80.3	46,000	No	S
Pesticides and PCBs (μg/kg)								
4,4'-DDD	1/30	3.5 to 18	3.8	3.8	NA	2,700	No	S, F
4,4'-DDE	3/30	3.5 to 18	1.9 to 50	18.3	NA	1,900	No	S
4,4'-DDT	2/30	3.5 to 18	4.4 to 14	9.2	NA	1,900	No	S
Inorganic Analytes (mg/kg)								
Aluminum	30/30	40	3,280 to 13,400	7,159	15,300	7,800	No	B
Arsenic	30/30	2	0.75 to 6.8	1.6	[7]4.6	0.43	Yes	
Barium	30/30	40	3.2 to 11.8	6.8	23.8	110	No	B, S
Beryllium	3/30	0.05 to 1	0.07 to 0.09	0.08	0.36	16	No	B, S
Calcium	18/30	1,000	22.05* to 263*	79.5	402	1,000,000	No	B, S
Chromium	30/30	2	2.8 to 14.4*	6.1	10.8	23	No	S
Cobalt	11/30	0.33 to 10	0.49 to 1.2	0.72	3	470	No	B, S
Copper	8/30	5	1.6 to 12.5	5.4	9.4	110	No	B, S

See notes at end of table.

Table 6-1 (Continued)
Selection of Human Health Chemicals of Potential Concern for Surface Soil

Remedial Investigation Report
Site 15, Southwest Landfill
Naval Air Station Whiting Field
Milton, Florida

Analyte	Frequency of Detection[1]	Range of Reporting Limits	Range of Detected Concentrations[2]	Mean of Detected Concentrations[3]	Background Screening Concentration[4]	Selected Screening Concentration[5]	Analyte HHCPC? (Yes/No)	Reason[6]
Inorganic Analytes (mg/kg) (Continued)								
Cyanide	3/30	0.24 to 0.5	0.09 to 0.31	0.19	0.26	30	No	S
Iron	30/30	20	1,610 to 11,150*	4,278	8,588	2,300	Yes	
Lead	30/30	0.6 to 1	2.3 to 59.9	6.6	11.4	400	No	S
Magnesium	30/30	1,000	43 to 156	92.3	258	460,468	No	B, S
Manganese	30/30	3	8.08 to 143	53.5	404	160	No	B, S
Mercury	22/30	0.06 to 0.1	0.01 to 0.19	0.02	0.12	2.3	No	S
Nickel	1/30	2.3 to 8	3.3	3.3	7.2	110	No	B, S, F
Potassium	5/30	128 to 1,000	131 to 334.5*	190	177	1,000,000	No	S
Selenium	6/30	0.39 to 1	0.24 to 0.41	0.33	0.44	39	No	B, S
Silver	4/30	0.32 to 2	0.66 to 2	1	0.7	39	No	S
Sodium	5/30	1,000	170 to 179	174	388	1,000,000	No	B, S
Vanadium	30/30	10	4.1 to 33.85*	11	21.2	15	Yes	S
Zinc	28/30	4	2.4 to 15.9	5.4	15.4	2,300	No	S

See notes at end of table.

Table 6-1 (Continued)
Selection of Human Health Chemicals of Potential Concern for Surface Soil

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[1] Frequency of detection is the number of samples in which the analyte was detected over the total number of samples analyzed (excluding rejected values).
[2] A value indicated by an asterisk is the average of a sample and its duplicate. For duplicate samples having one nondetect, one-half of the contract-required quantification limit/contract-required detection limit is used as a surrogate concentration for the nondetect.
[3] The mean of detected concentrations is the arithmetic mean of all samples in which the analyte was detected. It does not include those samples with "R", "U", or "UJ" validation qualifiers.
[4] The background screening value is twice the average of detected concentrations for inorganic analytes in background samples.
[5] For all chemicals except the essential nutrients (calcium, magnesium, potassium, and sodium), the lesser of the U.S. Environmental Protection Agency (USEPA) Region III Risk-Based Concentration (RBC) table for residential soil exposure per January 1993 guidance (*Selecting Exposure Routes and Contaminants of Concern by Risk-Based Screening*, EPA/903/R-93-001 [USEPA, 1993a]) or the Florida Soil Cleanup Target Levels (FDEP, 1999) was used for screening. Values from the USEPA Region III RBC Tables, dated October 1, 1998, are based on an excess lifetime cancer risk of 1×10^{-6} or an adjusted hazard quotient of 0.1 (USEPA, 1998). For the essential nutrients, screening values were derived based on recommended daily allowances. Lead value is from the Revised Interim Guidance on Establishing Soil Lead Cleanup Levels at Superfund Sites (OSWER Directive 9355.4-12 [USEPA, 1994c]). Values are presented in Appendix G of this report.
[6] Analyte was excluded from the risk assessment for the following reasons:
B = the maximum detected concentration did not exceed the background screening concentration; therefore the analyte will not be considered further.
S = the maximum detected concentration did not exceed the screening concentration; therefore, the analyte will not be considered further.
F = the frequency of detected concentrations was less than five percent; therefore, the analyte will not be considered further.
[7] Arsenic background number is presented in Appendix I of the GIR (ABB-ES, 1998).

Notes: The average of a sample and its duplicate is used for all table calculations.
Samples: 15-SL-01, 15-SL-02, 15-SL-03, 15-SL-04, 15-SL-05, 15S00101, 15S00201, 15S00301, 15S00401, 15S00501, 15S00601, 15S00701, 15S00801, 15S00901 (all analytes except semivolatiles), 15S00901RE (only semivolatiles), 15S01001, 15S01101, 15S01201, 15S01301, 15S01401, 15S01501, 15S01601, 15S01701, 15S01801, 15S01901, 1501901RE, 15S02001, 15S2101, 15S02201, 15S02301, 15S02401, 15S02501.
Sample duplicates: 15S00101D, 15S01701D, 15S02001D.
Background samples: BKG-SL-02, BKG-SL-06, BKG-SL-07, BKG-SL-08, BKS00101, BKS00201, BKS00301, BKS00401, and BKS00501.
Background duplicate sample: BKS00201D.

HHCPC = human health chemical of potential concern.
μg/kg = micrograms per kilogram.
NA = not applicable.
* = average of sample and duplicate.
PCB = polychlorinated biphenyl.
DDD = dichlorodiphenyldichloroethane.
DDE = dichlorodiphenyldichloroethene.
DDT = dichlorodiphenyltrichloroethane.
mg/kg = milligrams per kilogram.

statistics for the detected analytes and identifies three inorganic analytes (arsenic, iron, and vanadium) as HHCPCs for surface soil at Site 15.

Vanadium was recently added as an HHCPC because the Florida residential cleanup target level was lowered to 15 mg/kg in Chapter 62-777, FAC. However, all detections of vanadium were below the USEPA Region III RBC of 55 mg/kg. Vanadium was not carried through the remainder of the HHRA, but it will be addressed in the feasibility study as an HHCPC along with arsenic.

6.2.2 Subsurface Soil Five samples (15SS0201, 15SS0502, 15SS0603, 15SS0804, and 15SS1005) were collected from Site 15. VOCs, SVOCs, pesticides, PCBs and inorganic analyte data from all of these samples are evaluated in this HHRA (Table 5-12). Table 6-2 presents the HHCPCs selection for subsurface soil at Site 15. Aroclor-1242 was the only compound selected as an HHCPC in the subsurface soil.

Aroclor-1242 was recently added as an HHCPC because the Florida industrial soil cleanup target level was lowered to 2,100 μg/kg in Chapter 62-777, FAC. Aroclor-1242 was detected in only one sample at a concentration of 2,200 μg/kg which was below the USEPA Region III RBC of 2,900 μg/kg. Aroclor-1242 was not carried through the remainder of the HHRA, but it will be addressed in the feasibility study as an HHCPC.

6.2.3 Groundwater Twenty groundwater samples (15G00101, 15G00201, 15G00202, 15G00203, 15G00301, 15G00302, 15G00303, 15G00401, 15G00501, 15G00502, 15G00503 [which includes a dilution sample for trichloroethene, 15G00503DL], 15G00601, 15G00602, 15G00603, 15G00701, 15G00702, 15G00703, 15G00801, 15G00802, and 15G00803) as well as duplicate samples (15G00601D, 15G00602D, 15G00701D, 15G00703D, 15G00801D, and 15G00803D) was collected from Site 15. The most recent data (July 1997) for groundwater were used. Only the Phase IIB groundwater sampling data, which were collected using low-flow sampling techniques, were used in the HHRA.

VOCs, SVOCs, pesticides, PCBs, and inorganic data from these samples are evaluated in this HHRA (Table 5-19). Table 6-3 presents the summary statistics for the detected analytes and identifies 1,1-dichloroethene, 1,2-dichloroethene, benzene, chlorobenzene, trichloroethene, 1,4-dichlorobenzene, bis(2-ethylhexyl)-phthalate, 4,4'-DDT, and five inorganics (aluminum, arsenic, iron, manganese, and thallium) as HHCPCs for groundwater at Site 15.

6.3 EXPOSURE ASSESSMENT. The exposure assessment methodology is described in Subsection 2.5.3 of the GIR (ABB-ES, 1998). This process involves several steps including

- characterization of the exposure setting in terms of physical characteristics and the populations that may hypothetically be exposed to site-related chemicals;
- identification of potential exposure pathways and receptors; and

Table 6-2
Selection of Human Health Chemicals of Potential Concern for Subsurface Soil

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Analyte	Frequency of Detection[1]	Range of Reporting Limit	Range of Detected Concentrations	Mean of Detected Concentrations[2]	Background Screening Concentration[3]	Selected Screening Concentration[4]	Analyte HHCPC? (Yes/No)	Reason[5]
Volatile Organic Compounds (µg/kg)								
2-Hexanone	1/5	11	3	3	NA	34,000	No	S
Chlorobenzene	1/5	11	2	2	NA	200,000	No	S
Xylenes (total)	4/5	11	4 to 6	5	NA	40,000,000	No	S
Semivolatile Organic Compounds (µg/kg)								
1,4-Dichlorobenzene	1/5	350 to 370	110	110	NA	9,000	No	S
2-Methylnaphthalene	2/5	350 to 370	68 to 76	72	NA	560,000	No	S
4-Methylphenol	2/5	350 to 370	42 to 77	59.5	NA	1,000,000	No	S
Diethylphthalate	1/5	350 to 370	41	41	NA	160,000,000	No	S
Naphthalene	2/5	350 to 370	92 to 140	116	NA	270,000	No	S
Phenol	1/5	350 to 370	53	53	NA	120,000,000	No	S
bis(2-Ethylhexyl)phthalate	2/5	350 to 370	42 to 230	136	NA	280,000	No	S
Pesticides and PCBs (µg/kg)								
4,4'-DDE	1/5	3.5 to 37	2.3	2.3	NA	13,000	No	S
Aroclor-1242	1/5	35 to 370	2,200	2,200	NA	2,100	Yes	S
Inorganic Analytes (mg/kg)								
Aluminum	5/5	40	3,520 to 15,100	9,506	27,834	200,000	No	B, S
Arsenic	5/5	2	0.63 to 2.6	1.8	6.2	3.8	No	B, S
Barium	5/5	40	1.6 to 13.2	7.2	15.8	14,000	No	B, S
Beryllium	4/5	0.05 to 1	0.09 to 0.17	0.13	0.26	410	No	B, S
Cadmium	1/5	0.63 to 1	2.1	2.1	0.92	100	No	S
Calcium	5/5	NA	72.7 to 267	177	444	1,000,000	No	B, S

See notes at end of table.

Table 6-2 (Continued)
Selection of Human Health Chemicals of Potential Concern for Subsurface Soil

Remedial Investigation Report
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Naval Air Station Whiting Field
Milton, Florida

Analyte	Frequency of Detection[1]	Range of Reporting Limit	Range of Detected Concentrations	Mean of Detected Concentrations[2]	Background Screening Concentration[3]	Selected Screening Concentration[4]	Analyte HHCPC? (Yes/No)	Reason[5]
Inorganic Analytes (mg/kg) (Continued)								
Chromium	5/5	NA	3.8 to 12.7	8.1	22.8	420	No	B, S
Cobalt	1/5	0.71 to 10	0.71	0.71	1.5	12,000	No	B, S
Copper	5/5	NA	0.86 to 6.8	4.1	8.8	8,200	No	B, S
Cyanide	2/5	0.09 to 1	0.53 to 0.55	0.54	ND	4,100	No	S
Iron	5/5	NA	2,100 to 9,640	5,490	18,100	61,000	No	B, S
Lead	5/5	NA	2.8 to 86.2	21.5	8.4	400	No	S
Magnesium	5/5	NA	18.8 to 109	74.7	272	460,468	No	B, S
Manganese	5/5	NA	10 to 44.2	25.3	42.6	4,100	No	S
Mercury	5/5	NA	0.09 to 0.59	0.4	ND	26	No	S
Nickel	3/5	1.1 to 8	2.1 to 3	2.5	5	4,100	No	B, S
Potassium	3/5	145 to 1,000	137 to 157	149	181	1,000,000	No	B, S
Silver	3/5	0.43 to 2	0.48 to 0.62	0.54	0.3	1,000	No	S
Sodium	5/5	NA	165 to 191	178	1.1	1,000,000	No	S
Vanadium	5/5	NA	6.5 to 25	15.8	45	1,400	No	B, S
Zinc	5/5	NA	3.1 to 19.1	10.5	15.6	61,000	No	S

See notes at end of table.

Table 6-2 (Continued)
Selection of Human Health Chemicals of Potential Concern for Subsurface Soil

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Site 15, Southwest Landfill
Naval Air Station Whiting Field
Milton, Florida

[1] Frequency of detection is the number of samples in which the analyte was detected over the total number of samples analyzed (excluding rejected values).
[2] The mean of detected concentrations is the arithmetic mean of all samples in which the analyte was detected. It does not include those samples with "R", "U", or "UJ" validation qualifiers.
[3] The background screening value is twice the average of detected concentrations for inorganic analytes in background samples.
[4] The lesser of the U.S. Environmental Protection Agency (USEPA) Region III Risk-Based Concentration (RBC) table for industrial soil exposure per January 1993 guidance (*Selecting Exposure Routes and Contaminants of Concern by Risk-Based Screening*, EPA/903/R-93-001 [USEPA, 1993a]) or Florida Soil Cleanup Target Levels (FDEP, 1999) were used for screening. Actual values are taken from the USEPA Region III RBC Tables dated October 1, 1998, and are based on an excess lifetime cancer risk of 1×10^{-6} or an adjusted hazard quotient of 0.1 (USEPA, 1998). Values are presented in Appendix G of this report.
[5] Analyte was included or excluded from the risk assessment for the following reasons:
B = the maximum detected concentration did not exceed the background; therefore the analyte will not be considered further.
S = the maximum detected concentration did not exceed the screening concentration; therefore, the analyte will not be considered further.

Notes: The average of a sample and its duplicate is used for all table calculations.
Samples: 15SS0201, 15SS0502, 15SS0603, 15SS0804, 15SS1005.
Background samples: BKB00101, BKB00102, BKB00201, BKB00202, BKB00301, BKB00302, BKB00401, BKB00402, BKB00501, BKB00502, BKB00601, BKB00602, BKB00701, BKB00702.
Background duplicate samples: BKB00401D and BKB00602D.

HHCPC = human health chemical of potential concern.
μg/kg = micrograms per kilogram.
NA = not applicable.
PCB = polychlorinated biphenyl.
DDE = dichlorodiphenyldichloroethene.
mg/kg = milligrams per kilogram.
ND = not detected in any background sample.

Table 6-3
Selection of Human Health Chemicals of Potential Concern for Unfiltered Groundwater

Remedial Investigation Report
Site 15, Southwest Landfill
Naval Air Station Whiting Field
Milton, Florida

Analyte	Frequency of Detection[1]	Reporting Limit Range	Detected Concentrations Range[2]	Mean of Detected Concentrations[3]	Background Screening Concentration[4]	Selected Screening Concentration[5]	Analyte HHCPC? (Yes/No)	Reason[6]
Volatile Organic Compounds (μg/ℓ)								
1,1-Dichloroethene	2/20	10 to 25	3.5 to 10	6.8	NA	0.044	Yes	
1,2-Dichloroethane	1/20	10 to 25	2	2	NA			
1,2-Dichloroethene (total)	8/20	10 to 25	1 to 14	5.4	NA	5.5	Yes	
Acetone	1/20	10 to 25	140	140	NA	370	No	S, F
Benzene	4/20	10 to 25	1 to 100	32.3	NA	0.36	Yes	
2 Butanone	1/20	10 to 25	7	7	NA	190	No	S, F
Chlorobenzene	2/20	10 to 25	4 to 12	8	NA	3.5	Yes	
Ethylbenzene	1/20	10 to 25	2	2	NA	30	No	S, F
Trichloroethene	11/20	10 to 25	1 to 330	37.1	NA	1.6	Yes	
Xylene (total)	1/20	10 to 25	1	1	NA	20	No	S, F
Semivolatile Organic Compounds (μg/ℓ)								
1,4-Dichlorobenzene	3/19	10	1 to 12	7	NA	0.47	Yes	
Diethylphthalate	3/19	10	1 to 2	1.3	NA	2,900	No	S
Naphthalene	2/19	10	1 to 4	2.5	NA	20	No	S
bis(2-Ethylhexyl)phthalate	8/19	10	1 to 5	2.3	NA	4.8	Yes	
Pesticides and PCBs (μg/ℓ)								
4,4'-DDT	2/19	0.1	0.12	0.12	NA	0.1	Yes	
Inorganic Analytes (μg/ℓ)								
Aluminum	14/20	35.8 to 200	58.65 to 1,030	252	654	200	Yes	
Antimony	1/20	8.6 to 60	25.6	25.6	20.4	1.5	No	F

See notes at end of table.

Table 6-3 (Continued)
Selection of Human Health Chemicals of Potential Concern for Unfiltered Groundwater

Remedial Investigation Report
Site 15, Southwest Landfill
Naval Air Station Whiting Field
Milton, Florida

Analyte	Frequency of Detection[1]	Reporting Limit Range	Detected Concentrations Range[2]	Mean of Detected Concentrations[3]	Background Screening Concentration[4]	Selected Screening Concentration[5]	Analyte HHCPC? (Yes/No)	Reason[6]
Inorganic Analytes (μg/ℓ) (Continued)								
Arsenic	6/20	0.5 to 10	0.6 to 17.2	6.6	ND	0.045	Yes	
Barium	20/20	200	7.8 to 68.3	19.7	72.6	260	No	B, S
Cadmium	1/20	1.2 to 5	2.3	2.3	4.4	1.8	No	B, F
Calcium	19/20	5,000	358 to 15,000	2,529	3,316	1,055,398	No	S
Chromium	6/20	2 to 10	1.95 to 2.8	2.4	30	18	No	B, S
Cobalt	1/20	2.3 to 50	1.78	1.8	ND	220	No	S, F
Copper	6/20	1.1 to 25	1.3 to 3.3	2.2	10.8	150	No	B, S
Cyanide	7/19	1.5 to 7.6	1.9 to 5	3	7	73	No	B, S
Iron	18/20	100	56.7 to 40,200	3,020	964	300	Yes	
Lead	10/20	0.5 to 3	0.5 to 4.05	1.3	ND	15	No	S
Magnesium	20/20	5,000	273 to 2,140	735	2,426	118,807	No	B, S
Manganese	18/20	15	1.8 to 553	65	42.8	73	Yes	
Mercury	1/20	0.1 to 0.2	0.06	0.06	ND	1.1	No	S, F
Nickel	1/20	7.3 to 40	7.4	7.4	42.8	73	No	B, S, F
Potassium	17/20	5,000	338 to 2,190	882	1,528	297,016	No	S
Silver	1/20	2.5 to 10	2.9	2.9	ND	18	No	S, F
Sodium	20/20	5,000	1,070 to 18,300	3,570	4,772	160,000	No	S
Thallium	2/20	0.6 to 10	0.98 to 2.95	2	ND	0.26	Yes	
Vanadium	7/20	1.2 to 50	0.9 to 5.2	2.2	3.8	26	No	S
Zinc	12/20	20	1.6 to 306	107	200	1,100	No	S

See notes at end of table.

Table 6-3 (Continued)
Selection of Human Health Chemicals of Potential Concern for Unfiltered Groundwater

Remedial Investigation Report
Site 15, Southwest Landfill
Naval Air Station Whiting Field
Milton, Florida

[1] Frequency of detection is the number of samples in which the analyte was detected over the total number of samples analyzed (excluding rejected values).
[2] For duplicate samples having one nondetect, one-half of the contract-required quantification limit/contract-required detection limit is used as a surrogate concentration for the nondetect.
[3] The mean of detected concentrations is the arithmetic mean of all samples in which the analyte was detected. It does not include those samples with "R", "U", or "UJ" validation qualifiers.
[4] The background screening value is twice the average of detected concentrations for inorganic analytes in background samples.
[5] For all chemicals except the essential nutrients (calcium, magnesium, potassium, and sodium), the lesser of the U.S. Environmental Protection Agency (USEPA), Region III Risk-Based Concentration (RBC) table for tap water exposure per January 1993 guidance (*Selecting Exposure Routes and Contaminants of Concern by Risk-Based Screening*, EPA/903/R-93-001 [USEPA, 1993a]) or the Florida Groundwater Cleanup Target Levels (FDEP, 1999) was used for screening. Actual values are taken from the USEPA Region III RBC Tables dated October 1, 1998, and are based on a excess lifetime cancer risk of 1×10^{-6} or an adjusted hazard quotient of 0.1 (USEPA, 1998). For the essential nutrients, screening values were derived based on recommended daily allowances. Values are presented in Appendix G of the report.
[6] Analyte was included or excluded from the risk assessment for the following reasons:

B = the maximum detected concentration did not exceed the background screening concentration; therefore, the analyte will not be considered further.
S = the maximum detected concentration did not exceed the screening concentration; therefore, the analyte will not be considered further.
F = the frequency of detected concentrations was less than five percent; therefore, the analyte will not be considered further.

Notes: The average of a sample and its duplicate is used for all table calculations.
Samples: 15G00101, 15G00201, 15G00202, 15G00203, 15G00301, 15G00302, 15G00303, 15G00401, 15G00501, 15G00502, 15G00503 (all analytes except trichloroethene), 15G00503DL (trichloroethene only), 15G00601, 15G00602, 15G00603, 15G00701, 15G00702, 15G00703, 15G00801, 15G00802, 15G00803.
Duplicate sample: 15G00602D.
Background samples: BKG00101 through BKG00103, BKG00201 through BKG00203, and BKG00301.
Background duplicate sample: BKG00101D.

HHCPC = human health chemical of potential concern.
$\mu g/\ell$ = micrograms per liter.
NA = not applicable.
PCB = polychlorinated biphenyl.
DDT = dichlorodiphenyltrichloroethane.
ND = not detected in any background samples.

- quantification of exposure for each population in terms of the amount of chemical either ingested, inhaled, or absorbed through the skin from all complete or hypothetically complete (potential future) exposure pathways.

Summaries of hypothetical exposure pathways to chemicals detected at Site 15 are presented on Figure 6-1.

The hypothetical pathways including medium and route of exposure, the hypothetical exposed population, and the rationale for pathway selection or exclusion, are presented in Table 6-4 and are described in more detail in Subsections 6.3.1 through 6.3.3. Receptor-specific exposure parameters for each exposure scenario are presented in Appendix G to the GIR (ABB-ES, 1998). Risk calculation spreadsheets in Appendix G to this RI report also contain the assumed exposure parameters and quantitation of exposures.

6.3.1 Surface Soil No humans currently reside or work at Site 15. Currently there are no buildings present at the site; therefore, exposure of occupational workers will be only considered as part of the future land-use scenario. Site 15 may be eventually developed for residential land use; therefore, the residential receptor will be evaluated as part of the hypothetical future land-use scenario. Other possible future exposure scenarios include excavation activities, such as installation of utility lines, and site maintenance, such as mowing the grass.

Exposures of hypothetical future residents (adult and child), hypothetical future occupational workers, current and future site maintenance workers, future excavation workers, and current and future trespassers (adult and child) to surface soil contaminants through ingestion, dermal contact, and inhalation of particulates are evaluated in this HHRA.

6.3.2 Subsurface Soil There are no current exposures to subsurface soil because no excavation or construction activities are ongoing at Site 15. Therefore, subsurface soil exposure pathways are not evaluated as current or potential future (hypothetical) exposure pathways in this HHRA. The presence of Aroclor-1242 above the Florida industrial cleanup target level will be addressed in the feasibility study.

6.3.3 Groundwater Currently, groundwater at Site 15 is not used for any potable or nonpotable purpose. There are no plans to use the water resource in the foreseeable future. In the event that Site 15 or areas hydraulically downgradient of Site 15 are developed for residential use, the exposure pathway to chemicals in groundwater could become complete. Therefore, hypothetical future domestic use (adult and child ingestion) has been evaluated in this HHRA as a worst-case estimate of hypothetical future receptors.

6.3.4 Exposure Point Concentrations (EPCs) EPCs for all HHCPCs in surface soil and groundwater were calculated according to Paragraph 2.5.3.3 of the GIR (ABB-ES, 1998). This quantification process involves developing assumptions regarding exposure conditions and exposure scenarios for each receptor to estimate the total amount of contaminants that a hypothetical receptor may ingest, dermally absorb, or inhale from each exposure pathway. The ultimate goal of this step, as defined in USEPA guidance, is to identify the combination of these exposure variables or parameters that result in the most intense level of exposure that may "reasonably" be expected to occur under current and future site

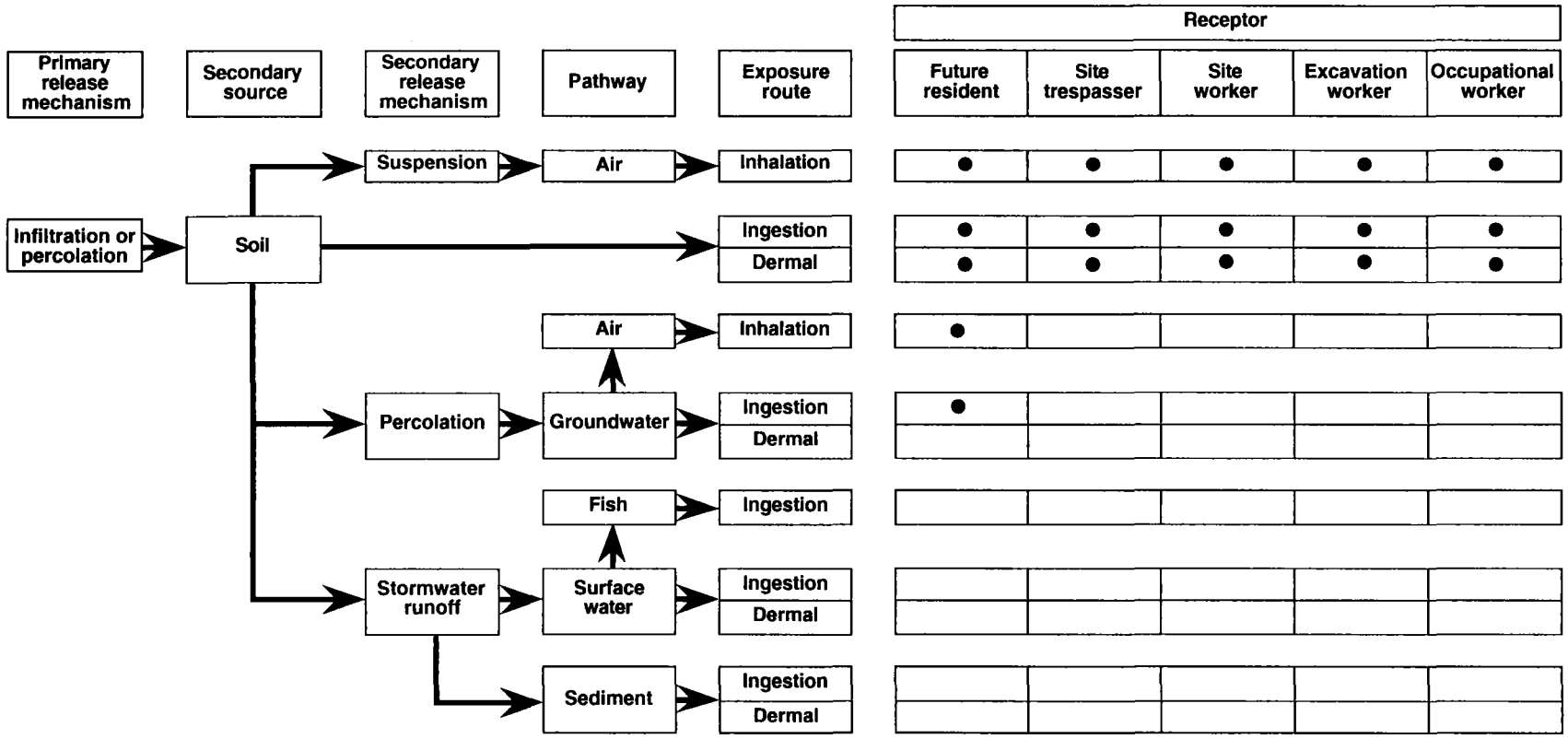


FIGURE 6-1
SITE 15, COMPLETE EXPOSURE PATHWAYS
FOR HUMAN RECEPTORS

REMEDIAL INVESTIGATION REPORT
SITE 15, SOUTHWEST LANDFILL

NAVAL AIR STATION WHITING FIELD
MILTON, FLORIDA

2534-09 WHITING SITE 15RI FIG 6-1 FINAL 050198HAS

Table 6-4
Summary of Potential Exposure Pathways

Remedial Investigation Report
Site 15, Southwest Landfill
Naval Air Station Whiting Field
Milton, Florida

Medium of Exposure	Route of Exposure	Potentially Exposed Population	Selected for Evaluation?	Reason for Selection or Evaluation
Current Land Use				
Surface soil	Dermal contact with soil, ingestion of soil, and inhalation of fugitive dust.	Resident (adult and child) Trespasser (adult and adolescent) Occupational worker (adult) Site maintenance worker (adult) Excavation worker (adult)	No Yes No Yes No	No humans currently reside or work at Site 15. Adolescents and adults may be exposed to contaminants in the surface soil while trespassing. The site maintenance workers may be exposed to contaminants in surface soil while performing routine site activities.
Subsurface soil	Dermal contact with soil, ingestion of soil, and inhalation of fugitive dust.	Excavation worker	No	There are no excavation activities currently at Site 15. Additionally, there are no HHCPCs selected for subsurface soil.
Groundwater	Ingestion of groundwater as drinking water	Resident (adult)	No	There are no current exposures to groundwater.
Future Land Use				
Surface soil	Dermal contact with soil, ingestion of soil, and inhalation of fugitive dust.	Resident (child and adult) Trespasser (adolescent and adult) Occupational worker (adult) Site maintenance worker (adult) Excavation worker (adult)	Yes Yes Yes Yes Yes	If Site 15 is developed for residential use, residents could be exposed to chemicals in surface soil. Exposure of trespasser, occupational worker, site maintenance worker, and excavation worker to chemicals in surface soil is possible.
Subsurface soil	Dermal contact with soil, ingestion of soil, and inhalation of fugitive dust.	Excavation worker	No	Although it is possible that an excavation worker could be exposed to subsurface soil in the future if the site is developed, there were no HHCPCs identified; therefore, this hypothetical exposure pathway is not evaluated in this human health risk assessment.
Groundwater	Ingestion of groundwater as drinking water and inhalation of volatiles while showering	Resident (adult and child)	Yes	If Site 15 is developed for residential use, drinking water wells in the surficial aquifer could be influenced by contaminants in the groundwater associated with Site 15. Therefore, future residents could be exposed to contaminants in the surficial aquifer.

conditions (USEPA, 1989b). The EPCs for HHCPCs in surface soil for Site 15 are presented in Table 6-5. The EPCs for HHCPCs in groundwater for Site 15 are presented in Table 6-6. The EPCs were used with receptor-specific exposure parameters to quantify exposures to the HHCPCs. Risk calculation spreadsheets and exposure assumptions are in Appendix C to this report.

6.4 TOXICITY ASSESSMENT. The toxicity assessment methodology is described in Subsection 2.5.4 of the GIR (ABB-ES, 1998). The toxicity assessment evaluates the available evidence on the hypothetical adverse effects associated with exposure to each HHCPC. This information is used to develop a relationship between the extent of exposure and the likelihood or severity of adverse human health effects. Two steps are typically associated with toxicity assessment: hazard identification and dose-response assessment.

- Hazard identification is the process of determining if exposure to an agent can cause a particular adverse health effect and, more importantly, if that effect will occur in humans. The objectives of the hazard identification in the HHRA are to (1) identify which of the contaminants detected at the site are hypothetical hazards, and (2) summarize their potential toxicity in brief nontechnical language.

- A dose-response assessment is conducted to characterize and quantify the relationship between intake, or dose, of an HHCPC and the likelihood of a toxic effect or response. There are two categories of toxic effects evaluated in this HHRA: carcinogenic and noncarcinogenic. Following USEPA guidance for HHRAs (USEPA, 1989b), these two endpoints (cancer and noncancer) are evaluated separately. As a result of the dose-response assessment, identified toxicity values are used to estimate the incidence of adverse effects as a function of human exposure to a chemical.

Appendix G to this report contains brief toxicity profiles for HHCPCs identified in the surface soil and groundwater at Site 15. Appendix G to this report also contains dose-response information for the HHCPCs (Tables G-4 through G-9). Toxicity values used in this HHRA were current as of February 1998 for Integrated Risk Information System (USEPA, 1998a) and July 1997 for Health Effects Assessment Summary Tables (USEPA, 1997b).

6.5 RISK CHARACTERIZATION. Risk characterization is the final step in the risk assessment process. This step involves the integration of the exposure and toxicity assessments into a qualitative or quantitative expression of potential human health risks associated with contaminant exposure. Quantitative estimates of both carcinogenic and noncarcinogenic risks are made for each HHCPC and each complete exposure pathway identified in the exposure assessment. The risk characterization methodology is described in Subsection 2.5.5 of the GIR (ABB-ES, 1998).

Risk estimates for hypothetical exposures to surface soil and groundwater under current and hypothetical future land-use scenarios are discussed below in Sections 6.5.1 and 6.5.2. These risk estimates are then compared to Federal USEPA and FDEP carcinogenic and noncarcinogenic target levels.

Table 6-5
Exposure Point Concentrations for
Human Health Chemicals of Potential Concern
for Surface Soil

Remedial Investigation Report
Site 15, Southwest Landfill
Naval Air Station Whiting Field
Milton, Florida

Analyte	Frequency of Detection[1]	Maximum Detected Concentration	95% UCL[2]	Exposure Point Concentration[3]
Inorganic Analytes (mg/kg)				
Arsenic	30/30	6.8	1.9	1.9
Iron	30/30	11,200	5,060	5,060

[1] Frequency of detection is the number of samples in which the analyte was detected over the total number of samples analyzed (excluding rejected values).
[2] 95% UCL of the arithmetic mean is calculated using all samples. One-half the contract-required quantitation limit/contract-required detection limit is used as a surrogate for nondetects.
[3] Exposure point concentration is the lower of either the 95% UCL concentration or maximum detected concentration.

Notes: % = percent.
UCL = upper confidence limit.
mg/kg = milligrams per kilogram.

Table 6-6
Exposure Point Concentrations for Human Health Chemicals of Potential Concern for Groundwater

Remedial Investigation Report
Site 15, Southwest Landfill
Naval Air Station Whiting Field
Milton, Florida

Analyte	Frequency of Detection[1]	Maximum Detected Concentration	Arithmetic Mean[2]	Exposure Point Concentration[3]
Volatile Organic Compounds (μg/ℓ)				
1,1-Dichloroethene	2/20	10	5.2	5.2
1,2-Dichloroethene (total)	8/20	14	5.2	5.2
Benzene	4/20	100	10.8	10.8
Chlorobenzene	2/20	12	5.7	5.7
Trichloroethene	11/20	330	22.7	22.7
Semivolatile Organic Compounds (μg/ℓ)				
1,4-Dichlorobenzene	3/19	12	5.3	5.3
bis(2-Ethylhexyl)phthalate	8/19	5	3.9	3.9
Pesticides and PCBs (μg/ℓ)				
4,4'-DDT	2/19	0.12	0.06	0.06
Inorganic Analytes (μg/ℓ)				
Aluminum	14/20	1,030	202	202
Arsenic	6/20	17.2	5.2	5.2
Iron	18/20	40,200	2,720	2,720
Manganese	18/20	553	59.2	59.2
Thallium	2/20	2.95	4.5	2.95

[1] Frequency of detection is the number of samples in which the analyte was detected over the total number of samples analyzed (excluding rejected values).
[2] Arithmetic mean of all samples calculated using one-half the contract-required quantitation limit and contract-required detection limit for nondetects.
[3] Exposure point concentration is the lower of either the mean concentration or maximum detected concentration.

Notes: μg/ℓ = micrograms per liter.
PCB = polychlorinated biphenyl.
DDT = dichlorodiphenyltrichloroethane.

The USEPA guidelines, established in the NCP, indicate that the total excess lifetime cancer risk (ELCR) due to exposure to the HHCPCs at a site should not exceed a range of 1 in 1,000,000 (1×10^{-6}) to 1 in 10,000 (1×10^{-4}) (USEPA, 1990). FDEP has indicated that chemical-specific risks greater than one in one million (1×10^{-6}) warrant further consideration.

An HQ less than 1 indicates that noncarcinogenic toxic effects are not expected to occur due to HHCPC exposure. HIs greater than 1 may be indicative of a possible noncarcinogenic toxic effect, but the circumstances must be evaluated on a case-by-case basis (USEPA, 1989b). As the hazard index (HI) increases, so does the likelihood that adverse effects might be associated with exposure. Both USEPA and FDEP consider that chemicals with HIs greater than 1 warrant further evaluation and require an evaluation of the noncarcinogenic effects.

Table 6-7 summarizes the cancer and noncancer risk under a current land-use scenario for Site 15. Table 6-8 summarizes the cancer and noncancer risk under a hypothetical future land-use scenario for Site 15.

6.5.1 Surface Soil The risk calculations for surface soil exposure are shown in Tables G-10 through G-23 in Appendix G to this report. For the current land-use scenario, the cancer risks associated with exposure to surface soil (ingestion, dermal contact, and fugitive dust inhalation) are 2×10^{-6} for an aggregate (combined adult and adolescent) trespasser and 7×10^{-8} for a site maintenance worker. Both receptors cancer risk values are below or within the USEPA acceptable cancer risk range of 1 in 10,000 to 1 in 1,000,000. However, the level for the aggregate trespasser exceeds the FDEP level of concern. The noncancer risks associated with surface soil ingestion, dermal contact, and fugitive dust inhalation for all receptors under current land use are below USEPA's and FDEP's target HI of 1. Figures 6-2 and 6-3 present summaries of cancer risks and HIs, respectively, associated with exposure scenarios under potential current land-use exposure scenario.

The cancer risks associated with exposure to surface soil ingestion, dermal contact, and fugitive dust inhalation under hypothetical future land use are 4×10^{-6} for an aggregate resident (combined adult and child), 2×10^{-6} for an aggregate trespasser (combined adult and adolescent), 5×10^{-7} for an occupational worker, 7×10^{-8} for a site maintenance worker, and 3×10^{-8} for an excavation worker under hypothetical future land use. Figure 6-4 presents a summary of cancer risk associated with exposure scenarios under future land use. All of these hypothetical future receptor risks are within or below the USEPA acceptable cancer risk range; however, the hypothetical future residential risk and aggregate trespasser exceed the Florida level of concern of 1×10^{-6} (due to arsenic).

The noncancer risks associated with surface soil ingestion, dermal contact, and fugitive dust inhalation under future land use for all hypothetical future receptors are below USEPA's and FDEP's target HI of 1. Figure 6-5 presents a summary of HIs associated with exposure scenarios under future land-use.

6.5.2 Groundwater The risk calculations for groundwater exposure are shown in Tables G-24 through G-27 in Appendix G to this report. Currently, there are no potable supply wells at the site; thus, there is no human exposure to groundwater. Therefore, risk was not evaluated for the current land-use scenario.

Table 6-7
Risk Summary, Current Land Use

Remedial Investigation Report
Site 15, Southwest Landfill
Naval Air Station Whiting Field
Milton, Florida

Land Use		Exposure Route	HI	ELCR
Current Land Use				
Surface Soil:				
	Adult Trespasser:	Incidental ingestion	0.004	1×10^{-7}
		Dermal contact	0.01	8×10^{-9}
		Inhalation of particulates	ND	4×10^{-11}
		Total Adult Trespasser:	0.01	1×10^{-7}
	Adolescent Trespasser:	Incidental ingestion	0.006	2×10^{-6}
		Dermal contact	0.01	7×10^{-8}
		Inhalation of particulates	ND	2×10^{-11}
		Total Adolescent Trespasser:	0.02	2×10^{-6}
		Total Risk to Trespasser (Adult and Adolescent) Exposed to Surface Soil:	NC	2×10^{-6}
	Site Maintenance Worker:	Incidental ingestion	0.001	6×10^{-8}
		Dermal contact	0.006	7×10^{-9}
		Inhalation of particulates	ND	2×10^{-10}
		Total Site Maintenance Worker:	0.007	7×10^{-8}

Notes: HI = hazard index.
ELCR = excess lifetime cancer risk.
NC = not calculated because child and adult HIs are not additive.
ND = no dose-response data for this exposure route were available for human health chemicals of potential concern in this medium.

Table 6-8
Risk Summary, Future Land Use

Remedial Investigation Report
Site 15, Southwest Landfill
Naval Air Station Whiting Field
Milton, Florida

Land Use	Exposure Route	HI	ELCR
Future Land Use			
Surface Soil:			
Adult Trespasser:	Incidental ingestion	0.004	1×10^{-7}
	Dermal contact	0.01	8×10^{-9}
	Inhalation of particulates	ND	4×10^{-11}
	Total Adult Trespasser:	0.01	1×10^{-7}
Adolescent Trespasser:	Incidental ingestion	0.006	2×10^{-6}
	Dermal contact	0.01	7×10^{-8}
	Inhalation of particulates	ND	2×10^{-11}
	Total Adolescent Trespasser:	0.02	2×10^{-6}
	Total Risk to Trespasser (Adult and Adolescent) Exposed to Surface Soil:	NC	2×10^{-6}
Adult Resident:	Incidental ingestion	0.03	1×10^{-6}
	Dermal contact	0.07	8×10^{-8}
	Inhalation of particulates	ND	1×10^{-9}
	Total Adult Resident:	0.1	1×10^{-6}
Child Resident:	Incidental ingestion	0.3	3×10^{-6}
	Dermal contact	0.1	3×10^{-8}
	Inhalation of particulates	ND	2×10^{-9}
	Total Child Resident:	0.4	3×10^{-6}
	Total Risk to Resident (Adult and Child) Exposed to Surface Soil:	NC	4×10^{-6}
Occupational Worker:	Incidental ingestion	0.06	5×10^{-7}
	Dermal contact	0.003	2×10^{-8}
	Inhalation of particulates	ND	5×10^{-10}
	Total Occupational Worker:	0.07	5×10^{-7}
Site Maintenance Worker:	Incidental ingestion	0.001	6×10^{-8}
	Dermal contact	0.006	7×10^{-9}
	Inhalation of particulates	ND	2×10^{-10}
	Total Site Maintenance Worker:	0.007	7×10^{-8}

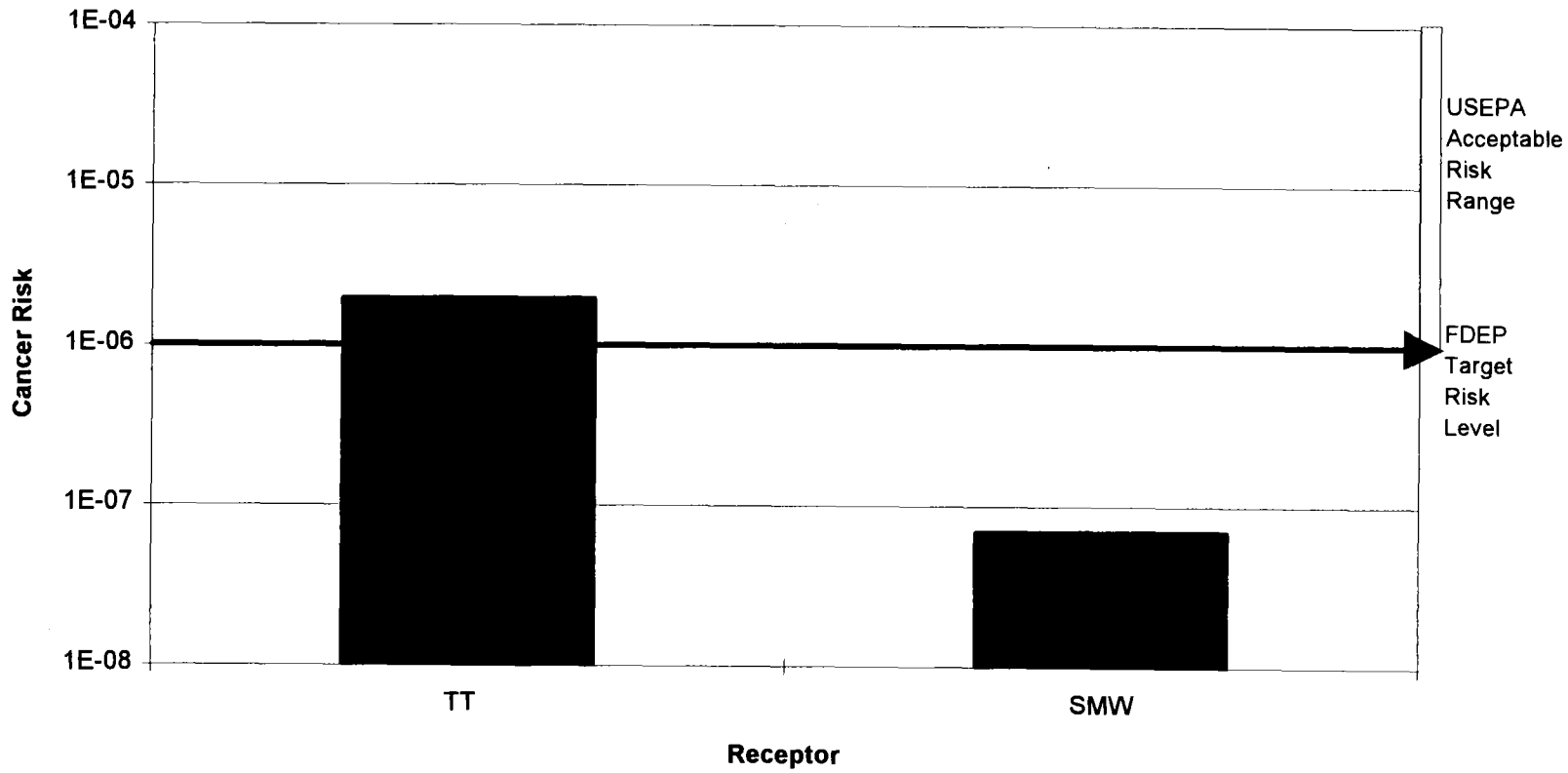
See notes at end of table.

Table 6-8 (Continued)
Risk Summary, Future Land Use

Remedial Investigation Report
Site 15, Southwest Landfill
Naval Air Station Whiting Field
Milton, Florida

Land Use		Exposure Route	HI	ELCR
Future Land Use (Continued)				
	Excavation Worker:	Incidental ingestion	0.01	3×10^{-8}
		Dermal contact	0.01	4×10^{-10}
		Inhalation of particulates	ND	8×10^{-12}
		Total Excavation Worker:	0.02	3×10^{-8}
Groundwater:				
	Adult Resident:	Ingestion of groundwater as drinking water	4	1×10^{-4}
		Inhalation of volatiles while showering	0.01	5×10^{-6}
		Total Adult Resident:	4	1×10^{-4}
	Child Resident:	Ingestion of groundwater as drinking water	8	6×10^{-5}
		Total Child Resident:	8	6×10^{-5}
		Total Risk to Resident (Adult and Child) Exposed to Groundwater:	NC	2×10^{-4}
		Total Risk to Resident (Adult and Child) Exposed to Surface Soil, Groundwater:	NC	2×10^{-4}

Notes: HI = hazard index.
ELCR = excess lifetime cancer risk.
ND = no dose-response data for this exposure route were available for human health chemicals of potential concern in this medium.
NC = not calculated because child and adult HIs are not additive.



NOTES:
USEPA = U.S. Environmental Protection Agency
FDEP = Florida Department of Environmental Protection
TT = Total trespasser
SMW = Site maintenance worker

FIGURE 6-2
CANCER RISK SUMMARY
CURRENT LAND USE FOR SURFACE SOIL AT SITE 15

REMEDIAL INVESTIGATION REPORT
SITE 15, SOUTHWEST LANDFILL

NAVAL AIR STATION WHITING FIELD
MILTON, FLORIDA

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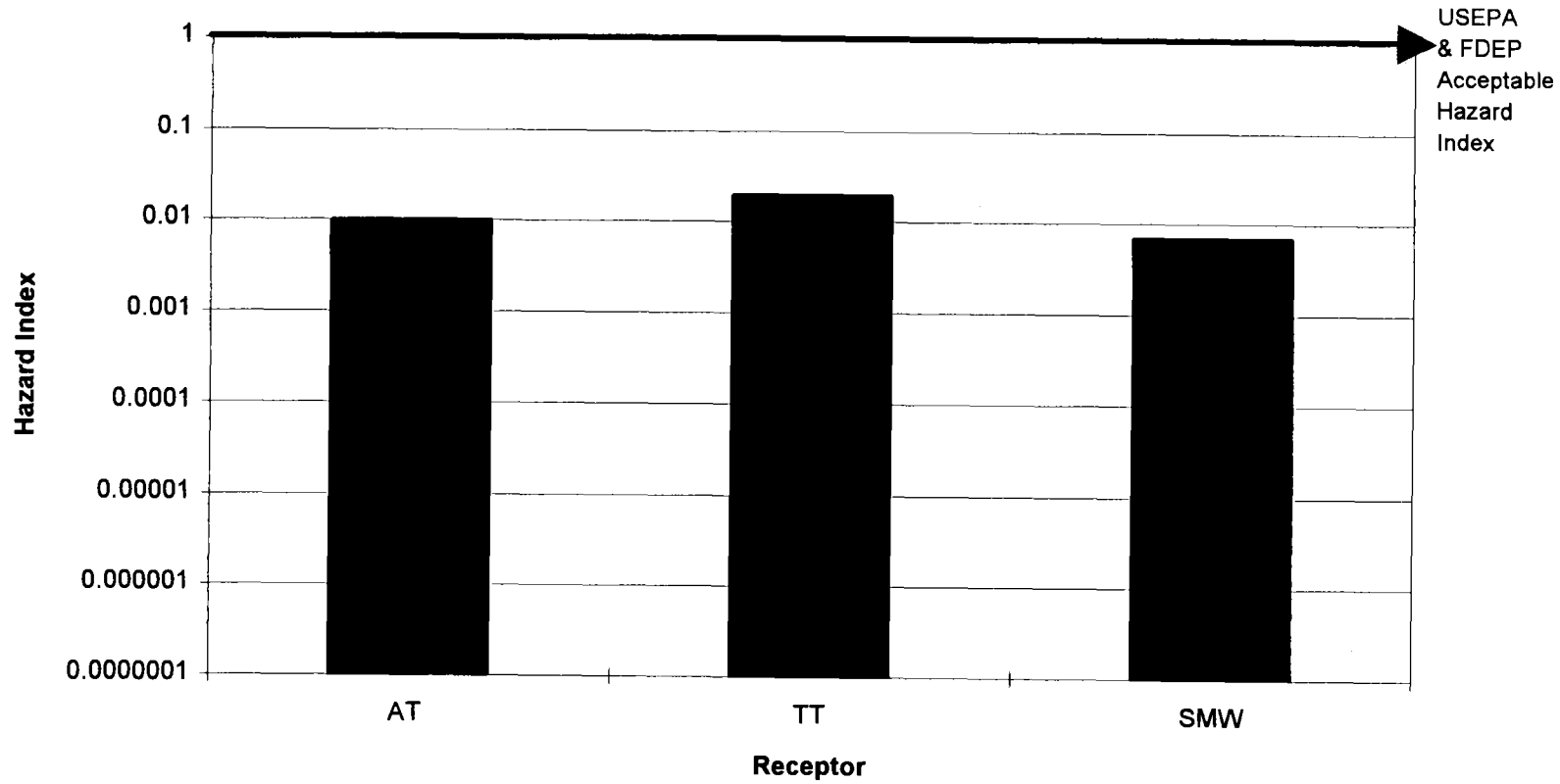


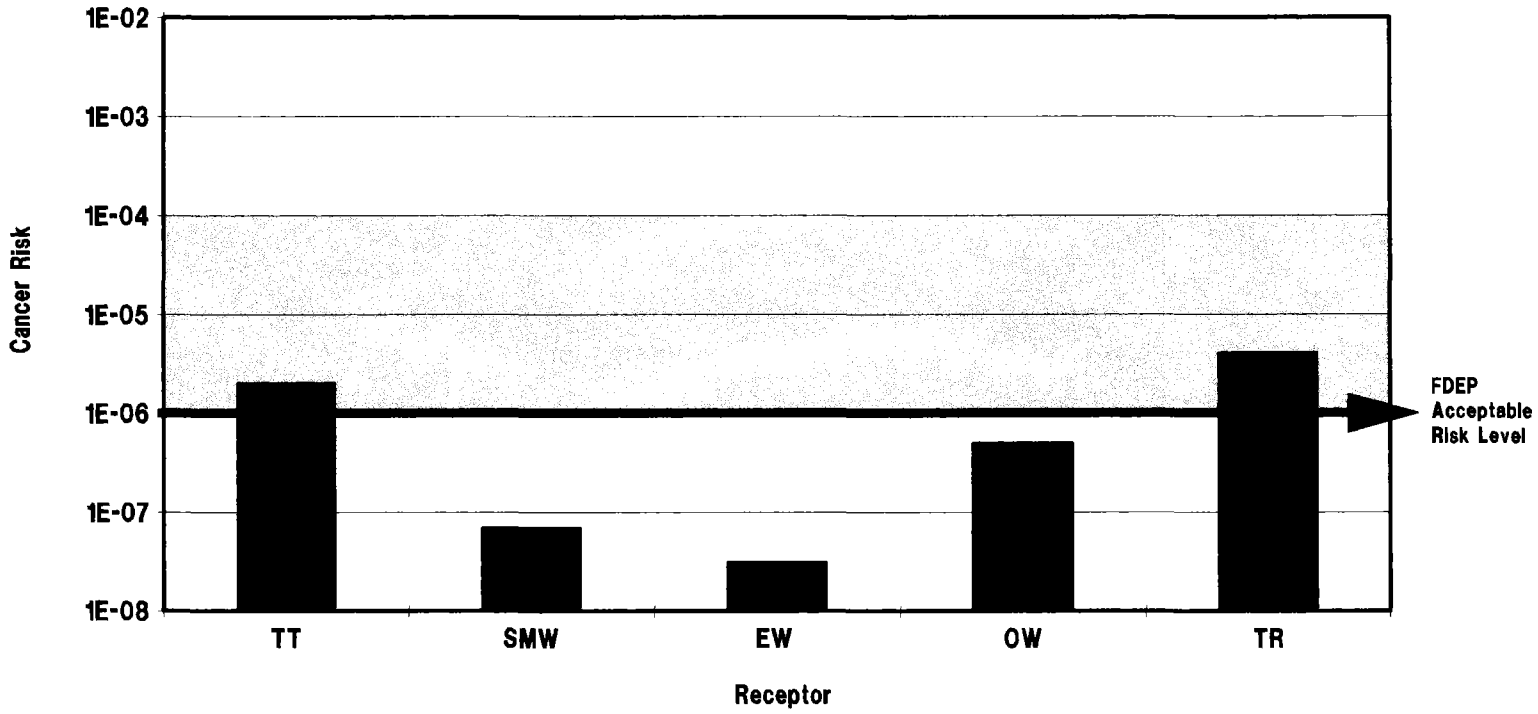
NOTES:
USEPA = U.S. Environmental Protection Agency
FDEP = Florida Department of Environmental Protection
AT = Adult trespasser
TT = Total trespasser
SMW = Site maintenance worker

FIGURE 6-3
NONCANCER RISK SUMMARY
CURRENT LAND USE FOR SURFACE SOIL AT SITE 15

REMEDIAL INVESTIGATION REPORT
SITE 15, SOUTHWEST LANDFILL

NAVAL AIR STATION WHITING FIELD
MILTON, FLORIDA

H:\HEID\WHITING\SITE15\FIG6-3.PM5 FIGS15B.XLS 050498HAS



LEGEND

	USEPA acceptable risk range
USEPA	U.S. Environmental Protection Agency
FDEP	Florida Department of Environmental Protection
TT	Total trespasser
SMW	Site maintenance worker
EW	Excavation worker
OW	Occupational worker
TR	Total resident

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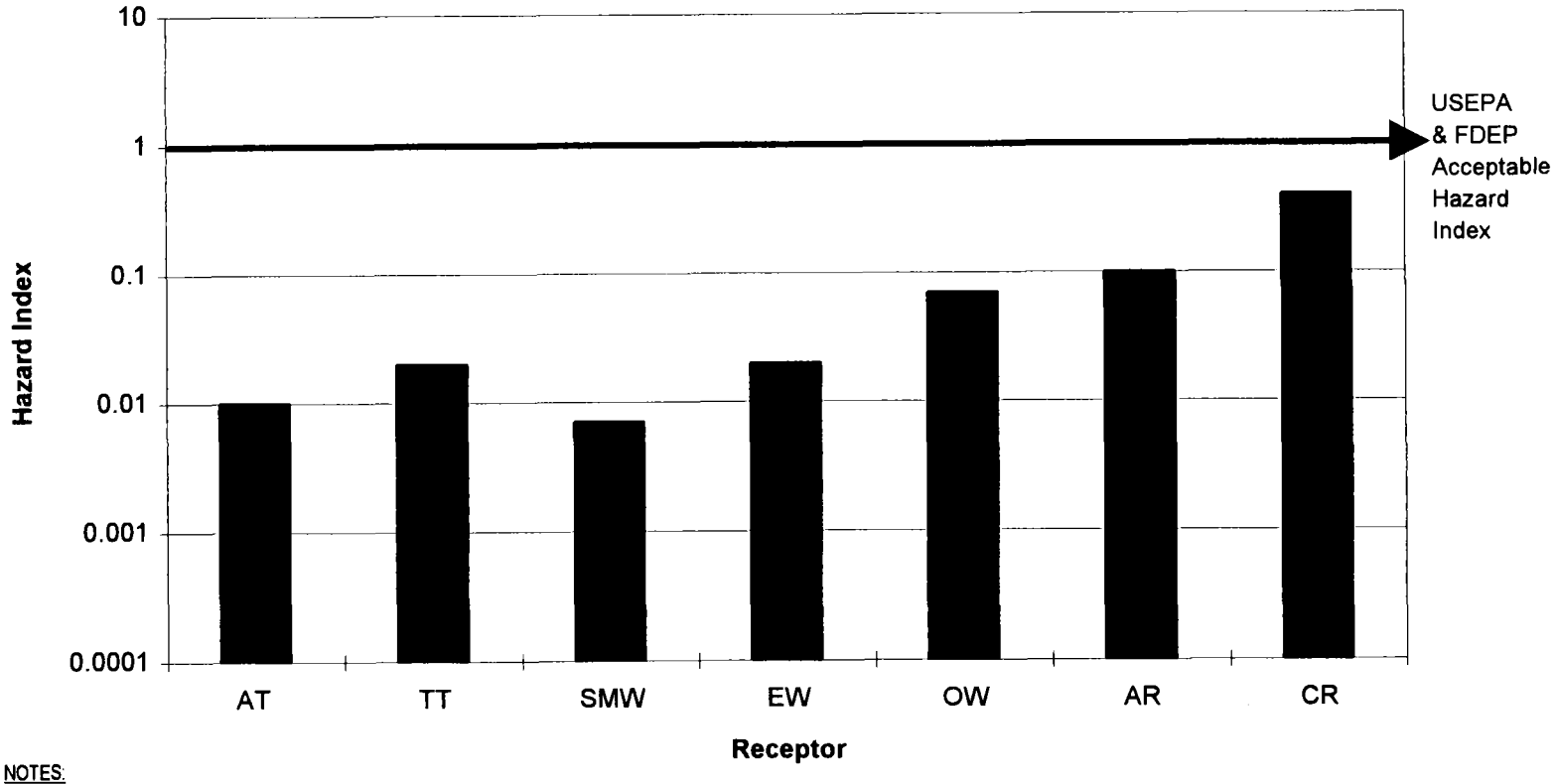
FIGURE 6-4
CANCER RISK SUMMARY
FUTURE LAND USE FOR SURFACE SOIL AT SITE 15

REMEDIAL INVESTIGATION REPORT
SITE 15, SOUTHWEST LANDFILL

NAVAL AIR STATION WHITING FIELD
MILTON, FLORIDA



NOTES:
USEPA = U.S. Environmental Protection Agency
FDEP = Florida Department of Environmental Protection
AT = Adult trespasser
TT = Total trespasser
SMW = Site maintenance worker
EW = Excavation worker
OW = Occupational worker
AR = Adult resident
CR = Child resident

FIGURE 6-5
NONCANCER RISK SUMMARY
FUTURE LAND USE FOR SURFACE SOIL AT SITE 15

REMEDIAL INVESTIGATION REPORT
SITE 15, SOUTHWEST LANDFILL

NAVAL AIR STATION WHITING FIELD
MILTON, FLORIDA

H:\HEIDI\WHITING\SITE15\FIG8-5.PM5 FIGS15B.XLS 050498HAS

The cancer risks associated with exposure to groundwater ingestion and inhalation of volatiles while showering under hypothetical future land use are 2×10^{-4} for an aggregate resident (combined adult and child). Figure 6-6 presents a summary of cancer risk associated with exposure scenarios under future land use. The hypothetical future residential receptor risks exceed the Florida level of concern of 1×10^{-6} mainly due to 1,1- dichloroethene and arsenic, although benzene, trichlorobenzene, and 1,4-dichlorobenzene also contribute ELCRs greater than 1×10^{-6}. Figure 6-6 presents a summary of the cancer risk to potential future residents.

Under hypothetical future land use, the noncancer risks associated with groundwater ingestion for both the adult resident (HI of 3) and child resident (HI of 7) exceed the USEPA's and the FDEP's target HI of 1. The major contributors to this HI are benzene, arsenic, iron, and thallium. Figure 6-5 presents a summary of HIs associated with exposure scenarios under future land use. Figure 6-7 presents a summary of the noncancer risk to potential future residents.

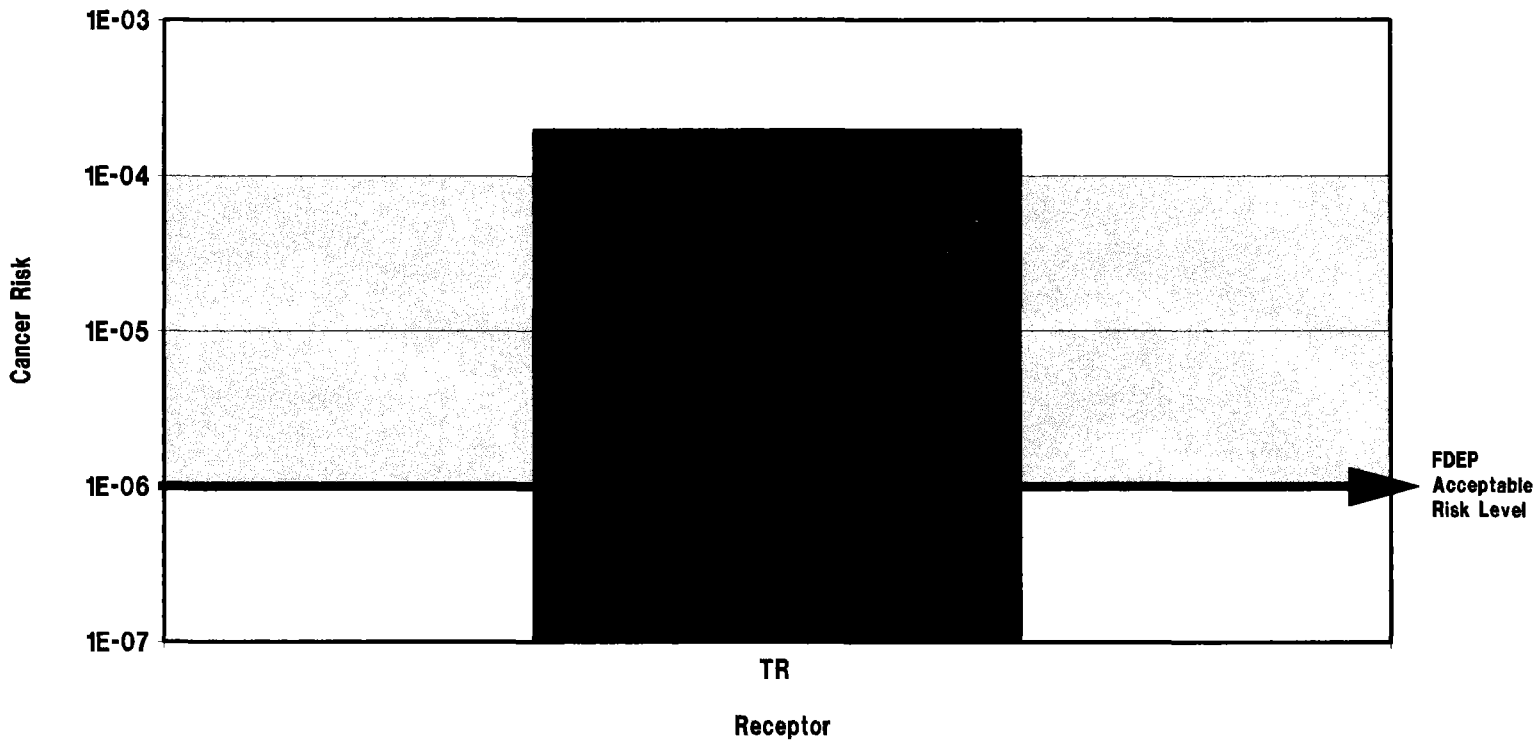
6.6 UNCERTAINTY ANALYSIS. General uncertainties associated with the collection, analysis, and evaluation of data; exposure assessment; toxicity assessment; and the risk estimation process are discussed in Paragraph 2.5.5.1 of the GIR (ABB-ES, 1998). Site-specific uncertainties that are important for the interpretation of the calculated risk estimates for surface soil and groundwater at Site 15 are discussed below.

- The surface soil carcinogenic risk at Site 15 is driven by a naturally occurring metal, arsenic. It is uncertain whether or not this risk to hypothetical future residents is actually due to past site operations. Detected arsenic concentrations may actually be at naturally occurring levels or due to other anthropogenic activities such as pesticide application. This is especially noteworthy because the risk from arsenic at background conditions is 7×10^{-6}. Therefore, the risk from arsenic at Site 15 is likely to be an overestimate.

- The lack of inhalation reference doses for the HHCPCs in surface soil may have resulted in underestimates of the HIs associated with exposure to surface soil at Site 15; however, these noncancer risks are not likely to be significant when compared to oral and dermal risks that are fully characterized.

- Groundwater samples at Site 15 were collected at different intervals (shallow, intermediate, and deep). Samples were collected at different intervals to determine if contamination is concentrated at one interval. Groundwater HHCPCs were identified from each of the intervals. It does not appear that the risks can be isolated at one interval; therefore, the groundwater risks from each aquifer were characterized together.

- According to the methodology described in the GIR (ABB-ES, 1998) (Paragraph 2.5.3.3), central tendency carcinogenic risk to hypothetical future receptors that have risks exceeding Florida or USEPA levels of concern was evaluated. The central tendency evaluation is designed to provide a probable risk level (USEPA, 1995a).



LEGEND

USEPA acceptable risk range

USEPA U.S. Environmental Protection Agency
FDEP Florida Department of Environmental Protection
TR Total resident

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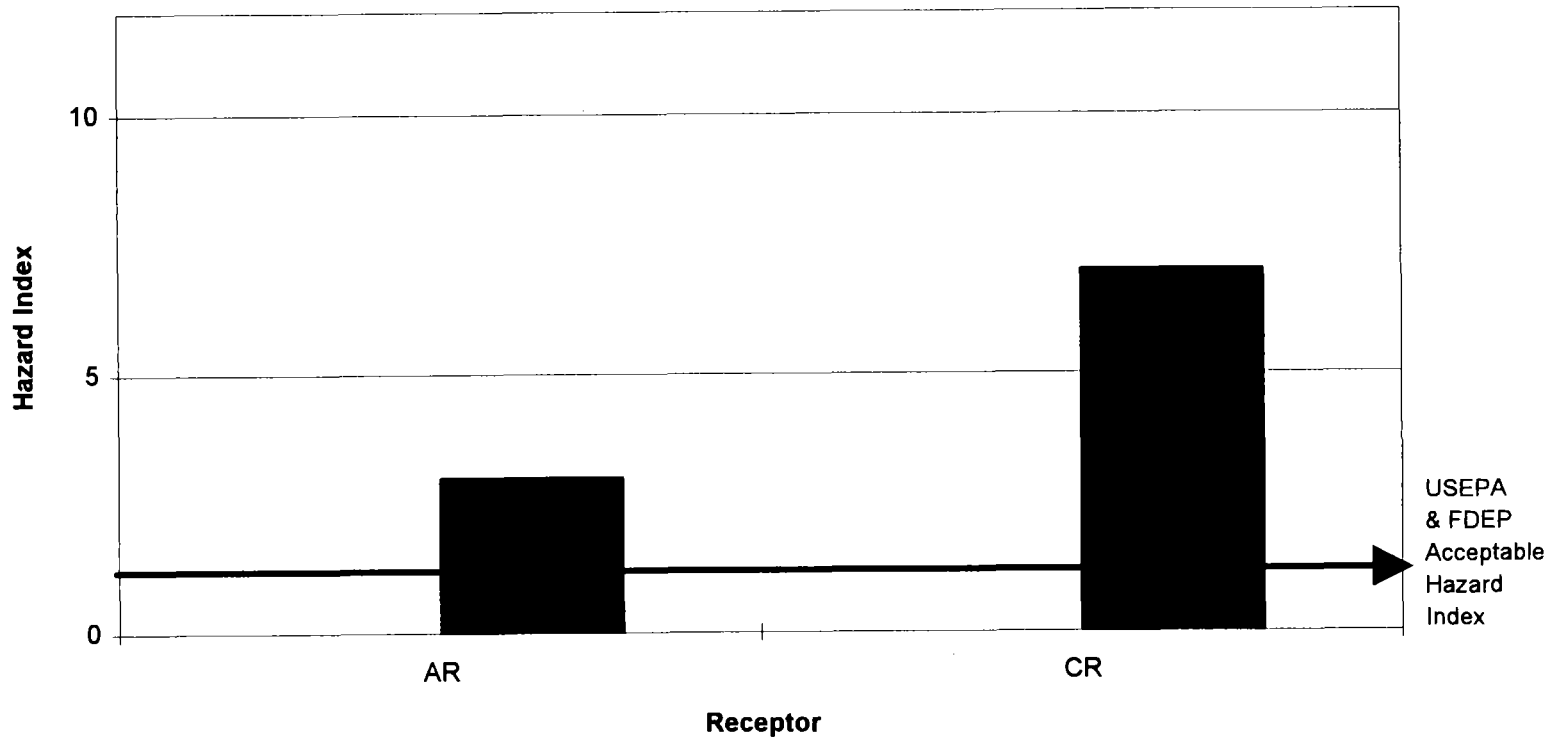
FIGURE 6-6
CANCER RISK SUMMARY
FUTURE LAND USE FOR GROUNDWATER AT SITE 15

REMEDIAL INVESTIGATION REPORT
SITE 15, SOUTHWEST LANDFILL

NAVAL AIR STATION WHITING FIELD
MILTON, FLORIDA



NOTES:
USEPA = U.S. Environmental Protection Agency
FDEP = Florida Department of Environmental Protection
AR = Adult resident
CR = Child resident

FIGURE 6-7
NONCANCER RISK SUMMARY
FUTURE LAND USE FOR GROUNDWATER AT SITE 15

REMEDIAL INVESTIGATION REPORT
SITE 15, SOUTHWEST LANDFILL

NAVAL AIR STATION WHITING FIELD
MILTON, FLORIDA

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The hypothetical future resident's reasonable maximum exposure (RME) carcinogenic risk exceeded its target of 1×10^{-6}. The central tendency carcinogenic risk results for hypothetical trespasser, and future residential and central tendency exposure parameters are presented in Table C-28 through C-33 in Appendix C of this report. Only central tendency ingestion and dermal exposures were characterized because the contribution from inhalation was insignificant compared to the total risk.

The central tendency aggregate residential and trespasser risks exposed to surface soil are 4×10^{-8} and 7×10^{-7}. These central tendency results are below the USEPA and FDEP target risk levels.

The central tendency aggregate residential risk exposed to groundwater is 3×10^{-5}. This central tendency groundwater risk remains above the FDEP target level. The noncancer central tendency risks also remain above the USEPA and FDEP target level of 1.

The risk range presented by the RME and central tendency exposure scenarios for hypothetical future residential receptors are useful information to provide perspective for the risk manager and compliance with Agency guidance (USEPA, 1995a).

- The SQLs were compared to the risk-based screening criteria and Florida and State regulatory guidelines for all analytes not selected as HHCPCs to assess whether the detection limits were adequate to detect analytes at levels of concern (SQLs of analytes with 100 percent frequency of detection were not evaluated). The analytes with a SQL that exceeds it's screening criteria is beryllium in surface soil and naphthalene, antimony, thallium, and vanadium in groundwater because the laboratory equipment was able to detect the below the SQL for beryllium, the SQL was considered adequate for this HHRA.

6.7 REMEDIAL GOAL OPTIONS (RGOs). RGO tables are presented for each medium with a total ELCR greater than 1×10^{-6} or an HI greater than 1 per USEPA guidance, and for media with chemicals whose EPCs exceed Florida standards. The RGO concentrations are calculated using the scenario representing the highest estimated risk for a given medium. Based on the above criteria, RGOs are developed for each chemical with a total ELCR greater than 1×10^{-6} or an HQ greater than 0.1. Analytes whose EPCs exceed Florida standards are also presented in the RGO tables.

RGOs and available Federal and FDEP risk-based criteria are intended to provide the basis for the development of remedial alternatives in the FS. The RGOs are not actual or proposed cleanup levels, but are provided to assist risk management decision making in the FS.

Table 6-9 presents the RGOs for surface soil at Site 15. RGOs are presented for arsenic based on cancer risks for the adult and child resident at Site 15.

Table 6-10 presents the RGOs for groundwater at Site 15. RGO is presented for 1,1-dichloroethene, benzene, trichloroethene, antimony, arsenic, iron, and thallium based on cancer and noncancer risks for the adult and child resident at

Table 6-9
Summary of Remedial Goal Options for Surface Soil

Remedial Investigation Report
Site 15, Southwest Landfill
Naval Air Station Whiting Field
Milton, Florida

Analyte	Range of Detected Concentrations	Exposure Point Concentration	Total Excess Lifetime Cancer Risk (Based on Risk to Resident (adult and child)			Total Hazard Index (Based on Risk to Child Resident)			Florida Soil Cleanup Target Level (Residential)[1]	Florida Soil Cleanup Target Level (Leaching)[1]	Background Screening Concentration
			10^{-4}	10^{-5}	10^{-6}	3	1	0.1			
Inorganic Analytes (mg/kg)											
Arsenic	0.75 to 6.8	1.9	NR	NR	0.42	NA	NA	NA	0.8	29	4.62

[1] Values are from Chapter 62-777, Florida Administrative Code, June 1999.

Notes: mg/kg = milligrams per kilogram.
NR = not reported because the calculated remedial goal option exceeds the exposure point concentration.
NA = not applicable.

Table 6-10
Summary of Remedial Goal Options for Groundwater

Remedial Investigation Report
Site 15, Southwest Landfill
Naval Air Station Whiting Field
Milton, Florida

Analyte	Range of Detected Concentrations	Exposure Point Concentration	Total Excess Lifetime Cancer Risk (Based on Risk to Resident (adult and child)			Total Hazard Index (Based on Risk to Child Resident)			Florida Groundwater Guidance Concentration[1]	Federal MCL[2]	Background Screening Concentration
			10^{-4}	10^{-5}	10^{-6}	3	1	0.1			
Volatile Organic Compounds (μg/ℓ)											
1,1-Dichloroethene	3.5 to 10	5.2	NR	1.0	0.1	NA	NA	NA	7	7	NA
Benzene	1 to 100	10.8	NR	NR	1.8	NA	NA	NA	1	5	NA
Trichloroethene	1 to 330	22.7	NR	NR	5.3	NA	NA	NA	3	5	NA
Semivolatile Organic Compounds (μg/ℓ)											
1,4-Dichlorobenzene	1 to 12	5.3	NR	NR	2.8	NA	NA	NA	75	75	NA
Pesticides (μg/ℓ)											
4-4'DDT	0.12	0.06	NA	NA	NA	NA	NA	NA	0.1	NSC	NA
Inorganic Analytes (μg/ℓ)											
Aluminum	35.8 to 200	202	NA	NA	NA	NA	NA	NA	200	50	654
Antimony	25.6	25.6	NA	NA	NA	18.7	6.2	0.62	6	6	20.4
Arsenic	0.6 to 17.2	5.2	4	0.4	0.04	NR	4.7	0.47	50	50	ND
Iron	56.7 to 40,200	2,720	NA	NA	NA	NR	NR	469	300	300	964
Manganese	15	59.2	NA	NA	NA	NA	NA	NA	50	50	42.8
Thallium	0.98 to 2.95	2.95	NA	NA	NA	NR	1.2	0.12	2	2	ND

[1] Values are from Chapter 62-777, Florida Administrative Code, June 1999.
[2] Federal MCLs are taken from USEPA Drinking Water Regulations and Health Advisories from October 1996.

Notes: MCL = maximum contaminant level.
μg/ℓ = micrograms per liter.
NR = not reported because the calculated remedial goal option exceeds the exposure point concentration.
NA = not applicable.
NSC = no screening criteria.
ND = not detected in any background sample.

Site 15. Aluminum, manganese, and 4,4'-DDT are presented because they exceed the FDEP groundwater guidance concentration values. It should be noted that the EPC for arsenic is an order of magnitude less than the Federal drinking water standard and Florida groundwater guidance concentration.

6.8 SUMMARY OF HHRA FOR SITE 15. HHCPCs were identified and risks were estimated for surface soil and groundwater associated with Site 15.

The following conclusions were drawn based on this HHRA:

- The HHCPCs detected in surface soil do not pose unacceptable carcinogenic risks to the receptors evaluated based on evaluation of the samples using USEPA guidelines and target risk range.

- The total ELCR of 4×10^{-6} at Site 15, associated with exposure to soil by a hypothetical future resident, exceeds Florida's target risk level of concern 1×10^{-6} due to arsenic. The background levels of arsenic at Site 15 exceed the Florida soil cleanup target level for residential soil and may result in an unacceptable carcinogenic risk. It is likely that naturally occurring arsenic contributes to the FDEP target risk-level exceedance.

- Aroclor-1260 was detected above the Florida cleanup target level in one subsurface soil sample. Aroclor-1260 will be addressed in the feasibility study as an HHCPC.

- The ELCR for groundwater exceeds the USEPA acceptable risk range and the FDEP cancer level of concern due to 1,1-dichloroethene, arsenic benzene, trichlorobenzene, and 1,4-dichlorobenzene; however, facility-wide groundwater has been designated as a separate site (Site 40) and is being addressed under a facilitywide investigation.

CHAPTER 7.0

7.0 ECOLOGICAL RISK ASSESSMENT

The ERA evaluates actual and potential adverse effects to ecological receptors associated with exposure to chemicals from Site 15, the Southwest Landfill, at NAS Whiting Field. The ERA for Site 15 follows the methodologies described in the NAS Whiting Field GIR (ABB-ES, 1998), and current guidance materials for ERAs at Superfund sites including the following:

- *Risk Assessment Guidance for Superfund Environmental Evaluation Manual* (USEPA, 1989c)
- *Ecological Assessment of Hazardous Waste Sites: A Field and Laboratory Reference* (USEPA, 1989d)
- *Framework for Ecological Risk Assessment* (USEPA, 1992b)
- *Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments* (USEPA, 1997a)
- Supplemental Guidance to RAGS: Region IV Bulletins on Ecological Risk Assessment (USEPA, 1995b)
- *Proposed Guidelines for Ecological Risk Assessment* (USEPA, 1996b)

Risk assessment guidance included in the USEPA "Eco Update" bulletins (1991d and 1992d) and recent publications (e.g., Maughan, 1993; Suter, 1993) were also consulted.

This ERA was conducted to determine if ecological receptors are potentially exposed to contaminants from Site 15 at concentrations that could cause adverse ecological effects. The Site 15 ERA consists of the following eight subsections:

- Site Characterization (Section 7.1) describes current ecological conditions at the site;
- Problem Formulation (Section 7.2) establishes the goals and focus of the assessment and identifies major factors to be considered;
- Hazard Assessment and Selection of ECPCs (Section 7.3) reviews the analytical data and identifies chemicals present at the site that may pose ecological risks;
- Exposure Assessment (Section 7.4) identifies complete exposure pathways and quantifies the magnitude and frequency of exposure;
- Ecological Effects Assessment (Section 7.5) identifies potential adverse effects to ecological receptors associated with the chemicals of concern identified in Section 7.3;
- Risk Characterization (Section 7.6) integrates exposure and concentration-toxicity response information to derive a likely estimate of adverse effects;

- Uncertainties (Section 7.7) identifies assumptions of the ERA process that may influence the risk assessment conclusions; and

- Summary of Ecological Risk (Section 7.8).

7.1 SITE CHARACTERIZATION. NAS Whiting Field Site 15 is approximately 21 acres and is located along the southwestern boundary of the facility near the South Air Field (see Figure 1-2). The site was used as an operational landfill from 1965 to 1979 and consisted of seven trenches covering approximately 15 of the 21 acres of the site area. The landfill reportedly received the majority of waste generated at NAS Whiting Field including general refuse, waste paints, oils, solvents, paint thinner, hydraulic fluid, bagged asbestos, and potentially PCB-contaminated transformer oil (Envirodyne Engineers, Inc., 1985). It is estimated that approximately 3,000 to 4,500 tons of waste per year were disposed of at Site 15. Although buried wastes were reportedly covered on a daily basis, Envirodyne Engineers reported in 1985 that erosion of the soil had uncovered numerous areas where buried waste was exposed at the land surface. Currently, there are few, if any, areas of exposed soil, and no buried waste appears near the surface.

The site has a surface slope of approximately 5 percent to the southwest toward Clear Creek, which is located 1,200 feet southwest of the site. Although overland transport of surface water runoff toward Clear Creek is possible, most of the on-site rainfall infiltrates directly into the soil due to the silty sand type at Site 15.

As shown in the Site 15 vegetative cover map (Figure 7-1), the landfill area of Site 15 is characterized as planted pine forest. In addition to slash pine (*Pinus elliottii*) and long-leaf pine (*Pinus palustris*), other saplings and shrubs commonly found in the planted pine area and herbaceous layer of Site 15 include ragweed (*Ambrosia* sp.), broomsedge (*Andropogon* sp.), persimmon (*Diospyros virginia*), St. Andrew's cross (*Hypericum hypericoides*), hairy indigo (*Indigofera hirsuta*), blazing star (*Liastris chapmanii*), staggerbush (*Lyonia fruticosa*), prickly-pear cactus (*Opuntia* sp.), yellow wood sorrel (*Oxalis stricta*), rustweed (*Polypremum procumbens*), cherry tree (*Prunus* sp.), oaks (*Quercus* sp.), winged sumac (*Rhus copallina*), blackberry vine (*Rubus* sp.), poison ivy (*Toxicodendron radicans*), blueberry (*Vaccinium* sp.), dog fennel (*Eupatorium capillifolium*), yaupon holly (*Ilex vomitoria*), goldenaster (*Pityopis graminifolia*), and greenbriar (*Smilax* sp.). A complete list of vegetative species occurring at Site 15 is provided in Appendix G of the GIR (ABB-ES, 1998).

NAS Whiting Field maintains a program for planting and harvesting of pine trees, primarily long-leaf and slash pines. The planted pine area of Site 15 is subject to controlled burns and timber harvesting activities. As part of the ecosystem management plan, planted pine forests undergo periodic burning, usually once every four years, and selective thinning of long-leaf and slash pines, every eight to ten years. These forestry management activities provide a variety of habitats and food sources for wildlife and other ecological receptors. The planted pine area of Site 15 has reached a mature status with a well-developed canopy and an open understory typical of uplands pine forests of the southeastern United States. The forested area at Site 15 is contiguous with a mature planted pine forest that surrounds the site. The pine forest canopy is over 40 feet

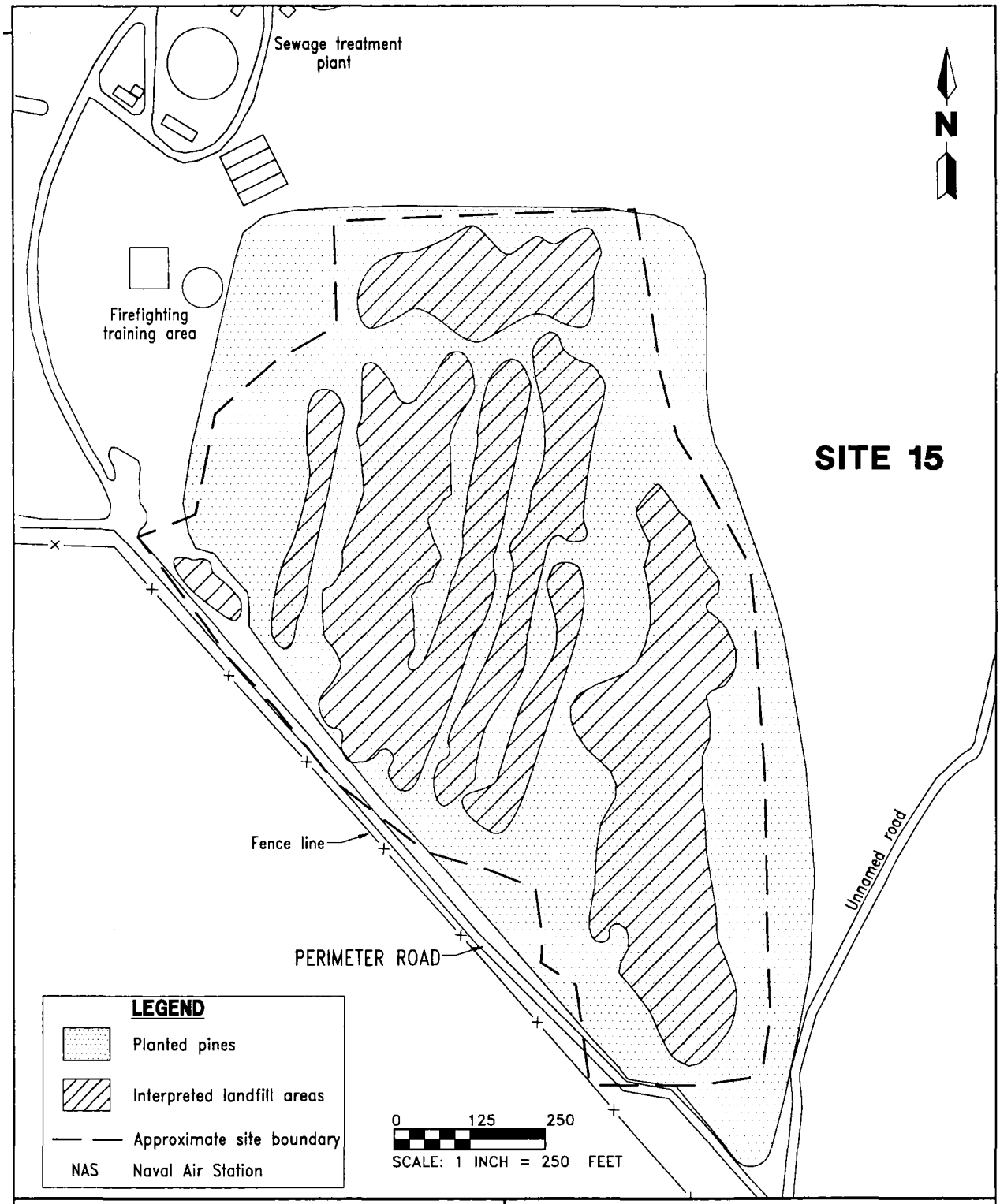

FIGURE 7-1
SITE 15, VEGETATIVE COVER MAP

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REMEDIAL INVESTIGATION REPORT
SITE 15, SOUTHWEST LANDFILL

NAS WHITING FIELD
MILTON, FLORIDA

high, typical tree diameter is approximately 8 inches, and spacing between planted pines is about 6 to 10 feet.

Southeastern pine forests provide habitat for a diverse array of birds, including insectivorous gleaners of pine needles and bark, flycatchers, seed-eaters, and nocturnal and diurnal aerial predators (Wolfe et al., 1988). The pine flatwoods at and surrounding Site 15 are likely to host such an assemblage of species. Birds of prey, such as owls and hawks, may also nest in these wooded areas.

It is likely that the terrestrial invertebrate biomass at Site 15 serves as a forage base for a variety of wildlife species, including adult amphibians, reptiles, small birds, and small mammals. Small reptiles, mammals, and birds may use the forested pine area for protection. Predatory birds and mammals inhabiting the pine flatwood areas may also be attracted to the site.

Mammals and birds that may occur in the planted pine area of Site 15 include the hispid cotton rat (*Sigmodon hispidus*), cotton mouse (*Peromyscus gossypinus*), short-tailed shrew (*Blarina brevicauda*), American robin (*Turdus migratorius*), and Eastern meadowlark (*Sturnella magna*). Predatory mammals and birds such as the red fox (*Vulpes vulpes*), gray fox (*Urocyon cinereoargenteus*), great horned owl (*Bubo virginianus*), and the red-tailed hawk (*Buteo jamaicensis*) may also forage in the area of Site 15.

Although no aquatic habitat is present at Site 15, groundwater from Site 15 may discharge off site to Clear Creek, which is located approximately 1,200 feet downgradient and the southwest of the site. Clear Creek, which is classified by the FDEP as Class III surface waters, is a tributary to Blackwater River, located to the south. Florida Class III surface waters are suitable for the propagation of fish and aquatic life. Blackwater River is classified as an Outstanding Florida River, which is considered to be of exceptional ecological significance.

Groundwater discharge to the surface water of Clear Creek is qualitatively evaluated as part of the ERA for Site 15 because Clear Creek receives groundwater discharge from Site 15. However, the section of Clear Creek that receives groundwater from Site 15 is included as part of NAS Whiting Field Site 39, Clear Creek Flood Plain. The ERA for Site 39 will present the results of surface water and sediment sampling in Clear Creek and provide further information on whether or not Site 15 is a potential source of contamination to Clear Creek.

7.2 PROBLEM FORMULATION. The problem formulation is the initial step of the ERA process. Problem formulation is composed of identification of receptors, identification of exposure pathways for those receptors, and selection of assessment and measurement endpoints based on information gathered from the site characterization.

7.2.1 Identification of Receptors Ecological receptors that may potentially utilize the available planted pine forest habitat at Site 15 include terrestrial wildlife (i.e., mammals, birds, reptiles, and adult amphibians), terrestrial plants, and soil invertebrates. Terrestrial flora and fauna potentially using NAS Whiting Field are identified in the GIR (ABB-ES, 1998). Freshwater aquatic receptors in Clear Creek downgradient of Site 15 are evaluated in the ERA because groundwater from Site 15 may potentially migrate to the surface water of Clear Creek.

Certain species that potentially reside at NAS Whiting Field are protected by Federal and/or State laws. A list of State and federally protected species is provided in the GIR (ABB-ES, 1998). No State or federally listed rare, threatened, or endangered species or species of concern are known or likely to inhabit Site 15.

7.2.2 Identification of Exposure Pathways Exposure pathways are identified for four groups of receptors (terrestrial wildlife, terrestrial plants, soil invertebrates, and aquatic receptors). A complete exposure pathway includes a source of contamination, an exposure route, and a receptor. A conceptual model of the exposure pathways from source to ecological receptors is depicted in the contaminant pathway model on Figure 7-2.

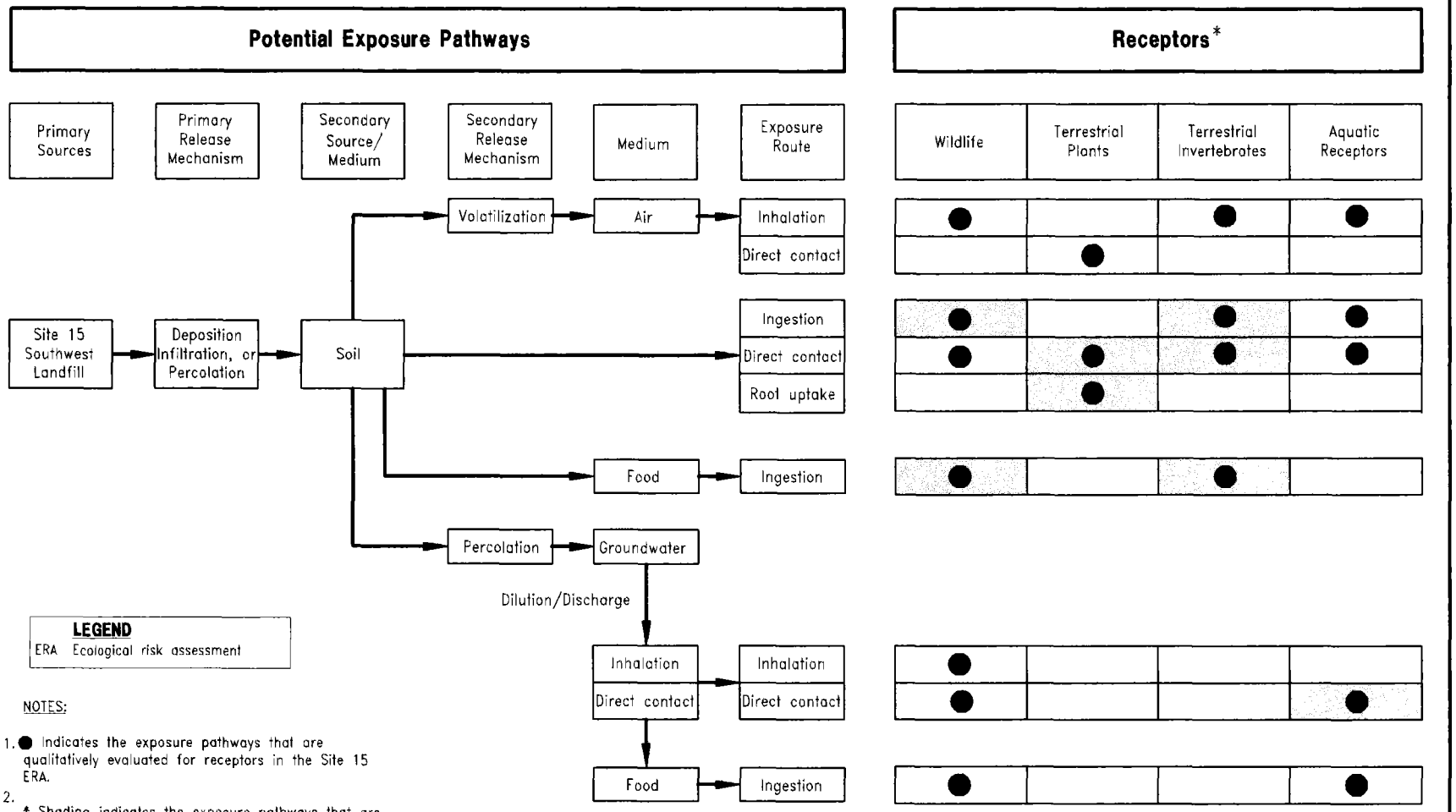
All potential routes of exposure are considered in the ERA and are presented in the contaminant pathway model. The model differentiates between those exposure routes that are quantitatively evaluated and those that are qualitatively discussed. This limitation is necessary to focus the risk evaluation on those pathways for which contaminant exposures are the highest and most likely to occur. Those pathways that cannot be quantitatively evaluated due to a lack of toxicological information are qualitatively discussed and addressed as uncertainties. The general approach used to identify exposure pathways for the four groups of receptors is explained below.

Terrestrial Wildlife. Terrestrial wildlife may be exposed to contaminants in surface soil and food items that are contaminated as a result of ingestion, dermal adsorption, and inhalation of fugitive dust and volatile emissions. Because surface water is not present at Site 15, only terrestrial wildlife exposures associated with ingestion of surface soil and potentially contaminated food are evaluated in the Site 15 ERA. Although ingestion of surface water from Clear Creek downgradient of Site 15 is possible, these exposures will be evaluated as part of the ERA for Site 39.

Dermal adsorption is considered to be a negligible exposure pathway because the presence of fur, feathers, or a chitinous exoskeleton is likely to prevent contamination from coming in direct contact with the skin (personal communication with Ted Simon, USEPA Region IV, September 1997). In addition, soil trapped in the fur or feathers is likely to be ingested during grooming or preening activities, which are evaluated as part of the indirect ingestion exposure pathway.

Exposure via inhalation of fugitive dust is also not likely to be a significant exposure pathway because the vegetation at Site 15 would limit the release of fugitive dust. Although volatile constituents were detected in the surface soil of Site 15, exposures associated with VOCs are not evaluated in the ERA because of the low frequency and detection of VOCs in the surface soil. In addition, no evidence of burrowing animals and/or burrows was noted at Site 15 during the October 1995 biological field investigation conducted by ABB-ES (presently HLA) ecologists.

Potential contaminant exposures for reptiles and adult amphibians exist at NAS Whiting Field; however, ingestion toxicity data and bioaccumulation factors (BAF) are generally not available for these receptors. Therefore, potential risks associated with ingestion of affected surface soil and food to these reptiles and amphibians will be qualitatively addressed in the Uncertainties Section of the ERA.



LEGEND
ERA Ecological risk assessment

NOTES:

1. ● Indicates the exposure pathways that are qualitatively evaluated for receptors in the Site 15 ERA.
2. * Shading indicates the exposure pathways that are quantitatively evaluated for receptors in the Site 15 ERA. Nonshaded pathways are not evaluated because they are not considered significant pathways or data to quantatively evaluate these pathways are not available. The ingestion exposure routes for terrestrial invertebrates include the ingestion of soil and food items containing chemicals accumulated from Site 15 surface soil.

FIGURE 7-2
CONTAMINANT PATHWAY MODEL FOR SITE 15 ECOLOGICAL RECEPTORS

REMEDIAL INVESTIGATION REPORT SITE 15, SOUTHWEST LANDFILL

NAVAL AIR STATION WHITING FIELD MILTON, FLORIDA

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Terrestrial Plants and Invertebrates. Terrestrial plants and soil invertebrates may be exposed to contamination in surface soil by direct contact with and root uptake (plants) or ingestion (invertebrates) of soil. The ingestion exposure routes include the ingestion of soil and food items containing chemicals accumulated from Site 15 surface soil. The inhalation exposure route is not evaluated for terrestrial plants and invertebrates due to the reasons discussed above for terrestrial wildlife. Because the depth to groundwater is approximately 35 to 40 feet bls, well below the root zone of Site 15 plants, it is unlikely that terrestrial plants will be exposed to potential groundwater contamination.

Aquatic Receptors. Exposure pathways evaluated for aquatic receptors in Clear Creek downgradient of Site 15 (including invertebrates, plants, amphibians, and fish) include direct contact with groundwater (as it discharges to the surface water of Clear Creek). Although direct contact with the surface water and sediment and ingestion of sediment and food items is possible, these pathways will be evaluated as part of the ERA for Site 39, Clear Creek Flood Plain.

A qualitative screening evaluation of Site 15 groundwater migration to surface water and potential adverse effects to aquatic receptors in Clear Creek will be completed as part of this ERA. It should be noted that the purpose of this evaluation is not to predict actual surface water and sediment conditions in Clear Creek. Surface water and sediment data from Clear Creek downgradient of Site 15 will be evaluated as part of the ERA for Site 39, Clear Creek Flood Plain.

7.2.3 Identification of Endpoints The assessment and measurement endpoints selected for the Site 15 ERA are listed in Table 7-1. Assessment endpoints represent the ecological component to be protected, whereas the measurement endpoints approximate or provide a measure of the achievement of the assessment endpoint. One of the assessment endpoints selected for the Site 15 ERA is the survival and maintenance of receptor populations and communities at Site 15. The measurement endpoints used to gauge the likelihood of population- and community-level effects are chemical-specific toxicological benchmark values derived from the literature that are based on laboratory-measured survival, growth, and reproductive effects. Table 7-1 presents the assessment endpoint, endpoint species, measurement endpoint, and decision point (i.e., the outcome at which additional evaluation may be warranted).

Four questions were developed to gauge potential risks associated with exposure to Site 15 surface soil and groundwater. These questions are designed for multiple species and trophic levels and represent both individual and community dynamics. Questions for the Site 15 ERA include the following:

1. ECPCs present in the surface soil are not at concentrations sufficiently high enough to reduce plant or soil invertebrate biomass or plant cover availability such that small mammal and bird populations would be affected.

2. ECPCs in plants and invertebrates are not sufficiently high enough to adversely affect foraging small mammal or bird populations following consumption of contaminated prey.

Table 7-1
Endpoints Selected for
Ecological Risk Assessment, Site 15

Remedial Investigation Report
Site 15, Southwest Landfill
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Milton, Florida

Assessment Endpoint	Receptor	Measurement Endpoint	Decision Point
Reduction in the biomass of terrestrial plants used as forage material.	Wildlife species	Chemical concentrations (mg/kg) in surface soil that result in adverse effects on growth, reproduction, or survival to terrestrial plants.	The reasonable maximum exposure concentration (mg/-kg) of an ECPC in surface soil is greater than the terrestrial plant RTV.
Reduction in the abundance of earthworms used as forage material.	Wildlife species	Chemical concentrations (mg/kg) in surface soil that result in adverse effects on survival (e.g., LC_{50} studies) or measured adverse effects on reproduction and growth to terrestrial invertebrates.	The reasonable maximum exposure concentration (mg/-kg) in surface soil is greater than the terrestrial invertebrate RTV.
Survival and maintenance of wildlife populations.	Wildlife Species	Oral chemical doses (mg/kg BW/day) based on measured adverse effects on growth, reproduction, or survival (e.g., NOAEL, LOAEL, and LD_{50} studies) of mammalian and avian laboratory test populations.	Comparison of potential dietary exposures in mammalian and avian wildlife with literature-derived RTVs. HQs >1 indicate potential risk.
Survival and maintenance of fish and macroinvertebrate populations.	Aquatic Receptors	Chemical concentrations in groundwater associated with adverse effects to growth, reproduction, or survival of aquatic organisms.	The predicted exposure concentration of groundwater in Clear Creek is greater than available criteria and aquatic toxicity benchmark values.

Notes: mg/kg = milligrams per kilogram.
ECPC = ecological chemical of potential concern.
RTV = reference toxicity value.
LC_{50} = lethal concentration to 50 percent of a test population.
BW/day = body weight per day.
NOAEL = no observed adverse effect level.
LOAEL = lowest observed adverse effect level.
LD_{50} = lethal dose to 50 percent of a test population.
HQ = hazard quotient.
> = greater than.

3. Bioaccumulating chemicals are not present at concentrations sufficiently high enough to reduce survivability, growth, or reproduction in top predators (i.e., foxes and owls).

4. ECPCs present in the groundwater are not at concentrations sufficiently high enough to reduce the survival and maintenance of aquatic receptors in Clear Creek, located approximately 1,200 feet downgradient of Site 15.

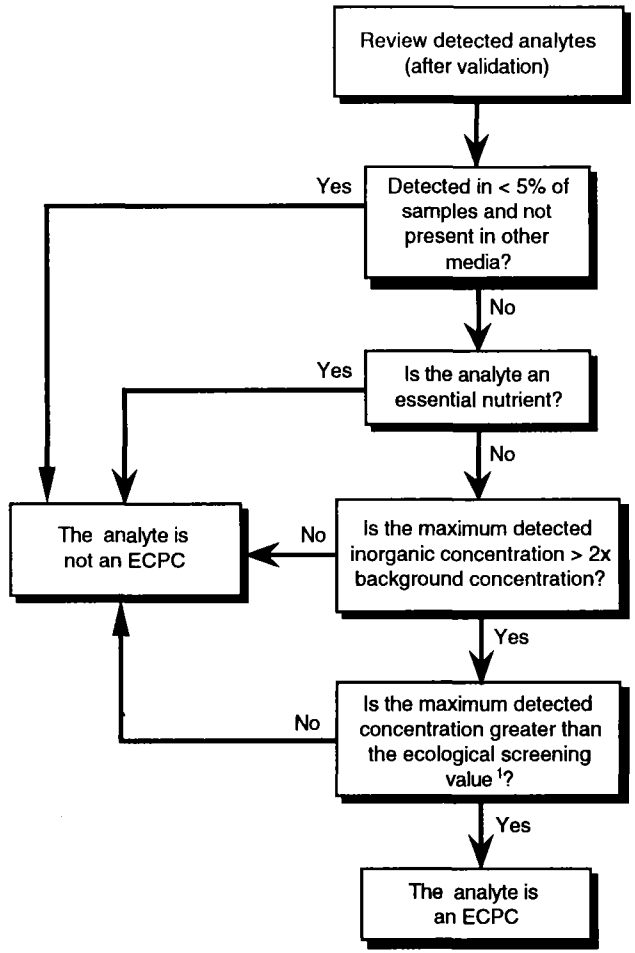
7.3 HAZARD ASSESSMENT AND SELECTION OF ECPCs. The hazard assessment includes a review of analytical data and selection of ECPCs. ECPCs represent analytes detected in environmental media (i.e., surface soil and groundwater) that are considered in the ERA and could present a potential risk for ecological receptors. The process for selecting ECPCs is depicted on Figure 7-3. Additional details regarding the ECPC selection process are provided in Subsection 2.4.2 of the GIR (ABB-ES, 1998). Analytical data for Site 15 were evaluated for use in risk assessment pursuant to national guidance, *Guidance for Data Useability in Risk Assessment (Parts A and B)* (USEPA, 1992a).

Following the data validation step, analytes in surface soil and groundwater were not selected as ECPCs if the analyte was detected in 5 percent or fewer of the samples analyzed and not present in any other media. Calcium, magnesium, potassium, and sodium were excluded as ECPCs for groundwater. In addition to these analytes, iron is also excluded as an ECPC for surface soil. These analytes are considered to be essential nutrients and not toxic. The rationale for eliminating essential nutrients as ECPCs is provided in the GIR (ABB-ES, 1998).

Inorganic chemicals representative of background conditions are not selected as ECPCs. In accordance with USEPA Region IV guidance (USEPA, 1991a), an inorganic analyte is not selected as an ECPC if the maximum detected concentration is less than 2 times the average detected inorganic concentration in background samples. The maximum detected concentrations are compared against representative site-specific background surface soil and groundwater screening concentrations to eliminate chemicals that are unlikely to be site related.

A site-specific background investigation of surface soil and groundwater was conducted at NAS Whiting Field, and the findings are presented in Subsections 3.3.1 and 3.3.3 of the GIR, respectively (ABB-ES, 1998). The site-specific background study used to establish background screening values for Site 15 surface soil consists of nine surface soil samples (BKG-SL-02, BKG-SL-06, BKG-SL-07, BKG-SL-08, BKS00101, BKS00201, BKS00301, BKS00401, and BKS00501) and one duplicate sample (BKS00201D) collected from Troup and Dothan/Lucy/Bonifay soil types, which are considered most geologically similar to the soil from Site 15. The site-specific background study used to establish background screening values for groundwater consists of seven groundwater samples (BKG00101, BKG00102, BKG00103, BKG00201, BKG00202, BKG00203, and BKG00301) and one duplicate sample (BKG00101D) collected from monitoring wells upgradient of any potential site-related contamination.

Analytes that exceed the background screening concentration and are not essential nutrients are also screened against ecological screening values for surface soil and groundwater. The surface soil ecological screening values are the Dutch Soil



NOTES:
ECPC = ecological chemical of potential concern
> = greater than
x = times
[1] Media-specific ecological screening values include the Dutch Soil Criteria for surface soil ECPCs and the U.S. Environmental Protection Agency - Region 4 Surface Water Chronic Screening Values for groundwater.

FIGURE 7-3
ECOLOGICAL CHEMICAL OF POTENTIAL CONCERN SELECTION PROCESS

REMEDIAL INVESTIGATION REPORT
SITE 15, SOUTHWEST LANDFILL

NAVAL AIR STATION WHITING FIELD
MILTON, FLORIDA

2534-09 FIG 7-3 SITE 15 022498HAS

Criteria "A", which refer to background concentrations in surface soil issued by the U.S. Fish and Wildlife Service (Beyer, 1990). The groundwater ecological screening values are the Freshwater Surface Water Chronic Screening Values for Hazardous Waste Sites issued by USEPA Region IV (USEPA, 1995b). If the maximum detected concentration of an analyte exceeds the surface soil ecological screening value, the analyte is retained as an ECPC for terrestrial wildlife, terrestrial plants, and soil invertebrates. If the maximum detected concentration of an analyte exceeds the groundwater ecological screening value, the analyte is retained as an ECPC for aquatic receptors.

Thirty surface soil samples (15-SL-01 through 15-SL-05 and 1500101 through 15S02501 with duplicates at 15S00101D, 15S01701D, and 15S02001D) were collected at Site 15 (see Figure 3-2). Samples 15-SL-01 through 15-SL-05 were collected as part of the Phase IIA investigation in August 1992, and samples 15S00101 through 15S02501 were collected as part of the Phase IIB investigation in December 1995. Surface soil samples were analyzed for VOCs, SVOCs, pesticides and PCBs, and inorganic analytes. Unfiltered groundwater data were used to screen potential ecological risks. A discussion of which groundwater samples were used to evaluate both human health and ecological risks is provided in Paragraph 6.2.3.1.

Tables 7-2 and 7-3 present a summary of the respective surface soil and groundwater analytical data and the following information: frequency of detection, range of detection limits, range of detected concentrations, average of detected concentrations, background screening concentrations, ecological screening values, 95 percent upper confidence limits (UCLs), and selected ECPCs.

As shown in Table 7-2, ECPCs selected for the surface soil samples collected at Site 15 include three VOCs (acetone, methylene chloride, and xylenes), two SVOCs (di-*n*-butylphthalate and bis(2-ethylhexyl)phthalate), and four inorganic analytes (cyanide, lead, silver, and vanadium).

As shown in Table 7-3, ECPCs selected for the unfiltered groundwater samples collected at Site 15 include four VOCs (acetone, benzene, trichloroethene, and xylenes), two SVOCs (1,4-dichlorobenzene, and bis(2-ethylhexyl)phthalate), one pesticide (4,4'-DDT), and nine inorganic analytes (aluminum, cobalt, iron, lead, manganese, mercury, silver, vanadium, and zinc).

7.4 EXPOSURE ASSESSMENT. The purpose of the ecological exposure assessment is to estimate or measure the amount of an ECPC to which an ecological receptor may be exposed. The following sections briefly describe how contaminant exposures are estimated or measured for wildlife, terrestrial plants, and invertebrates at Site 15 and aquatic receptors in Clear Creek downgradient of Site 15. The contaminant pathway model (Figure 7-2) provides a summary of the potential exposure pathways that exist at Site 15 for each group of receptors. Additional details regarding the exposure assessment are provided in the GIR (ABB-ES, 1998).

7.4.1 Calculation of EPCs The EPC is a representative concentration used for evaluating risks throughout this ERA. RME and central tendency concentrations are derived for each ECPC. Because the sample sizes for both the surface soil and groundwater data sets are greater than ten, the RME value is equal to the lesser of the maximum detected concentration and the 95 percent UCL calculated on the log-transformed arithmetic mean (USEPA, 1992b). One-half of the detection

Table 7-2
Selection of Ecological Chemicals of Potential Concern for Surface Soil Associated with Site 15

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Analyte	Frequency of Detection[1]	Reporting Limit Range	Detected Concentration Range[2]	Average of Detected Concentrations[3]	Background Screening Concentration[4]	Ecological Screening Value[5]	Chemical of Ecological Concern[6]	95% UCL[7]	Average of All Samples[8]	Exposure Point Concentration	
										RME[9]	CT[10]
Volatile Organic Compounds (μg/kg)											
Acetone	1/30	10 to 22	11 to 11	11	ND	NA	Yes	6.2	6	6.2	6
Methylene chloride	4/30	5 to 12	3 to 9	5.3	ND	NA	Yes	5.6	5.1	5.6	5.1
Xylenes (total)	3/30	5 to 12	1 to 4	2.3	ND	NA	Yes	5.9	5	4	4
Semivolatile Organic Compounds (μg/kg)											
Butylbenzylphthalate	1/30	350 to 430	240 to 240	240	ND	NA	No[11]				
Di-*n*-butylphthalate	6/30	350 to 420	560 to 1,100	800	ND	NA	Yes	369	307	369	307
bis(2-Ethylhexyl)phthalate	4/30	350 to 430	39 to 947.5*	299	80.3	NA	Yes	240	200	240	200
Pesticides/PCBs (μg/kg)											
4,4'-DDD	1/30	3.5 to 18	3.8 to 3.8	3.8	ND	100	No[11,12]				
4,4'-DDE	3/30	3.5 to 18	1.9 to 50	18.3	ND	100	No[12]				
4,4'-DDT	2/30	3.5 to 18	4.4 to 14	9.2	ND	100	No[12]				
Inorganic Analytes (mg/kg)											
Aluminum	30/30	40 to 40	3,280 to 13,400	7,159	15,334	NA	No[13]				
Arsenic	30/30	2 to 2	0.75 to 6.8	1.6	4.7	20	No[12]				
Barium	30/30	40 to 40	3.2 to 11.8	6.8	23.8	200	No[12,13]				
Beryllium	3/30	0.05 to 1	0.07 to 0.09	0.08	0.36	NA	No[13]				
Calcium	18/30	1,000 to 1,000	22.05* to 262.6*	79.5	402	NA	No[13,14]				
Chromium	30/30	2 to 2	2.8 to 14.4*	6.1	10.8	100	No[12]				
Cobalt	11/30	0.33 to 10	0.49 to 1.2	0.72	3.0	20	No[12,13]				
Copper	8/30	5 to 5	1.6 to 12.5	5.4	9.4	50	No[12]				
Cyanide	3/30	0.24 to 0.5	0.09 to 0.31	0.19	0.26	NA	Yes	0.25	0.22	0.25	0.22
Iron	30/30	20 to 20	1,610 to 11,150*	4,278	8,588	NA	No[14]				

See notes at end of table.

Table 7-2 (Continued)
Selection of Ecological Chemicals of Potential Concern for Surface Soil Associated with Site 15

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Analyte	Frequency of Detection[1]	Reporting Limit Range	Detected Concentration Range[2]	Average of Detected Concentrations[3]	Background Screening Concentration[4]	Ecological Screening Value[5]	Chemical of Ecological Concern[6]	95% UCL[7]	Average of All Samples[8]	Exposure Point Concentration	
										RME[9]	CT[10]
Inorganic Analytes (mg/kg) (Continued)											
Lead	30/30	0.6 to 1	2.3 to 59.9	6.6	11.4	50	Yes	7.3	6.6	7.3	6.6
Magnesium	30/30	1,000 to 1,000	43 to 156	92.3	258	NA	No[13,14]				
Manganese	30/30	3 to 3	8.8* to 143	53.5	404	NA	No[13]				
Mercury	22/30	0.06 to 0.1	0.01 to 0.19	0.02	0.12	0.5	No[12]				
Nickel	1/30	2.3 to 8	3.3 to 3.3	3.3	7.2	50	No[12,13]				
Potassium	5/30	128 to 1,000	131 to 334.5*	190	177	NA	No[14]				
Selenium	6/30	0.39 to 1	0.24 to 0.41	0.33	0.44	NA	No[13]				
Silver	4/30	0.32 to 2	0.66 to 2	1	0.7	NA	Yes	1.2	0.86	1.2	0.86
Sodium	5/30	1,000 to 1,000	170 to 179	174	388	NA	No[13,14]				
Vanadium	30/30	10 to 10	4.1 to 33.85*	11	21.2	NA	Yes	13.3	11	13.3	11
Zinc	28/30	4 to 4	2.4 to 15.9	5.4	15.4	200	No[12]				

[1] Frequency of detection is the number of samples in which the analyte was detected divided by the total number of samples analyzed (excluding rejected values).
[2] The value indicated by an asterisk is the average of a sample and its duplicate. For duplicate samples having one nondetect value, one-half of the detection limit is used as a surrogate for the nondetect value.
[3] The average of detected concentrations is the arithmetic mean of all samples in which the analyte was detected. It does not include those samples with "R", "U", or "UJ" validation qualifiers.
[4] The background screening value is twice the average of detected concentrations for inorganic analytes in background samples. Background screening values for organic analyte values are one times the average of detected concentrations. Organic values are included for comparison purposes only (i.e., not used to select ECPCs).
[5] The ecological screening values are the Dutch Soil Criteria as reported in the U.S. Fish and Wildlife Service, *Biological Report* 90(2), "Evaluating Soil Contamination," (Beyer, 1990).
[6] These chemicals are retained for further evaluation in the ecological risk assessment.

Notes continued on following page.

Table 7-2 (Continued)
Selection of Ecological Chemicals of Potential Concern for Surface Soil Associated with Site 15

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[7] The 95 percent UCL is calculated on the log-transformed average of all samples using the formula provided in the U.S. Environmental Protection Agency (USEPA) *Supplemental Guidance to RAGS: Calculating the Concentration Term*. The 95 percent UCL is not calculated when there are less than 10 total samples (USEPA, 1992c).
[8] The average of all samples assigns a value of one-half of the detection limit as a surrogate concentration for nondetect values.
[9] The RME exposure point concentration (EPC) is equal to the lesser of the maximum detected concentration or the 95 percent UCL.
[10] The CT EPC is equal to the lesser of the average of all samples or the RME concentration.
[11] The analyte was detected in less than 5 percent of the samples and was not detected in groundwater.
[12] The maximum detected concentration is less than the ecological screening value.
[13] The maximum detected concentration is less than the background screening concentration.
[14] The analyte is an essential nutrient and not considered toxic.

Notes: The average of a sample and its duplicate is used for all table calculations.

Samples: 15-SL-01 through 15-SL-05 and 15S00101 through 15S02501.
Duplicate samples: 15S00101D, 15S01701D, 15S02001D.
Background samples: BKG-SL-02, BKG-SL-06, BKG-SL-07, BKG -SL-08, BKS00101, BKS00201, BKS00301, BKS00401, and BKS00501.
Background duplicate samples: BKS00201D.

% = percent.
RME = reasonable maximum exposure.
CT = central tendency.
μg/kg = micrograms per kilogram.
ND = not detected.
NA = not available.
* = average of sample and duplicate.
PCB = polychlorinated biphenyl.
DDD = dichlorodiphenyldichloroethane.
DDE = dichlorodiphenyldichloroethene.
DDT = dichlorodiphenyltrichloroethane.
mg/kg = milligrams per kilogram.

Table 7-3
Selection of Ecological Chemicals of Potential Concern for Groundwater Associated with Site 15

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Analyte	Frequency of Detection[1]	Reporting Limit Range	Detected Concentration Range[2]	Average of Detected Concentrations[3]	Background Screening Concentration[4]	Ecological Screening Value[5]	Chemical of Ecological Concern[6]	95% UCL[7]	Average of All Samples[8]	Exposure Point Concentration	
										RME[9]	CT[10]
Volatile Organic Compounds (µg/ℓ)											
1,1-Dichloroethene	2/20	10 to 25	3.5 to 10	6.8	ND	303	No[12]				
1,2-Dichloroethane	1/20	10 to 15	2	2	ND	2,000	No[6]				
1,2-Dichloroethene (total)	8/20	10 to 25	1 to 14	5.4	ND	1,350	No[12]				
Acetone	1/20	10 to 25	140 to 140	140	ND	NA	Yes	12.3	12.1	12.3	12.1
Benzene	4/20	10 to 25	1 to 100	32.3	ND	53	Yes	14	10.8	14	10.8
Chlorobenzene	2/20	10 to 25	4 to 12	8	ND	195	No[12]				
Ethylbenzene	1/20	10 to 25	2 to 2	2	ND	453	No[12]				
Trichloroethene	11/20	10 to 25	1 to 330	37.1	ND	NA	Yes	26.1	22.7	26.1	22.7
Xylenes (total)	1/20	10 to 25	1 to 1	1	ND	NA	Yes	6.4	5.2	1	1
Semivolatile Organic Compounds (µg/ℓ)											
1,4'-Dichlorobenzene	3/19[15]	10 to 10	1 to 12	7	ND	11.2	Yes	6.8	5.3	6.8	5.3
Diethylphthalate	3/19[15]	10 to 10	1 to 2	1.3	ND	521	No[12]				
Naphthalene	2/19[15]	10 to 10	1 to 4	2.5	ND	62	No[12]				
bis(2-Ethylhexyl)phthalate	8/19[15]	10 to 10	1 to 5	2.3	4	0.3	Yes	5.2	3.9	5	3.9
Pesticides and PCBs (µg/ℓ)											
4,4-DDT	2/19[15]	0.1 to 0.1	0.12 to 0.12	0.12	ND	0.001	Yes	0.06	0.06	0.06	0.06
Inorganic Analytes (mg/ℓ)											
Aluminum	14/20	35.8 to 200	58.65 to 1,030	252	654	87	Yes	317	202	317	202
Antimony	1/20	8.6 to 60	25.6 to 25.6	25.6	20.4	160	No[12]				

See notes at end of table.

Table 7-3 (Continued)
Selection of Ecological Chemicals of Potential Concern for Groundwater Associated with Site 15

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Analyte	Frequency of Detection[1]	Reporting Limit Range	Detected Concentration Range[2]	Average of Detected Concentrations[3]	Background Screening Concentration[4]	Ecological Screening Value[5]	Chemical of Ecological Concern[6]	95% UCL[7]	Average of All Samples[8]	Exposure Point Concentration	
										RME[9]	CT[10]
Inorganic Analytes (mg/ℓ) (Continued)											
Arsenic	6/20	0.5 to 10	0.6 to 17.2	6.6	ND	190[16]	No[12]				
Barium	20/20	200 to 200	7.8 to 68.3	19.7	72.6	NA	No[13]				
Cadmium	1/20	1.2 to 5	2.3 to 2.3	2.3	4.4	0.66	No[13]				
Calcium	19/20	5,000 to 5,000	358 to 15,000	2,529	3,316	NA	No[14]				
Chromium	6/20	2 to 10	1.95 to 2.8	2.4	30	11[17]	No[12,13]				
Cobalt	1/20	2.3 to 50	1.78 to 1.78	1.8	ND	NA	Yes	45.6	22.7	1.8	1.8
Copper	6/20	1.1 to 25	1.3 to 3.3	2.2	10.8	6.54	No[12,13]				
Cyanide	7/19[15]	1.5 to 7.6	1.9 to 5	3	7	5.2	No[12,13]				
Iron	18/20	100 to 100	56.7 to 40,200	3,020	964	1,000	Yes	7,864	2,723	7,864	2,723
Lead	10/20	0.5 to 3	0.5 to 4.05	1.3	ND	1.32	Yes	1.9	1.4	1.9	1.4
Magnesium	20/20	5,000 to 5,000	273 to 2,140	735	2,426	NA	No[13,14]				
Manganese	18/20	15 to 15	1.8 to 553	65	42.8	NA	Yes	194	59.2	194	59.2
Mercury	1/20	0.1 to 0.2	0.06 to 0.06	0.06	ND	0.012	Yes	0.1	0.1	0.06	0.06
Nickel	1/20	7.3 to 40	7.4 to 7.4	7.4	42.8	87.71	No[12,13]				
Potassium	17/20	5,000 to 5,000	338 to 2,190	882	1,528	NA	No[13]				
Silver	1/20	2.5 to 10	2.9 to 2.9	2.9	ND	0.012	Yes	5.5	4.7	2.9	2.9
Sodium	20/20	5,000 to 5,000	1,070 to 18,300	3,570	4,772	NA	No[14]				
Thallium	2/20	0.6 to 10	0.98 to 2.95	2	ND	4.0	No[12]				
Vanadium	7/20	1.2 to 50	0.9 to 5.2	2.2	3.8	NA	Yes	66.7	15.8	5.2	5.2
Zinc	12/20	20 to 20	1.6 to 306	107	200	58.91	Yes	270	68.1	270	68.1

See notes at end of table.

Table 7-3 (Continued)
Selection of Ecological Chemicals of Potential Concern for Groundwater Associated with Site 15

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[1] Frequency of detection is the number of samples in which the analyte was detected divided by the total number of samples analyzed (excluding rejected values).
[2] For duplicate samples having one nondetect value, one-half of the detection limit is used as a surrogate for the nondetect value.
[3] The average of detected concentrations is the arithmetic mean of all samples in which the analyte was detected. It does not include those samples with "R", "U", or "UJ" validation qualifiers.
[4] The background screening value is twice the average of detected concentrations for inorganic analytes in background samples. Background screening values for organic analyte values are one times the average of detected concentrations. Organic values are included for comparison purposes only (i.e., not used to select Ecological Chemicals of Potential Concern).
[5] The ecological screening values are the Region IV Waste Management Division Freshwater Surface Water Chronic Screening Values for Hazardous Waste Sites as reported in the *Supplemental Guidance to RAGS: Region IV Bulletins* (USEPA, 1995b).
[6] These chemicals are retained for further evaluation in the ecological risk assessment.
[7] The 95 percent UCL is calculated on the log-transformed average of all samples using the formula provided in the USEPA *Supplemental Guidance to RAGS: Calculating the Concentration Term*. The 95 percent UCL is not calculated when there are less than 10 total samples. (USEPA, 1992c).
[8] The average of all samples assigns a value of one-half of the detection limit as a surrogate concentration for nondetect values.
[9] The RME exposure point concentration (EPC) is equal to the lesser of the maximum detected concentration or the 95 percent UCL.
[10] The central tendency (CT) EPC is equal to the lesser of the average of all samples or the RME concentration.
[11] The analyte was detected in less than 5 percent of the samples and was not detected in surface soil.
[12] The maximum detected concentration is less than the ecological screening value.
[13] The maximum detected concentration is less than the background screening concentration.
[14] The analyte is an essential nutrient and not considered toxic.
[15] Semivolatile organic compounds, pesticides and PCBs, and cyanide were analyzed in sample 15G00602 or its duplicate 15G00602D.
[16] This value is based on trivalent arsenic form.
[17] This value is based on hexavalent chromium form.

Notes: The average of a sample and its duplicate is used for all table calculations.

Samples: 15G00101, 15G00201, 15G00202, 15G00203, 15G00301, 15G00302, 15G00303, 15G00401, 15G00501, 15G00502, 15G00503, 15G00601, 15G00602, 15G00603, 15G00701, 15G00702, 15G00703, 15G00801, 15G00802, and 15G00803.
Duplicate samples: 15G00602D.
Background samples: BKG00101 through BKG00103, BKG00201 through BKG00203, and BKG00301.
Background duplicate samples: BKG00101D.

% = percent.
UCL = upper confidence level.
RME = reasonable maximum exposure.
CT = central tendency.
$\mu g/\ell$ = micrograms per liter.
ND = not detected in any background sample.
NA = not available.
PCB = polychlorinated biphenyl.
DDT = dichlorodiphenyltrichloroethane.

limit is used to calculate the 95 percent UCL. If potential risks are predicted based on the RME scenario, then the central tendency exposure scenario is also evaluated. The central tendency exposure concentration is represented by the arithmetic mean of all samples. One-half of the detection limit is also used as a surrogate value for sample results that are below the detection limit.

Table 7-2 presents the RME and central tendency EPCs for selected surface soil ECPCs. RME EPCs are also derived for groundwater ECPCs based on the lesser of the 95 percent UCL and the maximum detected concentration. Table 7-3 presents the RME and central tendency EPCs for selected groundwater ECPCs. Because the point of groundwater discharge to surface water is located approximately 1,200 feet downgradient of Site 15, a 10-fold attenuation factor is applied to the RME concentration in order to derive an realistic exposure concentration for groundwater constituents in the surface water of Clear Creek. The 10-fold attenuation factor is a conservative estimate of the attenuation that occurs between constituents in groundwater and surface water exposure. The attenuation factor is assumed to more accurately represent potential exposure concentrations in the ambient waters of Clear Creek.

7.4.2 Terrestrial Wildlife Exposure routes for wildlife receptors include direct and indirect ingestion of soil and ingestion of food containing site-related chemicals. The actual amount of an ECPC taken in by wildlife species (i.e., ingestion dose in milligrams per kilogram per day [mg/kg-day]) depends on a number of factors. A potential dietary exposure (PDE) model is used to estimate exposure to representative wildlife species. The PDE (or body dose) is calculated for each ECPC in surface soil using the equations presented in Table 7-4 and the methodologies described in the GIR (ABB-ES, 1998).

Wildlife species from different trophic guilds that may be present at the site were selected for the PDE model. The model uses species-specific feeding and habitat characteristics to estimate chemical exposures to wildlife species respective to their position in the food chain. Terrestrial receptors were chosen to represent the trophic levels typically found in the planted pine forest habitat present at Site 15. The representative wildlife species considered in the ERA are summarized in Table 7-5 and discussed below.

- **Cotton mouse** (*Peromyscus gossypinus*). The cotton mouse represents a small mammalian herbivore that could potentially be exposed to contamination in soil and in plant tissue (accumulated from the soil). The cotton mouse home range is estimated at 0.147 acre and could reside entirely on the site. The cotton mouse represents the small mammal herbivore community at Site 15.

- **Short-tailed shrew** (*Blarina brevicauda*). The short-tailed shrew finds suitable habitat in forests, fields, marshes, and brush, and has a home range of approximately 1 acre. It primarily feeds on earthworms, snails, centipedes, insects, small vertebrates, and slugs (DeGraaf and Rudis, 1986). Insectivorous species may receive relatively high chemical doses of bioaccumulating compounds as a result of their voracious appetites. The shrew represents small omnivorous mammals that may be found in the pine forest of Site 15.

Table 7-4
Estimation of Potential Chemical Exposures for Representative Wildlife Species

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Estimation of Chemical Exposures Related to Surface Soil

Scope: Estimates the amount (dose) of a chemical ingested and accumulated by a species via incidental ingestion of surface soil and food items containing site-related chemicals.

Soil Chemical Concentration: The maximum detected concentration of the ecological chemicals of potential concern when the sample size is ≤ 9, and the lesser of the maximum detected concentration or the 95th percent upper confidence limit (UCL) of the mean when the sample size is ≥ 10.

Soil Exposure Concentration:

$$\underset{(mg/kg)}{Soil\ Exposure} = \left(\underset{as\ Soil}{\%\ of\ Diet} \times \underset{(mg/kg)}{Soil\ Concentration} \right)$$

Primary Prey Item Concentration (T_{N1})

$$\underset{(mg/kg)}{Primary\ Prey\ Item\ Concentration} = \left(BAF_{inv\ or\ plant} \times \underset{(mg/kg)}{Soil\ Concentration} \right)$$

Secondary Prey Item Concentration (T_{N2}):

$$\underset{(mg/kg)}{Secondary\ Prey\ Item\ Concentration} = \left(BAF_{mam\ or\ bird} \times \underset{(mg/kg)}{Tissue\ Concentration\ of\ Primary\ Prey\ Items^{*}} \right)$$

where: BAF = Bioaccumulation factor or mg/kg fresh weight tissue over mg/kg dry weight soil for invertebrates and plants, and mg/kg fresh weight tissue over mg/kg fresh weight food for small mammals and small birds.

* For a discussion of the weighted chemical concentration in prey items, see explanation of the PDE term below, and the General Information Report (ABB-ES, 1998)

Total Exposure Related to Surface Soil:

$$\underset{(mg/kgBW\text{-}day)}{PDE} = \frac{[P_1 \times T_1 + \ldots + P_N \times T_N + \underset{exposure}{soil}] \times IR_{Diet} \times SFF \times ED}{BW}$$

where: PDE = potential dietary exposure (mg/kgBW-day),
P_N = percent of diet composed of food item N,
T_N = tissue concentration in food item N (mg/kg),
IR_{Diet} = food ingestion rate of receptor (kg of food or dietary item per day),
BW = body weight (kg) of receptor,
SFF = site foraging frequency (site area [acres] divided by home range [acres]), assumed to be equal to 1 for lethal exposure scenario, and
ED = exposure duration (fraction of year species is expected to occur on site).

Notes: ≤ = less than or equal to.
≥ = greater than or equal to.
mg/kg = milligrams per kilogram.
% = percent.
inv = invertebrate species.
mam = mammal species.
mg/kg BW-day = milligrams per kilograms of body weight per day.
kg = kilograms.

- **Eastern meadowlark** (*Sturnella magna*). The eastern meadowlark is most commonly found in open pastures, prairies, farms, and meadows, and has a home range of approximately 5 acres. The meadowlark feeds primarily on invertebrates, although its diet is supplemented with plants. The meadowlark represents insectivorous avian receptors found in the open disturbed area of Site 15.

- **Red Fox** (*Vulpes vulpes*). This omnivorous mammal prefers open woodlands and grassy fields and is most active at night and twilight. It is an opportunistic forager, feeding on small mammals, birds, amphibians, reptiles, invertebrates, berries, and other fruits (Burt and Grossen-heider, 1976). The red fox has an estimated home range of approximately 250 acres and represents the large predatory mammal guild at Site 15.

- **Red-tailed Hawk** (*Buteo jamaicensis*). The red-tailed hawk forages in open country, frequently on woodland edges, feeding primarily on small mammals and has a home range of approximately 800 acres. It will also consume invertebrates, reptiles, and small birds in the diet. Red-tailed hawks are year-round residents in the Southeast and are frequently seen perched adjacent to open fields (DeGraaf and Rudis, 1986). The hawk may reside in forested areas and feed on species that have been exposed to surface soil ECPCs at Site 15.

Table 7-5
Ecological Receptors Evaluated for Surface Soil

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Receptor Evaluated		Method of Evaluation
Common Name	Scientific Name	
Terrestrial Plants	NA	Benchmark comparison
Terrestrial Invertebrate	NA	Benchmark comparison
Cotton mouse	*Peromyscus gossypinus*	Food-web model
Short-tailed shrew	*Blarina brevicauda*	Food-web model
Eastern meadowlark	*Sturnella magna*	Food-web model
Red fox	*Vulpes vulpes*	Food-web model
Red-tailed hawk	*Buteo jamaicensis*	Food-web model

Note: NA = not applicable.

Parameters for quantitatively evaluating exposures to wildlife include body weight, food ingestion rate, home range, and relative consumption of food items. Exposure assumptions for each of the representative wildlife species for Site 15 are provided in Table 7-6 and Table H-6 of Appendix H. In addition to these parameters, the species foraging habits and bioaccumulation in food items are also considered.

The site foraging frequency (SFF) is an adjustment term that accounts for the frequency a receptor feeds within the site area. The SFF is based on both the

Table 7-6
Exposure Parameters for Representative Wildlife Species

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Representative Wildlife Species	Body Weight (kg)	Reported Diet	Assumed Diet for Terrestrial Exposure Assessment (% of diet)	Food Ingestion Rate (kg/day)	Home Range (acres)
Cotton mouse [a] *(Peromyscus gossypinus)*	0.021 [b]	Seeds and some insects. [c]	88% Plants 10% Invertebrates 2% Soil [d]	0.0029 [e]	0.147 [f]
Short-tailed shrew *(Blarina brevicauda)*	0.017 [g]	Earthworms, slugs and snails, fungi, insects, and vegetation. [c]	78% Invertebrates 12% Plants 10% Soil [c]	0.0024 [e]	0.96 ± 0.09 [c]
Eastern meadowlark *(Sturnella magna)*	0.087 [h]	Weed seeds, grass seeds, and invertebrates including beetles, grubs, bugs, grasshoppers, crickets, ants, and spiders. [h]	75% Invertebrates 20% Plants 5% Soil [h]	0.0119 [i]	5 [h]
Red fox *(Vulpes vulpes)*	4.69 [c]	Small mammals, birds, and invertebrates, as well as berries and other fruits. [c]	57% Small mammals 20% Invertebrates 10% Small birds 10% Plants 3% Soil [c]	0.24 [e]	250 [c]
Red-tailed hawk *(Buteo jamaicensis)*	1.02 [h]	Primarily small mammals; also birds, snakes, turtles, frogs, crickets, beetles, crayfish, and carp. [c]	70% Small mammals 27% Small birds 3% Soil [c]	0.059 [i]	800 [c]

References:
[a] Values for the deer mouse were used for the cotton mouse (U.S. Environmental Protection Agency [USEPA], 1993b).
[b] Average of adult male and female deer mice in North America (USEPA, 1993b).
[c] Wildlife Exposure Factors Handbook (USEPA, 1993b).
- invertebrate, plant and soil values for the short-tailed shrew are derived from data presented in Whitaker & Ferraro, 1963.
- invertebrate, plant, small mammal, small bird, and soil values for the red fox are averages of values presented in the Wildlife Exposure Factors Handbook.
- small mammal, small bird, and soil values are averages of values for the red-tailed hawk presented in the Wildlife Exposure Factors Handbook.

[d] Deer mouse value used for cotton mouse based on similarities in diet. Plant, invertebrate, and soil values are averages of values presented in the Wildlife Exposure Factors Handbook. Other values were based on diet composition (USEPA, 1993b).
[e] Calculated using the mammal equation based on body weight (Wt) in kg. Food ingestion (kg/day) = $0.0687 \times Wt^{0.822}$ (kg) (USEPA, 1993b).
[f] Average for male and female deer mice, Virginia/mixed deciduous forest (USEPA, 1993b).
[g] Mean of means reported for male and female shrews in summer and fall (USEPA, 1993b).
[h] Terres (1980).
[i] Calculated using the bird equation based on body weight (Wt) in kg. Food ingestion (kg/day) = $0.0582 \times Wt^{0.651}$ (kg) (USEPA, 1993b).

Notes: kg = kilograms. ± = plus or minus.
% = percent. kg/day = kilograms per day.

acreage of the site relative to the receptor's home range and the fraction of the year the receptor would be exposed to site-related chemicals (i.e., the exposure duration). By definition the SFF cannot exceed 1. The area of Site 15 (approximately 21 acres) is larger than the home range for the cotton mouse, short-tailed shrew, and Eastern meadowlark and smaller than the home range for the red fox and the red-tailed hawk. Because all representative wildlife species are expected to actively forage at the site year round, it is assumed that the exposure durations for these organisms are 1.

Wildlife species may be exposed to ECPCs in surface soil via incidental ingestion of soil or by ingesting prey items that have bioaccumulated these ECPCs. To estimate this exposure, a PDE is estimated for all representative wildlife species for each ECPC according to the equations in Table 7-4 and the methodologies described in Subsection 2.4.3 of the GIR (ABB-ES, 1998).

BAFs are used in the wildlife exposure model to estimate the transfer of chemicals between soil and plants or soil invertebrates, and between these organisms and primary consumer species. To estimate the PDE, tissue concentrations of ECPCs in prey items are estimated using BAFs for surface soil. BAFs for most receptors are extrapolated from literature values or estimated using regression equations from scientific literature. Based on the evidence provided in several reference materials (Suter, 1993; Maughan, 1993), an assumption is made that VOCs do not bioaccumulate in prey tissue. The general approach used to select BAFs for Site 15 is summarized in Table 7-7.

BAFs for invertebrate and plant food items are defined as the ratio of the ECPC concentration in plant or invertebrate tissue (mg chemical/kg tissue wet-weight) to the ECPC concentration in surface soil (mg chemical/kg dry-weight soil). BAFs reported in the scientific literature for avian and mammalian receptors are the reported ratios of ECPC concentrations in the tissues of these receptors (mg chemical/kg tissue wet-weight) to the concentrations of ECPCs in their food items (mg chemical/kg tissue wet-weight). BAFs for each of the ECPCs evaluated at Site 15 are included in Table H-1 of Appendix H.

7.4.3 Terrestrial Plants and Invertebrates Terrestrial plants and invertebrates may be exposed to ECPCs via direct contact with and root uptake (plants) or ingestion (invertebrates) of ECPCs measured in Site 15 surface soil. For the purposes of the Site 15 ERA, exposures to terrestrial plants and invertebrates are assumed to occur within the top one foot interval of surface soil. Exposure of terrestrial plants to groundwater is not evaluated because the depth to the water table is approximately 35 to 40 feet bls (see hydrogeological discussion in Chapter 5.0 of this report).

7.4.4 Aquatic Receptors Exposure concentrations for aquatic receptors in Clear Creek are equal to the RME concentrations of ECPCs detected in groundwater divided by an attenuation factor of 10. As previously discussed, the 10-fold attenuation factor is applied to RME concentrations of groundwater ECPCs to account for the 1,200-foot travel distance that groundwater must migrate before it discharges to the surface water of Clear Creek. It is assumed that attenuation of constituents in groundwater will occur from Site 15 prior to discharge to Clear Creek.

Table 7-7
Estimation of Bioaccumulation Factors

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Receptor Group	Nature of Approach	General Approach
Terrestrial Plants		
Unit: mg/kg wet tissue per mg/kg dry soil	Literature Values	When available, literature values were used to estimate plant BAFs.
	Extrapolation and Empirical Data	When literature values were not available, plant BAFs for inorganic compounds were obtained from Baes et al. (1984).[1]
	Assumption	Although evidence suggests that plants may transport organic analytes with log K_{ow}s < 5 (i.e., volatile organic compounds [VOCs]) from the roots into leafy portions (Briggs et al., 1982; Briggs et al., 1983), bioaccumulation data for VOCs is generally lacking in the scientific literature. In addition, evidence in the literature (Suter, 1993; Maughan, 1993) suggests that analytes with log K_{ow}s < 3.5 are not bioaccumulated into animal tissue. Therefore, it is assumed that transfer of VOCs from plant tissue to animal tissue does not occur.
Terrestrial Invertebrates		
Unit : mg/kg wet tissue per mg/kg dry soil	Literature Values	When no specific values were available, literature values were used to estimate BAFs for invertebrates.
	Assumption	Bioaccumulation data for VOCs is generally lacking in the scientific literature. In addition, evidence in the literature (Suter, 1993; Maughan, 1993) suggests that analytes with log K_{ow}s < 3.5 are not bioaccumulated into animal tissue. Therefore, it is assumed that soil invertebrates do not bioaccumulate VOCs.
Small Mammals		
Unit : mg/kg wet tissue per mg/kg wet food	Literature Values	When available, literature values were used to estimate BAFs for small mammals.
	Extrapolation and Empirical Data	When literature values were not available, BAFs for small mammals for inorganics were derived from ingestion-to-beef biotransfer factors (BTFs) presented in Baes et al. (1984)[2].
	Assumption	Bioaccumulation data for VOCs are generally lacking in the scientific literature. In addition, evidence in the literature (Suter, 1993; Maughan, 1993) suggests that analytes with log K_{ow}s < 3.5 are not bioaccumulated into animal tissue. Therefore, it is assumed that small mammals do not bioaccumulate VOCs.

See notes at end of table.

Table 7-7 (Continued)
Estimation of Bioaccumulation Factors

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Receptor Group	Nature of Approach	General Approach
Small Birds		
Unit: mg/kg wet tissue per mg/kg wet food	Literature Values	When available, literature values were used to estimate BAFs for small birds.
	No Information	BAFs were not obtained for semivolatile organic compounds or for inorganic compounds because there is little bioaccumulation data available for birds. It is assumed that small birds do not accumulate VOCs.

[1] BAFs derived from Baes et al. (1984). Values are based on analysis of literature references, correlations with other chemical and physical parameters, or comparisons of observed and predicted elemental concentrations in vegetative and reproductive plant material and soil. Data are based on dry weight and were converted to a fresh weight basis assuming that plants are 80 percent water. This is generally consistent with the water content of berries (82 to 87 percent water) and leafy vegetables (87 to 95 percent water), presented in Suter (1993). Grains contain a much lower percentage of water (approximately 10 percent); therefore, this assumption likely underestimates exposure to graminivores.

[2] BTFs were converted to a BAF (mg/kg tissue divided by mg/kg food) by multiplying by a food ingestion rate of 50 kg (wet weight) per day (average intake for lactating and nonlactating cattle reported in Travis and Arms, 1988).

Notes: mg/kg = milligrams per kilogram.
BAFs = bioaccumulation factors.
kg = kilograms.
Log K_{ow} = logarithmic expression of the octanol-water partition coefficient.
< = less than.

7.5 ECOLOGICAL EFFECTS ASSESSMENT. The ecological effects assessment discusses what measurement endpoints were used to evaluate potential adverse impacts to the assessment endpoints (i.e., the maintenance of receptor populations). The methods used for identifying and characterizing ecological effects for ECPCs in surface soil and groundwater are described in the following subsections and in greater detail in Subsection 2.4.4 of the GIR (ABB-ES, 1998).

Wildlife receptors, terrestrial plants, and terrestrial invertebrates are potentially exposed to ECPCs in surface soil at Site 15, and aquatic receptors are potentially exposed to ECPCs in groundwater that discharge to the surface water of Clear Creek. The measures of adverse ecological effects for these receptors are discussed separately.

7.5.1 Terrestrial Wildlife As identified in the problem formulation, the assessment endpoint selected for terrestrial wildlife is the survival and maintenance of wildlife populations and communities present within the planted pine forest area of Site 15. Because no long-term wildlife population data are available at NAS Whiting Field, a direct measurement of this assessment endpoint is not possible. The literature-derived results of laboratory toxicity studies that relate the dose of a chemical in an oral exposure with an adverse response to growth, reproduction, or survival of a test population (avian or mammalian species) are used as a measure of the assessment endpoint. Wildlife ingestion toxicity data are presented in Appendix H, Table H-2.

Reference toxicity values (RTVs) are derived for each ECPC and representative wildlife species according to the data hierarchy presented in *Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments* (USEPA, 1997a). The RTV represents the highest exposure level (e.g., concentration in the diet) not shown to produce adverse effects (e.g., reduced growth, impaired reproduction, increased mortality). For each ECPC, two RTVs representing lethal and sublethal effects are selected for each representative wildlife species. Lethal effects are those that result in mortality while sublethal effects include those that impair or prevent reproduction or growth. The RTVs are assumed to be a measure of the assessment endpoints for the protection of the survival, growth, and reproduction of terrestrial wildlife populations. Lethal RTVs are developed using the following data hierarchy discussed in bullet items 1, 2, and 3, while sublethal RTVs are derived using the methodology discussed in bullet items 1 and 2:

1. For contaminants with well-documented adverse effects, the highest reported exposure level not resulting in significant adverse effects (i.e., a no observable adverse effect level (NOAEL)) was selected as the RTV.

2. Generally, one-tenth of the lowest observed adverse effect level (LOAEL) was selected as the RTV for analytes lacking NOAEL values. However, application of the 10-fold uncertainty factor was based on consideration of the exposure duration, type of toxicity test, and the relationship between the selected measurement and assessment endpoints.

3. The lowest reported oral dose (in mg/kg body weight-day) lethal dose to 50 percent of a test population (LD_{50}) was used to derive the lethal RTV if NOAEL or LOAEL values (based on lethal effects) were not available. The lethal RTV is one-fifth of the lowest reported LD_{50} value for the

species most closely related to the representative wildlife receptor. One-fifth of an oral LD_{50} value is considered to be protective against lethal effects for 99.9 percent of individuals in a test population (USEPA, 1986b). An assumption is made that the value represented by one-fifth of an oral LD_{50} would be protective of 99.9 percent of the individuals within the terrestrial wildlife populations and represents a level of acceptable risk.

A summary of lethal and sublethal RTVs selected from the ingestion toxicity data is provided in Table H-3 of Appendix H.

If neither lethal nor sublethal toxicity information were available for a taxonomic group, no RTVs were identified and risks associated with the respective ECPC were not quantitatively evaluated. However, the absence of specific data for a taxonomic group does not imply that there is no toxicological effect associated with contaminant exposure by these receptors; therefore, potential risks to these taxonomic groups are qualitatively discussed in the Uncertainties Section (Section 7.7).

7.5.2 Terrestrial Plants and Invertebrates The assessment endpoints selected for terrestrial plants and soil invertebrates are reduction in the biomass of terrestrial plants and abundance of soil invertebrates used as forage material. Site-specific toxicity data for plants and invertebrates are not available for Site 15; therefore the results of toxicity studies from the literature that relate the soil concentrations of a contaminant with adverse effects to growth, reproduction, or survival of a test population are used as a measure of the assessment endpoint. These study results are summarized for each ECPC in Appendix H, Tables H-4 (plants) and H-5 (invertebrates).

7.5.3 Aquatic Receptors Potential adverse effects associated with Site 15 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 (USEPA, 1994d). Information on the AQUIRE database is included in Appendix I. The State of Florida Surface Water Quality Standards (Florida Legislature, 1996) and USEPA ambient water quality criteria (AWQC) (USEPA, 1991c) were also used to assess the potential for adverse effects to aquatic receptors.

7.6 RISK CHARACTERIZATION. This section presents the risk characterization for ecological receptors exposed to affected surface soil and groundwater at Site 15. Potential risks associated with exposures to ECPCs in surface soil at Site 15 are discussed separately for wildlife, terrestrial plants, and soil invertebrates. Risks are also characterized for aquatic receptors for exposures resulting from ECPCs in groundwater.

Risks to wildlife are characterized by comparing the PDE concentrations (based on RME and central tendency exposure concentrations) for each surface soil ECPC with its respective RTV (estimated threshold dose for toxicity). Risks for terrestrial plants and soil invertebrates are evaluated by comparing toxicity benchmarks to RME and central tendency exposure concentrations. Risks for aquatic receptors in Clear Creek are evaluated by comparing aquatic toxicity benchmarks to groundwater RME concentrations following application of a 10-fold dilution/attenuation factor.

7.6.1 Terrestrial Wildlife Risks for the representative wildlife species associated with ingestion and bioaccumulation of ECPCs in surface soil and prey items were quantitatively evaluated using HQs. HQs are calculated for each ECPC by dividing the PDE concentration by the selected lethal and sublethal RTV. HIs were determined for each receptor by summing the HQs for all ECPCs. When the estimated PDE is less than the RTV (i.e., the HQ less than 1), it is assumed that chemical exposures are not associated with adverse effects to receptors and risks to wildlife populations are unlikely to be significant. For instance, if the PDE calculated using the RME concentration is less than the lethal RTV, then it is assumed that adverse effects to the survival of wildlife populations are unlikely to occur. Similarly, if the reasonable maximum PDE is less than the sublethal RTV, then it is assumed that adverse effects to wildlife populations related to growth and reproduction are unlikely to occur. When an HI is greater than 1, a discussion of the ecological significance of the HQs comprising the HI is completed and risks from exposure to central tendency concentrations of ECPCs are evaluated.

This HRS evaluates potential ecological effects to individual organisms and does not evaluate potential populationwide effects. Contaminants may cause population reductions by affecting birth and mortality rates, immigration, and emigration (USEPA, 1989d). In many circumstances, lethal or sublethal effects may occur to individual organisms with little population- or community-level impacts; however, as the number of individual organisms experiencing toxic effects increases, the probability that population effects will occur also increases. The number of affected individuals in a population presumably increases with increasing HQ or HI values; therefore, the likelihood of population-level effects occurring is generally expected to increase with higher HQ or HI values.

The HQs and HIs based on lethal and sublethal RTVs were calculated for each ECPC and each representative wildlife species. Tables H-6 through H-9 of Appendix H present the HQ and HI calculations. A summary of risks to representative wildlife receptors is provided in Table 7-8.

Table 7-8
Summary of HIs for Terrestrial Wildlife[1]

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Ecological Receptors	Lethal Effects from Exposure to Reasonable Maximum EPCs	Sublethal Effects from Exposure to Reasonable Maximum EPCs
Cotton mouse	0.033	0.082
Short-tailed shrew	0.077	0.17
Eastern meadowlark	0.093	0.28
Red fox	0.17	0.51
Red-tailed hawk	0.094	0.45

[1] The information is a summary of the HIs presented in Tables H-6 through H-9 of Appendix H.

Notes: HI = Hazard Index.
EPC = exposure point concentration.

Summary HIs for representative wildlife species exposed to RME concentrations of ECPCs for lethal and sublethal effects were less than 1; therefore risks are not predicted for these receptors (i.e., bioaccumulating chemicals are not sufficiently high to reduce survivability, growth, and reproduction in terrestrial wildlife populations at Site 15).

7.6.2 Terrestrial Plants Risks for terrestrial plants are evaluated by comparing the selected phytotoxicity RTVs to the RME and central tendency exposure concentrations. The results of this comparison are summarized in Table 7-9. Phytotoxicity RTVs are not available for acetone and cyanide.

With the exception of vanadium, RME and central tendency exposure concentrations of all other surface soil ECPCs are well below their respective phytotoxicity benchmarks. Although the RME (13.3 mg/kg) and central tendency (11 mg/kg) exposure concentrations of vanadium exceed the benchmark value of 2 mg/kg, these exposure concentrations are less than the background screening value for vanadium of 21.2 mg/kg. It appears that detected concentrations of vanadium in Site 15 surface soil are not likely to be site related. In addition, no areas of stressed vegetation were observed at Site 15 during the site characterization. Therefore, it is unlikely that the assessment endpoint including plant biomass and/or plant cover would be reduced such that small mammal and bird populations would be affected at Site 15.

7.6.3 Terrestrial Invertebrates Risks for terrestrial invertebrates are evaluated by comparing invertebrate toxicity benchmark values to RME and central tendency exposure concentrations. The results of this evaluation for Site 15 surface soil are also presented in Table 7-9. Invertebrate toxicity benchmark values are not available for acetone, silver, and vanadium.

RME exposure concentrations of ECPCs are well below the available invertebrate toxicity benchmark values; therefore it is unlikely that the assessment endpoint including invertebrate biomass and/or abundance would be reduced such that small mammal and bird populations would be affected at Site 15.

7.6.4 Aquatic Receptors The risks associated with ECPCs in groundwater discharged to Clear Creek were evaluated based on comparison of the predicted EPC in surface water to reported laboratory toxicity test data (AQUIRE information, [USEPA 1994d], Federal AWQC [USEPA, 1991c], and State of Florida Surface Water Quality Standards for Class III waters [Florida Legislature, 1996]). As previously discussed, EPCs for groundwater ECPCs were derived by dividing the RME concentration by a 10-fold attenuation factor. Comparison of groundwater EPCs to benchmark values are presented in Table 7-10.

Of the organic ECPCs in unfiltered groundwater, only the predicted surface water concentrations of 4,4'-DDT exceed available screening values. The EPC of 4,4'-DDT (0.006 $\mu g/\ell$) is six times greater than the Florida standard and AWQC value of 0.001 $\mu g/\ell$ and less than the lowest reported adverse effect concentration in AQUIRE of 0.04 $\mu g/\ell$. Although the predicted surface water concentration of 4,4'-DDT exceeds the lowest toxicity benchmark, this pesticide was detected in only two of 19 monitoring wells at Site 15. In addition, this organochlorine pesticide has relatively low water solubility and a high octanol-water partition coefficient; therefore, it is expected that this constituent would not be particularly mobile in groundwater. Due to the low frequency of detection and hydrophobic nature of this pesticide, it is unlikely that groundwater discharge

Table 7-9
Summary of Ecological Risk for Plants and Invertebrates in Surface Soil at Site 15

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Analyte	Exposure Point Concentrations[1]		RTV		RTV Exceeded?[3] (by RME/by CT)	
	RME	CT	Plant[2]	Invertebrate[2]	Plant	Invertebrate
Volatile Organic Compounds (mg/kg)						
Acetone	0.0062	0.006	NA	NA	NA	NA
Methylene chloride	0.0056	0.0051	1,000	150	No/No	No/No
Xylenes (total)	0.004	0.004	1,000	21	No/No	No/No
Semivolatile Organic Compounds (mg/kg)						
Di-*n*-butylphthalate	0.369	0.307	200	478	No/No	No/No
bis(2-Ethylhexyl)phthalate	0.54	0.36	1,000	478	No/No	No/No
Inorganic Analytes (mg/kg)						
Cyanide	0.25	0.22	NA	NA	NA	NA
Lead	7.3	6.6	50	1,190	No/No	No/No
Silver	1.2	0.86	2	NA	No/No	NA
Vanadium	13.3	11	2	NA	Yes/Yes	NA

[1] Exposure point concentrations (EPCs) are presented in Table 7-2. The RME EPCs are equal to the lesser of the maximum detected concentration and the 95 percent upper confidence limit. CT EPCs are equal to the arithmetic mean of all concentrations. When the average is greater than the RME EPC, the maximum EPC is used.
[2] Plant and invertebrate RTVs are presented in Appendix H, Tables H-4 and H-5, respectively. Generally, the plant RTVs are the lowest observed effect concentration from among growth studies on plants in solid media, and invertebrate RTVs are the lowest concentration lethal to 50 percent of a test population (14-day soil test on *Eisenia foetida*) from among chemicals in the same chemical class (applies to organic compounds). A conservative factor of 0.2 was applied to invertebrate RTVs; the resultant value should be protective of 99.9 percent of the population from acute effects (Neuhauser et al., 1986).
[3] Comparison shown is RME EPC to RTV/CT EPC to RTV.

Notes: Shading indicates exceedances.

RME = reasonable maximum exposure.
CT = central tendency.
RTV = reference toxicity value.
mg/kg = milligram per kilogram.
NA = not available.

Table 7-10
Comparison of Site 15 Diluted Groundwater ECPC Exposure Concentrations to Toxicity Benchmark Values

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Analyte	Exposure Point Concentration ($\mu g/\ell$)[1]	FDEP Class III Fresh Water Quality Standards ($\mu g/\ell$)[2]	AWQC ($\mu g/\ell$)[3]	AQUIRE Lowest Reported Adverse Effect Concentration/Test Species[4]	Result
Volatile Organic Compounds					
Acetone	1.23	NA	NA	550,000/water flea mortality	
Benzene	1.4	71.28	5,300	3,660/leopard frog LC_{50}	
Trichloroethene	2.61	[5]80.7	21,900	1,900/medaka LC_{50}	
Xylenes (total)	0.1	NA	NA	350/scud LC_{50}	
Semivolatile Organic Compounds					
1,4-Dichlorobenzene	0.68	50	NA	1.8/rainbow trout mortality	
bis(2-ethylhexyl)phthalate	0.5	3	160	0.89/moorfrog hatchability	
Pesticides and PCBs					
4,4'-DDT	0.006	0.001	0.001	0.04/water flea mortality	Exceed TBV
Inorganic Analytes					
Aluminum	31.7	NA	87	[6]50/narrow-mouthed frog LC_{50}	
Cobalt	0.18	NA	NA	[7]11/pikeperch mortality	
Iron	786.4	1,000	1,000	460/brown trout hatchability	Exceeds TBV
Lead	0.19	[8]0.5	[8]0.5	52/rainbow trout mortality	
Manganese	19.4	NA	NA	280/phytoplankton species diversity	
Mercury	0.006	0.012	0.012	5.7/freshwater prawn LC_{50}	
Silver	0.29	0.05	0.12	7.5/invertebrate LC_{50}	
Vanadium	0.52	NA	NA	128/guppy LC_{50}	
Zinc	27	[8]86	[8]86	17/invertebrate species diversity	Exceeds TBV

See notes at end of table.

Table 7-10 (Continued)
Comparison of Site 15 Diluted Groundwater ECPC Exposure Concentrations to Toxicity Benchmark Values

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[1] The exposure point concentration is equal to the RME concentration from Table 7-3 divided by a dilution/attenuation factor of 10.
[2] Chapter 62-302, Surface Water Quality Standards (Florida Legislature, 1996).
[3] Federal Ambient Water Quality Chronic Criteria (USEPA, 1991c).
[4] From Appendix I, Table I-1. Only growth, mortality, and reproductive effects to plants, invertebrates, reptiles/amphibians, and fish were considered (USEPA, 1994d).
[5] This standard is based on human health effects.
[6] Value for aluminum as aluminum chloride.
[7] Value for cobalt as cobalt chloride.
[8] Criteria calculated based on an assumed site hardness concentration of 25 milligrams/liter as calcium carbonate.

Notes: ECPC = ecological chemical of potential concern.
$\mu g/\ell$ = micrograms per liter.
FDEP = Florida Department of Environmental Protection.
AWQC = Ambient Water Quality Criteria.
AQUIRE = Aquatic Information Retrieval.
NA = not available.
PCB = polychlorinated biphenyl.
DDT = dichlorodiphenyltrichloroethane.
▒ = concentration exceeds the most conservative benchmark.
TBV = toxicity benchmark value.

of 4,4'-DDT to the surface water of Clear Creek would pose substantial ecological risks to aquatic receptors.

Of the nine inorganic ECPCs in Site 15 groundwater, predicted exposure concentrations of two analytes (iron and zinc) in unfiltered groundwater were in excess of aquatic toxicity benchmarks.

Although the predicted iron concentration (786 $\mu g/\ell$) exceeds the LOAEL from AQUIRE (460 $\mu g/\ell$), the predicted exposure concentration is well below the 1,000 $\mu g/\ell$ AWQC and Florida benchmark. The AQUIRE value, which is based on brown trout hatchability, may be overly conservative because no salmonids (e.g., trout) occur in Clear Creek downgradient of Site 15. Predicted exposure concentrations of iron are well below the next highest AQUIRE value of 3,700 $\mu g/\ell$, which is based on duckweed growth inhibition. Therefore, it is unlikely that the levels of iron in groundwater will have an adverse effect on aquatic receptors in Clear Creek.

Predicted groundwater exposure concentrations of zinc (27 $\mu g/\ell$) slightly exceed the AQUIRE value (17 $\mu g/\ell$), which is based on reduction of species diversity in invertebrates. However, the predicted zinc concentration is less than the 86 $\mu g/\ell$ AWQC and Florida benchmark. In addition, review of additional AQUIRE data for zinc (Table I-1 of Appendix I) indicates that the predicted 27 $\mu g/\ell$ exposure concentration would not result in adverse effects to the majority of aquatic receptors in Clear Creek. The AQUIRE data on zinc was reviewed for toxicity information on specific receptors that would most likely inhabit Clear Creek. The results of this review indicated that exposure to concentrations of zinc at 27 $\mu g/\ell$ would not pose a risk to these aquatic receptors. Therefore, it is also unlikely that the predicted levels of zinc in groundwater will have an adverse effect on aquatic receptors in Clear Creek.

In summary, it is unlikely that groundwater discharge to the surface water of Clear Creek downgradient of Site 15 will pose an unacceptable risk to aquatic receptors. Further information on potential risks to aquatic receptors in Clear Creek associated with exposures to surface and sediment will be provided in the ERA for Site 39.

7.7 UNCERTAINTY ANALYSIS. The objective of the uncertainty analysis is to discuss the assumptions of the ERA process that may influence the risk assessment results and conclusions. Table 2-5 of the GIR presents several general uncertainties inherent in the risk assessment process (ABB-ES, 1998).

Specific uncertainties associated with exposure to surface soil and groundwater at Site 15 include the following:

- Risks to avian species may have been underestimated because bio-accumulation and toxicity data for this taxonomic group are generally lacking in the literature. As a result, potential risks associated with several ECPCs were not evaluated for avian species. If the toxicological and contaminant transport data obtained from studies conducted on mammals were used to estimate risks to avian species, then risk estimates for birds would be higher. However, there is also uncertainty in assuming that the metabolic functions of mammals and birds are similar enough to use intertaxonomic surrogates.

- Risks to adult amphibians and reptiles species were not estimated for surface soil ECPCs because bioaccumulation and toxicity data for this taxonomic group are generally lacking in the literature. As a result, potential risks associated with ECPCs are uncertain for these species. Intertaxonomic surrogates were not used to calculate dietary risks to reptiles because of the uncertainty associated with extrapolation of data from endothermic to essentially ectothermic species.

- Site-specific toxicity data for Site 15 surface soil is not available. Phytotoxicity and invertebrate benchmark values used in the risk assessment were designed for risk screening purposes only and may not be relevant to the specific conditions of the surface soil at Site 15. The conservative nature of these screening tools may overestimate the actual risk to terrestrial plants and invertebrates at Site 15. However, invertebrate benchmark values for several analytes are not available, potentially resulting in an underestimation of risk for terrestrial invertebrates.

- The PDEs for the red fox and red-tailed hawk assume no exposure from small birds as prey items due to a lack of Avian BAFs. Birds make up a small portion of the red fox and red-tailed hawk diet, and for this evaluation it is assumed that small birds would not provide a source of contamination exposure. In addition, the risks predicted (i.e., the HQs and HIs) for the red fox and red-tailed hawk were so low that it is unlikely that including Avian BAFs (if they were available) would alter the findings of the ERA.

- Application of the 10-fold attenuation factor used to predict exposure concentrations of groundwater ECPCs in the surface water of Clear Creek may over- or underestimate risks to aquatic receptors, depending on the actual dilution.

7.8 SUMMARY OF ECOLOGICAL ASSESSMENT FOR SITE 15. Potential risks for ecological receptors were evaluated for ECPCs in surface soil and groundwater at Site 15.

Risks associated with exposures to ECPCs in Site 15 surface soil were evaluated for terrestrial wildlife based on a model that estimates the amount of contaminant exposure obtained via the diet and incidental ingestion of surface soil. Comparison of estimated doses for wildlife species to reference toxicity doses representing thresholds for lethal and sublethal effects is the basis of wildlife risk evaluation. Risks were not identified for terrestrial wildlife resulting from exposure to ECPCs in surface soil; therefore, reductions in the survivability, growth, and reproduction of wildlife receptor populations at Site 15 are not expected to occur.

Reduction in terrestrial plant and soil invertebrate biomass used as forage material was evaluated by comparing exposure concentrations for surface soil with toxicity benchmarks. Based on this comparison, it is unlikely that plant and invertebrate biomass or plant cover availability would be reduced such that small mammal and bird populations at Site 15 would be affected.

Potential risks for aquatic receptors were evaluated for exposures to ECPCs in groundwater. The concentrations of ECPCs in groundwater as they discharge to Clear Creek 1,200 feet downgradient of Site 15 were estimated based on application of a 10-fold attenuation factor to the RME concentration. Comparison of the predicted exposure concentrations of each ECPC with available criteria and toxicity benchmarks is the basis of the risk characterization. Based on the screening evaluation of groundwater, risks to aquatic receptors in Clear Creek associated with exposure to groundwater ECPCs from Site 15 are not expected. The ERA for Site 39 will provide additional information regarding potential risks for aquatic receptors in Clear Creek based on actual site-related surface water and sediment data.

In summary, the results of the ERA suggest that risks are not predicted for ecological receptor populations at Site 15.

CHAPTER 8.0

8.0 CONTAMINANT FATE AND TRANSPORT

This chapter discusses the fate and transport of human health and ECPCs detected in soil and groundwater samples at Site 15. Fate, in the context of this chapter, refers to the ultimate disposition of a given CPC following its release into the environment. Transport refers to the mechanism(s) by which a given chemical released into the environment will arrive at its fate. Explanation of the fate and transport of chemicals in the environment can be very complicated or very simple, depending on the physical, chemical, and biological characteristics of the compound or metal considered and the environment into which that compound is released.

Several organic and inorganic analytes were detected in soil and groundwater sampled at Site 15. Because of the number of potential chemicals detected and the myriad fate and transport scenarios possible for those chemicals in the media, this discussion will focus only on those chemicals that may pose adverse risk to human or ecological receptors, as identified by the HHRA (Chapter 6.0) and the ERA (Chapter 7.0) in this report.

The following discussion of contaminant fate and transport is divided into two sections. Section 8.1 discusses potential migration routes of a chemical(s) in the media evaluated and does not focus specifically on media found to be of concern at Site 15. 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 8.2.

8.1 POTENTIAL ROUTES OF MIGRATION. Several routes of migration are possible for a contaminant in the various media: air, soil, surface water, groundwater, and biota. These routes are summarized below.

Air. Gases and particulate material can be transported in the atmosphere. Organic compounds, metals, and metal complexes that exist as gases at surface temperature and pressure may disperse or diffuse into the air and particulates may become entrained in air and thereby migrate. The extent to which gaseous constituents and particulate material remain airborne is a function of the level of excitation of the air (wind and temperature) and fate processes acting on the constituent and, for particulates, their density. Particulate material as discussed herein consists of organic compounds and inorganic material that would otherwise not be present in a gaseous medium under atmospheric conditions.

Soil. The primary agents of migration acting on soil include wind, rainwater, running water, biological activity, and human activity. Wind commonly transports soil in the form of particulate material. Rainwater may cause soil to migrate either by washing soil particles downward into the subsurface or by carrying soil particles over land to surface water bodies or other areas of deposition. The amount and type of vegetative cover and surface disturbance affects the degree to which wind and water cause soil to migrate.

Surface Water. The mechanisms for migration of constituents in surface water are dissolution and suspension. Several organic compounds and metals are soluble in water and can be transported in the aqueous phase. 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; 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) in water of very low energy (e.g., standing water).

Sediment. Saltation, traction, suspension, biological action, and human action are the primary mechanisms of migration for sediment. Physical, chemical, and biological processes affecting a constituent will determine where and how migration from sediment will occur.

Groundwater. Groundwater is a liquid medium capable of transporting constituents as colloidal forms, complexes, pure-phase liquids, or dissolved-phase liquids. Organic compounds and elements generally reach groundwater either by being placed directly into the water table (e.g., disposal pits) or by being leached from soil or solid waste to the water table by physical or chemical processes. Groundwater may discharge to the land surface, surface water bodies, other aquifers, or pumping wells. The migration of constituents from groundwater upon discharge depends on the chemical and/or physical processes acting upon that individual constituent in the medium to which it is discharged.

Biota. Biota may be considered a medium for migration of certain organic compounds and inorganics. Several compounds and elements are known to accumulate in the tissues of organisms at various levels in the food chain. As these organisms are consumed by other organisms, compounds and elements are accumulated in their tissue and passed on to organisms higher in the food chain. In this manner, contaminants may be transported by biota. Additionally, some organisms disturb bed sediments in streams and rivers. This disturbance can cause organic compounds and elements to be transported downstream as suspended material in surface water.

8.2 CONTAMINANT PERSISTENCE AND FATE. The discussion of contaminant persistence and fate in the environment is divided into three subsections. Subsection 8.2.1 discusses the processes that control the persistence and fate of organic compounds and inorganics in the environment. Subsection 8.2.2 discusses the primary persistence and fate characteristics of the constituents detected at Site 15. Subsection 8.2.3 discusses contaminant transport for Site 15.

8.2.1 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 speciation, complexion, precipitation or coprecipitation, cationic exchange, sorption, biodegradation or biotransformation, and bioaccumulation. These processes are briefly summarized below.

Solubility. The solubility of chemical constituents in water is important in assessing their mobility in the environment. This is particularly important for the transport and ultimate fate of chemicals from soil and sediment to water (i.e., groundwater and/or surface water). Generally, for organic compounds, aqueous solubility is a function of molecular size, molecular polarity, temperature, and the presence of other dissolved organic cosolvents. For metals and other inorganic parameters, solubility is generally controlled by chemical

speciation, pH, Eh (redox potential), oxygen content, and the presence of dissolved and/or colloidal organic compounds (e.g., humic and fulvic acids) or other inorganic ion species (e.g., hydroxides and sulfates) (USEPA, 1979). Increased solubility is usually directly related to increased environmental mobility with groundwater and/or surface water being the principal transport medium. Therefore, solubility is a significant factor affecting the fate of a compound or element in the water environment.

Photolysis. Many chemical constituents, particularly organic compounds, are susceptible to photolytic degradation either directly or indirectly. Direct photolysis involves a splitting of the chemical compound by light, whereas indirect photolysis occurs when another compound is transformed by light into a reactive species (i.e., usually an hydroxyl radical) that reacts with and modifies the original compound. In general, photolysis primarily occurs within the atmosphere, although it may also occur to a limited extent in surface water and/or soil under certain environmental conditions (USEPA, 1979).

Volatilization. Volatilization of organic chemicals from soil or water to the atmosphere is an important pathway for chemicals with high vapor pressures. For organic compounds, volatilization is a function of partial pressure gradients, temperature, and molecular size and is more likely to occur for compounds with low molecular weights. In addition, certain metals such as mercury, arsenic, and lead are capable of undergoing biologically mediated transformation (i.e., alkylation) that form volatile end products. Volatilization is important for the transport of certain chemical constituents from surface soil (i.e., vadose zone), sediment, and surface water and is evaluated using Henry's law and other associated chemical-specific rate constants.

Hydrolysis. Hydrolysis involves the decomposition of a chemical compound by its reaction with water. The rate of reaction may be promoted by acid (hydronium ion, $[H_3O^+]$) and/or base (hydroxyl ion, $[OH^-]$) compounds. In general, most organic compounds are resistant to hydrolytic reactions unless they contain a functional group (or groups) capable of reacting with water. Metallic compounds, however, generally dissociate readily in water depending upon the aqueous environmental conditions (e.g., pH and ionic strength). For metals, hydrolytic dissociation is an indirect process that affects the primary fate and transport mechanism of aqueous solubility.

Oxidation. The direct oxidation of organic compounds in natural environmental matrices may occur but this is generally a slow, insignificant transformation mechanism of minimal importance (USEPA, 1979). However, some inorganic compounds may be rapidly oxidized under naturally occurring environmental conditions when the surrounding environment changes from anaerobic to aerobic conditions.

Chemical Speciation. Chemical speciation is important primarily for metals that may exist in multiple forms in the environment, particularly within aqueous matrices. In general, the aqueous speciation of metals depends primarily upon the relative stabilities of individual valence states (which are element-specific), oxygen content, pH and Eh condition, and the presence of available complexating agents and/or other cations and anions (USEPA, 1979). Because various metallic species exhibit differential aqueous solubilities and differential mobilities within soil and/or sediment (USEPA, 1979), the particular speciation of an individual metal will greatly affect its environmental mobility.

Complexation. For metals, complexation with various ligands is an important process because these complexes may be highly soluble in water. Complexation may, therefore, greatly enhance mobility within environmental matrices, particularly in groundwater and surface water, depending upon the aqueous solubility of the resulting complex. Complexation depends upon numerous factors such as pH, Eh, type and concentration of complexing ligands, and other ions present (USEPA, 1979).

Most metals are capable of forming numerous organic and/or inorganic complexes in the natural environment (USEPA, 1979). Metals may form organo-metallic complexes, especially with naturally occurring organic acids (i.e., humic and fulvic acids). In some cases, these metallic species may exhibit varying affinities for different organic ligands (i.e., mercury and arsenic for amino acids and their derivatives) (USEPA, 1979). Metals may also form metallo-inorganic complexes with inorganic ligands such as carbonate, halogens (usually chlorine), hydroxyl, and sulfate (USEPA, 1979). However, organo-metallic complex formation is usually favored over metallo-inorganic complexes.

Precipitation and Coprecipitation. Both chemical precipitation and co-precipitation are important removal mechanisms, particularly for metals and metallo-cyanides in the environment. Precipitation and/or coprecipitation reactions depend on numerous aqueous environmental conditions such as pH, Eh, organic ligands present, oxygen content, and cationic and anionic species present (USEPA, 1979). Depending on the specific conditions, the removal of aqueous metallic species and metallo-cyanides from groundwater and/or surface water can greatly affect a metal's environmental mobility and, hence, its ultimate fate and transport.

Cation Exchange. Cation exchange is important primarily for metals and other ions that may substitute with other cations of similar charge and size within the lattice structure of clay minerals in soil and/or sediment (USEPA, 1979). This process, therefore, can significantly affect the mobility of an aqueous metal cation by removing it from solution under certain environmental conditions.

Sorption. The sorption of chemical constituents by inorganic particulate matter (i.e., soil or sediment) and organic compounds is an important process that affects mobility in the environment. This process is particularly important for the fate and transport of chemicals from soil or sediment to water (i.e., groundwater and surface water). In general, most metals exhibit a potential for adsorption to inorganic particulate matter and organic compounds (USEPA, 1979). Organic compounds also exhibit sorptive capability, but show greater variability in their ability to sorb to particulate or organic matter. The tendency for organic compounds to sorb to soil or sediment is reflected in their organic carbon partitioning coefficients (K_{oc}). K_{oc} is a measure of relative adsorption potential. The normal range of K_{oc} values is from 1 to 10^7 with higher values indicating greater sorption potential. Actual adsorption is chemical-specific and is largely dependent on the organic content of the soil. The fraction of organic carbon, f_{oc}, in soil times the K_{oc} is defined as the distribution coefficient, K_d. The K_d is a ratio of the concentration adsorbed to the concentration partitioned to water.

Regardless of chemical class, sorption is a reversible process whereby desorption can be favored over sorption under certain environmental conditions (e.g., low pH for metals). For organic compounds in general, as the molecular weight

increases and the aqueous solubility decreases (i.e., low polarity and high hydrophobicity), the sorptive binding affinity increases (i.e., K_{oc} increases). The tendency for chemical constituents to adsorb to inorganic particulate and/or organic compounds is a particularly important process because sorption to soil and/or sediment can effectively reduce a chemical constituent's mobility.

Biodegradation or Biotransformation. Biodegradation is a result of the enzyme-catalyzed transformation of chemicals. Organisms require energy, carbon, and essential nutrients from the environment for their growth and maintenance. In the process, chemicals from the environment will be transformed by enzymes into a form that can be used by the organism. The biodegradation rate is the rate by which contaminants will be degraded. The rate is a function of microbial biomass and a chemical's concentration under given environmental conditions. When a pollutant is introduced into the environment, there is often a lag time before biodegradation begins while the organism generates an enzyme capable of digesting the chemical. Co-metabolism occurs when a pollutant can be biotransformed only in the presence of another compound that serves as a carbon and energy source (USEPA, 1979).

Bioaccumulation. Bioconcentration and bioaccumulation data are important when evaluating the impact of chemicals in the aquatic environment. The process is characterized by hydrophobic chemicals that can be partitioned into fat and lipid tissues and inorganic chemicals that can be partitioned into bone marrow. The bioconcentration factor is a measure of the concentration of a chemical in tissue (on a dry-weight basis) divided by the concentration in water, and is a commonly used parameter to quantify bioconcentration (USEPA, 1979). The process is significant because bioaccumulation magnifies up through the food chain.

8.2.2 Persistence and Fate of Site 15 CPCs This section discusses the persistence and fate characteristics for CPCs detected at Site 15. To focus the discussion of persistence and fate characteristics, only those constituents that were (1) identified by the human health or ERAs (presented in Chapters 6.0 and 7.0, respectively) as CPCs and (2) those constituents that were present above relevant standards will be addressed. These constituents are summarized below by medium for Site 15.

Human Health Assessment Constituents

- Surface soil: Two inorganic analytes, arsenic and iron
- Subsurface Soil: No analytes selected
- Groundwater: Five VOCs, 1,1-dichloroethene, 1,2-dichloroethene, benzene, chlorobenzene, and trichloroethene; two SVOCs, 1,4-dichlorobenzene and bis(ethylhexyl)phthalate; one pesticide, 4,4'-DDT; five inorganic analytes, aluminum, arsenic, iron, manganese, and thallium

Ecological Assessment Constituents

- Surface soil: Three VOCs, acetone, methylene chloride, and xylenes; two SVOCs, di-*n*-butylphthalate, bis(2-ethylhexyl)phthalate; no pesticides or PCBs; five inorganics: cyanide, lead, silver, vanadium, and zinc

- Groundwater: four VOCs, acetone, benzene, trichloroethene, and xylenes; two SVOCs, 1,4-dichlorobenzene and bis(2-ethylhexyl)phthalate; one pesticide/PCB; 4,4'-DDT; nine inorganics, aluminum, cobalt, iron, lead, manganese, mercury, silver, vanadium, and zinc.

The fate and persistence characteristics of these constituents are summarized below by analytical fraction.

VOCs

Acetone. Acetone (C_3H_6O) is both a naturally occurring and man-made compound. It has been identified as a naturally occurring volatile metabolite of both plants and insects; forest fires have also been identified as a natural source of the compound. Acetone is commonly used as a solvent and is a by-product of several manufacturing processes (Howard, 1990).

The majority of acetone released to the environment is by emissions to the atmosphere; in the atmosphere it will break down by photolysis or be removed by rain. If released to the soil, it will both volatilize and leach into the ground. In soil and groundwater, acetone will readily biodegrade and is not likely to significantly adsorb to either soil or sediment (Howard, 1990).

Acetone is a commonly recognized field- or laboratory-derived contaminant according to the USEPA CLP Functional Guidelines for Organic Data Review (USEPA, 1994a). As such, the detected concentrations of acetone at Site 15 may not be related to past disposal activities at the site. Furthermore, given the fact that acetone readily volatilizes, it is unlikely that surface soil would retain detectable quantities of acetone for 19 years (waste disposal at Site 15 ended in approximately 1979).

Benzene. Benzene (C_6H_6) may enter the environment as result of the production, storage, transport, venting, and combustion of gasoline, as well as, the production, transport and storage of benzene as a pure product. Benzene is also natural by-product of forest fires (Howard, 1990).

Benzene is highly volatile, and is highly mobile in soil. If released to the soil, benzene will evaporate or leach from the soil to the groundwater. Biodegradation of benzene is likely in shallow aerobic waters, though not under anaerobic conditions. Abiotic degradation is largely limited to benzene present in the atmosphere. Hydrolysis is an insignificant mechanism for the breakdown of benzene (Howard, 1990).

1,1-Dichloroethene. 1,1-Dichloroethene, also known as vinylidene chloride, is used to make plastics, flexible films like SARAN® wrap and packing materials, and flame-retardant coatings for fibrous materials. It is a clear, colorless liquid at room temperatures that evaporates quickly, based on a vapor pressure of 592 millimeters mercury (mm Hg), from soil and surface water, has a mild sweet smell like chloroform, and burns quickly.

When released to soil, 1,1-dichloroethene will either evaporate or leach to the groundwater. Adsorption to soil and sediment particles is low and biodegradation in soil and groundwater is slow. The greatest removal mechanism of 1,1-dichloroethene from soil and surface water is through volatilization. 1,1-

Dichloroethene has high water solubility and will migrate through soil and groundwater without significant retardation by adsorption to organic carbon.

Biotransformation of 1,1-dichloroethene in soil has been shown to be significant under aerobic conditions where the compound was completely mineralized to inorganic end products (Agency for Toxic Substances and Disease Registry [ATSDR] 1993a).

1,2-Dichloroethene (DCE). 1,2-DCE ($C_2H_2CL_2$) exists as two isomers, *cis* and *trans*. The *trans* isomer is twice as toxic as the *cis* isomer. Both may enter the environment in emissions and wastewater and as a solvent and extractant in the production of perfumes, lacquers, and thermoplastics. In addition, 1,2-DCE is a breakdown product in the reductive dehalogenation of trichloroethene (TCE) and tetrachloroethene (PCE) (Howard, 1990).

When released to soil, 1,2-DCE will either evaporate or leach to the groundwater. Adsorption to soil and sediment particles is low, and biodegradation in soil and groundwater is slow. The greatest removal mechanism of 1,2-DCE from soils and waters is through volatilization (Howard, 1990).

Methylene Chloride. Methylene chloride is a man-made chemical used as an industrial solvent and paint stripper. Most of the methylene chloride released to the environment results from its use as an end product by various industries.

Methylene chloride is not strongly sorbed to soil or sediment and is likely to be highly mobile in soil, thus, it can be expected to leach into groundwater. Methylene chloride has a vapor pressure of 349 mm Hg at 20°C, therefore tends to volatilize to the atmosphere from water and soil. Because of its high vapor pressure, volatilization to the atmosphere is the most likely fate process (ATSDR, 1993b).

Trichloroethene. Trichloroethene is used as an industrial solvent particularly in metal degreasing. It is also used in a wide variety of other applications such as dry cleaning, as a fumigant, as a diluent in paints and adhesives, and in textile processing (Howard, 1990).

Trichloroethene has a relatively high vapor pressure of 58.7 mm Hg at 25°C and would be expected to volatilize rapidly from surface soil. Trichloroethene has a relatively small sorption value of 125 K_{oc}, indicating that it would not sorb strongly to organic material in soil. Trichloroethene is soluble in water (1,100 mg/ℓ at 25°C [USEPA 1986b]) and would be carried by infiltrating rainwater to groundwater where migration with groundwater will occur.

Xylenes. Xylenes are chemicals that are primarily man-made from petroleum or coal. Xylene is a colorless liquid with a sweet odor that evaporates and burns easily. Xylene does not mix well with water, but does mix well with alcohol and other chemicals. Xylene has three isomers: meta-xylene, ortho-xylene, and para-xylene, (respectively m-, o-, and p-xylene) that, when mixed together, are termed xylenes.

Xylene is used as a solvent in the printing, rubber, cleaning, and leather industries, and as a thinner for paints. Xylene is found in gasoline and airplane fuel and is used as a material/ingredient in the manufacture of some plastics.

When xylenes are spilled on land, they either volatilize or leach into the ground. Sorption is an important factor in soil with high organic matter or high carbon content. Xylenes are relatively mobile in soil with low carbon content and may leach into groundwater depending on soil conditions. Xylenes in groundwater are known to persist for several years (ATSDR, 1993c).

SVOCs

Bis(2-ethylhexyl)phthalate. Bis(2-ethylhexyl)phthalate (also known as di(2-ethylhexyl)phthalate) ($C_{24}H_{38}O_4$) is principally used as a plasticizer in the production of polyvinyl chloride (PVC) and vinyl chloride resins. PVC is used in many common household items such as toys, vinyl upholstery, shower curtains, adhesives, and as a component of paper and paperboard. Bis(2-ethylhexyl)phthalate has also been used as a solvent, an acaracide in orchards, and as an inert ingredient in pesticide products (ATSDR, 1993d).

Bis(2-ethylhexyl)phthalate is a widely used chemical that enters the environment primarily through the disposal of industrial and municipal wastes in landfills. Bis(2-ethylhexyl)phthalate tends to adsorb strongly to soil and sediment and to bioconcentrate in aquatic organisms. Sorption, bioaccumulation, and biodegradation are likely to be competing processes, with the dominant fate being determined by local environmental conditions (ATSDR, 1993d).

Bis(2-ethylhexyl)phthalate has a strong tendency to be adsorbed to atmospheric particulate matter, soil, and sediment. Bis(2-ethylhexyl)phthalate biodegradation in soil is slow because strong adsorption reduces the availability for degradation. Biodegradation is expected to occur under aerobic conditions. Bis(2-ethylhexyl)phthalate may slowly volatilize into air. In air, direct photolysis and photooxidation are not likely (ATSDR, 1993d).

Bis(2-ethylhexyl)phthalate is relatively insoluble; however, it may leach to the groundwater in the presence of common organic solvents such as alcohols and ketones. Bis(2-ethylhexyl)phthalate in the water will undergo biodegradation under aerobic conditions. Chemical hydrolysis occurs too slowly to be important (ATSDR, 1993d).

Di-*n*-butylphthalate. Di-*n*-butylphthalate is used in the manufacture of plasticizers, plastics, the recycling and processing of plastics, cosmetics, and industrial stains. The solubility of di-*n*-butylphthalate in water is relatively low (11.2 mg/ℓ at 25°C) indicating that it will not readily dissolve in water (Howard, 1990). Di-*n*-butylphthalate does not readily volatilize to the atmosphere from surface soil or water due to a vapor pressure of 0.000014 mm Hg at 25°C. As with most phthalates, biodegradation of di-*n*-butylphthalate is an important mechanism for removal from both soil and water, although the process is slow (Howard, 1990).

1,4-Dichlorobenzene. 1,4-Dichlorobenzene is usually called para-DCB, p-DCB or paramoth. 1,4-Dichlorobenzene is used as the main ingredient in mothballs, deodorant blocks, and for odor control in animal holding areas where it also acts as an insecticide. 1,4-Dichlorobenzene is a white solid that sublimates at room temperatures and smells like mothballs.

1,4-Dichlorobenzene volatilizes to the atmosphere from surface soil and water at a relatively rapid rate. Half-life in a model river was 4.3 hours (Howard,

1990). Adsorption to soil particles may inhibit volatilization relative to water. Biotransformation in soil has not been studied extensively, but has been shown to occur by methanogenic organisms (ATSDR, 1993e).

Pesticides and PCBs

4,4'-DDT. 4,4'-DDT (DDT) and its primary metabolites, 4,4'-DDE (DDE) and 4,4'-DDD (DDD), are man-made chemicals and are not known to occur naturally in the environment. Most releases of the chemicals are related to their manufacture and use as insecticides in agriculture and vector control. Pesticidal use of DDT, except in public health emergency, was banned in the United States in 1972. Due to the extensive past use of DDT worldwide and the persistence of DDT and its metabolites, these materials are virtually ubiquitous and are continually being transformed and redistributed in the environment (ATSDR, 1992).

DDT, DDE, and DDD are only slightly soluble in water. Therefore, they are not easily displaced from their site of application, nor do they tend to leach to groundwater. Appreciable amounts of the compounds may remain in the soil for extended periods of time and are only readily moved by physical erosion of soil particles (ATSDR, 1992).

Four mechanisms have been identified as accounting for the most losses of DDT residues from soils: volatilization, removal by harvest of organic matter, water runoff, and chemical transformation. Photooxidation of DDT is known to occur on soil surfaces; however, it is not known to hydrolyze. Biodegradation may occur under both aerobic and anaerobic conditions in the presence of certain soil microorganisms (ASTDR, 1992).

Inorganic Analytes

Aluminum. Aluminum is the third most common element in the environment, though not generally found in elevated concentrations in groundwater. Aluminum is known to complex readily; however, and high concentrations present in groundwater are generally due to silt-sized particles of aluminum-containing compounds often present as clays or aluminum hydroxides. Complexing and polymerization of the most common valence state of aluminum, Al^{+3}, represents the predominant transport mechanism for aluminum in the environment.

Arsenic. Arsenic has two stable forms in solution in groundwater, arsenate (As^{5+}) and arsenite (As^{3+}). In groundwater with pH ranging from 3 to 7, the monovalent arsenate anion $H_2AsO_4^-$ is the dominant form. Upon entering surface water, via groundwater discharge, arsenic may partition to sediment from solution by hydrous iron oxide adsorption and/or coprecipitation (or a combination of both) with sulfides in the sediment. The Eh and pH conditions of the surface water and sediment govern the effectiveness of these mechanisms (adsorption and coprecipitation) as a sink for arsenic. These mechanisms appear to be the major inorganic factors controlling arsenic concentrations in surface water (Hem, 1992).

Arsenic may be very mobile in the aquatic environment, cycling through the water column, sediment, biota, and air. Most arsenic released into the environment (on the earth's surface) eventually ends up either in sediment (in stream beds or lakes) or in the oceans. Eh and pH conditions largely govern the fate of arsenic (USEPA, 1979).

Cobalt. Cobalt is a relatively rare element, ranking 30th in abundance in the earth's crust. Cobalt exists as a mixture of two allotropes with the β form predominating below 400 °C, and the α form predominating above that temperature. Cobalt has two oxidation states, besides the environmental form: +2, which is the most important oxidation state and +3, which is a strong oxidizing agent. Cobalt forms oxides, nitrates, and ammines, as well as chloride, sulfate, and acetate (Hem, 1992).

Aqueous species of $Co^{3}+$ do not appear to be thermodynamically stable under Eh and pH conditions that normally occur in natural waters (Hem, 1992). $Co^{2}+$ compounds are moderately soluble in groundwater or surface water and are expected to migrate with the water. Cobalt will sorb to the soil and sediment, especially when iron and manganese are present (Moore, 1991).

Cyanide. Cyanides are any of the compounds that include the group $-(CN)^{-}$. The cyanide ion (CN^{-}) can react with a variety of metals to form insoluble metal cyanides. If the ion is present in excess, in an environment with transitional metals, complex metallocyanides may form which, are soluble and may be transported in solution.

Cyanide is typically used in the form of hydrogen cyanide, a highly toxic gas, to manufacture acrylonitrile, acrylates, adiponitrile, cyanide salts, dyes, chelates, rodenticides, and pesticides (Hawley's, 1987). Metal cyanides are soluble and are used extensively in electroplating.

Simple metal cyanide complexes are sorbed by sediments while more complex metal cyanide complexes are highly soluble in water, however, adsorption does not appear to be important in controlling the mobility of cyanides in soil or water. Metal cyanide salts are not volatile. Bioaccumulation of metal cyanide complexes occurs but the toxic effects limit the amount of accumulation (USEPA, 1979).

Iron. Iron is the second most abundant element in the environment, though dissolved concentrations present in groundwater are generally low. The chemical behavior of iron and its solubility depend upon the oxidation intensity and pH of the environmental system in which it is found. Iron exists in two valence states, Fe^{2+} and Fe^{3+}, with the Fe^{2+} or ferrous form the most common form of iron found in solution in the reducing conditions within the groundwater environment. Dissolved iron generally sorbs to sediment and may precipitate as iron hydroxide or may oxidize to form iron oxides and iron oxyhydroxides (USEPA, 1979). Iron also may complex with organic molecules, especially fluvic and humic acids. Aerated or flowing water with a pH in the range of 6.5 to 8.5 should contain little dissolved iron.

Lead. The accumulation of lead in most soil is primarily a function of the rate of deposition from the atmosphere. Most lead is retained strongly in soil and very little is transported into surface water or groundwater. The fate of lead in soil is affected by the specific or exchange adsorption at mineral interfaces, the precipitation of sparingly soluble solid phases, and the formation of relatively stable organic-metal complexes or chelates with organic soil matter. These processes are dependant on such factors as soil pH, organic content of soil, the presence of inorganic colloids and iron oxides, ion-exchange characteristics, and the amount of lead in soil (ASTDR, 1988a).

The chemistry of lead in aqueous solutions is highly complex because this element can be found in a many forms. Lead has a tendency to form compounds of low solubility with major anions of natural water. In the natural environment, the divalent form (Pb^{2+}) is the stable ionic species of lead. Hydroxide, carbonate, sulfide, and, more rarely, sulfate may act as solubility controls in precipitating lead from water. The amount of lead that remains in the solution depends upon the pH of the water and the dissolved salt content (ASTDR, 1988a).

Manganese. Manganese is a naturally occurring element found in soil, lakes, streams, and food. Manganese does not occur in the environment as a pure metal, but is found combined with other chemicals like oxygen, sulfur, and chlorine. Elemental manganese and inorganic manganese compounds have negligible vapor pressures, but exist in air as suspended particulate matter derived from industrial emissions or the erosion of soil. Manganese is often transported in rivers as suspended sediment. The metal may exist in any of four oxidation states (2+, 3+, 4+, or 7+). Mn+2 is the most common form found in water with a pH between 4 and 7, but manganese may oxidize at a pH greater than 8. The transportation of manganese in water is controlled by the solubility of the specific chemical form present and the characteristics of available anions (ATSDR, 1990a).

Mercury. Mercury is an element that occurs naturally in the environment, typically at very low levels. In the elemental form mercury is a shiny, silver-white odorless liquid with a metallic taste. Mercury in combination with carbon-containing compounds is called "organic mercury"; if no carbon is present, the compound is called "inorganic mercury". All compounds of mercury are considered poisonous.

Mercury has three valence states that are dependant on a number of factors, including redox potential and pH of the medium. In soil and surface water, mercury can exist in the mercuric (Hg^{+2}) and mercurous (Hg^{+1}) states as a number of complex ions with varying water solubilities.

Mercury released to the environment is typically very stable and lingers for a long time, possibly changing from the organic to the inorganic form and vice versa. Mercury released to the environment by human activity is typically higher than is naturally found. Mercury released to surface soil remains in the soil for a long time and seldom migrates through soil to groundwater.

Silver. The major source of elevated silver levels in cultivated soil is from the application of sewage sludge and sludge effluents as agricultural amendments. Additional anthropogenic sources of silver in soil include atmospheric deposition and landfilling of household refuse or industrial wastes (ASTDR, 1989).

The mobility of silver in soils is affected by drainage (silver tends to be removed from well-drained soils), oxidation-reduction potential and pH conditions, and the presence of organic matter (which complexes with silver and reduces its mobility). Silver tends to form complexes with inorganic chemicals and humic substances in soils. Silver is toxic to soil microorganisms and inhibits bacterial biodegrative enzymes; therefore, biotransformation is not expected to be a significant process in the transformation and degradation of silver (ASTDR, 1989).

Thallium. Thallium is soluble over a wide range of oxidizing conditions but in reducing conditions, it precipitates to the metal form, and in the presence of sulfur, to an insoluble sulfide. Under high oxidizing conditions, thallium precipitates in the oxide or hydroxide form and settles into bed sediments.

The most common fate processes affecting thallium are adsorption and bioaccumulation. The ionic radius of thallium is similar to that of lead; thus, the fate of thallium in the environment is believed to be similar to that of lead (USEPA, 1979). Thallium may be strongly adsorbed by montmorilonite clay; thus, sediment is an active sink for thallium in the environment. The adsorption of thallium to clay particles is pH demandant. Adsorption is more effective under alkaline conditions rather than acidic conditions.

Thallium also may remain in solution in aerobic environments and is known to bioaccumulate.

Vanadium. Vanadium commonly exists in the V^{3+}, V^{4+}, and V^{5+} valence states. Its aqueous chemistry is quite complex, but overall concentrations seem to be controlled more by availability of a vanadium source rather than equilibrium considerations. Bioconcentration of vanadium by vegetation has been reported by several researchers.

Zinc. Zinc is a natural element found in soil. Zinc is also deposited in soil by atmospheric deposition. It is released to the atmosphere as dust and fumes from zinc production facilities, lead smelters, brass works, automobile emissions, fuel combustion, incineration, and soil erosion. Zinc occurs in the environment in the +2 oxidation state. The relative mobility of zinc in soil is determined by the solubility of the compound, soil type, and pH and salinity of the soil (ASTDR, 1988b).

8.2.3 Transport of Contaminants This section discusses the transport of chemicals in various media at Site 15. All media, surface soil, subsurface soil, surface water, sediment, and groundwater will be discussed.

Surface Soil. Transport of the CPCs in soil is dependent on several factors, as discussed in Section 8.1. The primary agents of migration acting on soil include wind, water, and human activity. Soil can also act as a source medium from which the CPCs are transported to other media. Transport of the CPCs from soil via wind is not expected to be a major transport mechanism because of the heavy vegetation present at Site 15. Vegetative cover is an effective means of limiting wind erosion of soil. Humans are effective at moving soil and can greatly affect the transport of soil-bound chemicals at hazardous waste sites. Under the current use of Site 15, human activity is not a major transport mechanism for the CPCs in soil. This condition may change based on the future use of Site 15.

Water can cause the transport of soil and, therefore, the CPCs in soil, via the mechanisms of physical transport of soil or the leaching of constituents from the soil to groundwater. Soil erosion, the physical transport of soil via surface water runoff, is currently not considered a major mechanism for the transport of the CPCs in soil at Site 15 because of (1) the low grade (slope) of the land surface at the site, (2) the heavy vegetation at the site, and (3) the nature of the constituents remaining in the soil at the site.

During the period of reported active disposal at the Site 15, 1965 to 1979, the potential for physical transport of both soil and CPCs via runoff could have been a potentially significant mechanism for transport. If pits were excavated into the soil and waste materials were dumped into the pits, heavy precipitation events could have easily moved the unvegetated soil around the pits. Additionally, the possibility exists that the pits overflowed during heavy rain storms, because they were not covered during their operation. The pits are presumed to be backfilled following their periods of use, and the area revegetated. No significant transport of surface soil is expected since revegetation of the Site 15 area.

Subsurface Soil. Transport of CPCs through subsurface soil occur via the physical transport of small soil particles or the leaching of contaminants from soil to groundwater. Once the contaminants reach groundwater there is the potential for transport through groundwater and ultimately discharging into Clear Creek.

Surface Water. There are no permanent surface water bodies associated with Site 15. Transport of the waterborne CPCs from Site 15 may occur during heavy rain events as surface runoff. Surface water runoff is directed west (approximately 1,500 feet) toward Clear Creek. Water infiltration directly into the soil is presumed to occur during all but the heaviest rain events. Infiltrating water and shallow groundwater at Site 15 will eventually discharge to Clear Creek.

Currently, transport of the CPCs at Site 15 via runoff is not considered an important transport mechanism because of (1) the low slope of the land surface at the site, (2) high infiltration capacity of soil at the site, (3) the heavy vegetation at Site 15, and (4) the tendency of the surface soil contaminants at the sites to remain attached to clays in the soil.

When Site 15 was an active disposal area, transport of the CPCs via surface water runoff may have been a more significant means of contaminant transport. If disposal pits were open to rainfall during their operation, it is possible that intense precipitation could have caused the pits (if they existed) to overflow. Transport of the CPCs via surface water runoff is not considered important now that the site is vegetated.

Sediment. The transport of sediment at Site 15 by the action of humans is not currently a significant transport mechanism, because very little human activity occurs in the drainage ditch. Saltation, traction, and suspension are possible means of sediment transport in water at Site 15 during heavy rain events.

Normally there is no over land flow off the site. During heavy rain events, sediment may become suspended in surface water runoff. Suspended sediment may be transported to ditches that ultimately lead to Clear Creek. It is believed that the sediment would not remain in suspension long enough to reach the tributary of Clear Creek because most of the surface water would infiltrate rapidly into the ground. Sediment transport to Clear Creek will be addressed during the Site 39 Clear Creek Flood Plain investigation.

Groundwater. As discussed in Section 5.5, the observed concentrations of the inorganics in unfiltered groundwater at Site 15 was affected by turbidity in the groundwater samples at the time of collection. The groundwater samples collected in 1996 (during Phase IIB) are thought to be more representative of groundwater conditions at the site. It is probable that particulate material of larger than colloidal sizes does not easily move through the matrix of the aquifer. Colloid-

sized material may be transported through the aquifer matrix at flow rates present in the surficial aquifer system at Site 15.

Hydrogeology at Site 15 is discussed in Section 5.2 of this report. The aquifer present at the site is the surficial (sand and gravel) aquifer. The CPCs identified for groundwater are associated with the surficial aquifer system. Recharge of the surficial aquifer at Site 15 occurs primarily by rainfall on the site and in the area north of the site. Groundwater flow direction in the surficial aquifer at Site 15 is primarily to the south-southwest. Clear Creek acts as a point of discharge approximately 1,200 feet southwest of the site.

Hydraulic data from well clusters completed at Site 15 indicate that the vertical gradient in this area is downward. The upper (approximately) 100 feet of material is a sand with varying amounts of silt and clay and likely acts as a single hydraulic unit.

Horizontal hydraulic gradient estimates have been developed for the combined Site 15 and 16 area. The gradient was calculated for the periods of January 1997 and August 1997 and averaged (Table 5-2). The average hydraulic gradient in the surficial aquifer is 0.0067 and 0.0064 ft/ft respectively in a southwest direction.

Hydraulic conductivity testing was completed on seven monitoring wells at Site 15. The average hydraulic conductivity value for the site is 0.00252 feet per minute or 10.8 ft/day (Table 5-4).

Horizontal groundwater seepage velocity calculations have been completed for the surficial aquifer system at Site 15 using available hydraulic information (Section 5.2). A seepage velocity of 139 ft/yr was calculated using the average hydraulic conductivity from eight monitoring wells at Site 15 (0.38 ft/day), an average horizontal gradient of 0.0067 ft/ft for these monitoring wells, and an estimated effective porosity of 0.35. Disposal activities at Site 15 may have begun releasing contaminants to the aquifer approximately 33 years ago. Using the seepage velocity calculated above, the total distance of potential contaminant migration was estimated to be approximately 4,587 feet.

The calculated estimate of 4,587 feet of migration relies on hydraulic conductivity values derived from slug test data. Slug tests provide a rough estimate of hydraulic conductivity that can be more accurately measured using pumping tests. Slug data may differ by up to a factor of 10 (Bouwer and Rice, 1989). If the hydraulic conductivity value used in the calculation were decreased by an order of magnitude, a total migration of only 458 feet would be expected for the 50-year history of the site.

Clear Creek is the final point of discharge for groundwater from the surficial aquifer at Site 15. Clear Creek is located approximately 1,500 feet southwest of Site 15. Surface water and sediment samples collected during Phase I of the RI from sampling locations located upstream and downstream of the expected groundwater discharge points from Site 15 do not conclusively support any impact to surface water quality of Clear Creek from past Site 15 activities (ABB-ES, 1992a). The results of surface water and sediment sampling are presented in Technical Memorandum No. 4, Surface Water and Sediments, May 1992 (ABB-ES, 1992b) and will also be evaluated in the RI for Site 39, Clear Creek Flood Plain. Additional surface water and sediment samples will be collected during the RI for Site 39 to evaluate potential impacts of the IR sites on Clear Creek.

CHAPTER 9.0

9.0 CONCLUSIONS AND RECOMMENDATIONS

9.1 CONCLUSIONS. The following is a summary based on the RI at Site 15, Southwest Landfill, NAS Whiting Field.

- Geophysical surveys results suggested the presence of geophysical anomalies indicating buried ferromagnetic debris in a series of trenches covering approximately 15 of the 21 acres of the site.

- Ten test pits were excavated at the locations of geophysical anomalies at Site 15. Materials encountered during test pit excavations include construction debris, metallic debris, and aircraft parts.

- Methane and VOCs were detected during the soil gas survey conducted at Site 15. The highest soil gas concentrations (exceeding 5,000 parts per million [ppm] total VOCs and 5,000 ppm methane) were reported near the western boundary of the site.

- Three VOCs, three SVOCs, and three pesticide compounds were detected in Site 15 surface soil samples. Detected concentrations in all VOCs, SVOCs, and pesticides are lower than the USEPA Region III RBCs and Florida residential cleanup target levels for surface soil.

- Twenty inorganic analytes and cyanide were detected in the 30 surface soil samples. Ten inorganic analytes exceeded the background screening values for surface soil. Arsenic exceeded the USEPA Region III RBC and the Florida residential soil cleanup target level in 28 surface soil samples. The detected concentrations of arsenic also exceeded the FDEP-approved site-specific nonresidential soil cleanup target level of 4.62 μg/kg in one soil sample. The arsenic concentration exceeded the USEPA Region III industrial RBC screening criterion in one surface soil sample.

- Three VOCs, seven SVOCs, and one pesticide compound were detected in Site 15 subsurface soil samples. None of the detected concentrations of VOCs, SVOCs, or pesticides exceeded the USEPA Region III RBCs for industrial-use soils. The PCB Aroclor-1242 was detected in one subsurface sample. Aroclor-1242 exceeded the Florida industrial-use soil cleanup target level and the USEPA Region III RBC industrial soil screening criterion in this sample. Phenol and 4-methylphenol were detected at concentrations exceeding the Florida cleanup target level for leaching to groundwater.

- Twenty inorganic analytes were detected in the five subsurface soil samples. Eight analytes (calcium, chromium, iron, manganese, potassium, vanadium, zinc, and cyanide) were detected at concentrations exceeding the background screening values. None of the detected concentrations exceeded industrial standards for either the Florida soil cleanup target levels or USEPA Region III RBCs.

- The pH values of the groundwater samples collected from monitoring wells were below the lower range for the Federal and State secondary

MCLs of 6.5 SUs but were within the range of pH values observed in background groundwater samples collected at NAS Whiting Field.

- Five VOCs and four SVOCs were detected in groundwater samples collected from the shallow monitoring wells at Site 15. None of the compounds with the exception of bis(2-ethylhexyl)phthalate, were detected in the background groundwater samples and none of the detected concentrations exceeded their Federal or Florida MCLs. The pesticide compound 4,4'-DDT was detected at a concentration exceeding the Florida groundwater guidance concentration.

- Eighteen inorganic analytes were detected in groundwater samples from shallow monitoring wells. Nine inorganic analytes, (aluminum, arsenic, cyanide, iron, magnesium, potassium, thallium, vanadium, and zinc) were detected at concentrations exceeding the background screening concentration. Concentrations of aluminum, iron, and manganese were reported to exceed Federal MCLs and Florida groundwater guidance concentrations.

- Five VOCs (1,1-dichloroethene, 1,2-dichloroethene, trichloroethene, benzene, and xylene) and one SVOC (bis(2-ethylhexyl)phthalate) were detected in groundwater samples collected from intermediate depth monitoring wells. Bis(2-ethylhexyl)phthalate was the only compound detected in the background sample. Trichloroethene and benzene were both detected at concentrations exceeding Federal MCLs and Florida groundwater guidance concentrations.

- Fifteen inorganic analytes were detected in groundwater samples from intermediate depth wells. Seven analytes (arsenic, calcium, iron, lead, manganese, sodium, and zinc) were detected at concentrating exceeding the background screening criteria. Aluminum, iron, and manganese were detected at concentrations exceeding Federal MCLs and the Florida groundwater guidance concentrations.

- Five VOCs, two SVOCs, and one pesticide compound were detected in groundwater samples collected from the deep monitoring wells at Site 15. One SVOC (bis[2-ethylhexyl]phthalate) was the only organic compound detected in the background groundwater samples. Two compounds (1,1-dichloroethene and trichloroethene) were detected at concentrations that either equaled or exceeded Federal MCLs and Florida groundwater guidance concentrations.

- Sixteen inorganic analytes were detected in the groundwater samples from the Site 15 deep monitoring wells. Nine of the compounds including antimony, arsenic, calcium, cobalt, copper, lead, manganese, potassium, and sodium were detected at concentrations exceeding the background screening concentration (Table 5-21). Three of the analytes, antimony, iron, and manganese, were detected at concentrations exceeding the Federal MCLs and Florida groundwater guidance concentrations.

- The extent of groundwater contamination downgradient of Site 15 has not been defined. Benzene and trichloroethene were detected in groundwater at concentrations above cleanup target levels and Federal MCLs between Site 15 and the base boundary.

- The groundwater flow direction is toward the southwest and likely discharges to Clear Creek. Clear Creek is located approximately 1,200 feet southwest of the site. The average horizontal hydraulic gradient for the site is 0.0066 ft/ft. The geometric mean for the hydraulic conductivity data for monitoring wells in the site area is 10.8 ft/day and the average seepage velocity value is 0.38 ft/day.

- The HHRA identified three inorganic analytes as HHCPCs for surface soils at Site 15. Aroclor-1242 was identified as an HHCPC for subsurface soil. Thirteen analytes including 1,1-dichloroethene, 1,2-dichloroethene, benzene, chlorobenzene, trichloroethene, 1,4-dichlorobenzene, bis(2-ethylhexyl)phthalate, 4,4'-DDT, aluminum, arsenic, iron, manganese, and thallium were identified as HHCPCs for groundwater at Site 15.

- The HHCPCs detected in surface soil do not pose unacceptable carcinogenic risks to the receptors evaluated based on evaluation of the samples using USEPA guidelines and target risk range.

- The total ELCR of 4×10^{-6} at Site 15, associated with exposure to soil by a hypothetical future resident, exceeds Florida's target risk level of concern 1×10^{-6} due to arsenic. The background levels of arsenic at Site 15 exceed the Florida residential soil cleanup target level and may result in an unacceptable carcinogenic risk. It is likely that naturally occurring arsenic contributes to the FDEP target risk-level exceedance.

- The ELCR for groundwater exceeds the USEPA acceptable risk range and the FDEP cancer level of concern due to 1,1-dichloroethene, arsenic, benzene, trichlorobenzene, and 1,4-dichlorobenzene; however, groundwater contamination is being addressed as a separate RI site under a facilitywide investigation.

- The ERA selected three VOCs (acetone, methylene chloride, and xylene) two SVOCs (di-*n*-butylphthalate and bis[2-ethylhexyl]phthalate) and five inorganic analytes (cyanide, lead, silver, vanadium, and zinc) as ECPCs for surface soil at Site 15. In addition, four VOCs (acetone, benzene, trichloroethene, and xylene), two SVOCs (1,4-dichlorobenzene and bis[2-ethylhexyl]phthalate), one pesticide (4,4'-DDT), and nine inorganic analytes (aluminum, cobalt, iron, lead, manganese, mercury, silver, vanadium, and zinc) were identified as ECPCs in groundwater at the site.

- Risks were not identified for terrestrial wildlife resulting from exposure to ECPCs in surface soil; therefore, reductions in the survivability, growth, and reproduction of wildlife receptor populations at Site 15 are not expected to occur.

- Reduction in terrestrial plant and soil invertebrate biomass used as forage material was evaluated by comparing exposure concentrations for surface soil with toxicity benchmarks. Based on this comparison it is unlikely that plant and invertebrate biomass or plant cover availability would be reduced such that small mammal and bird populations at Site 15 would be affected.

- Potential risks for aquatic receptors were evaluated for exposures to ECPCs in groundwater. The concentrations of ECPCs in groundwater as they discharge to Clear Creek 1,200 feet downgradient of Site 15 were estimated based on application of a 10-fold attenuation factor to the RME concentration. Based on the screening evaluation of groundwater, risks to aquatic receptors in Clear Creek associated with exposure to groundwater ECPCs from Site 15 are not expected. The ERA for Site 39, Clear Creek Flood Plain, will provide additional information regarding potential risks to aquatic receptors in Clear Creek based on actual site-related surface water and sediment data.

- The results of the ERA suggest that risks are not predicted for ecological receptor populations at Site 15.

9.2 RECOMMENDATIONS. Based upon the interpretation of findings from the RI activities, a FS is recommended for Site 15 to evaluate potential strategies for the reduction in human health risks associated with surface and subsurface soil at the site. In addition, the presence of organic and inorganic analytes in Site 15 groundwater samples at concentrations exceeding Florida's target risk levels indicates that additional sampling and remedial measures may be required. Leaching of contaminants (phenol and 4-methylphenol) from subsurface soil to groundwater will also need to be addressed. However, all groundwater contamination issues will be addressed as part of the ongoing RI for the Site 40 facilitywide groundwater study.

CHAPTER 10.0

10.0 PROFESSIONAL REVIEW CERTIFICATION

The work and professional opinions rendered in this report were conducted or developed in accordance with commonly accepted procedures and protocols consistent with applied standards of practice. This report is based on the geologic investigation and associated information detailed in the text and appended to this report. If conditions are discovered or determined to exist that differ from those described, the undersigned geologist should be notified to evaluate the effects of any additional information on the assessment described in this report. The RI for Site 15, Southwest Landfill was developed for NAS Whiting Field in Milton, Florida, and should not be construed to apply for any other purpose or to any other site.

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Date

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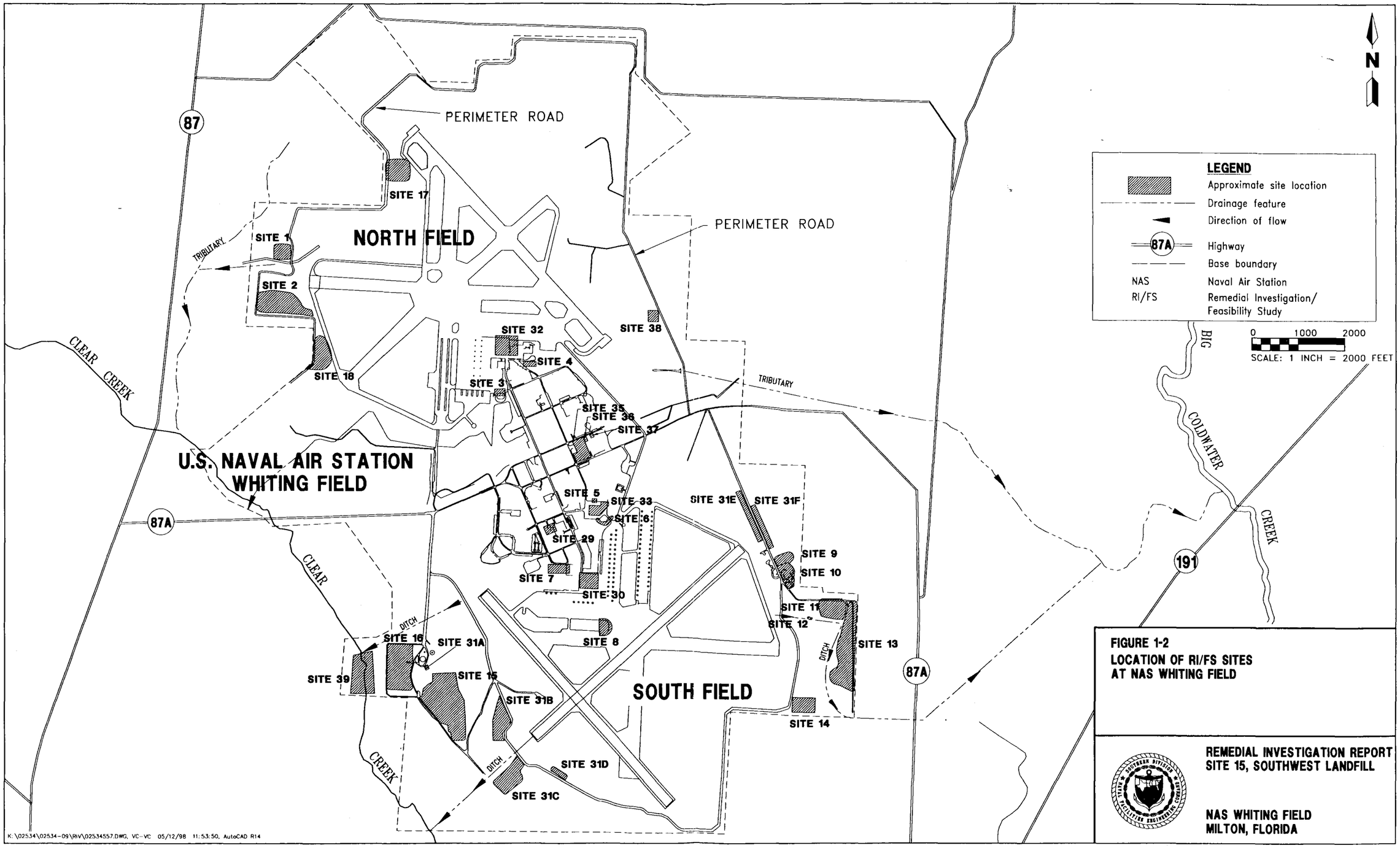

FIGURE 1-2
LOCATION OF RI/FS SITES AT NAS WHITING FIELD

REMEDIAL INVESTIGATION REPORT
SITE 15, SOUTHWEST LANDFILL

NAS WHITING FIELD
MILTON, FLORIDA

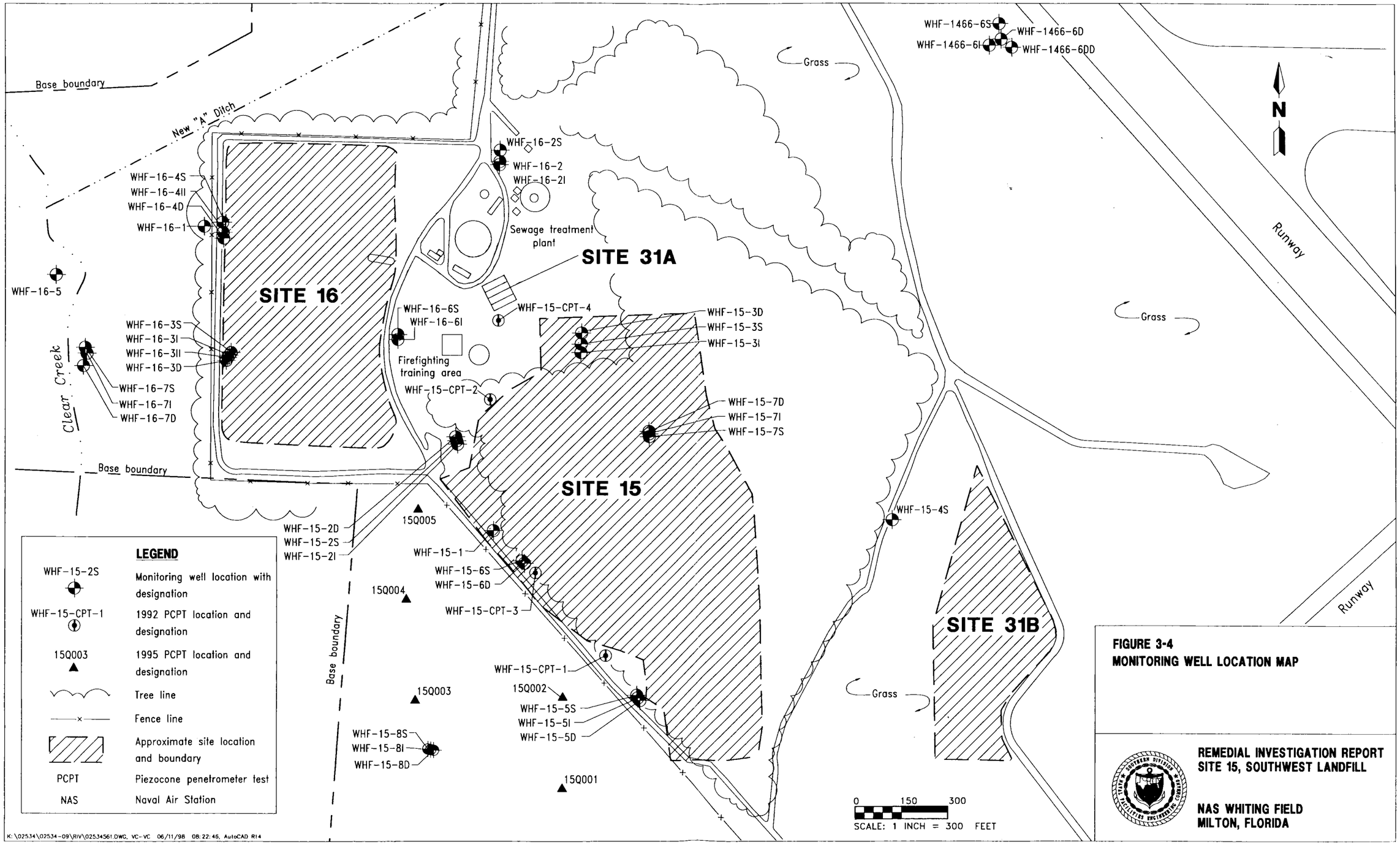

FIGURE 3-4
MONITORING WELL LOCATION MAP

REMEDIAL INVESTIGATION REPORT
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NAS WHITING FIELD
MILTON, FLORIDA

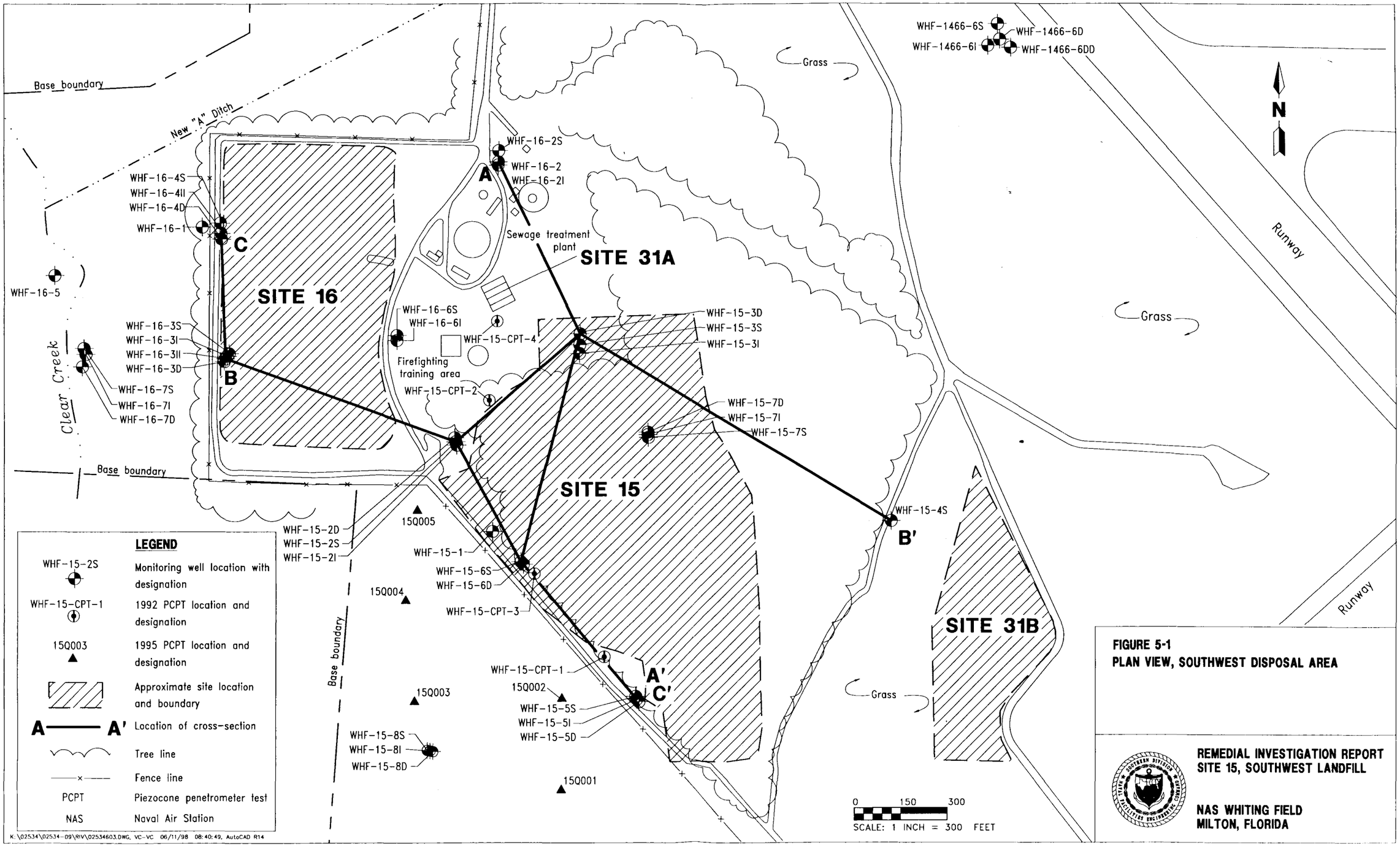

FIGURE 5-1
PLAN VIEW, SOUTHWEST DISPOSAL AREA

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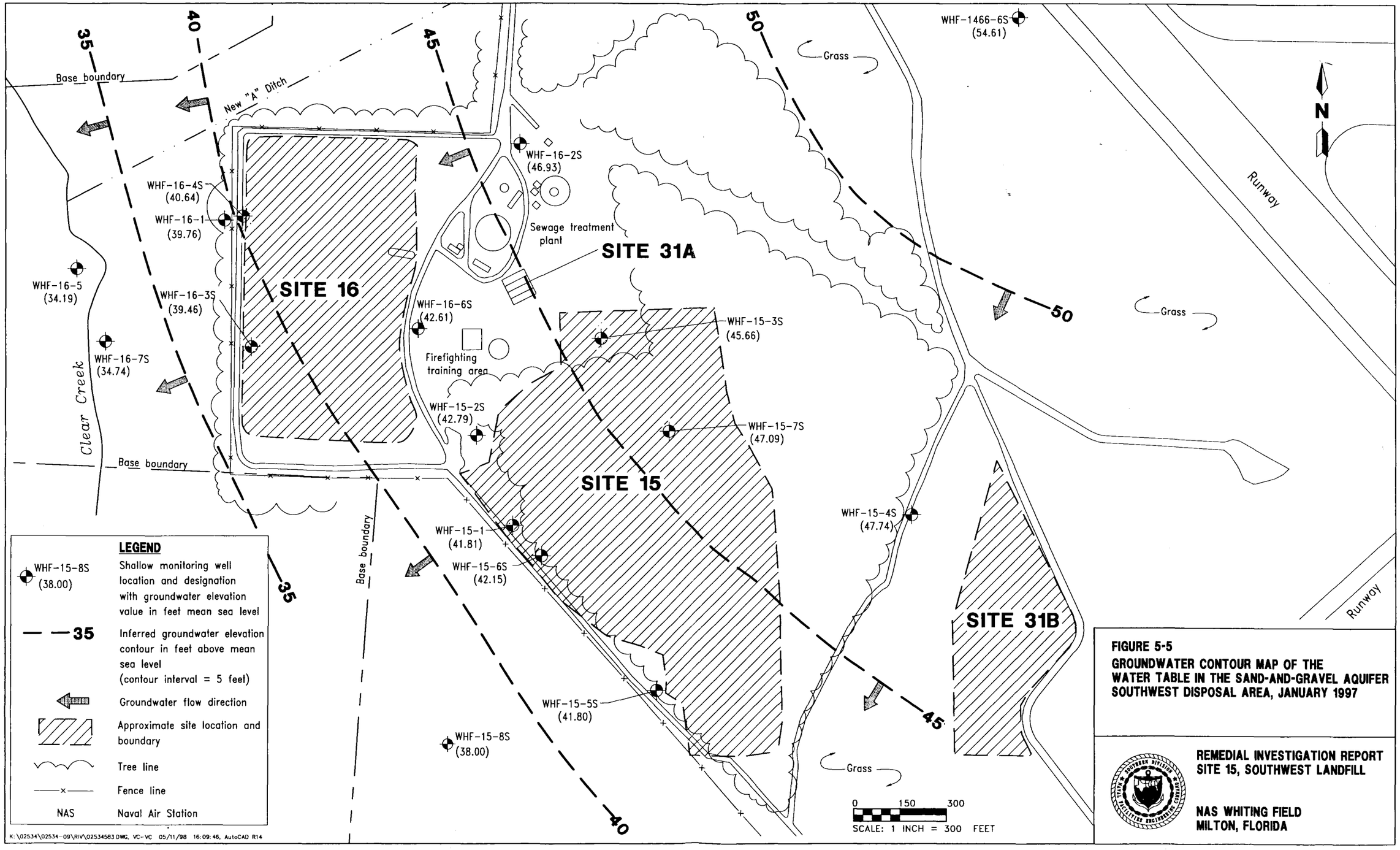

FIGURE 5-5
GROUNDWATER CONTOUR MAP OF THE WATER TABLE IN THE SAND-AND-GRAVEL AQUIFER SOUTHWEST DISPOSAL AREA, JANUARY 1997

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MILTON, FLORIDA

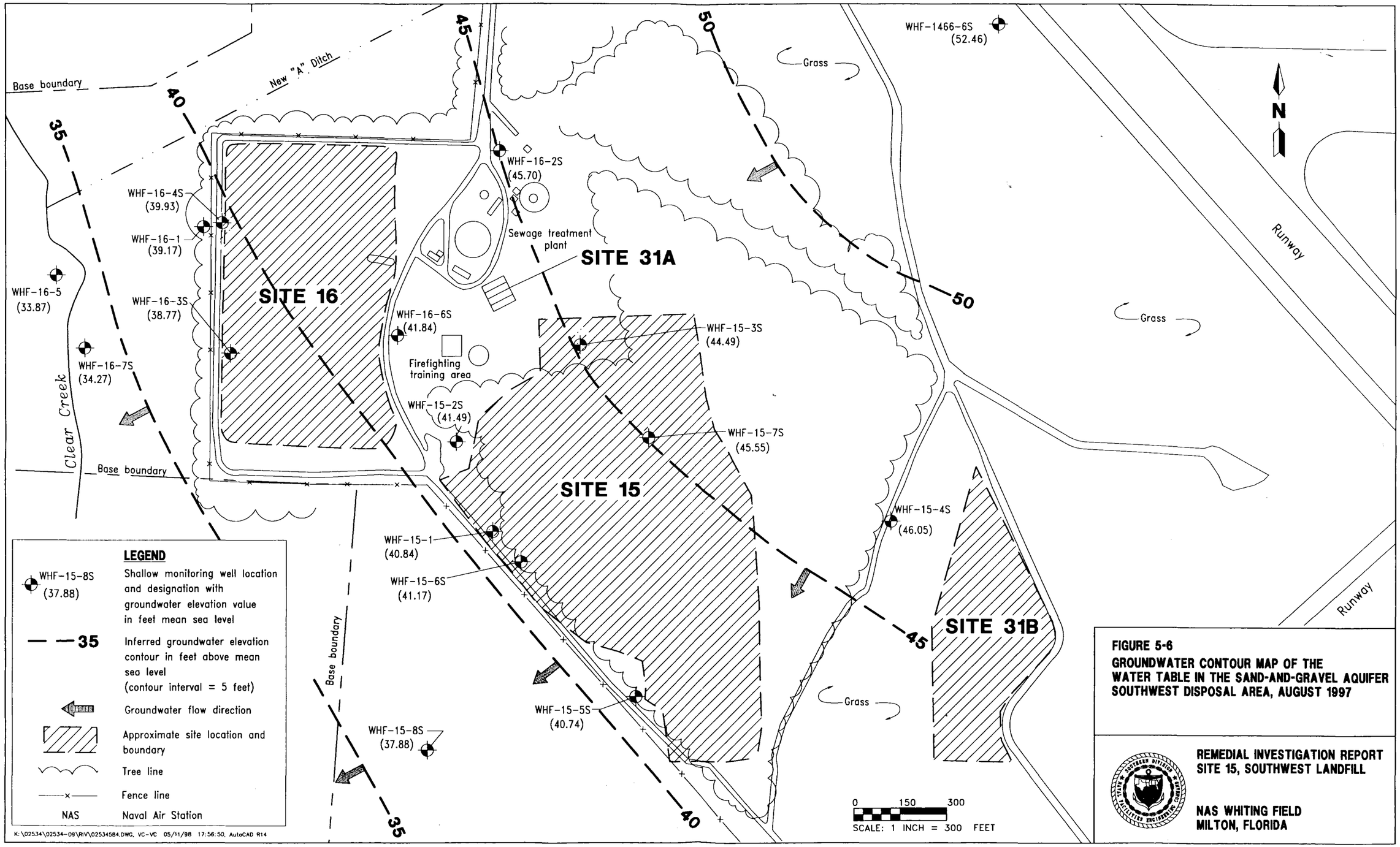

FIGURE 5-6
GROUNDWATER CONTOUR MAP OF THE WATER TABLE IN THE SAND-AND-GRAVEL AQUIFER SOUTHWEST DISPOSAL AREA, AUGUST 1997

REMEDIAL INVESTIGATION REPORT
SITE 15, SOUTHWEST LANDFILL

NAS WHITING FIELD
MILTON, FLORIDA