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REMEDIAL INVESTIGATION FOR SITE 31 NAS WHITING FIELD
10/1/1998
HARDING LAWSON ASSOCIATES

REMEDIAL INVESTIGATION REPORT

SITE 31, SLUDGE DRYING BEDS AND DISPOSAL AREAS

NAVAL AIR STATION WHITING FIELD
MILTON, FLORIDA

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CERTIFICATION OF TECHNICAL
DATA CONFORMITY (MAY 1987)

The Contractor, Harding Lawson Associates, 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.

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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 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 (SARA), 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 Naval Air Station (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 (803) 820-7341.

EXECUTIVE SUMMARY

A remedial investigation (RI) and feasibility study is being conducted at Naval Air Station (NAS) Whiting Field in Milton, Florida, by Southern Division, Naval Facilities Engineering Command, 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 May 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 August 1997.

This RI report contains the results of assessment activities used to characterize site-specific chemicals detected in environmental media (soil and groundwater) at Site 31, Sludge Drying Beds and Disposal Areas at NAS Whiting Field. Site 31 is composed of 6 areas, Site 31A (sludge drying beds) and Sites 31B through 31F (sludge disposal areas). 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:

- surface soil sampling,
- subsurface soil sampling,
- monitoring well installation,
- groundwater sampling, and
- hydrogeologic investigations.

Soil and groundwater samples were analyzed for target compound list organic analytes, target analyte list inorganic analytes, and secondary water quality parameters.

The following conclusions are based on results of the RI investigation activities at Site 31, Sludge Drying Beds and Disposal Areas, NAS Whiting Field.

Surface Soil Summary

- Site 31A: Two inorganic analytes (mercury and silver) were detected in surface soil samples at concentrations exceeding their respective background screening values. None of the analytes exceeded the residential or industrial soil cleanup goals for Florida and the U.S. Environmental Protection Agency (USEPA) Region III Risk-Based Concentrations (RBCs).

- Site 31B: Three inorganic analytes (copper, mercury, and silver) were detected in samples at concentrations exceeding their respec-

tive background screening values. No compounds or analytes exceeded their respective residential and industrial soil cleanup goals for Florida and the USEPA Region III RBCs.

- Site 31C: One pesticide compound (dieldrin) was detected in samples at concentrations exceeding the residential values of soil cleanup goals for Florida and the USEPA Region III RBCs. Seventeen inorganic analytes (aluminum, barium, beryllium, cadmium, calcium, chromium, cobalt, copper, iron, lead, magnesium, mercury, nickel, selenium, silver, zinc, and cyanide) were detected in samples at concentrations exceeding their respective background screening values. Concentrations of arsenic and chromium exceeded their respective residential soil cleanup goals for Florida and the USEPA Region III RBCs in some surface soil samples. Beryllium exceeded the industrial soil cleanup goals for Florida in some surface soil samples. Lead exceeded the industrial values for the soil cleanup goals for Florida and the USEPA Region III RBCs in some surface soil samples.

- Site 31D: One inorganic analyte (potassium) was detected in a sample at a concentration in slight exceedance of the background screening value. Arsenic exceeded the residential soil cleanup goals for Florida and the USEPA Region III RBCs.

- Site 31E: Three inorganic analytes (magnesium, potassium, and silver) were detected in samples at concentrations exceeding their respective background screening values. Arsenic, beryllium, and manganese exceeded their respective residential values of the soil cleanup goals for Florida and the USEPA Region III RBCs.

- Site 31F: Eight inorganic analytes (barium, calcium, copper, magnesium, manganese, selenium, silver, and zinc) were detected in samples at concentrations exceeding their respective background screening values. Aluminum, arsenic, iron, and manganese exceeded their respective residential values of the soil cleanup goals or the USEPA Region III RBCs. Arsenic and manganese also exceeded their respective residential values of the soil cleanup goals for Florida.

Subsurface Soil Summary

- Site 31A: Six inorganic analytes (beryllium, cobalt, manganese, mercury, sodium, and thallium) were detected in subsurface soil samples at concentrations exceeding their respective background screening values. The inorganic analytes did not exceeded their respective residential and industrial soil cleanup goals for Florida and the USEPA Region III RBCs.

- Site 31C: Six inorganic analytes (copper, lead, mercury, silver, zinc, and cyanide) were detected in subsurface soil samples at concentrations exceeding the background screening values. The inorganic analytes did not exceed their respective residential and industrial soil cleanup goals for Florida and the USEPA Region III RBCs.

Groundwater Summary

- The pH values of groundwater samples collected from Site 31C monitoring wells were below the lower range for Federal and State Secondary MCLs; however, these values were within the range observed in facility-specific background groundwater samples collected at NAS Whiting Field (Harding Lawson Associates, 1998).

- Site 31C: Three analytes (potassium, vanadium, and cyanide) were detected at concentrations exceeding the background screening values in groundwater samples collected from monitoring wells. However, none of the analytes were detected at concentrations exceeding the Federal maximum contaminant levels (MCLs) or Florida Groundwater Guidance Concentrations.

Hydrogeologic Summary

- The groundwater flow direction is toward the southwest for Sites 31A, 31B, 31C, and 31D and likely discharges at Clear Creek, located from 1,400 to 2,700 feet west of these sites. The groundwater flow direction is toward the east-southeast for Sites 31E and 31F and likely discharges to Big Coldwater Creek, located approximately 9,000 feet east of these sites.

- Based on a 50-year site history and an evaluation of hydrogeologic data, a potential migration distance for chemicals of potential concern is estimated to be approximately 4,200 feet for Site 31C; however, there is no evidence of any chemical migration from the site.

Human Health Risk Assessment Summary

- The human health chemicals of potential concern detected in surface soil, subsurface soil, and groundwater do not pose unacceptable carcinogenic risks to the receptors evaluated based on evaluation of the samples using USEPA guidelines and target risk range.

- The groundwater risks levels are below both the USEPA target cancer risk range and the Florida Department of Environmental Protection (FDEP) target level of concern.

- Noncancer risk levels for groundwater meet the USEPA and FDEP target hazard index of one.

- The total excess lifetime cancer risk at Site 31C associated with ingestion of soil by a hypothetical future resident, current and hypothetical future trespasser, and hypothetical future occupational worker exceeded Florida's target risk level of concern of 1×10^{-6} due primarily to Aroclor-1260, dieldrin, arsenic, and beryllium.

- The central tendency risks to a hypothetical future trespasser and occupational worker were below the Florida level of concern (1×10^{-6}) for Site 31C.

Ecological Risk Assessment Summary

- Risks were identified for terrestrial wildlife resulting from exposure to ecological chemicals of potential concern (ECPCs) in Site 31C surface soil. Cadmium, copper, lead, mercury, and zinc are the primary contributors to risks to wildlife receptors.

- Risks were not identified for terrestrial wildlife resulting from exposure to ECPCs in surface soil at Sites 31A, 31 B, 31D, 31E, and 31F; therefore, reductions in the survivability, growth, and reproduction of wildlife receptor populations at these locations is not expected to occur.

- Reduction in terrestrial plant biomass used as forage material was evaluated by comparing exposure concentrations for surface soil with phytotoxicity benchmarks. Based on this comparison, it is unlikely plant biomass or plant cover at Sites 31A, 31D, 31E and 31F would be reduced enough to affect small mammal and bird populations at Site 31.

- Site 31B has a higher concentration of silver. This may have adverse effects on individuals but it is unlikely to result in changes in community and populations.

- Site-specific toxicity test were performed on two samples collected from areas showing stressed vegetation. The toxicity test showed a reduction in lettuce seed germination; however, there was no significant ($R^2 \geq 0.9$) correlation between lettuce seed germination rates and ECPC concentrations detected in surface soil from Site 31C. This suggests other nonmeasured physical, biological, or chemical factors may be responsible for the observed reduction in lettuce seed germination.

- It is unlikely soil invertebrate biomass at Sites 31A, 31B, 31D, 31E and 31F would be reduced enough to affect small mammal and bird populations at Site 31. Site-specific toxicity test were performed on samples collected from two areas showing stressed vegetation. A comparison of survival and growth rates between background and control samples an Site 31C samples showed no significant ($p \geq 0.05$) difference.

- The results of the ecological risk assessment suggest changes in community structure and populations are not predicted for Sites 31A, 31B, 31D, 31E, and 31F. Samples collected from stressed areas of Site 31C indicated potential risks to plants and wildlife receptors.

Based on the interpretation of findings from the remedial investigation activities, No Further Action (NFA) is proposed for Sites 31A (Sludge Drying Beds) and Sites 31B, 31D, 31E, and 31F (Sludge Disposal Areas). Based on the recommendation for NFA, a feasibility study does not need to be conducted for these areas.

However, interpretation of findings from the RI activities indicates a focused feasibility study is required for Site 31C (Sludge Disposal Area) to address potential risk of a surface soil exposure by a hypothetical future resident, current and hypothetical future trespasser, and hypothetical future occupational worker. The calculated risk to a hypothetical resident (2×10^{-5}) exceeded Florida's target level due to Aroclor-1260, dieldrin, arsenic, and beryllium.

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GLOSSARY

ABB-ES	ABB Environmental Services, Inc.
ARAR	applicable or relevant and appropriate requirement
ATSDR	Agency for Toxic Substances and Disease Registry
BAF	bioaccumulation factor
bls	below land surface
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CLP	Contract Laboratory Program
cm/sec	centimeters per second
CPC	chemical of potential concern
CT	central tendency
DDD	dichlorodiphenyldichloroethane
DDE	dichlorodiphenyldichloroethene
DDT	dichlorodiphenyltrichloroethane
DQO	data quality objective
ECPC	ecological chemical of potential concern
Eh	Redox potential
ELCR	excess lifetime cancer risk
EPC	exposure point concentration
ERA	ecological risk assessment
FAC	Florida Administrative Code
FDEP	Federal Department of Environmental Protection
FS	feasibility study
ft/day	feet per day
ft/ft	feet per foot
ft/min	feet per minute
ft/yr	feet per year
GIR	General Information Report
HHCPC	human health chemical of potential concern
HHRA	Human Health Risk Assessment
HI	hazard index
HLA	Harding Lawson Associates
HQ	hazard quotient
HRS	Hazard Ranking System
IAS	Initial Assessment Study
IDL	instrument detection limit
IR	Installation Restoration
IRIS	Integrated Risk Information System
k_{oc}	organic carbon partitioning coefficient
k_d	distribution coefficient

GLOSSARY (Continued)

LD_{50}	lethal dose to 50 percent of test population
LDC	Laboratory Data Consultants, Inc.
LOAEL	lowest observed adverse effects level
MCL	maximum contaminant level
$\mu g/\ell$	micrograms per liter
mg/kg	milligrams per kilogram
MS/MSD	matrix spike and matrix spike duplicate
NAS	Naval Air Station
NCP	National Oil and Hazardous Substances Contingency Plan
NEESA	Naval Energy and Environmental Support Activity
NFA	no further action
NOAEL	no observable adverse effect level
NPL	National Priority List
NTU	nephelometric turbidity unit
PAH	polynuclear aromatic hydrocarbon
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
QAPP	Quality Assurance Project Plan
QC	quality control
RBC	risk-based concentration
RGO	remedial goal option
RI	remedial investigation
RI/FS	remedial investigation and feasibility study
RME	reasonable maximum exposure
RPD	relative percent difference
RRF	relative response factor
%RSD	percent Relative Standard Deviation
RTECS	Registry of Toxic Effects of Chemical Substances
RTV	reference toxicity value
SARA	Superfund Amendments and Reauthorization Act
SDG	sample delivery group
SFF	site foraging frequency
SI	site inspection
SOUTHNAV-FACENGCOM	Southern Division, Naval Facilities Engineering Command
SQL	sample quantitation limit
SVOC	semivolatile organic compound

TAL	target analyte list
TCE	trichloroethene
TCL	target compound list
UCL	upper confidence limit
USDA	U.S. Department of Agriculture
USEPA	U.S. Environmental Protection Agency
VOC	volatile organic compound

CHAPTER 1.0

1.0 INTRODUCTION

Harding Lawson Associates (HLA), under contract to the Department of Navy, Southern Division, Naval Facilities Engineering Command (SOUTHNAVFACENGCOM) is submitting the Remedial Investigation (RI) Report for Site 31, Sludge Drying Beds and Disposal Areas at Naval Air Station (NAS) Whiting Field located in Milton, Florida. The RI Report for Site 31 is one in a series of site-specific reports being completed in conjunction with the NAS Whiting Field General Information Report (GIR) (HLA, 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 August 1997.

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 entire 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 (HLA, 1998).

1.1 PURPOSE OF THE REMEDIAL INVESTIGATION AND FEASIBILITY STUDY. 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 a 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 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. 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 (SI), 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) (U.S. Environmental Protection Agency [USEPA], 1990).

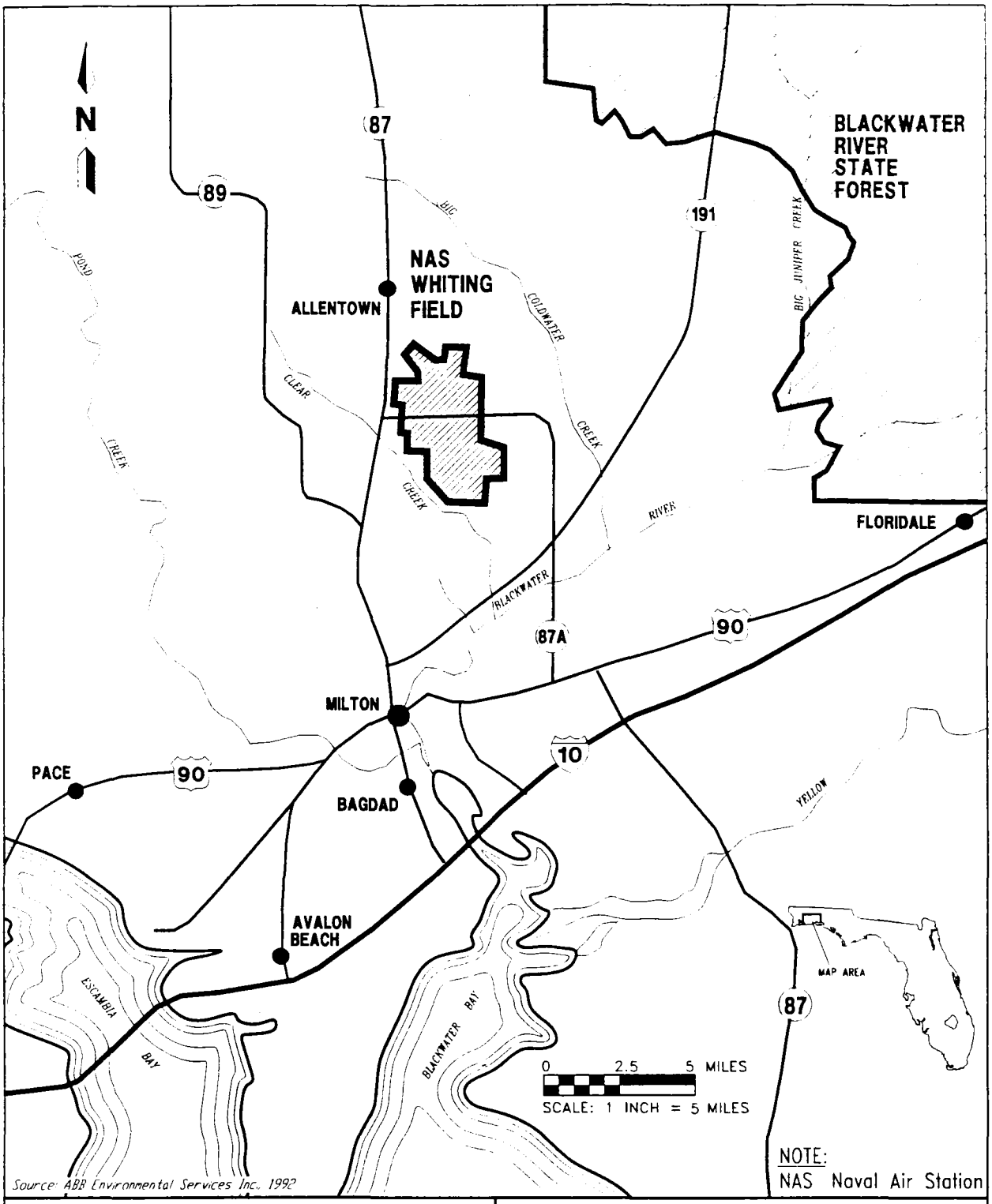

FIGURE 1-1
FACILITY LOCATION MAP

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REMEDIAL INVESTIGATION REPORT
SITE 31, SLUDGE DRYING BEDS
AND DISPOSAL AREAS

NAS WHITING FIELD
MILTON, FLORIDA

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

11 x 17

Section 105(a)(8)(A) of SARA requires the 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 (March 1991) 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.

1.3 REPORT ORGANIZATION. The RI Report is organized into ten chapters (Chapters 1.0 to 10.0). Chapter 1.0 presents the purpose and regulatory setting for the RI at NAS Whiting Field. Chapter 2.0 summarizes the site history and description. 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. Chapter 9.0 provides a summary of the conclusions and recommendations. Chapter 10.0 presents professional review certification.

CHAPTER 2.0

2.0 SITE BACKGROUND

This chapter summarizes the history and description of Site 31, Sludge Drying Beds and Disposal Areas at NAS Whiting Field.

2.1 SITE HISTORY. Site 31, Sludge Drying Beds and Disposal Areas, was not included initially with sites identified during the Initial Assessment Study (IAS) conducted by Envirodyne Engineers. Table 5-6 in the IAS indicated several waste sources in the South Field area that had used the sanitary sewer as a disposal location (Envirodyne Engineers Inc., 1985). Aircraft cleaning compound for helicopter washing was disposed of in the storm sewer and sanitary sewer from 1940 to 1984. Mixed photo processing chemicals, wastewater, and silver sludge from the photo lab were disposed of in the sanitary sewer from 1940 to 1984. These compounds potentially accumulated in the sludge at the facility wastewater plant.

Site 31 is one of five sites identified during Phase I of the RI and subsequently added to the Phase II RI program for investigation. Site 31 is composed of six locations used for sludge drying and disposal from the facility wastewater treatment plant. Table 2-1 summarizes the site designations and their location.

From the 1940s until 1990, liquid sludge was dried at Site 31A and the resulting solids were later spread at Sites 31B, 31C, and 31D. Liquid sludge was also periodically sprayed from a tanker truck over the area of Sites 31B, 31C, 31D, 31E, and 31F.

Table 2-1
Site 31, Sludge Drying Beds Location Summary

Remedial Investigation Report
Site 31, Sludge Drying Beds and Disposal Areas
Naval Air Station Whiting Field
Milton, Florida

Site Designation	Size (Acres)	Approximate Location
31A	0.2	Sludge Drying Bed at the Wastewater Treatment Plant (Figure 1-2)
31B	2.5	East of Site 15, and west of and adjacent to Perimeter Road in the South Air Field (Figure 1-2).
31C	2.8	Southeast of Site 15, and south of Perimeter Road in the South Air Field.
31D	1.0	Southeast of Runway 4, and north of and adjacent to Perimeter Road in the South Air Field (Figure 1-2).
31E	3.45	Northwest of Site 9 and west of the south part of Perimeter Road in the South Air Field (Figure 1-2).
31F	3.45	Northwest of Site 9 and east of the south part of Perimeter Road in the South Air Field (Figure 1-2).

2.2 SITE DESCRIPTION. Site 31, Sludge Drying Beds and Disposal Areas, is a single site designation, including multiple disposal areas along the South Field perimeter road (Figure 1-2). Site 31 includes the sludge drying beds located near the Wastewater Treatment Plant (Site 31A), three disposal areas at the southwest perimeter of Runway 4 (Sites 31B, 31C, and 31D), and two sludge disposal areas at the northeast perimeter of Runway 4 (Sites 31E and 31F) (Figure 1-2).

Site 31A is a sludge drying bed unit, 92 feet long by 80 feet wide (Figure 2-1). The unit consists of four sludge drying beds surrounded by containment walls 2.5 to 3.0 feet deep. The area of the site is approximately 0.2 acre. The surface of each sludge drying bed is covered with a coarse-grained sand and fine gravel mixture.

Site 31A received wet sludge from the wastewater treatment plant that may have contained hazardous substances such as methylene chloride and heavy metals. The dried sludge was periodically removed and disposed of at Sites 31B, 31C, and 31D. The sludge drying bed was taken out of service in 1990.

Sites 31B, 31C, and 31D are mowed grassy areas located in an area of surface water control berms on the southwestern slopes of the South Air Field (Figure 2-2). The purpose of the berms is to reduce soil erosion from surface water runoff. In addition to dried sludge solids received from Site 31A, disposal in these areas also consisted of spraying liquid sludge from a tanker truck.

Site 31C also received concrete, asphalt, and metal rubble from former base operations. A rubble pile containing these materials is located in the southwest area of Site 31C.

Sites 31E and 31F are locations where liquid sludge was formerly sprayed on the grassy surface on the east and west sides of the perimeter road (Figure 2-3). The extent of the disposal areas is not known with certainty but an estimate of the area covered for both sites is approximately 6.9 acres.

According to the U.S. Department of Agriculture (USDA), the soil at Sites 31A, 31C, 31D, 31E, and 31F is classified as Troup Loamy Sand and the soil at Site 31B is classified as Troup Loamy Sand and Bonifay Sand (USDA, 1980).

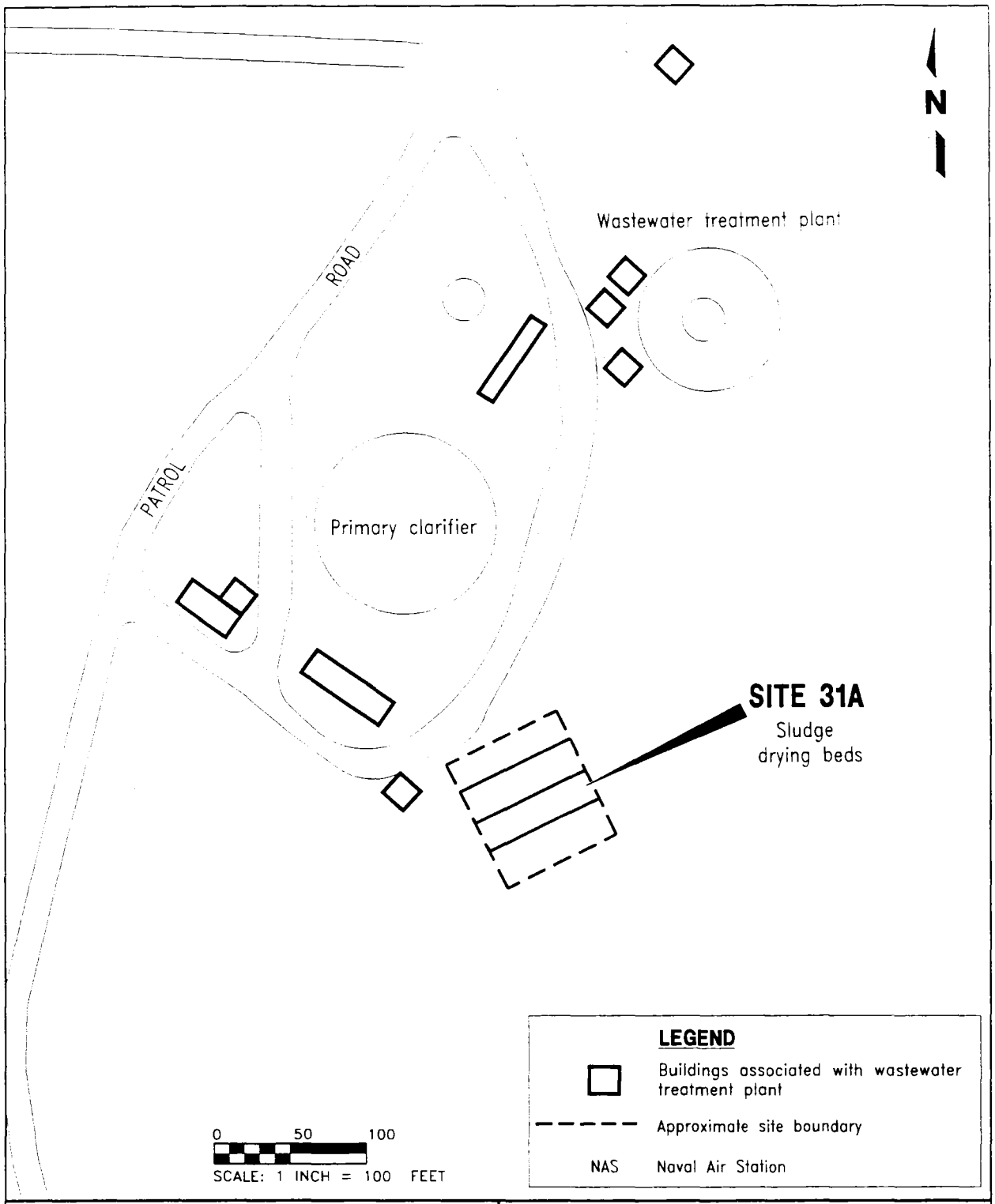

FIGURE 2-1
SITE 31A, SLUDGE DRYING BEDS, SITE PLAN MAP

REMEDIAL INVESTIGATION REPORT
SITE 31, SLUDGE DRYING BEDS AND DISPOSAL AREAS

NAS WHITING FIELD
MILTON, FLORIDA

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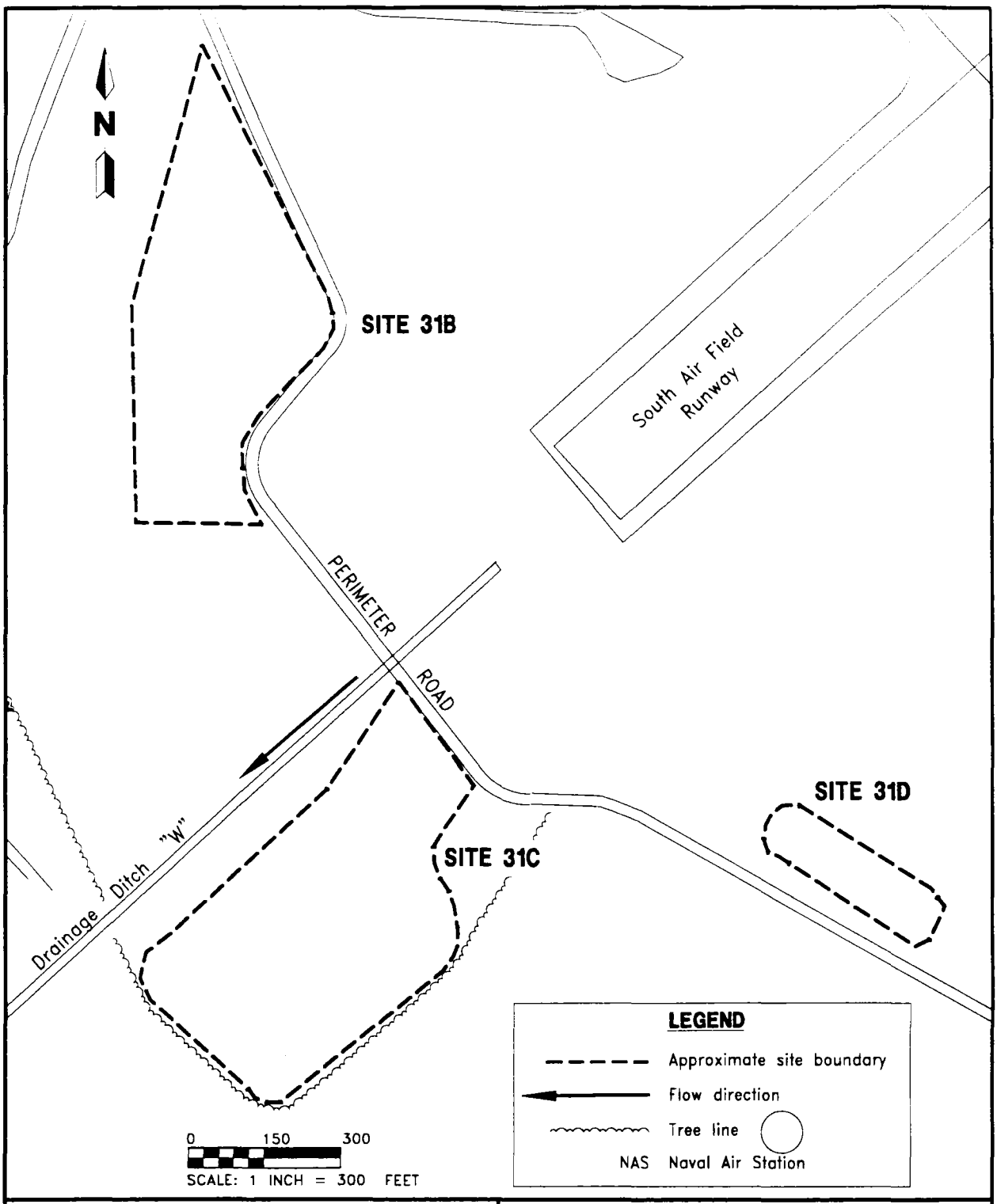

FIGURE 2-2
SITES 31B, 31C, AND 31D, SLUDGE DISPOSAL AREAS, SITE PLAN MAP

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REMEDIAL INVESTIGATION REPORT
SITE 31, SLUDGE DRYING BEDS AND DISPOSAL AREAS

NAS WHITING FIELD
MILTON, FLORIDA

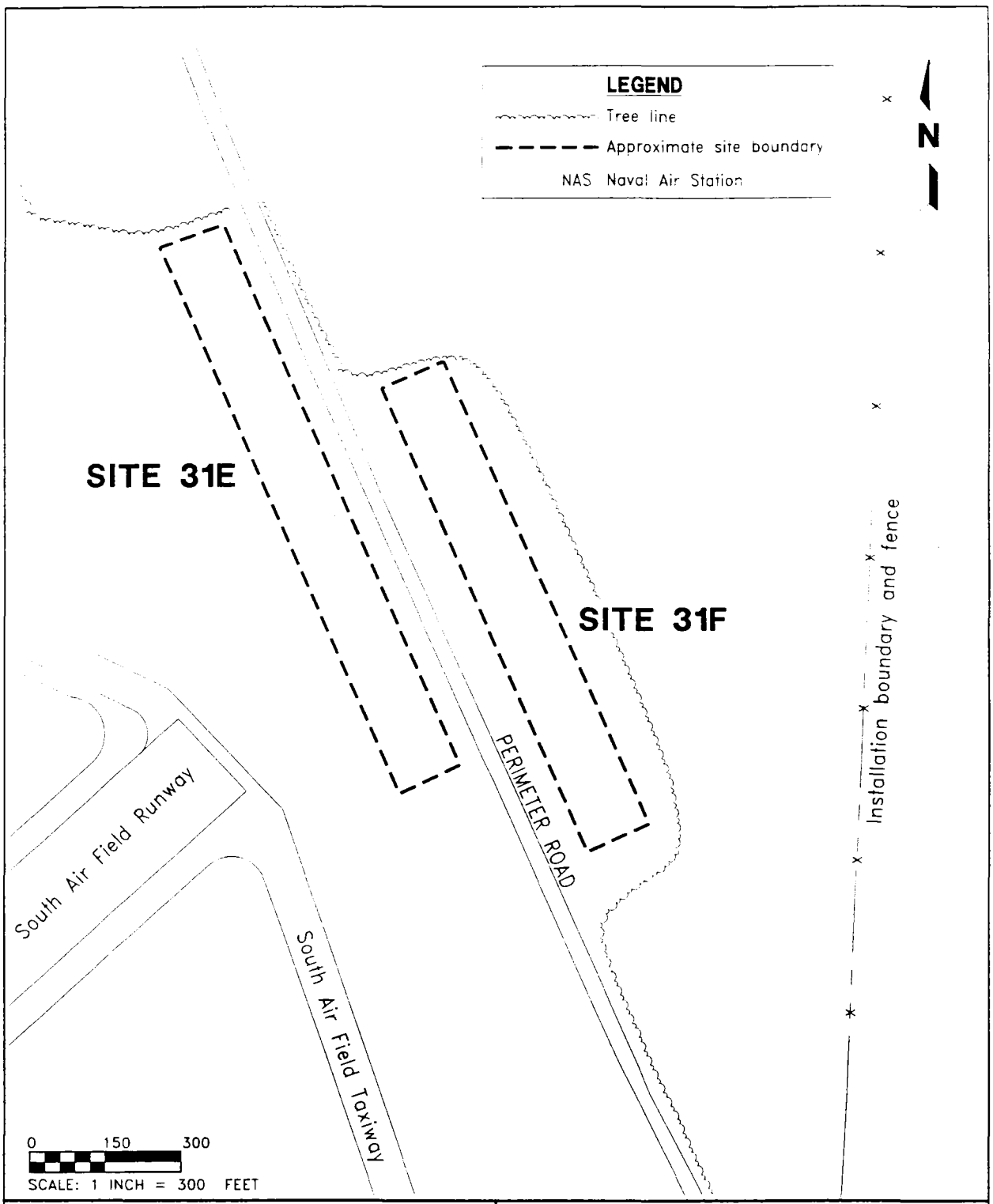

FIGURE 2-3
SITES 31E AND 31F, SLUDGE DISPOSAL AREAS, SITE PLAN MAP

REMEDIAL INVESTIGATION REPORT
SITE 31, SLUDGE DRYING BEDS AND DISPOSAL AREAS

NAS WHITING FIELD
MILTON, FLORIDA

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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 Workplan, 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 (QC) requirements for the RI activities comply with the RI/FS Quality Assurance Project Plan (QAPP) located in Appendix A of the RI/FS Workplan, Volume II (E.C. Jordan, 1990). Health and safety requirements were in accordance with the general Health and Safety Plan located in Volume III of the RI/FS Workplan (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 Environmental Services, Inc. [ABB-ES], 1995a) and in the NAS Whiting Field GIR (HLA, 1998).

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

The Phase IIA investigation included collection of surface soil samples at each area associated with Site 31. The Phase IIB investigation included collection of surface soil samples from each area associated with Site 31, collection of subsurface soil samples from Sites 31A and 31C, installation of six monitoring wells at Site 31C, and collection of six groundwater samples. The samples were analyzed for target compound list (TCL) volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), pesticides, and polychlorinated biphenyls (PCBs) and target analyte list (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 31, Sludge Drying Beds and Disposal Areas.

3.1 SURFACE SOIL ASSESSMENT. The surface soil assessment included the collection of 24 surface soil samples during Phase IIA and 19 surface soil samples during Phase IIB of the RI.

The Phase IIA surface soil samples (designated 31-SL-01 through 31-SL-24) were collected from the interval between land surface to a depth of 2 feet below land surface (bls) in August 1992 at each of the Site 31 areas (see Figures 3-1, 3-2, and 3-3). Additional surface soil samples (Phase IIB) from other random locations were collected to confirm the presence or absence of chemicals previously detected and to characterize the nature and extent of contamination.

The Phase IIB surface soil samples were collected in December 1995 at locations (designated 31S001 through 31S019, respectively) shown on Figures 3-1, 3-2 and 3-3. In addition to providing unbiased sampling locations, these samples also support the ecological and HHRAs. Locations at each site except for Site 31A, were determined using the systematic sampling method where a point is chosen

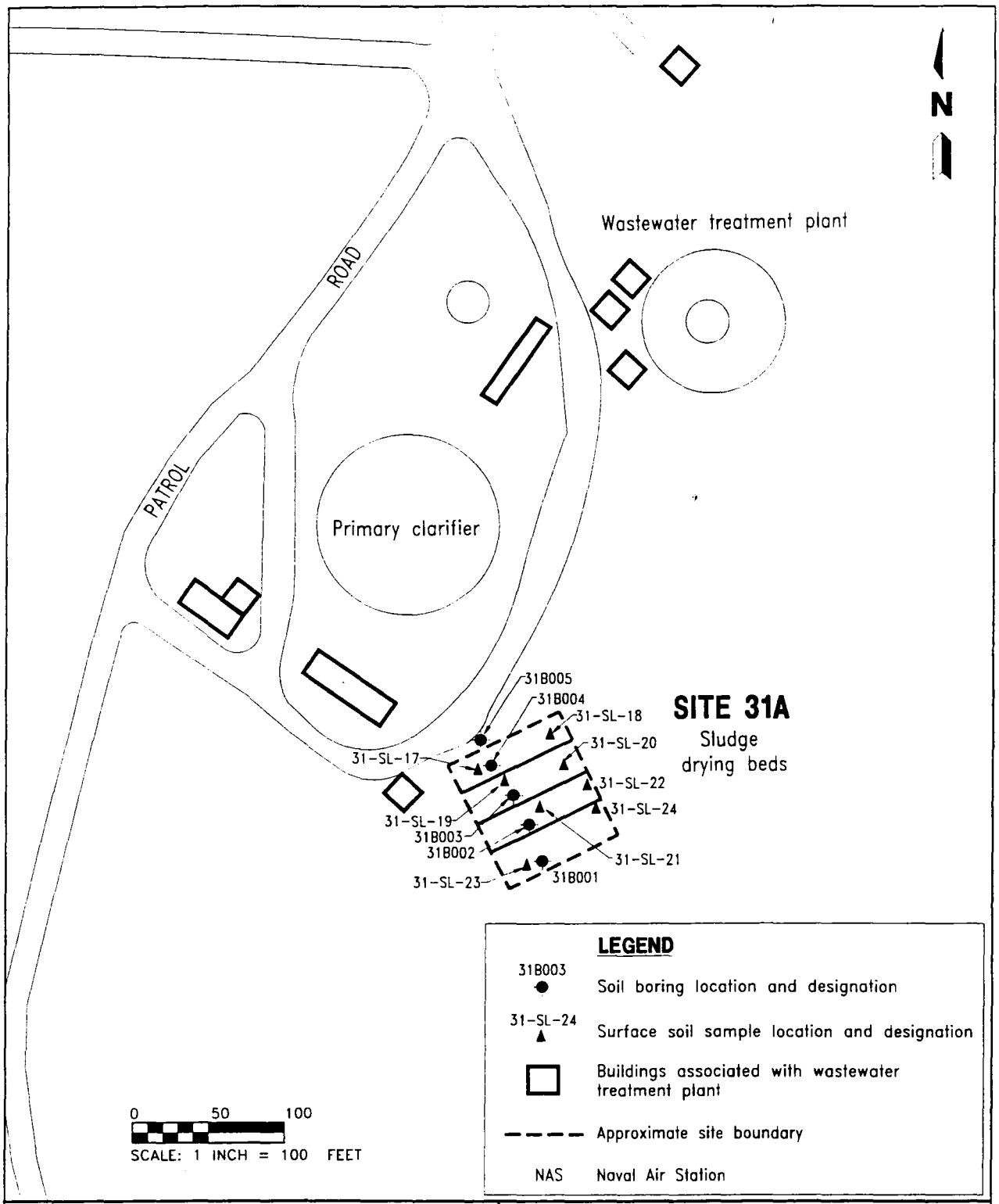

FIGURE 3-1
SITE 31A, LOCATIONS OF SOIL BORINGS AND SURFACE SOIL SAMPLES

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REMEDIAL INVESTIGATION REPORT
SITE 31, SLUDGE DRYING BEDS AND DISPOSAL AREAS

NAS WHITING FIELD
MILTON, FLORIDA

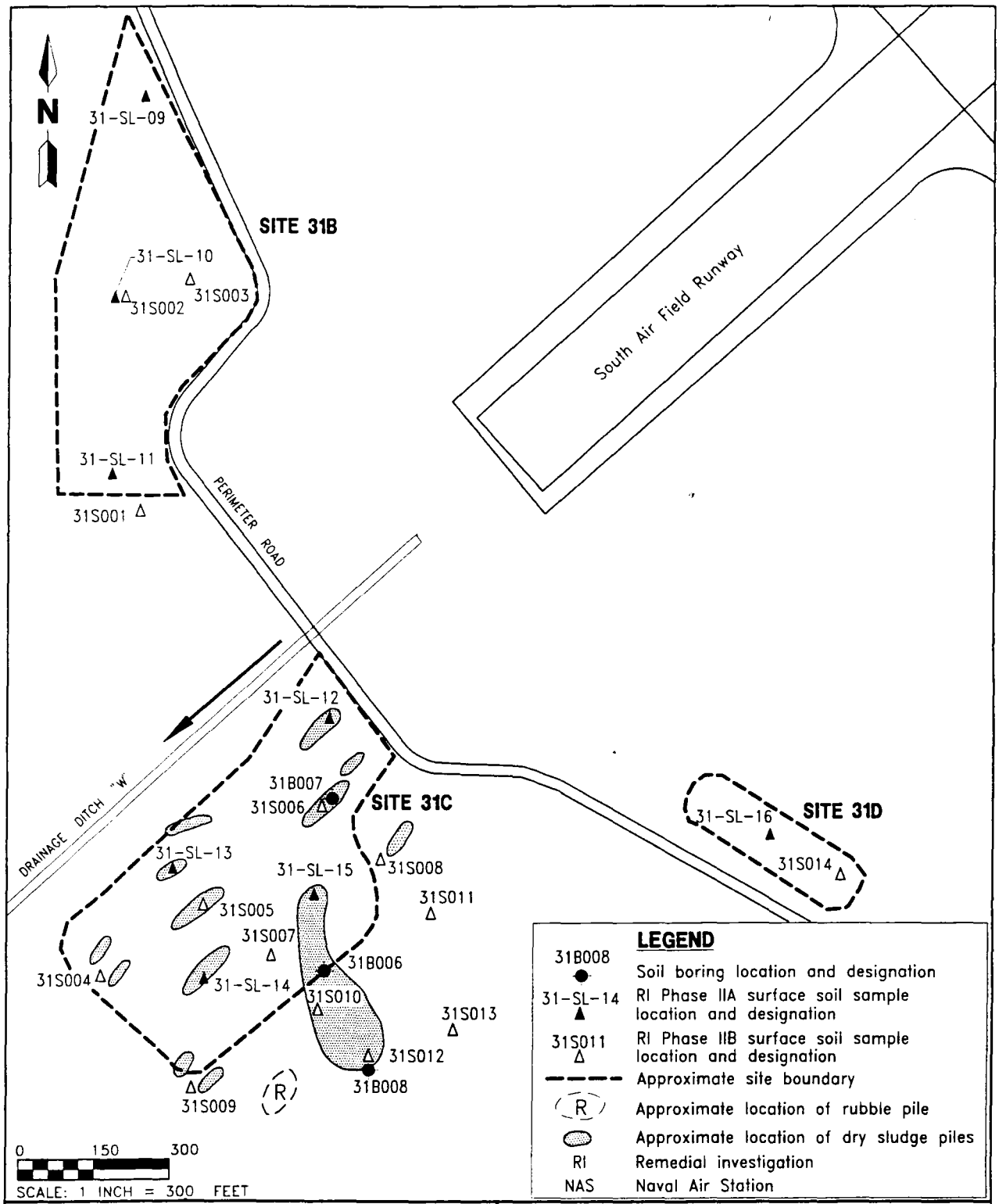

FIGURE 3-2
SITES 31B, 31C, AND 31D
LOCATIONS OF SOIL BORINGS
AND SURFACE SOIL SAMPLES

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REMEDIAL INVESTIGATION REPORT
SITE 31, SLUDGE DRYING BEDS
AND DISPOSAL AREAS

NAS WHITING FIELD
MILTON, FLORIDA

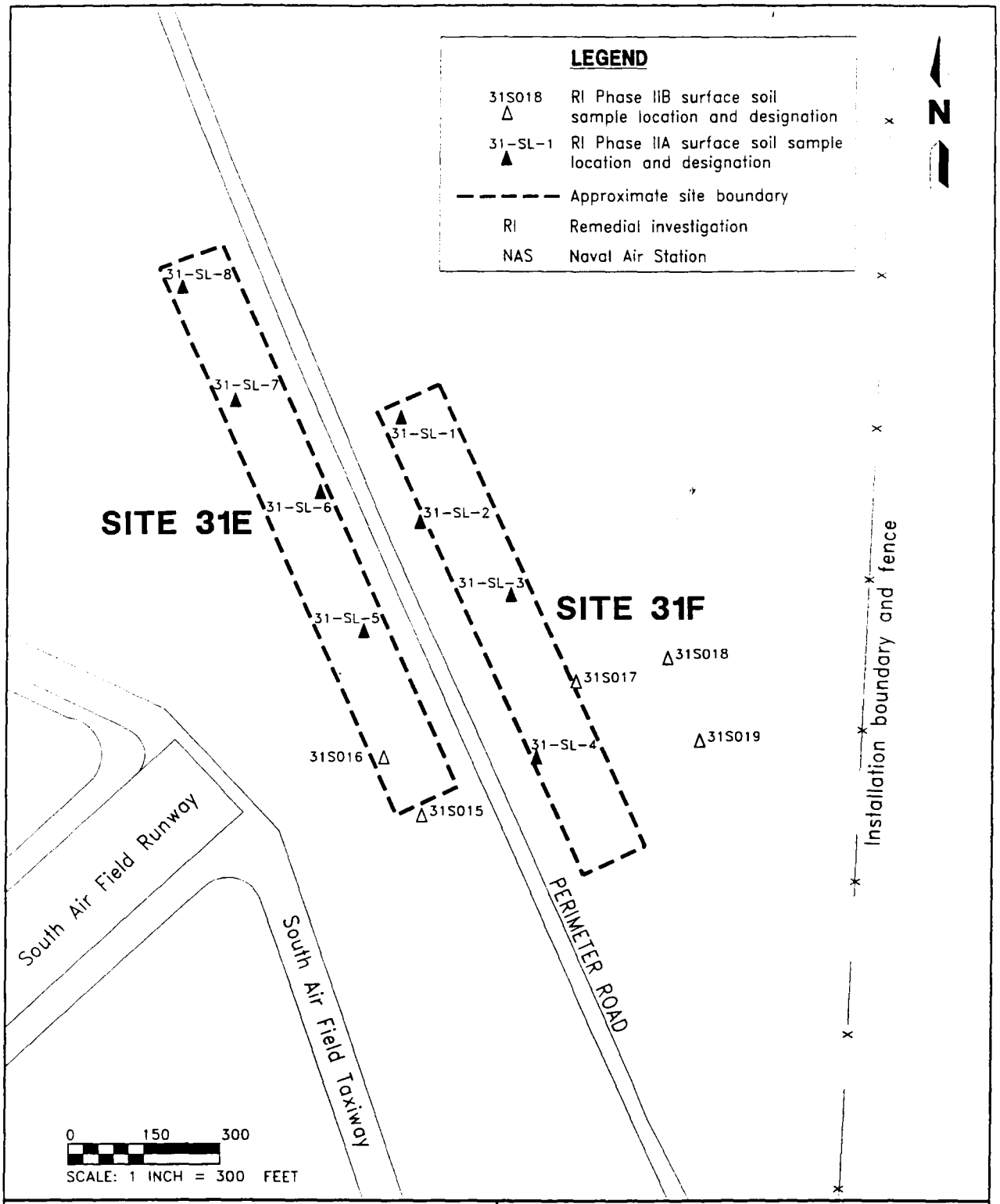

FIGURE 3-3
SITES 31E AND 31F, LOCATIONS OF SURFACE SOIL SAMPLES

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REMEDIAL INVESTIGATION REPORT SITE 31, SLUDGE DRYING BEDS AND DISPOSAL AREAS

NAS WHITING FIELD MILTON, FLORIDA

at random along a transect, and then samples are collected at equidistant intervals (Gilbert, 1987; USEPA, 1989a).

The Phase IIB 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 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 samples across the installation from each USDA soil type identified at NAS Whiting Field. These data are presented in Subsection 3.3.1 of the GIR (HLA, 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. Background samples associated with the Troup Loamy Sand soil type are presented in Table 3-8 and samples associated with the Dothan/Lucy/Bonifay soil types are presented in Table 3-14 in Subsection 3.3.1 of the GIR (HLA, 1998).

Surface soil sample analytical results were compared to twice the arithmetic mean of analyte concentrations detected in background surface soil samples associated with the Troup Loamy Sand soil types for Sites 31A, 31C, 31E, and 31F; the combined data set associated with the Troup Loamy Sand and Bonifay Loamy Sand soil types for Site 31B; the residential and industrial values for the USEPA Region III Risk-Based Concentrations (RBCs); and the Florida Soil Cleanup Goals. The combined data set associated with the Troup Loamy Sand and Dothan Fine Sandy Loam soil types was used for Site 31D. The statistical summary for the combined surface soil type background data for Sites 31B and 31D and the surface soil sampling results are discussed in Section 5.3 of this report. Soil sample analytical data are presented in Appendix A of this report.

3.2 SUBSURFACE SOIL ASSESSMENT. The RI subsurface investigation at Site 31 included hand-auger soil sampling, split-spoon sampling conducted during a soil boring operation, and split-spoon sampling conducted during monitoring well installations.

Detailed lithologic descriptions for all borings and monitoring wells are presented in Appendix B and for adjacent sites in Phase IIA Technical Memorandum No. 2, Geologic Assessment (ABB-ES, 1995b). A summary of the Site 31 lithology descriptions from Phase IIB is also presented in Section 5.1 of this report.

Subsurface soil samples from Site 31 were compared to a background subsurface soil data set for NAS Whiting Field and the industrial values for the USEPA Region III RBCs, and the Florida Soil Cleanup Goals. The background subsurface soil data set is presented in Subsection 3.3.1 of the GIR (HLA, 1998). Table 3-18 in the GIR presents a statistical summary of the background subsurface soil data at NAS Whiting Field (HLA, 1998).

3.2.1 Hand-Auger Soil Sampling Five subsurface soil samples (designated 31B00101 through 31B00501) were collected at shallow depths (ranging from 1.5 to 3 feet bls) with a hand-auger at Site 31A. Sampling methodology was followed as

presented in Paragraph 2.1.3.3 of the GIR (HLA, 1998). A subsurface soil sample was collected using a decontaminated, stainless-steel auger from within each sludge drying bed and also from a location outside the sludge drying beds (Figure 3-1).

3.2.2 Split-Spoon Sampling Fifteen subsurface soil samples (31B00601 to 31B00605, 31B00701 to 31B00705, and 31B00801 to 31B00805) were collected at Site 31C on May 21, 1996. The samples were collected at 5-foot intervals (5 to 7, 10 to 12, 15 to 17, 20 to 22, and 25 to 27 feet bls) from soil borings 31B006, 31B007, and 31B008 located at Site 31C (see Figure 3-2).

Subsurface soil samples were compared to the subsurface soil background sample concentrations to assess if detected analyte concentrations exceeded naturally occurring concentrations. Subsurface soil background concentrations are presented in Table 3-18 of the GIR (HLA, 1998). Sampling results are discussed in Section 5.4 of this report. Sampling methodology was followed as presented in Paragraph 2.1.3.5 of the GIR (HLA, 1998).

In addition to the soil boring location, lithologic data were also obtained by collecting subsurface soil samples at monitoring well locations (see Figure 3-4). A 2-foot split-spoon sample was collected for visual inspection by an HLA geologist. All data were entered into a bound logbook. Detailed soil descriptions and other pertinent data are presented in Section 5.1 and Appendix B of this report. Split-spoon samples were generally collected at 5-foot intervals during drilling of the monitoring wells. Monitoring well installations were conducted in conjunction with the hydrogeologic and groundwater investigations at Site 31C.

3.3 GROUNDWATER ASSESSMENT. Groundwater assessment activities included collecting groundwater samples from monitoring wells installed in Phase IIB.

Six groundwater monitoring wells (WHF-31-1S, WHF-31-2S, WHF-31-3S, WHF-31-4S, WHF-31-4I, and WHF-31-4D; Figure 3-4) were installed in 1996 during the Phase IIB investigation. Groundwater samples were collected during Phase IIB from these monitoring wells in October to November 1996 and in July 1997. The monitoring well locations are presented on Figure 3-4, and the groundwater analytical data are discussed in Section 5.5. The groundwater analytical data are presented in Appendix C of this report.

Purging and sampling methodology was followed as presented in Paragraph 2.1.7.2 of the GIR (HLA, 1998). Groundwater samples were collected from the six monitoring wells using low-flow sampling techniques. The groundwater samples were analyzed for CLP (NEESA Level D) TCL VOCs, SVOCs, pesticides and PCBs, and TAL inorganic analytes. Samples for TAL inorganic analytes 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, hardness, ammonia nitrates, total

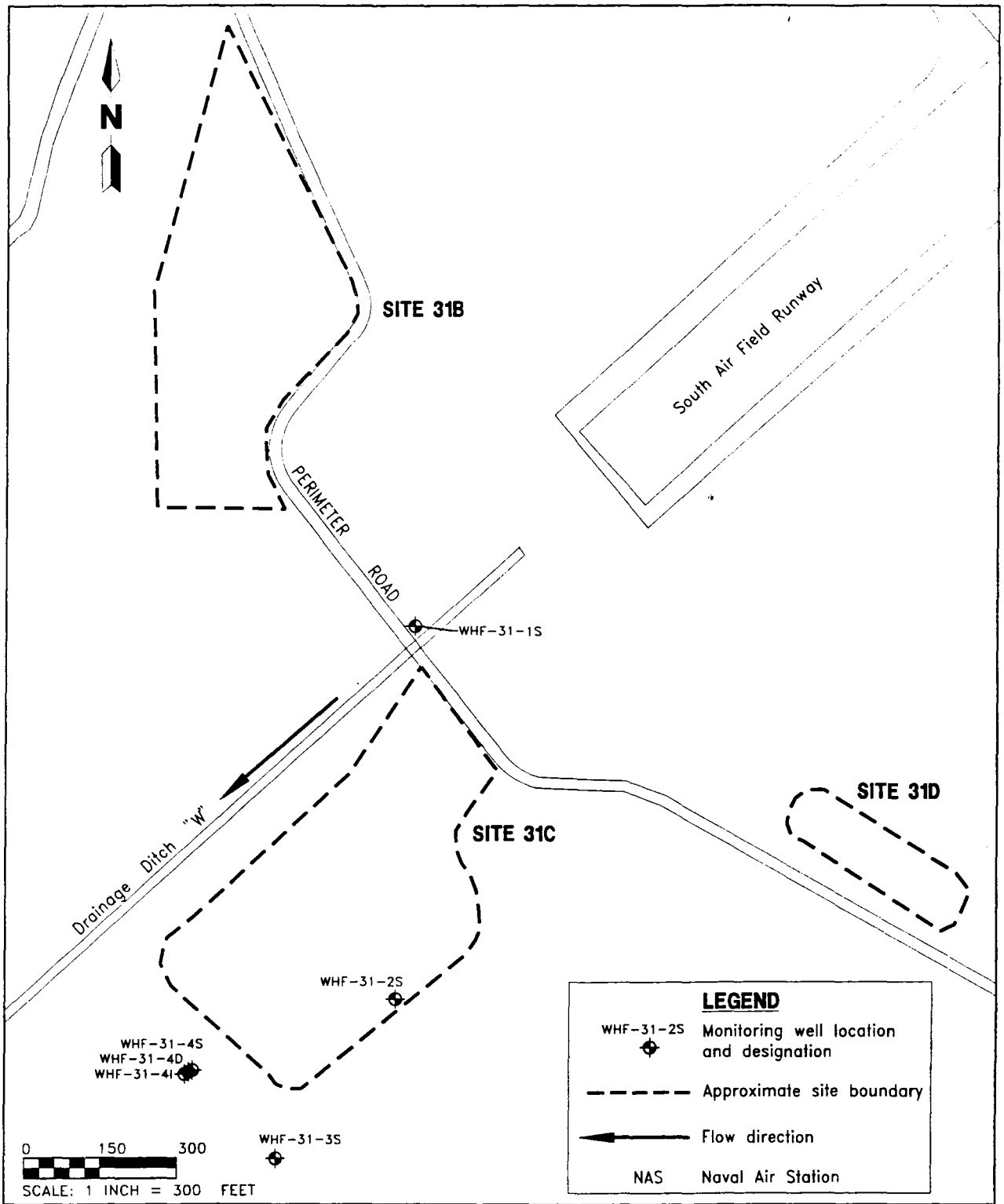

FIGURE 3-4
SITE 31C, LOCATION OF MONITORING WELLS

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REMEDIAL INVESTIGATION REPORT
SITE 31, SLUDGE DRYING BEDS AND DISPOSAL AREAS

NAS WHITING FIELD
MILTON, FLORIDA

Kjeldahl nitrogen, nitrate and nitrite, pH, phosphorous, total dissolved solids, and total organic carbon. Water quality parameter data are presented in Section 5.5 of this report.

3.4 HYDROGEOLOGIC ASSESSMENT. The hydrogeologic assessment of Site 31 also included several adjacent sites. The area investigated included Sites 15 and 16 (Southwest Disposal Areas) and Sites 9, 10, 11, 12, 13, and 14 (Southeast Disposal Areas). The hydrogeologic field investigation activities included the collection of water-level data from site monitoring wells and conducting slug test analyses on monitoring wells in each of these areas. Results of the Phase IIA hydrological assessment are presented in Phase IIA Technical Memorandum No. 4, Hydrogeologic Assessment (ABB-ES, 1995c). Monitoring well construction details are presented in Table 3-1. Results of the hydrogeologic assessment are also presented in Section 5.2 and in Appendix D of this report.

Table 3-1
Summary of Remedial Investigation and Feasibility Study
Monitoring Well Construction Details

Remedial Investigation Report
Site 31, Sludge Drying Beds and Disposal Areas
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)	Surface Casing Length (feet bls)
Basewide Monitoring Wells							
WHF-1466-6DD	IIB	2	172.86	172.86	218	208 to 218	NA
WHF-1466-6D	IIB	2	173.21	173.05	190	180 to 190	NA
WHF-1466-6I	IIB	2	173.01	173.06	160	150 to 160	NA
WHF-1466-6S	IIB	2	173.40	173.09	131	116 to 131	NA
WHF-1466-7S	IIB	2	--	172.26	131	116 to 131	NA
WHF-1466-21D	IIB	2	--	61.44	96	86 to 96	NA
WHF-1466-21I	IIB	2	--	61.75	69	59 to 69	NA
WHF-1466-21S	IIB	2	--	62.39	40	25 to 40	NA
WHF-1466-22D	IIB	2	--	139.11	167	157 to 167	NA
WHF-1466-22I	IIB	2	--	139.23	140	130 to 140	NA
WHF-1466-22S	IIB	2	--	139.36	108	93 to 108	NA
WHF-1466-23D	IIB	2	128.10	127.63	150	140 to 150	NA
WHF-1466-23I	IIB	2	127.83	128.22	120.57	110 to 120	NA
WHF-1466-23S	IIB	2	128.63	128.44	90.14	75 to 90	NA
Southwest Disposal Area							
Site 15, Southeast Landfill							
WHF-15-1	VS	4	64.17	66.35	73.20	63 to 73	NA
WHF-15-2I	IIA	2	57.24	60.10	63.20	53 to 63	NA
WHF-15-2S	IIA	2	57.18	59.58	32.90	17 to 32	NA
WHF-15-2D	IIA	2	57.05	59.39	112.44	107 to 112	NA
WHF-15-3D	IIA	2	67.84	69.44	119.48	109 to 119	NA
WHF-15-3I	IIA	2	67.26	69.69	87.83	77 to 87	NA
WHF-15-3S	IIA	2	67.35	69.29	37.94	22 to 37	NA
WHF-15-4S	IIA	2	140.62	143.29	109.15	94 to 109	NA
WHF-15-5D	IIA	2	102.81	106.11	128.38	115 to 125	NA
WHF-15-5I	IIA	2	102.05	105.17	98	85 to 95	NA
WHF-15-5S	IIA	2	101.73	104.14	68.18	58 to 68	NA
WHF-15-6D	IIA	2	72.56	75.08	123.36	113 to 123	NA
WHF-15-6S	IIA	2	71.87	74.29	43.73	28 to 43	NA
WHF-15-7D	IIB	2	116.36	119.49	147.53	136 to 146	NA
WHF-15-7I	IIB	2	116.59	119.85	121.50	106 to 116	NA
WHF-15-7S	IIB	2	116.96	120.18	88.85	71 to 86	NA

See notes at end of table.

Table 3-1 (Continued)
Summary of Remedial Investigation and Feasibility Study
Monitoring Well Construction Details

Remedial Investigation Report
Site 31, Sludge Drying Beds and Disposal Areas
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)	Surface Casing Length (feet bls)
Southwest Disposal Area							
Site 15, Southeast Landfill (Continued)							
WHF-15-8D	IIB	2	76.19	79.08	115	103 to 113	NA
WHF-15-8I	IIB	2	76.69	79.48	85.2	73 to 83	NA
WHF-15-8S	IIB	2	77.03	79.67	55	38 to 53	NA
Site 16, Open Disposal and Burning Area							
WHF-16-1	VS	4	47.47	50.04	43.00	33 to 43	NA
WHF-16-2	I	4	79.38	82.19	74.20	69 to 74	NA
WHF-16-2I	IIA	2	78.02	80.60	130.14	120 to 130	NA
WHF-16-2S	IIA	2	80.77	83.66	49.80	34 to 49	NA
WHF-16-3D	IIA	2	48.64	51.40	118.08	108 to 118	NA
WHF-16-3I	IIA	2	48.73	51.31	52.87	47 to 52	NA
WHF-16-3II	IIA	2	48.60	51.22	78.91	73 to 78	NA
WHF-16-3S	IIA	2	48.60	51.69	23.25	8 to 23	NA
WHF-16-4D	IIA	2	49.88	52.87	122.54	112 to 122	0 to 65
WHF-16-4II	IIA	2	50.62	53.01	64.80	54 to 64	NA
WHF-16-4S	IIA	2	52.19	54.79	22.38	7 to 22	NA
WHF-16-5	IIA	2	--	37.54	13.50	3 to 13	NA
WHF-16-6D	IIB	2	53.58	56.77	62.10	50 to 60	NA
WHF-16-6S	IIB	2	53.67	56.57	26	10 to 25?	NA
WHF-16-7D	IIB	2	35.19	38.05	75.20	63 to 73	NA
WHF-16-7I	IIB	2	35.14	38.17	43.50	33 to 43	NA
WHF-16-7S	IIB	2	35.05	38.27	13.00	3 to 13	NA
Site 31C, Sludge Disposal Area							
WHF-31-1S	IIB	2	149.25	149.70	115.35	100 to 115	NA
WHF-31-2S	IIB	2	119.03	122.37	88.80	73 to 88	NA
WHF-31-3S	IIB	2	102	105.49	75.70	60 to 75	NA
WHF-31-4D	IIB	2	104.05	106.63	144.20	134 to 144	NA
WHF-31-4I	IIB	2	104.22	107.14	105.40	95 to 105	NA
WHF-31-4S	IIB	2	104.03	106.52	82.40	67 to 82	NA

See notes at end of table.

Table 3-1 (Continued)
Summary of Remedial Investigation and Feasibility Study
Monitoring Well Construction Details

Remedial Investigation Report
Site 31, Sludge Drying Beds and Disposal Areas
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)	Surface Casing Length (feet bls)
Southeast Disposal Area							
Site 9, Waste Fuel Disposal Pit							
WHF-9-1	VS	4	144.66	146.55	118.40	108 to 118	NA
WHF-9-2	I	4	158.11	161.07	124.35	114 to 124	NA
WHF-9-3S	IIA	2	147.92	150.85	108.24	93 to 108	0 to 77
Site 10, Southeast Open Disposal Area (A)							
WHF-10-1	VS	4	144.19	146.73	118.20	108 to 118	NA
WHF-10-2	IIA	2	147.78	150.75	113.14	98 to 113	NA
Site 11, Southeast Open Disposal Area (B)							
WHF-11-1	VS	4	122.48	124.86	128.40	118 to 128	NA
WHF-11-1S	IIA	2	114.91	116.65	54.40	39 to 54	NA
WHF-11-2	I	4	145.19	148.12	125.84	120 to 125	NA
WHF-11-3	IIA	2	114.29	117.19	73.16	58 to 73	0 to 46
WHF-11-4D	IIB	2	--	125.79	109.00	99 to 109	NA
WHF-11-4S	IIB	2	--	129.43	79.00	64 to 79	NA
Site 12, Tetraethyl Lead Disposal Area							
WHF-12-1	VS	4	134.20	136.40	113.40	103 to 113	NA
WHF-12-2	IIB	2	--	135.56	85	70 to 85	NA
Site 13, Sanitary Landfill							
WHF-13-1	VS	4	100.40	102.66	122.90	112 to 122	NA
WHF-13-1I	IIB	2	--	109.17	93	83 to 93	NA
WHF-13-1S	IIA	2	104.61	108.97	61.30	46 to 61	NA
WHF-13-2S	IIA	2	99.94	102.86	72.41	57 to 72	0 to 42
WHF-13-3	IIB	2	81.37	81.44	41	26 to 41	NA
WHF-13-4	IIB	2	80.41	80.37	41	26 to 41	NA
Site 14, Short-Term Sanitary Landfill							
WHF-14-1	VS	4	137.83	139.69	153.20	143 to 153	NA
WHF-14-2	IIA	2	142.86	145.80	118.30	103 to 118	0 to 94

Notes: RI = Remedial Investigation.
msl = mean sea level.
TOC = top-of-casing.
BTOC = below top of casing.
bls = below land surface.
IIB = Remedial Investigation Phase IIB.
NA = not applicable.
-- = land surface elevation not available.
VS = Verification Study.
IIA = Remedial Investigation Phase IIA.
I = Remedial Investigation Phase I.

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 31 were managed and evaluated. Section 4.1 describes the analytical program and data management for the RI at Site 31. 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 samples collected during Phase IIA of the RI were qualified according to USEPA functional guidelines for evaluation of organic (USEPA, 1991b) and inorganic (USEPA, 1988a) 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/FS *Phase IIA Technical Memorandum No. 3* (ABB-ES, 1994).

4.1 ANALYTICAL PROGRAM. Environmental and QC samples collected during the Phase IIB of the RI at Site 31 were analyzed using field screening and off-site laboratory analytical methods. QC data for Site 31 are included with sample delivery groups (SDGs) WF010, WF012, WF014, WF017, WF036, and WF046 and are presented in Appendix E. Environmental sampling locations are presented in Chapter 3.0 of this report, and sample results are presented in Chapter 5.0 and Appendix A (soil data) and Appendix C (groundwater data).

Environmental samples (surface soil, subsurface soil, and groundwater) were collected and analyzed by an off-site laboratory using USEPA CLP methodology for analysis of TCL VOCs, SVOCs, pesticides, and PCBs, and TAL 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 (HLA, 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, 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 Workplans (E. C. Jordan Co., Inc., 1990 and ABB-ES, 1995a).
- NEESA guidance document 20.2-047B, *Sampling and Chemical Analysis Quality Assurance Requirements for the Navy Installation Program* (NEESA, 1988).
- USEPA, *Contract Laboratory Program National Functional Guidelines for Organic Data Review*, February 1994 (USEPA, 1994a).
- USEPA, *Contract Laboratory Program 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 (HLA, 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 (HLA, 1998). The Site 31 Phase IIB soil and groundwater analytical data were validated by Laboratory Data Consultants, Inc. (LDC) of Carlsbad, California, in 1996. The Site 31 Phase IIB surface soil data include SDGs WF010 and WF012. The Site 31 Phase IIB subsurface soil data include SDGs WF014 and WF017. The Site 31 Phase IIB groundwater data include SDGs WF036 and WF046. 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 RI sampling event is presented in Table 4-1 and summarized below.

The RPD criteria were not met for six environmental samples (four soil and two groundwater) and associated duplicates for two organics (acetone and di-*n*-butylphthalate) and several inorganic analytes. None of the organic analytical results were qualified during the data validation process based on RPD criteria for environmental and associated duplicate sample pairs.

The RPD criteria for nine inorganic analytes (arsenic, cadmium, chromium, cobalt, copper, magnesium, potassium, silver, and zinc) in soil samples from some SDGs may not have been met because of sample heterogeneity. The inorganic analytical results were not qualified during the data validation process based on the RPD evaluation criteria alone.

The RPD criteria for one VOC (di-*n*-butylphthalate) and two inorganic analytes (cobalt and zinc) were not met for groundwater samples and the associated duplicate in each SDG. The RPD criteria for cobalt were not met for one groundwater sample (54G00101) and the associated duplicate in SDG WF036. The RPD criteria for di-*n*-butylphthalate and zinc were not met for one groundwater sample (31G00101) and the associated duplicate in SDG WF046.

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. The evaluation of recoveries for MS/MSD samples is presented in Table 4-2 and summarized below.

The percent recovery for some of the soil and groundwater 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, one pesticide compound, and inorganic analytes were qualified based on the evaluation of percent recovery.

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

Remedial Investigation Report
Site 31, Sludge Drying Beds and Disposal Areas
Naval Air Station Whiting Field
Milton, Florida

SDG Number	Sample ID	Compound	Sample Concentration	Duplicate Concentration	RPD	Control Limits
SOIL						
WF010						
Volatile Organic Compounds (µg/kg)	31S01501	Acetone	ND	5	NC	50
Inorganic Analytes (mg/kg)	31S01501	Aluminum	9,620	8,270	15	20
		Arsenic	1.4	1.9	30	30
		Barium	14.6	12.2	18	30
		Beryllium	0.17	0.15	13	30
		Calcium	112	103	8	20
		Chromium	6.7	6.0	11	30
		Cobalt	0.80	1.2	40	30
		Copper	5.5	4.2	27	30
		Iron	4,730	4,380	8	20
		Lead	5.3	5.4	2	20
		Magnesium	154	114	30	30
		Manganese	183	172	6	20
		Mercury	0.01	0.01	0	30
		Nickel	3.9	3.4	13	30
		Potassium	ND	197	NC	30
		Vanadium	12.8	11.3	12	30
		Zinc	6.8	5.0	30	30
		Cyanide	ND	ND	NC	30

See notes at end of table.

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

Remedial Investigation Report
Site 31, Sludge Drying Beds and Disposal Areas
Naval Air Station Whiting Field
Milton, Florida

SDG Number	Sample ID	Compound	Sample Concentration	Duplicate Concentration	RPD	Control Limits
SOIL						
WF012						
Volatile Organic Compounds (µg/kg)	31S00501	Acetone	9	8	12	50
Inorganic Analytes (mg/kg)	31S00501	Aluminum	4,500	6,050	29	20
		Arsenic	1.3	1.2	8	30
		Barium	6.6	8.6	26	30
		Calcium	5,850	6,250	7	20
		Chromium	2.8	3.8	30	30
		Cobalt	ND	1.2	NC	30
		Copper	2.2	3.0	31	30
		Iron	2,470	2,840	14	20
		Lead	3.2	2.9	10	20
		Magnesium	80.1	138	53	30
		Manganese	87.0	95.3	9	20
		Nickel	1.9	2.2	15	30
		Potassium	81.9	115	34	30
		Selenium	0.18	ND	NC	30
		Sodium	192	175	9	30
		Vanadium	5.9	7.2	20	30
		Zinc	3.9	5.2	28	30
		Cyanide	0.09	ND	NC	30

See notes at end of table.

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

Remedial Investigation Report
Site 31, Sludge Drying Beds and Disposal Areas
Naval Air Station Whiting Field
Milton, Florida

SDG Number	Sample ID	Compound	Sample Concentration	Duplicate Concentration	RPD	Control Limits
SOIL						
WF014						
Volatile Organic Compounds (µg/kg)	31B00201	Acetone	3	11 U	NC	50
Semivolatile Organic Compounds (µg/kg)	31B00201	bis(2-Ethylhexyl)phthalate	370 U	48	NC	50
Inorganic Analytes (mg/kg)	31B00201	Aluminum	4,360	4,050	7	20
		Arsenic	1.0	1.2	18	30
		Barium	4.7	4.3	9	30
		Beryllium	0.05	ND	NC	30
		Cadmium	0.21	0.34	47	30
		Calcium	107	121	12	30
		Chromium	2.6	2.1	21	30
		Cobalt	0.76	ND	NC	30
		Copper	8.5	8.4	1	30
		Iron	2,960	2,750	7	20
		Lead	2.9	2.9	0	30
		Magnesium	81.1	72.0	12	30
		Manganese	8.0	7.5	7	30
		Mercury	0.04	0.04	0	30
		Nickel	1.8	1.6	12	30
		Potassium	88.8	114	25	30
		Sodium	175	183	5	30
		Vanadium	6.0	5.3	12	30
		Zinc	7.1	6.4	10	30

See notes at end of table.

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

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Naval Air Station Whiting Field
Milton, Florida

SDG Number	Sample ID	Compound	Sample Concentration	Duplicate Concentration	RPD	Control Limits
SOIL						
WF017						
Volatile Organic Compounds (µg/kg)	31B00601	Acetone	3	11	114	50
Semivolatile Organic Compounds (µg/kg)	31B00601	Di-*n*-butylphthalate	39	350 U	NC	50
		bis(2-Ethylhexyl)phthalate	110	79	33	50
Pesticides and PCBs (µg/kg)	31B00601	gamma-Chlordane	1.5	1.1	31	50
Inorganic Analytes (mg/kg)	31B00601	Aluminum	1,580	1,760	11	20
		Arsenic	0.44	0.29	41	30
		Barium	7.4	9.6	26	30
		Beryllium	0.07	0.07	0	30
		Cadmium	0.52	0.68	27	30
		Calcium	237	297	22	20
		Chromium	3.9	5.4	32	30
		Copper	11.4	13.6	18	30
		Iron	1,120	1,310	16	20
		Lead	6.3	7.0	11	30
		Magnesium	83.5	98.7	17	30
		Manganese	9.2	11.3	20	20
		Mercury	0.07	0.08	13	30
		Selenium	0.14	ND	NC	30
		Silver	1.1	1.7	43	30
		Sodium	23.5	26.3	11	30
		Vanadium	2.2	2.4	9	30
		Zinc	11.0	15.9	36	30
		Cyanide	0.10	ND	NC	30

See notes at end of table.

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

Remedial Investigation Report
Site 31, Sludge Drying Beds and Disposal Areas
Naval Air Station Whiting Field
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SDG Number	Sample ID	Compound	Sample Concentration	Duplicate Concentration	RPD	Control Limits
GROUNDWATER						
WF036						
Semivolatile Organic Compounds (µg/ℓ)	54G00101	Diethylphthalate	1	10 U	NC	40
		Di-*n*-butylphthalate	1	10 U	NC	40
Inorganic Analytes (µg/ℓ)	54G00101	Aluminum	87.6	91.6	4	25
		Barium	75.2	74.3	1	25
		Beryllium	0.18	0.18	0	25
		Calcium	1,680	1,660	1	25
		Chromium	1.2	1.0	2	25
		Cobalt	0.90	1.4	43	25
		Magnesium	1,950	1,920	2	25
		Manganese	13.9	12.9	7	25
		Mercury	0.02	0.01 U	NC	25
		Potassium	2,410	2,530	5	25
		Sodium	2,110	2,070	2	25
		Zinc	4.5	3.5	25	25

See notes at end of table.

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

Remedial Investigation Report
Site 31, Sludge Drying Beds and Disposal Areas
Naval Air Station Whiting Field
Milton, Florida

SDG Number	Sample ID	Compound	Sample Concentration	Duplicate Concentration	RPD	Control Limits
GROUNDWATER						
WF046						
Semivolatile Organic Compounds (μg/ℓ)	31G00101	Di-*n*-butylphthalate	6	3	67	40
Inorganic Analytes (μg/ℓ)	31G00101	Aluminum	96.0	91.1	5	25
		Barium	22.6	22.5	0.4	25
		Calcium	857	851	0.7	25
		Copper	1.3 U	1.4	NC	25
		Iron	120	103	15	25
		Magnesium	662	675	2	25
		Manganese	9.7	9.9	2	25
		Potassium	1,910	2,200	15	25
		Sodium	1,760	1,890	7	25
		Vanadium	1.8	1.7 U	NC	25
		Zinc	3.5	9.8	95	25

Notes: SDG = sample delivery group.
ID = identification.
RPD = relative percent difference.
μg/kg = micrograms per kilogram.
ND = not detected.
NC = not calculable.
mg/kg = milligrams per kilogram.
PCB = polychlorinated biphenyl.
U = the analyte was not detected above the reported sample instrument detection level.
μg/ℓ = micrograms per liter.
D_1 = sample concentration.
D_2 = duplicate concentration.

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

Table 4-2
Accuracy Summary for MS/MSD Samples

Remedial Investigation Report
Site 31, Sludge Drying Beds and Disposal Areas
Naval Air Station Whiting Field
Milton, Florida

SDG Number	MS/MSD Sample	Analyte	% Recovery MS/MSD	Control Limits
WF010 - Soil				
Semivolatile Organic Compounds	31S01501	4-Chloro-3-methylphenol	104/--	26 to 103
		2,4-Dinitrotoluene	94/--	28 to 89
Inorganic Analytes[1]	31S01501	Antimony	73.8	75 to 125
WF012 - Soil				
Semivolatile Organic Compounds	31S00501	4-Nitrophenol	120/115	11 to 114
WF014 - Soil				
Semivolatile Organic Compounds	BKS00201	Pentachlorophenol	133/136	17 to 109
		4-Nitrophenol	--/132	11 to 114
WF017 - Soil				
Semivolatile Organic Compounds	31B00601	N-Nitroso-di-*n*-propylamine	33/--	41 to 126
		1,2,4-Trichlorobenzene	33/--	38 to 107
Inorganic Analytes[1]	31B00601	Lead	179.2/--	75 to 125
WF036 - Groundwater				
Semivolatile Organic Compounds	54G00101	4-Nitrophenol	101/81	10 to 80
WF046 - Groundwater				
Semivolatile Organic Compounds	31G00101	4-Nitrophenol	88/96	10 to 80
Pesticides and PCBs	31G00101	Endrin	127/--	56 to 121

[1] MSD analyses are generally not performed for inorganic analysis and, therefore, only the percent recovery for the MS is reported.

MS/MSD = matrix spike and matrix spike duplicate.
SDG = sample delivery group.
% = percent.
-- = not detected
PCB = polychlorinated biphenyl.

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

Remedial Investigation Report
Site 31, Sludge Drying Beds and Disposal Areas
Naval Air Station Whiting Field
Milton, Florida

SDG Number	Sample ID	Spiked Analyte	Surrogate Recovery (%R)[1]	QC Limits (percent)
WF010	31S00101	Tetrachloro-m-xylene	57/56	60 to 150
WF012	31R00201	Decachlorobiphenyl	54/43	60 to 150
WF012	31S00901	Decachlorobiphenyl	45/40	60 to 150
WF012	31S01201	Decachlorobiphenyl	48/50	60 to 150
WF012	31S01301	Decachlorobiphenyl	46/--	60 to 150
WF014	BKR00101	Decachlorobiphenyl	43/39	60 to 150
WF017	31R00101	Decachlorobiphenyl	27/27	60 to 150
WF017	31B00603	Tetrachloro-m-xylene	46/49	60 to 150
WF017	31B00603	Decachlorobiphenyl	54/53	60 to 150
WF017	31B00604	Tetrachloro-m-xylene	52/54	60 to 150
WF017	31B00604	Decachlorobiphenyl	58/--	60 to 150
WF036	54G00101	Tetrachloro-m-xylene	57/52	60 to 150
WF046	31G00101	Tetrachloro-m-xylene	48/55	60 to 150
WF046	31R03301	Tetrachloro-m-xylene	59/--	60 to 150

[1] Reported as value for first column/second column.

Notes: QC = quality control.
SDG = sample delivery group.
ID = identification.
%R = percent recovery.
-- = second column value not reported.

A summary of the surrogate spike samples and the surrogate compounds that were outside control limits for the Phase IIB samples collected at Site 31 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 (HLA, 1998).

Initial calibrations are performed to make sure the instrument is capable of producing acceptable qualitative and quantitative data for compounds on the TCL for VOCs. Initial calibration demonstrates the instrument is capable of acceptable performance in the beginning of the analytical run and of producing a linear calibration curve. Continuing calibrations are performed to ensure that the instrument is capable of producing 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 analysis are measured by the percent Relative Standard Deviation (%RSD) for initial calibrations and the percent Difference (%D) for continuing calibrations. For inorganic analysis, the Initial Calibration Verification and continuing calibration verification are measured.

Table 4-4 summarizes the initial and continuing calibration details for the surface soil and groundwater samples collected at Site 31.

The evaluation of the %RSD for the initial calibrations and the %D for the continuing calibrations indicates the response factors for the system performance check compounds generally met the required criteria for VOCs, SVOCs, pesticides, and PCBs. Analytes exhibiting an RRF not meeting the minimum requirements were qualified as J/UJ.

4.2.3 Representativeness Representativeness is the degree to which the data obtained from an environmental sample accurately reflect the presence or absence of contamination at a site. Field QC samples (including source water blanks, equipment rinse blanks, and trip blanks) and laboratory QC samples (including method [organic analysis] 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 QC samples for the RI sampling event is presented in Table 4-5 and summarized below.

Trip Blanks. Acetone was detected in four of the eight trip blank samples at concentrations ranging from 4 to 12 micrograms per liter ($\mu g/\ell$). 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. Acetone (17 $\mu g/\ell$) and 1,2-dichloropropane (1 $\mu g/\ell$) were each detected in one of the four rinsate blanks. Two SVOCs, bis(2-ethylhexyl)phthalate and di-*n*-butylphthalate, were detected in one or more of the rinsate blank samples. Di-*n*-butylphthalate, if present, was not detected in associated samples at concentrations exceeding the detection

Table 4-4
Summary of Initial and Continuing Calibration for Site 31 Samples

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SDG	Date	Compound	Initial Calibration	Continuing Calibration	Qualifier
WF010	12/27/95	4-Nitrophenol	--	28.1	UJ
		Benzo(b)fluoranthene	--	31.4	UJ
		Indeno(1,2,3-cd)pyrene	--	32.8	UJ
	11/30/95	alpha-BHC	21.7	--	UJ
		alpha-BHC	20.3	--	UJ
WF012	1/11/96	Trichloroethene	--	27.7	UJ
		2-Hexanone	--	50.9	UJ
		1,1,2,2-Tetrachloroethane	--	34.2	UJ
	1/12/96	2-Hexanone	--	48.4	UJ
	1/13/96	Chloromethane	--	27.2	UJ
		Vinyl chloride	--	27.2	UJ
		Acetone	--	68.1	UJ
		2-Butanone	--	69.9	UJ
		1,2-Dichloroethane	--	29.6	UJ
		4-Methyl-2-pentanone	--	31.4	UJ
	1/15/96	Chloroethane	--	26.3	UJ
		Acetone	--	51.7	UJ/J
		2-Butanone	--	40.8	UJ
		1,2-Dichloroethane	--	35.4	UJ
	1/17/96	Endosulfan sulfate	24.0	--	UJ

See notes at end of table.

Table 4-4 (Continued)
Summary of Initial and Continuing Calibration for Site 31 Samples

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SDG	Date	Compound	Initial Calibration	Continuing Calibration	Qualifier
WF014	1/15/96	1,1-Dichloroethene	33.9	--	UJ
		Carbon disulfide	32.8	--	UJ
	1/14/96	Acetone	31.3	--	UJ/J
	1/16/96	Acetone	--	46.7	UJ/J
		Methylene chloride	--	32.2	UJ
		2-Butanone	--	54.2	UJ
		4-Methyl-2-pentanone	--	31.9	UJ
		2-Hexanone	--	60.0	UJ
	1/12/96	Acetone	--	36.7	UJ/J
	1/20/96	Benzo(k)fluoranthene	--	30.7	UJ/J
	1/31/96	4-Nitrophenol	--	38.2	UJ
		4-Nitroaniline	--	27.9	UJ
		Pentachlorophenol	--	29.4	UJ
		Benzo(g,h,i)perylene	--	35.3	UJ/J
	1/17/96	Endosulfan sulfate	24.0	--	UJ

See notes at end of table.

Table 4-4 (Continued)
Summary of Initial and Continuing Calibration for Site 31 Samples

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SDG	Date	Compound	Initial Calibration	Continuing Calibration	Qualifier
WF017	5/31/96	Chloromethane	48.8	26.5	UJ
	6/1/96	Chloromethane	42.0	--	UJ
	6/2/96	Chloromethane	--	37.6	UJ
	6/3/96	Chloromethane	--	33.4	UJ
	6/4/96	Chloromethane	--	64.3	UJ
		Chloroethane	--	37.9	UJ
		Chloromethane	--	62.2	UJ
	6/6/96	4-Nitroaniline	--	29.2	UJ
		Di-*n*-octylphthalate	--	25.2	UJ
	6/7/96	Butylbenzylphthalate	--	26.8	UJ
		3,3'-Dichlorobenzidine	--	32.9	UJ
		bis(2-Ethylhexyl)phthalate	--	27.4	UJ
	6/12/96	Endrin aldehyde	21.4	--	J
WF036	NA	Di-*n*-octylphthalate	--	30.0	J
		Di-*n*-octylphthalate	--	25.3	J
		alpha-BHC	23.9	--	J
WF046	7/31/97	alpha-BHC	20.3	--	J
		alpha-BHC	24.2	--	J
		gamma-BHC	21.9	--	J

Notes: Calibration values expressed as percent recovery.

SDG = sample delivery group.
-- = not detected.
UJ = the 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 = the analyte was positively identified and is reported as an approximate concentration.
NA = not available.

Table 4-5
Representativeness Summary for Site 31 Field Quality Control Samples

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Sample Identifier:	31T00101	31T00201	31R00101	31R00201	31T00201	31R00101
Sample Type:	Trip Blank	Trip Blank	Rinsate Blank	Rinsate Blank	Trip Blank	Rinsate Blank
Collection Date:	12-DEC-95	13-DEC-95	12-DEC-95	08-JAN-96	11-JAN-96	22-MAY-96
Laboratory Sample No.:	G8924005	G8938001	G8924006	RA855021	RA870018	RB592020
Volatile Organic Compounds (μg/ℓ)						
Acetone	10	12	--	--	--	17
Toluene	--	--	--	--	--	--
Methylene chloride	--	--	--	--	--	--
1,2-Dichloropropane	--	--	--	--	--	--
Semivolatile Organic Compounds (μg/ℓ)						
Di-*n*-butylphthalate	NA	NA	7	--	NA	6
bis(2-Ethylhexyl)phthalate	NA	NA	--	--	NA	6
Pesticides and PCBs (μg/ℓ)						
None detected						
Inorganic Analytes (μg/ℓ)						
Aluminum	NA	NA	56.5	--	NA	86.5
Barium	NA	NA	0.86	--	NA	2.3
Beryllium	NA	NA	0.42	--	NA	--
Calcium	NA	NA	18.7	--	NA	503
Chromium	NA	NA	--	--	NA	11.3
Copper	NA	NA	5.2	1.3	NA	1.4
Iron	NA	NA	35.6	21.2	NA	132
Lead	NA	NA	--	--	NA	0.60
Magnesium	NA	NA	--	--	NA	66.2
Manganese	NA	NA	--	--	NA	3.8
Sodium	NA	NA	--	40.3	NA	264
Zinc	NA	NA	3.2	3.0	NA	7.8
Cyanide	NA	NA	--	--	NA	--

See notes at end of table.

Table 4-5 (Continued)
Representativeness Summary for Site 31 Field Quality Control Samples

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Sample Identifier:	31T00301	31T03801	31R03301	31T06501	31T06601	31T06701
Sample Type:	Trip Blank	Trip Blank	Rinsate Blank	Trip Blank	Trip Blank	Trip Blank
Collection Date:	22-MAY-96	31-OCT-96	15-JUL-96	15-JUL-96	16-JUL-96	21-JUL-96
Laboratory Sample No.:	RB592021	MC262007	MW241002	ME241001	ME261001	ME305001
Volatile Organic Compounds (μg/ℓ)						
Acetone	4	--	--	4	--	--
Toluene	--	--	--	--	1	--
Methylene chloride	--	--	--	--	--	1
1,2-Dichloropropane	--	--	1	--	--	--
Semivolatile Organic Compounds (μg/ℓ)						
Di-*n*-butylphthalate	NA	NA	--	NA	NA	NA
bis(2-Ethylhexyl)phthalate	NA	NA	--	NA	NA	NA
Pesticides and PCBs (μg/ℓ)						
None detected						
Inorganic Analytes (μg/ℓ)						
Aluminum	NA	NA	--	NA	NA	NA
Barium	NA	NA	1.1	NA	NA	NA
Beryllium	NA	NA	--	NA	NA	NA
Calcium	NA	NA	126	NA	NA	NA
Chromium	NA	NA	--	NA	NA	NA
Copper	NA	NA	--	NA	NA	NA
Iron	NA	NA	4.4	NA	NA	NA
Lead	NA	NA	--	NA	NA	NA
Magnesium	NA	NA	--	NA	NA	NA
Manganese	NA	NA	0.40	NA	NA	NA
Sodium	NA	NA	65.6	NA	NA	NA
Zinc	NA	NA	5.4	NA	NA	NA
Cyanide	NA	NA	--	NA	NA	NA

Notes: μg/ℓ = micrograms per liter.
-- = analyte not detected.
NA = not analyzed.
PCB = polychlorinated biphenyl.

limits. Bis(2-ethylhexyl)phthalate was detected at similar and higher concentrations in many associated samples. Environmental samples associated with the field blank with results greater than the IDL but less than 10 times the amount detected in the field blank were appropriately annotated with a UJ qualifier.

Metals detected at concentrations exceeding the IDL and less than the contract-required detection limits are aluminum, barium, beryllium, calcium, chromium, copper, cyanide, iron, lead, magnesium, manganese, sodium, and zinc.

Laboratory Method and Preparation Blanks. Four VOCs (acetone, 2-butanone, styrene and xylenes) were detected in one or more of the laboratory method blanks associated with the SDGs for Site 31. Two SVOCs (bis(2-ethylhexyl) phthalate and di-*n*-butylphthalate) were detected one or more of the laboratory method blanks associated with SDGs for Site 31.

Environmental samples associated with method blanks containing acetone with results greater than IDL but less than 10 times the amount detected in the laboratory preparation blanks were annotated with a UJ qualifier (LDC, 1996).

Aluminum, barium, beryllium, cadmium, calcium, chromium, cobalt, copper, iron, manganese, mercury, potassium, thallium, vanadium and cyanide were detected in one or more of the laboratory method blanks. Sample results greater than IDL but less than five 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 was required because of the detection of target analytes in laboratory and field blanks. Qualification of the RI data, based on blank contamination, was performed according to USEPA data validation guidelines (USEPA, 1994a and USEPA, 1994b).

<u>4.2.4 Comparability</u> 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 operating procedures and methodologies described in work plans for NAS Whiting Field throughout the period of the RI.

<u>4.2.5 Completeness</u> 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. Only one sample (31B00301) of the analytical data was 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 and accuracy goals of the project were achieved (Table 4-6). Some field and/or laboratory derived contamination was present in some of the QC samples; therefore, the results from some of the environmental samples were required to be amended. QC sample results and data validation criteria indicate 100 percent completeness was achieved for SDGs WF010, WF012, WF017, WF036 and WF046. SDG WF014 had a completeness of 99.7 percent for TAL metals (low percent recovery for mercury only), thus satisfying the 85 percent completeness goal. Standard methods of analysis and units of measure were used throughout the project, thus meeting the QC criteria and the DQOs presented in the work plan.

Overall, the data generated during the sampling event meet established DQOs and are acceptable for use in site characterization, risk assessment, and evaluation of corrective measures.

Table 4-6
Summary of DQO Assessment - PARCC Parameters

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	Precision[1]	Accuracy[2]	Representativeness	Completeness (%)	Comparability
Surface and Subsurface Soil Samples					
TCL VOCs	Acceptable	Acceptable	Acceptable	100	Acceptable
TCL SVOCs	Acceptable	Acceptable	Acceptable	100	Acceptable
Pesticides and PCBs	Acceptable	Acceptable	Acceptable	100	Acceptable
TAL Metals	Acceptable	Acceptable	Acceptable	[3]100	Acceptable
Cyanide	Acceptable	Acceptable	Acceptable	100	Acceptable

[1] Cumulative of sampling and analytical components.
[2] Analytical component.
[3] WF014 had a completeness of 99.7 percent for TAL metals.

Notes: Includes sample delivery groups WF010, WF012, WF014, WF017, WF036, and WF046.
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.
TCL VOC = target compound list volatile organic compound.
TCL SVOC = target compound list semivolatile organic compound.
PCB = polychlorinated biphenyl.
TAL = target analyte list.

CHAPTER 5.0

5.0 INVESTIGATIVE RESULTS

The RI Phase IIA investigation (ABB-ES, 1995b) at Site 31 consisted of collecting a total of 24 surface soil samples from the six disposal areas associated with Site 31. All samples were analyzed for TCL VOCs, SVOCs, pesticides, and PCBs and TAL inorganic analytes.

The Phase IIB investigation included collecting 19 surface soil samples, collecting five subsurface soil samples from Site 31A, collecting fifteen subsurface soil samples from Site 31C, installing 6 monitoring wells at Site 31C, and collecting 6 groundwater samples. The samples were analyzed for TCL VOCs, SVOCs, pesticides, and PCBs and TAL inorganic analytes.

Below are results of the geologic and hydrogeologic assessment and the analytical results of the surface soil, subsurface soil, and groundwater sampling events.

5.1 GEOLOGIC ASSESSMENT. Surface soil is generally described as dark to light brown (fine- to very fine-grained) clayey silty loamy sand or light brown to orange (fine- to very fine-grained) silty sand (ABB-ES, 1995b).

The lithology of soil beneath Site 31C consists predominantly of light colored, poorly graded (fine- to medium-grained) sand to a depth of at least 144 feet bls. Layers of clay were common and encountered in most soil borings and monitoring wells at approximate depths of 15, 21 and 26 feet bls. The clay layers were approximately 6 inches in thickness.

A general discussion of the geology at NAS Whiting Field is presented in Subsection 1.4.5 of the GIR (HLA, 1998). Site 31C soil boring and monitoring well boring logs are presented in Appendix B of this report.

5.2 HYDROGEOLOGIC ASSESSMENT. The hydrogeologic assessment included determining horizontal and vertical hydraulic gradients, hydraulic conductivities, and seepage velocities. The hydrogeologic assessment results are used to characterize the transport of human health and ecological chemicals of potential concern from the site by groundwater flow. Contaminant fate and transport for human health and ecological chemicals of potential concern at Site 31 is presented in Chapter 8.0 of this report.

Groundwater Flow Direction. Table 5-1 summarizes the results of the water-level measurements for the RI/FS sites in the Southwest and Southeast Disposal Areas. Interpretation of the potentiometric surface maps suggests that groundwater flow patterns for the measurement events on January 16 to 18, 1997 (Figure 5-1) and August 7 to 9, 1997, (Figure 5-2) are similar. The potentiometric surface maps for the measurement events indicate a groundwater flow direction to the southwest for Sites 31A, 31B, 31C, and 31D. The potentiometric surface maps for the measurement events indicate a groundwater flow direction to the east-southeast for Sites 31E and 31F. Facilitywide water table elevation data for all measurement events are provided in Appendix D of this report.

Horizontal Hydraulic Gradients. Table 5-2 provides a summary of the horizontal hydraulic gradients calculated for the Southwest and Southeast Disposal Areas.

Table 5-1
Summary of Water-Level Elevations

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Site 31, Sludge Drying Beds and Disposal Areas
Naval Air Station Whiting Field
Milton, Florida

Monitoring Well Designation	Well TOC Elevation (msl)	Well Depth (ft BTOC)	January 16 to 18, 1997		August 7 to 9, 1997		Approximate Screen Interval (ft msl)
			Depth to Groundwater (ft BTOC)	Groundwater Elevation (ft msl)	Depth to Groundwater (ft BTOC)	Groundwater Elevation (ft msl)	
Background Locations							
WHF-1466-6DD	172.86	218	118.37	54.49	120.49	52.37	-35 to -45
WHF-1466-6D	173.05	190	118.50	54.55	120.62	52.43	-7 to -17
WHF-1466-6I	173.06	160	118.43	54.63	120.61	52.45	23 to 13
WHF-1466-6S	173.09	131	118.48	54.61	120.63	52.46	57 to 42
WHF-1466-7S	172.26	131	118.43	53.83	120.65	51.61	56 to 41
WHF-1466-21D	61.44	96	30.27	31.17	30.53	30.91	-24 to -34
WHF-1466-21I	61.75	69	30.90	30.85	31.16	30.59	3 to -7
WHF-1466-21S	62.39	40	31.52	30.87	31.80	30.59	37 to 22
WHF-1466-22D	139.11	167	95.00	44.11	96.51	42.60	-18 to -28
WHF-1466-22I	139.23	140	94.60	44.63	96.17	43.06	9 to -1
WHF-1466-22S	139.36	108	94.72	44.64	96.33	43.03	46 to 31
WHF-1466-23D	127.63	150	--	--	78.84	49.30	-12 to -22
WHF-1466-23I	128.22	120.57	--	--	78.86	49.29	18 to 8
WHF-1466-23S	128.44	90.14	--	--	78.98	49.90	53 to 38
Southwest Disposal Area							
Site 15, Southeast Landfill							
WHF-15-1	66.35	73.20	24.54	41.81	25.51	40.84	4 to -6
WHF-15-2I	60.10	63.20	18.01	42.09	18.93	41.17	7 to 2
WHF-15-2S	59.58	32.90	16.79	42.79	18.09	41.49	42 to 27
WHF-15-2D	59.39	112.44	17.33	42.06	18.24	41.15	-47 to -52
WHF-15-3D	69.44	119.48	23.59	45.85	24.85	44.59	-40 to -50
WHF-15-3I	69.69	87.83	24.25	45.44	25.57	44.12	-7 to -17
WHF-15-3S	69.29	37.94	23.63	45.66	24.80	44.49	47 to 32
WHF-15-4S	143.29	109.15	95.55	47.74	97.24	46.05	48 to 33
WHF-15-5D	106.11	128.38	64.34	41.77	65.40	40.71	-9 to -19
WHF-15-5I	105.17	98	63.40	41.77	64.46	40.71	20 to 10
WHF-15-5S	104.14	68.18	62.34	41.80	63.40	40.74	45 to 35
WHF-15-6D	75.08	123.36	33.19	41.89	34.15	40.93	-37 to -47
WHF-15-6S	74.29	43.73	32.14	42.15	33.12	41.17	46 to 31
WHF-15-7D	119.49	147.53	72.63	47.18	74.17	45.64	-16 to -26
WHF-15-7I	119.85	121.50	73.03	47.14	74.56	45.61	14 to 4
WHF-15-7S	120.18	88.85	73.36	47.09	74.90	45.55	49 to 34

See notes at end of table.

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

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Naval Air Station Whiting Field
Milton, Florida

Monitoring Well Designation	Well TOC Elevation (msl)	Well Depth (ft BTOC)	January 16 to 18, 1997		August 7 to 9, 1997		Approximate Screen Interval (ft msl)
			Depth to Groundwater (ft BTOC)	Groundwater Elevation (ft msl)	Depth to Groundwater (ft BTOC)	Groundwater Elevation (ft msl)	
Southwest Disposal Area							
Site 15, Southeast Landfill (Continued)							
WHF-15-8D	79.08	115	41.09	37.99	42.35	36.73	-24 to -34
WHF-15-8I	79.48	85.2	41.48	38.00	42.24	37.24	6 to 16
WHF-15-8S	79.67	55	41.67	38.00	41.79	37.88	42 to 57
Site 16, Open Disposal and Burning Area							
WHF-16-1	50.04	43.00	10.26	39.76	10.87	39.17	17 to 7
WHF-16-2	82.19	74.20	--	--	--	--	12 to 7
WHF-16-2I	80.60	130.14	33.88	46.72	35.11	45.49	-38 to -48
WHF-16-2S	83.66	49.80	35.26	46.93	36.49	45.70	48 to 33
WHF-16-3D	51.40	118.08	8.34	43.06	9.28	42.12	-56 to -66
WHF-16-3I	51.31	52.87	12.04	39.27	12.67	38.64	3 to -1
WHF-16-3II	51.22	78.91	12.12	39.10	12.75	38.47	-26 to -31
WHF-16-3S	51.69	23.25	12.23	39.46	12.92	38.77	43 to 27
WHF-16-4D	52.87	122.54	12.80	40.07	13.45	39.42	-59 to -79
WHF-16-4II	53.01	64.80	12.81	40.20	13.47	39.54	0 to -9
WHF-16-4S	54.79	22.38	14.15	40.64	14.86	39.93	47 to 32
WHF-16-5	37.54	10.00	3.35	34.19	3.67	33.87	34 to 24
WHF-16-6D	56.77	62.10	14.18	42.61	15.09	41.68	7 to -3
WHF-16-6S	56.57	22.50	13.96	42.61	14.73	41.84	50 to 35
WHF-16-7D	38.05	75.20	1.99	36.06	2.39	35.66	-25 to -35
WHF-16-7I	38.17	43.50	2.11	36.06	2.50	35.67	5 to -5
WHF-16-7S	38.27	13.00	3.53	34.74	4.00	34.27	35 to 25
Site 31C, Sludge Disposal Area							
WHF-31-1S	149.70	115.35	--	--	105.17	44.53	49 to 34
WHF-31-2S	122.37	88.80	80.12	42.25	82.36	40.01	49 to 34
WHF-31-3S	105.49	75.70	67.74	37.75	68.63	36.86	45 to 30
WHF-31-4D	106.63	144.20	68.17	38.46	69.09	37.54	-28 to -38
WHF-31-4I	107.14	105.40	68.53	38.61	69.45	37.69	12 to 2
WHF-31-4S	106.52	82.40	--	--	68.61	37.91	39 to 24

See notes at end of table.

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

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Naval Air Station Whiting Field
Milton, Florida

Monitoring Well Designation	Well TOC Elevation (msl)	Well Depth (ft BTOC)	January 16 to 18, 1997		August 7 to 9, 1997		Approximate Screen Interval (ft msl)
			Depth to Groundwater (ft BTOC)	Groundwater Elevation (ft msl)	Depth to Groundwater (ft BTOC)	Groundwater Elevation (ft msl)	
Southeast Disposal Area							
Site 9, Waste Fuel Disposal Pit							
WHF-9-1	146.55	118.40	83.07	63.48	84.69	61.86	39 to 29
WHF-9-2	161.07	124.35	96.01	65.06	97.88	63.19	44 to 36
WHF-9-3S	150.85	108.24	87.01	63.84	88.69	62.16	57 to 42
Site 10, Southeast Open Disposal Area (A)							
WHF-10-1	146.73	118.20	84.50	62.23	86.16	60.57	39 to 29
WHF-10-2	150.75	113.14	88.38	62.37	90.08	60.67	49 to 34
Site 11, Southeast Open Disposal Area (B)							
WHF-11-1	124.86	128.40	58.24	66.47	59.28	65.43	7 to -2
WHF-11-1S	116.65	54.40	45.71	70.94	44.83	71.82	78 to 63
WHF-11-2	148.12	125.84	90.29	57.83	92.20	55.92	27 to 22
WHF-11-3	117.19	73.16	59.10	58.09	60.13	57.06	59 to 44
WHF-11-4D	125.79	109	69.72	59.56	71.16	58.12	27 to 17
WHF-11-4S	129.43	79	70.07	59.36	71.19	58.24	65 to 50
Site 12, Tetraethyl Lead Disposal Area							
WHF-12-1	136.40	113.40	77.02	59.38	78.42	57.98	33 to 23
WHF-12-2	135.56	85	76.11	59.45	79.54	56.02	65 to 50
Site 13, Sanitary Landfill							
WHF-13-1	102.66	122.90	48.38	54.28	49.41	53.25	-9 to -19
WHF-13-1I	109.17	93	52.20	56.97	53.63	55.54	26 to 16
WHF-13-1S	108.97	61.30	52.27	56.70	53.55	55.42	61 to 46
WHF-13-2S	102.86	72.41	49.10	53.76	50.14	52.52	45 to 30
WHF-13-3	81.44	41	--	--	28.26	53.18	55 to 40
WHF-13-4	80.37	41	--	--	31.35	49.02	54 to 39
Site 14, Short-Term Sanitary Landfill							
WHF-14-1	139.69	153.20	85.85	53.84	87.11	52.58	-3 to -13
WHF-14-2	145.80	118.30	92.55	53.25	93.83	52.17	42 to 27

Notes: TOC = top of casing.
msl = mean sea level.
ft BTOC = feet below top of casing.
ft msl = feet above mean sea level.
-- = no water level was recorded for this round of sampling.

Figure 5-1 Potentiometric Surface Map of the Water Table in the Sand-and-Gravel Aquifer, January 1997

11 x 17

Figure 5-2 Potentiometric Surface Map of the Water Table in the Sand-and-Gravel Aquifer, August 1997

11 X 17

Table 5-2
Summary of Horizontal Hydraulic Gradients

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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					
WHF-16-2S	1,063	46.93	0.0070	45.70	0.0065
WHF-16-3S		39.46		38.77	
WHF-15-4S	983	47.74	0.0060	46.05	0.0054
WHF-15-5S		41.80		40.74	
WHF-15-3S	523	45.66	0.0055	44.49	0.0057
WHF-15-2S		42.79		41.49	
Site 31C					
WHF-31-1S	1,215	--	--	44.53	0.0063
WHF-31-3S		--		36.86	
		Average gradient	0.0062		0.0060
Southeast Disposal Area					
WHF-9-3S	526	63.84	0.0028	62.16	0.0028
WHF-10-2		62.37		60.67	
WHF-9-1	460	63.48	0.0027	61.86	0.0028
WHF-10-1		62.23		60.57	
WHF-9-2	842	65.06	0.0032	63.19	0.0030
WHF-10-2		62.37		60.67	
WHF-11-3	1,381	58.09	0.0031	57.06	0.0033
WHF-13-2		53.76		52.52	
WHF-11-2	1,123	57.83	0.0036	55.92	0.0030
WHF-14-1		53.84		52.58	
WHF-9-2	3,547	65.06	0.0033	63.19	0.0031
WHF-14-2		53.25		52.17	
		Average gradient	0.0031		0.0030

Notes: msl = mean sea level.
ft/ft = feet per foot.
-- = measurement not recorded.

The horizontal hydraulic gradients in the Southwest Disposal Area ranged from 0.0054 feet per foot (ft/ft) (monitoring wells WHF-15-4S and WHF-15-5S) to 0.0070 ft/ft (monitoring wells WHF-16-2S and WHF-16-3S). The average horizontal hydraulic gradient for each measurement event ranged from 0.0062 ft/ft for January 1997 to 0.0060 ft/ft for August 1997. The overall average horizontal hydraulic gradient for all measurement events in 1997 was 0.0061 ft/ft.

The horizontal hydraulic gradient calculated for Site 31C was 0.0063 ft/ft (monitoring wells WHF-31-1S and WHF-31-3S) for the August 7 to 9, 1997 measurement event.

The horizontal hydraulic gradients in the Southeast Disposal Area ranged from 0.0027 ft/ft (monitoring wells WHF-9-1 and WHF-10-1) to 0.0036 ft/ft (monitoring wells WHF-11-2 and WHF-14-1). The average horizontal hydraulic gradient for each measurement event ranged from 0.0030 ft/ft for August 1997 to 0.0031 ft/ft for January 1997. The overall average horizontal hydraulic gradient for all measurement events in 1997 was 0.0030 ft/ft.

Vertical Hydraulic Gradients. Table 5-3 presents a summary of the vertical hydraulic gradients calculated for the Southwest and Southeast Disposal Areas.

The vertical hydraulic gradients for the Southwest Disposal Area were calculated using well pairs at Sites 15, 16, and 31C. Values calculated for the paired monitoring wells ranged from 0.0012 ft/ft to 0.0378 ft/ft. Vertical hydraulic gradients were in a downward direction for five of the seven well pairs; however, an upward gradient was observed for two monitoring well pairs (WHF-15-3S/WHF-15-3D and WHF-16-3S/WHF-16-3D) during the January and August 1997 surveys.

The vertical hydraulic gradients for the Southeast Disposal Area were calculated using well pairs at Site 11 (monitoring wells WHF-11-4S and WHF-11-4D) and Site 14 (monitoring wells WHF-14-1 and WHF-14-2). Values calculated for the paired monitoring wells ranged from 0.0036 ft/ft to 0.0144 ft/ft. Vertical hydraulic gradients were in an upward direction; however, a downward gradient was observed on Site 11 during the August 7 to 9, 1997 survey.

Hydraulic Conductivity and Seepage Velocity. Ten slug tests were conducted in the Southwest Disposal Areas and five slug test were conducted in the Southeast Disposal Areas during the RI. Table 5-4 summarizes the hydraulic conductivity values calculated for monitoring wells in the Southwest and Southeast Disposal Areas. Two to six trials of rising head slug tests were conducted in each of the monitoring wells tested in these areas.

Average hydraulic conductivity values for individual monitoring wells in the Southwest Disposal Area ranged from 3.67 feet per day (ft/day) (1.29×10^{-3} centimeters per second [cm/sec]) for WHF-15-6S to 46.49 ft/day (1.64×10^{-2} cm/sec) for WHF-16-3II. The geometric mean of the hydraulic conductivity data from monitoring wells tested in the Southwest Disposal Area was 11.45 ft/day (4.04×10^{-3} cm/sec).

Average hydraulic conductivity values for individual monitoring wells in the Southeast Disposal Area ranged from 4.73 ft/day (1.67×10^{-3} cm/sec) for WHF-11-3 to 14.55 ft/day (5.13×10^{-3} cm/sec) for WHF-13-2S. The geometric mean of the hydraulic conductivity data from monitoring wells tested in the Southeast Disposal Area was 8.38 ft/day (2.96×10^{-3} cm/sec).

Table 5-3
Summary of Vertical Hydraulic Gradients

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Site 31, Sludge Drying Beds and Disposal Areas
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Well Number	Bottom of Well Elevation (msl)	Vertical Distance Between Screens (feet)	January 16 to 18, 1997			August 7 to 9, 1997		
			Groundwater Elevation (msl)	Vertical Gradient (ft/ft)	Vertical Flow Direction	Groundwater Elevation (msl)	Vertical Gradient (ft/ft)	Vertical Flow Direction
Southwest Disposal Area								
WHF-15-2S	26.68	79.73	42.79	0.0092	Downward	41.49	0.0043	Downward
WHF-15-2D	-53.05		42.06			41.15		
WHF-15-3S	31.35	81.39	45.66	0.0023	Upward	44.49	0.0012	Upward
WHF-15-3D	-50.04		45.85			44.59		
WHF-15-6S	30.56	78.84	42.15	0.0033	Downward	41.17	0.0030	Downward
WHF-15-6D	-48.28		41.89			40.93		
WHF-16-2S	33.85	83.39	46.93	0.0025	Downward	45.70	0.0025	Downward
WHF-16-2I	-49.54		46.72			45.49		
WHF-16-3S	28.44	95.12	39.46	0.0378	Upward	38.77	0.0352	Upward
WHF-16-3D	-66.68		43.06			42.12		
WHF-16-4S	32.41	102.08	40.64	0.0056	Downward	39.93	0.0050	Downward
WHF-16-4D	-69.67		40.07			39.42		
Site 31C								
WHF-31-4S	24.12	61.69	--	NC	ND	37.91	0.0060	Downward
WHF-31-4D	-37.57		38.46			37.54		
Southeast Disposal Area								
WHF-11-4S	50.43	33.64	59.36	0.0059	Upward	58.24	0.0036	Downward
WHF-11-4D	16.79		59.56			58.12		
WHF-14-2	27.5	41.01	53.25	0.0144	Upward	52.17	0.0100	Upward
WHF-14-1	-13.51		53.84			52.58		

Notes: msl = mean sea level.
ft/ft = feet per foot.
-- = groundwater elevation not recorded.
NC = not calculated.
ND = not determined.

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

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Milton, Florida

Well Number	Range of K (ft/day)	Number of Usable Runs	[1]Average K (ft/min)	[1]Average K (ft/day)	[1]Average K (cm/sec)
SHALLOW/INTERMEDIATE MONITORING WELLS					
Southwest Disposal Area					
Site 15, Southwest Landfill					
WHF-15-2S	6.66 to 6.86	3	0.0047	6.75	2.38×10^{-3}
WHF-15-2I	25.99 to 28.87	4	0.0194	27.91	9.85×10^{-3}
WHF-15-3S	8.88 to 8.95	2	0.0062	8.93	3.15×10^{-3}
WHF-15-3I	20.29 to 23.44	4	0.0153	22.08	7.79×10^{-3}
WHF-15-6S	3.50 to 3.80	3	0.0026	3.67	1.29×10^{-3}
Site 16, Open Disposal and Burning Area					
WHF-16-2S	27.20 to 30.96	4	0.0200	28.82	1.02×10^{-2}
WHF-16-2I	9.19 to 10.39	4	0.0068	9.73	3.43×10^{-3}
WHF-16-3S	3.99 to 4.56	3	0.0030	4.29	1.52×10^{-2}
WHF-16-3I	4.92 to 5.28	5	0.0035	5.07	1.79×10^{-3}
WHF-16-3II	43.98 to 49.10	3	0.0323	46.49	1.64×10^{-2}
			Geometric Mean	11.45	4.04×10^{-3}
Southeast Disposal Area					
Site 10, Southeast Open Disposal Area (A)					
WHF-10-2	R	R	R	R	R
Site 11, Southeast Open Disposal Area (B)					
WHF-11-2	R	R	R	R	R
WHF-11-3	4.41 to 5.23	3	0.0033	4.73	1.67×10^{-3}
Site 13, Sanitary Landfill					
WHF-13-2S	13.23 to 15.51	6	0.0101	14.55	5.13×10^{-3}
Site 14, Short-Term Sanitary Landfill					
WHF-14-2	8.53 to 8.57	2	0.0059	8.55	3.02×10^{-3}
			Geometric Mean	8.38	2.96×10^{-3}
DEEP MONITORING WELLS					
Southwest Disposal Area					
Site 15, Southwest Landfill					
WHF-15-2D	0.70 to 0.77	3	0.0005	0.73	2.59×10^{-4}
WHF-15-3D	5.59 to 5.75	3	0.0039	5.66	2.00×10^{-3}
Site 16, Open Disposal and Burning Area					
WHF-16-3D	0.27 to 0.30	3	0.0002	0.28	9.01×10^{-5}
			Geometric Mean	1.05	3.70×10^{-4}

[1] Average is the arithmetic average.

Notes: ft/day = feet per day.
ft/min = feet per minute.
cm/sec = centimeters per second.
R = data rejected.

Hydraulic conductivity data from monitoring wells WHF-10-2 and WHF-11-2 in the Southeast Disposal Area exceeded the 20 percent variance criteria in the data evaluation procedure and were rejected.

The evaluation of hydraulic conductivity data is presented in Section 2.3 in Table 2-2 of *Technical Memorandum No. 4, Hydrogeologic Assessment* (January) (ABB-ES, 1995c).

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 at sites in the Southwest and Southeast Disposal Areas. The calculations used an assumed effective porosity of 0.35 for the sites. The value represents silty through poorly graded sands (Fetter, 1988). Seepage velocities for the Southwest Disposal Area ranged from 0.13 ft/day to 0.32 ft/day. The average of the seepage velocity values for the Southwest Disposal Area sites was 0.23 ft/day (84 feet per year [ft/yr]). The average of the seepage velocity values for the Southeast Disposal Area sites was 0.08 ft/day (29 ft/yr).

5.3 SURFACE SOIL ASSESSMENT. Surface soil samples were collected at each disposal area of Site 31 during Phase II of the RI. The results for each disposal area are presented in the subsections below.

5.3.1 Site 31A Table 5-6 summarizes the analytical results for organic and inorganic analytes detected in eight surface soil samples (and one duplicate) at Site 31A. The sample locations are shown on Figure 3-1.

Table 5-7 summarizes the frequency of detection, range of detection limits, range of detection concentrations, mean of detected concentrations, and background screening values for Site 31A surface soil samples.

TCL VOCs. Six VOCs (1,1-dichloroethene, trichloroethene [TCE], benzene, toluene, chlorobenzene, and xylenes) were detected in one (31-SL-22) of the eight surface soil samples. Xylenes were also detected in five additional surface soil samples. The detected concentrations of all the compounds were below their respective residential and industrial values for the soil cleanup goals for Florida and the USEPA Region III RBCs.

TCL SVOCs. SVOCs were not detected in any of the surface soil samples collected at Site 31A.

Pesticides and PCBs. Five pesticide compounds (dieldrin, 4,4'-dichlorodiphenyl-dichloroethylene [DDE], 4,4'-dichlorodiphenyldichloroethane [DDD], alpha-chlordane, and gamma-chlordane) were detected in surface soil sample 31-SL-23 collected at Site 31A. Alpha-chlordane and gamma-chlordane were also detected in surface soil sample 31-SL-24. The detected concentrations were below their respective residential and industrial values for the soil cleanup goals for Florida and the USEPA Region III RBCs.

TAL Metals and (Total) Cyanide. Sixteen TAL metals were detected in the surface soil samples. Two TAL metals (mercury and silver) were detected in one or more sample at concentrations exceeding their respective background screening values. None of the detected concentrations of inorganic analytes exceeded the residen-

Table 5-5
Summary of Seepage Velocities

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Investigation Area	Sites	Monitoring Well Pair	Horizontal Gradient[1] (ft/ft)	K (ft/day)	Effective Porosity (n)	Seepage Velocity (ft/day)
Southwest Disposal Area	15	WHF-15-2S and WHF-15-3S	0.0056	[2]7.84	0.35	0.13
	16	WHF-16-2S and WHF-16-3S	0.0068	[2]16.56	0.35	0.32
					Arithmetic average	0.23
Southeast Disposal Area	11 and 13	WHF-11-3 and WHF-13-2	0.0032	[2]9.65	0.35	0.09
	9, 10, 11, 13, and 14	WHF-9-2 and WHF-14-2	0.0032	[3]8.37	0.35	0.08
					Arithmetic average	0.08

[1] Horizontal gradients based on January 16 to 18, 1997 and August 7 to 9, 1997 groundwater measurements.
[2] The hydraulic conductivity (K) is averaged where values are available for both wells in the well pair.
[3] Geometric mean for the area.

Notes: ft/ft = feet per foot.
ft/day = feet per day.

Table 5-6
Organic and Inorganic Analytes Detected in Site 31A Surface Soil Samples

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Location Identifier:	31-SL-17	31-SL-18	31-SL-19	31-SL-20	31-SL-21	31-SL-22 Duplicate Sample	31-SL-23	31-SL-24
Sample Identifier:	31-SL-17	31-SL-18	31-SL-19	31-SL-20	31-SL-21	31-SL-22A	31-SL-23	31-SL-24
Collection Date:	18-AUG-92	18-AUG-92	18-AUG-92	18-AUG-92	18-AUG-92	18-AUG-92	18-AUG-92	18-AUG-92
Laboratory Sample No.:	22527005	22527006	22527007	22527008	22527009	2258002	22527010	22527011
Volatile Organic Compounds (µg/kg)								
1,1-Dichloroethene	--	--	--	--	--	--	--	--
Trichloroethene	--	--	--	--	--	--	--	--
Benzene	--	--	--	--	--	--	--	--
Toluene	--	--	--	--	--	--	--	--
Chlorobenzene	--	--	--	--	--	--	--	--
Xylenes (total)	6	--	--	3 J	3 J	3 J	2 J	1 J
Semivolatile Organic Compounds (µg/kg)								
None detected								
Pesticides and PCBs (µg/kg)								
Dieldrin	--	--	--	--	--	--	1.3 J	--
4,4'-DDE	--	--	--	--	--	--	3.2 J	--
4,4'-DDD	--	--	--	--	--	--	1.6 J	--
alpha-Chlordane	--	--	--	--	--	--	1.7 J	1.9 J
gamma-Chlordane	--	--	--	--	--	--	2.3 J	4
Inorganic Analytes (mg/kg)								
Aluminum	154	240	167	293	307	185	298	296
Barium	1.2 J	2.9 J	2.6 J	2.1 J	2.5 J	6.9	2.9 J	2.9 J
Calcium	73.8 J	77.3 J	90.5 J	68 J	135	--	76.7 J	72.3 J
Chromium	0.75 J	2.2	1.6	1.5 J	0.98 J	--	1.5 J	1.5 J
Copper	3.1 J	6.1	7 J	4.1 J	4.5 J	--	5.9	5.1 J

See notes at end of table.

Table 5-6 (Continued)
Organic and Inorganic Analytes Detected in Site 31A Surface Soil Samples

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Location Identifier:	31-SL-17	31-SL-18	31-SL-19	31-SL-20	31-SL-21	31-SL-22 Dup	31-SL-23	31-SL-24
Sample Identifier:	31-SL-17	31-SL-18	31-SL-19	31-SL-20	31-SL-21	31-SL-22A	31-SL-23	31-SL-24
Collection Date:	18-AUG-92	18-AUG-92	18-AUG-92	18-AUG-92	18-AUG-92	18-AUG-92	18-AUG-92	18-AUG-92
Laboratory Sample No.:	22527005	22527006	22527007	22527008	22527009	22528002	22527010	22527011
Inorganic Analytes (mg/kg) (Continued)								
Iron	576	541	284	522	528	479	536	431
Lead	3.4	7	4	2.7	7.2	--	10.8	4.7
Magnesium	--	14.7 J	13.2 J	17 J	13.7 J	26.3 J	13.2 J	14 J
Manganese	1.6 J	1.8 J	2.6 J	1.5 J	1.4 J	0.84 J	1.7 J	1.2 J
Mercury	--	--	--	--	--	--	--	0.14
Nickel	--	--	--	--	--	--	--	6 J
Silver	0.62 J	1.1 J	0.39 J	0.82 J	0.39 J	--	1.3 J	1.3 J
Sodium	134 J	123 J	164 J	180 J	127 J	--	189 J	124 J
Thallium	--	--	0.36 J	--	--	--	--	--
Vanadium	0.64 J	0.42 J	0.38 J	1 J	0.33 J	--	0.38	--
Zinc	4.3	5.8	8.1	4.4	5.3	--	7.4	27.1

Notes: μg/kg = micrograms per kilogram.
-- = analyte, if present, was less than the detection limit.
J = estimated value.
PCB = polychlorinated biphenyl.
DDE = dichlorodiphenyldichloroethene.
DDD = dichlorodiphenyldichloroethane.
mg/kg = milligrams per kilogram.

Table 5-7
Comparison of Analytes Detected in Site 31A Surface Soil Samples to Background Screening and Benchmark Concentrations

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Analyte	Frequency of Detection[1]	Range of Detection Limits	Range of Detected Concentrations[2]	Mean of Detected Concentrations[3]	Background Screening Values[4]	USEPA Region III RBCs[5] Residential/ Industrial	Soil Cleanup Goals for Florida[6] Residential/ Industrial
Volatile Organic Compounds (µg/kg)							
1,1-Dichloroethene	1/8	5	2.25*	2.3	--	1,100/9,500	100/100
Trichloroethene	1/8	5	1.75*	1.8	--	58,000/520,000	6,500/9,300
Benzene	1/8	5	1.75*	1.8	--	22,000/200,000	1,400/2,000
Toluene	1/8	5	2.25*	2.3	--	[8]1,600,000/ 41,000,000	520,000/ 3,500,000
Chlorobenzene	1/8	5	2.25*	2.3	--	[8]160,000/ 4,100,000	44,000/300,000
Xylenes (total)	6/8	5	1 to 6	3	--	[8]16,000,000/ 410,000,000	13,000,000/- 92,000,000
Semivolatile Organic Compounds (µg/kg)							
None detected							
Pesticides and PCBs (µg/kg)							
Dieldrin	1/8	16 to 17	1.3	1.3	--	[7]40/360	70/300
4,4'-DDE	1/8	16 to 17	3.2	3.2	--	[7]1,900/17,000	3,000/11,000
4,4'-DDD	1/8	16 to 17	1.6	1.6	--	[8]2,700/24,000	4,500/17,000
alpha-Chlordane	2/8	82 to 84	1.7 to 1.9	1.8	--	[8]18,000/16,000	800/3,000
gamma-Chlordane	2/8	82 to 84	2.3 to 4	3.2	--	[7]1,800/16,000	800/3,000
Inorganic Analytes (mg/kg)							
Aluminum	8/8	40	154 to 307	242	15,848	[8]7,800/200,000	75,000/--
Barium	8/8	40	1.2 to 4.95*	2.8	23.2	[8]550/14,000	5,200/84,000
Calcium	7/8	109.15 to 1,000	68 to 135	84.8	396	--/--	--/--

See notes at end of table.

Table 5-7 (Continued)
Comparison of Analytes Detected in Site 31A Surface Soil Samples to Background Screening and Benchmark Concentrations

Remedial Investigation Report
Site 31, Sludge Drying Beds and Disposal Areas
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Analyte	Frequency of Detection[1]	Range of Detection Limits	Range of Detected Concentrations[2]	Mean of Detected Concentrations[3]	Background Screening Values[4]	USEPA Region III RBCs[5] Residential/ Industrial	Soil Cleanup Goals for Florida[6] Residential/ Industrial
Inorganic Analytes (mg/kg) (Continued)							
Chromium	7/8	1.95 to 2	0.75 to 2.2	1.4	11	[8,11]39/1,000	[11]290/430
Copper	8/8	4.7 to 5	3.1 to 7	4.9	9.4	[8]310/8,200	[9]2,900/72,000
Iron	8/8	20	284 to 576	495	8,832	[8]2,300/61,000	--/--
Lead	7/8	1 to 5.8	2.7 to 10.8	5.7	11.4	[10]400	500/1,000
Magnesium	7/8	10 to 1,000	13.2 to 17	14.5	268	--/--	--/--
Manganese	8/8	3	0.92* to 2.6	1.6	392	[8]160/4,100	370/5,500
Mercury	1/8	0.04 to 0.1	0.14	0.14	0.12	--/--	23/480
Nickel	1/8	2.2 to 8	6	6	7.2	[8]160/4,100	1,500/26,000
Silver	7/8	0.74 to 2	0.39 to 1.3	0.85	0.70	[8]39/1,000	390/9,000
Sodium	7/8	149 to 1,000	123 to 189	149	406	--/--	--/--
Thallium	1/8	0.33 to 2	0.36	0.36	1.16	--/--	--/--
Vanadium	6/8	0.27 to 10	0.33 to 1	0.53	21.8	[8]55/1,400	490/4,800
Zinc	7/8	4 to 6.15	4.3 to 27.1	8.9	15.4	[8]2,300/61,000	23,000/560,000

See notes at end of table.

Table 5-7 (Continued)
Comparison of Analytes Detected in Site 31A Surface Soil Samples to Background Screening and Benchmark Concentrations

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Naval Air Station Whiting Field
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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] Value indicated by an asterisk is the average of a sample and its duplicate. If the target analyte is not detected in either the environmental sample or associated duplicate, the value used for the nondetection is one-half the reporting limit.
[3] The mean of detected concentrations is the arithmetic mean of all environmental samples in which the analyte was detected; it includes a single value for an environmental sample and associated duplicate. The arithmetic mean does not include those environmental samples in which the analyte was not detected.
[4] The background screening value for organics is the mean detected concentration and will not be used for screening purposes in the risk assessment. The background screening value for inorganics is two times the mean detected background concentration and will be used for screening purposes in the risk assessment.
[5] Source: Memorandum dated February 17, 1997, from Roy L. Smith, Technical Support Section, USEPA Region II, to RBC Table Mailing List. Subject: Risk-Based Concentrations Table.
[6] Source: Memorandum dated September 29, 1995a, from John M. Ruddell, Director, Division of Waste Management to District Directors, Waste Program, Florida Department of Environmental Protection (FDEP). Subject: Soil Cleanup Goals for Florida.
[7] The values correspond to a human cancer risk level of 1 in 1,000,000.
[8] The calculated values correspond to a noncancer hazard quotient of 0.1.
[9] Source: Updated Memorandum dated April 5, 1995, from Ligia Mora Applegate, Director, Technical Review Section, Bureau of Waste Cleanup, FDEP, to Tim Bahr, Technical Review Section, Bureau of Waste Cleanup. Subject: Cleanup Goals for Military Sites in Florida.
[10] USEPA (1994) Office of Solid Waste and Emergency Response Directive No. 9355.4-12, Revised Interim Recommended Soil Cleanup for CERCLA and RCRA Sites.
[11] Reported values are for hexavalent chromium.

Notes: USEPA = U.S. Environmental Protection Agency.
RBC = risk-based concentration.
μg/kg = micrograms per kilogram.
* = average of a sample and its duplicate.
-- = criteria not available.
PCB = polychlorinated biphenyl.
DDE = dichlorodiphenyldichloroethene.
DDD = dichlorodiphenyldichloroethane.
mg/kg = milligrams per kilogram.

tial or industrial values for the USEPA Region III RBCs or the soil cleanup goals for Florida.

5.3.2 Site 31B Table 5-8 summarizes the frequency of detection, range of detection limits, range of detection concentrations, mean of detected concentrations, and background screening values for the combined background samples of the Troup Loamy Sand and Bonifay Sand soil types.

Table 5-9 summarizes the analytical results for organic and inorganic analytes detected in six surface soil samples at Site 31B. The sample locations are shown on Figure 3-2.

Table 5-10 summarizes the frequency of detection, range of detection limits, range of detection concentrations, mean of detected concentrations, and background screening values for Site 31B surface soil samples.

TCL VOCs. Xylenes was the only VOC detected in the surface soil samples. The compound was detected in two samples at concentrations below the residential and industrial values for the soil cleanup goals for Florida and the USEPA Region III RBCs.

TCL SVOCs. SVOCs were not detected in any surface soil sample collected at Site 31B.

Pesticides and PCBs. Two pesticide compounds (4,4'-DDD and 4,4'-dichlorodiphenyltrichloroethane [DDT]) were detected in one (31S00101) of six surface soil samples collected at Site 31B. The detected concentrations were below the residential and industrial values for the soil cleanup goals for Florida and the USEPA Region III RBCs.

TAL Metals and (Total) Cyanide. Twenty inorganic analytes were detected in the surface soil samples. Three of the analytes (copper, mercury, and silver) were detected at concentrations exceeding their respective background screening values; however, the detected concentrations were below the residential and industrial values of the soil cleanup goals for Florida and the USEPA Region III RBCs.

5.3.3 Site 31C Table 5-11 summarizes the analytical results for organic and inorganic analytes detected in fourteen surface soil samples (and one duplicate) at Site 31C. The sample locations are shown on Figure 3-2.

Table 5-12 summarizes the frequency of detection, range of detection limits, range of detection concentrations, mean of detected concentrations, and background screening values for Site 31C surface soil samples.

TCL VOCs. Four VOCs (methylene chloride, carbon disulfide, toluene, and xylenes) were detected in the surface soil samples. The detected concentrations were below their respective residential and industrial values for the soil cleanup goals for Florida and the USEPA Region III RBCs. Methylene chloride and carbon disulfide are commonly recognized field-or laboratory-derived contaminants according to the USEPA's *Contract Laboratory Program Functional Guidelines for Organic Data Review* (USEPA, 1994a).

Table 5-8
Comparison of Analytes Detected in Background Surface Soil Samples for the Troup Loamy Sand and Bonifay Sand

Remedial Investigation Report
Site 31, Sludge Drying Beds and Disposal Areas
Naval Air Station Whiting Field
Milton, Florida

Analyte	Frequency of Detection[1]	Range of Detection Limits	Range of Detected Concentrations[2]	Mean of Detected Concentrations[3]	Background Screening Values[4]	USEPA Region III RBCs[5] Residential/ Industrial	Soil Cleanup Goals for Florida[6] Residential/ Industrial
Volatile Organic Compounds (µg/kg)							
None detected							
Semivolatile Organic Compounds (µg/kg)							
bis(2-Ethylhexyl)phthalate	3/9	360 to 400	57 to 115*	80.3	80.3	46,000/410,000	48,000/110,000
Pesticides and PCBs (µg/kg)							
None detected							
Inorganic Analytes (mg/kg)							
Aluminum	9/9	40	5,080 to 21,300	7,667	15,334	[8]7,800/200,000	75,000/--
Antimony	9/9	2.7 to 12	2.9 to 5	4	8	[8]3.1/82	26/220
Arsenic	9/9	2	0.91 to 3.7	1.56	3.1	[7]0.43/3.8	[9]0.8/3.7
Barium	9/9	40	6 to 26.2	11.87	23.7	[8]550/14,000	5,200/84,000
Beryllium	5/9	0.08 to 1	0.05 to 0.35	0.18	0.36	[7]16/410	0.2/1.0
Cadmium	2/9	0.59 to 1	0.22 to 0.36*	0.29	0.58	[8]3.9/100	37/600
Calcium	9/9	1,000	82 to 269	202	404	--/--	--/--
Chromium	9/9	2	2.4 to 16.3	5.34	10.7	[8]39/1,000	[12]290/430
Cobalt	8/9	10	0.78 to 3*	1.44	2.87	[8]470/12,000	4,700/110,000
Copper	6/9	5	2.6 to 8.5	4.7	9.4	[8]310/8,200	[10]2,900/72,000
Iron	9/9	20	2,630 to 12,400	4,294	8,588	[8]2,300/61,000	--/--
Lead	9/9	0.6 to 1	2.7 to 9.8	5.76	11.5	[11]400	500/1,000
Magnesium	9/9	1,000	68.8 to 316	129	258	--/--	--/--
Manganese	9/9	3	66.7 to 314	201.55	403	[8]160/4,100	370/5,500
Mercury	4/9	0.03 to 0.1	0.04 to 0.07	0.06	0.12	--/--	23/480
Nickel	3/9	2.3 to 8	1.7 to 5.9	3.6	7.2	[8]160/4,100	1,500/26,000
Potassium	3/9	128 to 1,000	81.3* to 96.8	88.5	177	--/--	--/--
Selenium	6/9	0.41 to 1	0.15* to 0.4	0.22	0.44	[8]39/1,000	390/9,900

See notes at end of table.

Table 5-8 (Continued)
Comparison of Analytes Detected in Background Surface Soil Samples for the Troup Loamy Sand and Bonifay Sand

Remedial Investigation Report
Site 31, Sludge Drying Beds and Disposal Areas
Naval Air Station Whiting Field
Milton, Florida

Analyte	Frequency of Detection[1]	Range of Detection Limits	Range of Detected Concentrations[2]	Mean of Detected Concentrations[3]	Background Screening Values[4]	USEPA Region III RBCs[5] Residential/ Industrial	Cleanup Goals for Florida[6] Residential/ Industrial
Inorganic Analytes (mg/kg) (Continued)							
Silver	1/9	0.32 to 2	0.35	0.35	0.70	[8]39/1,000	380/9,000
Sodium	9/9	1,000	125 to 265	194	388	--/--	--/--
Thallium	1/9	0.44 to 2	0.58*	0.58	1.16	--/--	--/--
Vanadium	9/9	10	6 to 31.1	10.6	21.2	[8]55/1,400	490/4,800
Zinc	7/9	4	4.3 to 16.3	7.7	15.4	[8]2,300/61,000	23,000/560,000
Cyanide	2/9	0.23 to 0.5	0.11 to 0.14	0.125	0.25	--/--	1,600/40,000

[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] Value indicated by an asterisk is the average of a sample and its duplicate. If the target analyte is not detected in either the environmental sample or associated duplicate, the value used for the nondetection is one-half the reporting limit.
[3] The mean of detected concentrations is the arithmetic mean of all environmental samples in which the analyte was detected; it includes a single value for an environmental sample and associated duplicate. The arithmetic mean does not include those environmental samples in which the analyte was not detected.
[4] The background screening value for organics is the mean detected concentration and will not be used for screening purposes in the risk assessment. The background screening value for inorganics is two times the mean detected background concentration and will be used for screening purposes in the risk assessment.
[5] Source: Memorandum dated February 17, 1997, from Roy L. Smith, Technical Support Section. USEPA Region II to RBC Table Mailing List. Subject: Risk-Based Concentrations Table.
[6] Source: Memorandum dated September 29, 1995a, from John M. Ruddell, Director, Division of Waste Management to District Directors, Waste Program, Florida Department of Environmental Protection (FDEP). Subject: Soil Cleanup Goals for Florida.
[7] The values correspond to a human cancer risk level of 1 in 1,000,000.
[8] The calculated values correspond to a noncancer hazard quotient of 0.1.
[9] Source: Updated Memorandum dated January 19, 1996, from John M. Ruddell, Director, Division of Waste Management to District Directors, Waste Program, FDEP. Subject: Applicability of Soil Cleanup Goals for Florida.
[10] Source: Updated Memorandum dated April 5, 1995, from Ligia Mora Applegate, Director, Technical Review Section, Bureau of Waste Cleanup, FDEP, to Tim Bahr, Technical Review Section, Bureau of Waste Cleanup. Subject: Cleanup Goals for Military Sites in Florida.
[11] USEPA (1994) Office of Solid Waste and Emergency Response Directive No. 9355.4-12, Revised Interim Recommended Soil Cleanup for CERCLA and RCRA Sites.
[12] Values are for hexavalent chromium.

Notes: Background samples: BKG-SL-02, BKG-SL-06, BKG-SL-07, BKG-SL-08, BKS00101, BKS00201, BKS00301, BKS00401, and BKS00501.
Background duplicate sample: BKS00201D
USEPA = U.S. Environmental Protection Agency.
RBC = risk-based concentration.
μg/kg = micrograms per kilogram.
* = average of a sample and its duplicate.
PCB = polychlorinated biphenyl.
mg/kg = milligrams per kilogram.
-- = criteria not available.

Table 5-9
Organic and Inorganic Analytes Detected in Site 31B Surface Soil Samples

Remedial Investigation Report
Site 31, Sludge Drying Beds and Disposal Areas
Naval Air Station Whiting Field
Milton, Florida

Location Identifier:	31-SL-09	31-SL-10	31-SL-11	31S001	31S002	31S003
Sample Identifier:	31-SL-09	31-SL-10	31-SL-11	31S00101	31S00201	31S00301
Collection Date:	17-AUG-92	17-AUG-92	17-AUG-92	12-DEC-95	12-DEC-95	12-DEC-95
Laboratory Sample No.:	22515011	22515012	22515013	G8924001	G8924002	G8924003
Volatile Organic Compounds (μg/kg)						
Xylenes (total)	4 J	--	2 J	--	--	--
Semivolatile Organic Compounds (μg/kg)						
None detected						
Pesticides and PCBs (μg/kg)						
4,4'-DDD	--	--	--	4.9 J	--	--
4,4'-DDT	--	--	--	10 J	--	--
Inorganic Analytes (mg/kg)						
Aluminum	10,900	8,700	6,700	5,710	10,400	7,430
Arsenic	1.9 J	1.6 J	1.2 J	1.1 J	2.3	0.97 J
Barium	12.5 J	7.1 J	7 J	5.3 J	16.8 J	13.4 J
Beryllium	0.15 J	0.08 J	0.09 J	--	--	--
Calcium	229 J	237 J	354 J	43.2	279	227
Chromium	7.8	5.9	4.5	3.9	8.9	7
Cobalt	0.81 J	0.67 J	1.2 J	--	--	0.95 J
Copper	5.3 J	4.5 J	13.1	--	--	--
Iron	5,980	4,520	3,440	3,000	6,290	3,670
Lead	4.8	3.7	3.4	2.9	7.1	3.6
Magnesium	117 J	97.1 J	250	100 J	217 J	163 J
Manganese	154	117	143	86.2	206	250
Mercury	--	0.37	0.08 J	0.02 J	0.02 J	0.02 J
Nickel	--	--	--	--	4.5 J	5.1 J
Potassium	--	--	--	--	--	168 J
Selenium	--	--	--	--	0.37 J	--
Silver	5.9	4.2	3.6	--	--	--
Sodium	202 J	161 J	176 J	--	--	--
Vanadium	15.8	11.6	8.4 J	7.1 J	18.7	9.1 J
Zinc	12	11.3	9.6	3.8 J	4.2 J	6.1

Notes: μg/kg = micrograms per kilogram.
J = estimated value.
-- = analyte, if present, was less than the detection limit.
PCB = polychlorinated biphenyl.
DDD = dichlorodiphenyldichloroethane.
DDT = dichlorodiphenyltrichloroethane.
mg/kg = milligrams per kilogram.

Table 5-10
Comparison of Analytes Detected in Site 31B Surface Soil Samples to Background Screening and Benchmark Concentrations

Remedial Investigation Report
Site 31, Sludge Drying Beds and Disposal Areas
Naval Air Station Whiting Field
Milton, Florida

Analyte	Frequency of Detection[1]	Range of Detection Limits	Range of Detected Concentrations[2]	Mean of Detected Concentrations[3]	Background Screening Values[4]	USEPA Region III RBCs[5] Residential/ Industrial	Soil Cleanup Goals for Florida[6] Residential/ Industrial
Volatile Organic Compounds (µg/kg)							
Xylenes (total)	2/6	5 to 11	2 to 4	3	--	16,000/410,000	13,000,000/ 19,000,000
Semivolatile Organic Compounds (µg/kg)							
None detected							
Pesticides and PCBs (µg/kg)							
4,4'-DDD	1/6	3.6 to 35	4.9	4.9	--	2,700/24,000	4,500/17,000
4,4'-DDT	1/6	3.6 to 35	10	10	--	1,900/17,000	3,100/12,000
Inorganic Analytes (mg/kg)							
Aluminum	6/6	40	5,710 to 10,900	8,307	15,334	[8]7,800/200,000	75,000/--
Arsenic	6/6	2	0.97 to 2.3	1.5	3.1	[7]0.43/3.8	[9]0.8/3.7
Barium	6/6	40	5.3 to 16.8	10.4	23.7	[8]550/14,000	5,200/84,000
Beryllium	3/6	1	0.08 to 0.15	0.11	0.36	[7]16/410	0.2/1.0
Calcium	6/6	1,000	43.2 to 334	228	404	--/--	--/--
Chromium	6/6	2	3.9 to 8.9	6.3	10.7	[8]39/1,000	[12]290/430
Cobalt	4/6	10	0.67 to 1.2	0.91	2.87	[8]470/12,000	4,700/110,000
Copper	3/6	5	4.5 to 13.1	7.6	9.4	[8]310/8,200	[10]2,900/72,000
Iron	6/6	20	3,000 to 6,290	4,483	8,588	[8]2,300/61,000	--/--
Lead	6/6	0.6	2.9 to 7.1	4.3	11.5	[11]400	500/1,000
Magnesium	6/6	1,000	97.1 to 250	157	258	--/--	--/--
Manganese	6/6	3	86.2 to 250	159	403	[8]160/4,100	370/5,500
Mercury	5/6	0.06 to 0.1	0.02 to 0.37	0.1	0.12	[8]2.3/61	23/480
Nickel	2/6	2.3 to 8	4.5 to 5.1	4.8	7.2	[8]160/4,100	1,500/26,000
Potassium	1/6	129 to 1,000	168	168	177	--/--	--/--
Selenium	1/6	0.45 to 1	0.37	180	382	39/1,000	390/9,900

See notes at end of table.

Table 5-10 (Continued)
Comparison of Analytes Detected in Site 31B Surface Soil Samples to Background Screening and Benchmark Concentrations

Remedial Investigation Report
Site 31, Sludge Drying Beds and Disposal Areas
Naval Air Station Whiting Field
Milton, Florida

Analyte	Frequency of Detection[1]	Range of Detection Limits	Range of Detected Concentrations[2]	Mean of Detected Concentrations[3]	Background Screening Values[4]	USEPA Region III RBCs[5] Residential/ Industrial	Soil Cleanup Goals for Florida[6] Residential/ Industrial
Inorganic Analytes (mg/kg) (Continued)							
Silver	3/6	2	3.6 to 5.9	4.6	0.70	[8]39/1000	390/9,900
Sodium	3/6	1,000	161 to 202	180	382	--/--	--/--
Vanadium	6/6	10	7.1 to 18.7	11.8	21.2	[8]55/1,400	490/4,800
Zinc	6/6	4	3.8 to 12	7.8	15.4	[8]2,300/61,000	23,000/560,000

[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] If the target analyte is not detected in either the environmental sample or associated duplicate, the value used for the nondetection is one-half the reporting limit.
[3] The mean of detected concentrations is the arithmetic mean of all environmental samples in which the analyte was detected; it includes a single value for an environmental sample and associated duplicate. The arithmetic mean does not include those environmental samples in which the analyte was not detected.
[4] The background screening value for organics is the mean detected concentration and will not be used for screening purposes in the risk assessment. The background screening value for inorganics is two times the mean detected background concentration and will be used for screening purposes in the risk assessment.
[5] Source: Memorandum dated February 17, 1997, from Roy L. Smith, Technical Support Section, USEPA Region II, to RBC Table Mailing List. Subject: Risk-Based Concentrations Table.
[6] Source: Memorandum dated September 29, 1995a, from John M. Ruddell, Director, Division of Waste Management to District Directors, Waste Program, Florida Department of Environmental Protection (FDEP). Subject: Soil Cleanup Goals for Florida.
[7] The values correspond to a human cancer risk level of 1 in 1,000,000.
[8] The calculated values correspond to a noncancer hazard quotient of 0.1.
[9] Source: Updated Memorandum dated January 19, 1996, from John M. Ruddell, Director, Division of Waste Management to District Directors, Waste Program, FDEP. Subject: Applicability of Soil Cleanup Goals for Florida.
[10] Source: Updated Memorandum dated April 5, 1995, from Ligia Mora Applegate, Director, Technical Review Section, Bureau of Waste Cleanup, FDEP, to Tim Bahr, Technical Review Section, Bureau of Waste Cleanup. Subject: Cleanup Goals for Military Sites in Florida.
[11] USEPA (1994) Office of Solid Waste and Emergency Response Directive No. 9355.4-12, Revised Interim Recommended Soil Cleanup for CERCLA and RCRA Sites.
[12] Values are for hexavalent chromium.

Notes: USEPA = U.S. Environmental Protection Agency.
RBC = risk-based concentration.
μg/kg = micrograms per kilogram.
-- = criteria not available.
PCB = polychlorinated biphenyl.
DDD = dichlorodiphenyldichloroethane.
DDT = dichlorodiphenyltrichloroethane.
mg/kg = milligrams per kilogram.

Table 5-11
Organic and Inorganic Analytes Detected in Site 31C Surface Soil Samples

Remedial Investigation Report
Site 31, Sludge Drying Beds and Disposal Areas
Naval Air Station Whiting Field
Milton, Florida

Location Identifier:	31-SL-12	31-SL-13	31-SL-14	31-SL-15	31S004	31S005	31S005 Duplicate Sample	31S006
Sample Identifier:	31-SL-12	31-SL-13	31-SL-14	31-SL-15	31S00401	31S00501	31S00501D	31S00601
Collection Date:	17-AUG-92	17-AUG-92	17-AUG-92	17-AUG-92	07-JAN-96	07-JAN-96	07-JAN-96	07-JAN-97
Laboratory Sample No.:	22515014	22515015	22515016	22515017	RA855010	RA855011	RA855012	RA855013
Volatile Organic Compounds (µg/kg)								
Methylene chloride	160 J	120 J	240 J	160 J	--	--	--	--
Carbon disulfide	6 J	3 J	8	39 J	--	--	--	--
Toluene	--	--	--	--	--	--	--	--
Xylenes (total)	4 J	4 J	5 J	11 J	--	--	--	--
Semivolatile Organic Compounds (µg/kg)								
Butylbenzylphthalate	--	--	--	--	--	--	--	--
bis(2-Ethylhexyl)phthalate	1,300	1,300	2,600	720 J	--	--	--	--
Benzo(b)fluoranthene	100 J	--	--	--	--	--	--	--
Benzo(k)fluoranthene	110 J	--	--	--	--	--	--	--
Pesticides and PCBs (µg/kg)								
Dieldrin	27 J	33 J	99 J	120 J	--	--	--	--
4,4'-DDE	28 J	28 J	99 J	100 J	--	--	--	--
alpha-Chlordane	25 J	14 J	68 J	65 J	--	--	--	--
gamma-Chlordane	27 J	17 J	76 J	49 J	--	--	--	--
Aroclor-1260	350 J	340 J	1,400 J	860 J	--	--	--	--
Inorganic Analytes (mg/kg)								
Aluminum	6,520	5,030	16,800	9,260	4,840	4,500	6,050	4,870
Antimony	3.1 J	3.7 J	7.1 J	6.5 J	--	--	--	--
Arsenic	0.96 J	0.67 J	1.7 J	1.3 J	1.4 J	1.3 J	1.2 J	1.3 J
Barium	147	155	534	232	6.1 J	6.6 J	8.6 J	7.2 J

See notes at end of table.

Table 5-11 (Continued)
Organic and Inorganic Analytes Detected in Site 31C Surface Soil Samples

Remedial Investigation Report
Site 31, Sludge Drying Beds and Disposal Areas
Naval Air Station Whiting Field
Milton, Florida

Location Identifier:	31-SL-12	31-SL-13	31-SL-14	31-SL-15	31S004	31S005	31S005 Duplicate Sample	31S006
Sample Identifier:	31-SL-12	31-SL-13	31-SL-14	31-SL-15	31S00401	31S00501	31S00501D	31S00601
Collection Date:	17-AUG-92	17-AUG-92	17-AUG-92	17-AUG-92	07-JAN-96	07-JAN-96	07-JAN-96	07-JAN-97
Laboratory Sample No.:	22515014	22515015	22515016	22515017	RA855010	RA855011	RA855012	RA855013
Inorganic Analytes (mg/kg) (Continued)								
Beryllium	0.42 J	0.3 J	1.3 J	0.56 J	--	--	--	--
Cadmium	11.6	12	26.8	13.6	--	--	--	--
Calcium	2,000	1,520	4,160	2,320	154 J	143 J	146 J	160 J
Chromium	84.9	86.3	295	130	3.6	2.8	3.8	4.4
Cobalt	0.91 J	0.83 J	2.2 J	1.1 J	--	--	1.2 J	0.84 J
Copper	248	279	948	468	--	--	--	--
Iron	7,080	6,220	22,500	11,200	2,640	2,470	2,840	2,520
Lead	635	344	1,890	912	2.9	3.2	2.9	2.9
Magnesium	493	438 J	1,120	695	104 J	80.1 J	138 J	93.2 J
Manganese	170	64	76.7	46	61.4 J	87	95.3	139
Mercury	2.6	2.4	8.8	6.7	--	--	--	--
Nickel	4.9 J	7.8 J	8.6 J	3.9 J	1.9 J	1.9 J	2.2 J	--
Potassium	--	--	--	--	74.5 J	81.9 J	115 J	122 J
Selenium	1.5 J	1.4 J	4.9	2.6	0.29 J	0.18 J	--	0.15 J
Silver	73.7	48.1	154	128	--	--	--	--
Sodium	193 J	232 J	294 J	205 J	179 J	192 J	175 J	187 J
Vanadium	6.1 J	4.1 J	12.1 J	9.6 J	6.8 J	5.9 J	7.2 J	6 J
Zinc	276	287	346	186	6.9	3.9 J	5.2	4.8
Cyanide	0.57 J	0.5 J	1.1 J	0.52 J	0.12 J	0.09 J	--	0.09 J

See notes at end of table.

Table 5-11 (Continued)
Organic and Inorganic Analytes Detected in Site 31C Surface Soil Samples

Remedial Investigation Report
Site 31, Sludge Drying Beds and Disposal Areas
Naval Air Station Whiting Field
Milton, Florida

Location Identifier:	31S007	31S008	31S009	31S010	31S011	31S012	31S013
Sample Identifier:	31S00701	31S00801	31S00901	31S01001	31S001101	31S01201	31S01301
Collection Date:	07-JAN-96	07-JAN-96	07-JAN-96	07-JAN-96	07-JAN-96	08-JAN-96	08-JAN-96
Laboratory Sample No.:	RA855014	RA855018	RA855017	RA855015	RA855016	RA855019	RA855020
Volatile Organic Compounds (µg/kg)							
Methylene chloride	--	--	--	--	--	--	--
Carbon disulfide	--	--	--	--	--	--	--
Toluene	--	--	--	1 J	--	--	--
Xylenes (total)	--	--	--	--	--	--	--
Semivolatile Organic Compounds (µg/kg)							
Butylbenzylphthalate	--	--	--	--	--	39 J	--
bis(2-Ethylhexyl)phthalate	42 J	60 J	570	--	--	540	210 J
Benzo(b)fluoranthene	--	--	--	--	--	--	--
Benzo(k)fluoranthene	--	--	--	--	--	--	--
Pesticides and PCBs (µg/kg)							
Dieldrin	--	--	2.1 J	--	--	3.5 J	--
4,4'-DDE	--	--	2.3 J	--	--	4.1 J	--
alpha-Chlordane	--	--	1.3 J	--	--	2 J	--
gamma-Chlordane	--	--	1.4 J	--	--	--	--
Aroclor-1260	--	--	--	--	--	--	--
Inorganic Analytes (mg/kg)							
Aluminum	1,670	2,460	2,010	1,970	2,260	1,960	2,520
Antimony	--	--	--	--	--	--	--
Arsenic	0.59 J	1.2 J	0.77 J	0.74 J	1.1 J	0.89 J	0.91 J
Barium	5.4 J	5.1 J	19.3 J	2.7 J	2.7 J	31.1 J	9 J

See notes at end of table.

Table 5-11 (Continued)
Organic and Inorganic Analytes Detected in Site 31C Surface Soil Samples

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Site 31, Sludge Drying Beds and Disposal Areas
Naval Air Station Whiting Field
Milton, Florida

Location Identifier:	31S007	31S008	31S009	31S010	31S011	31S012	31S013
Sample Identifier:	31S00701	31S00801	31S00901	31S01001	31S001101	31S01201	31S01301
Collection Date:	07-JAN-96	07-JAN-96	07-JAN-96	07-JAN-96	07-JAN-96	08-JAN-96	08-JAN-96
Laboratory Sample No.:	RA855014	RA855018	RA855017	RA855015	RA855016	RA855019	RA855020
Inorganic Analytes (mg/kg) (Continued)							
Beryllium	--	--	--	--	--	--	--
Cadmium	--	--	1.6	--	--	1.4	0.22 J
Calcium	152 J	188 J	277 J	93.3 J	116 J	145 J	115 J
Chromium	2.4	3.6	9.4	1.4 J	1.7 J	12.9	4.9
Cobalt	--	--	--	0.94 J	--	0.83 J	--
Copper	--	--	57.4	--	--	118	29.8
Iron	645	2,200	1,920	1,080	1,310	2,090	1,790
Lead	11.6	11.1	19.5	1.8	2.5	28.5	6.7
Magnesium	40.3 J	53.4 J	76.1 J	52.7 J	45.7 J	56.7 J	78.9 J
Manganese	1.9 J	34.2	8.9	5.2	8.2	7.4	10.2
Mercury	--	0.13	0.64	--	--	0.24	0.15
Nickel	--	--	--	--	1.5 J	1.6 J	--
Potassium	73.5 J	73.8 J	101 J	--	94.4 J	134 J	82 J
Selenium	--	--	0.28 J	--	--	0.41 J	0.29 J
Silver	--	0.97 J	3.3	--	--	5.1	1.1 J
Sodium	201 J	192 J	189 J	197 J	182 J	201 J	196 J
Vanadium	3.5 J	5.9 J	3 J	2.3 J	2.9 J	3.1 J	3.8 J
Zinc	--	12.4	50	--	3.6	11.3	6.4
Cyanide	0.09 J	0.09 J	0.22 J	0.09 J	0.09 J	0.27 J	0.23 J

Notes: µg/kg = micrograms per kilogram.
J = estimated value.
-- = analyte, if present, was less than the detection limit.
PCB = polychlorinated biphenyl.
DDE = dichlorodiphenyldichloroethene.
mg/kg = milligrams per kilogram.

Table 5-12
Comparison of Analytes Detected in Site 31C Surface Soil Samples to Background Screening and Benchmark Concentrations

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Milton, Florida

Analyte	Frequency of Detection[1]	Range of Detection Limits	Range of Detected Concentrations[2]	Mean of Detected Concentrations[3]	Background Screening Values[4]	USEPA Region III RBCs[5] Residential/ Industrial	Soil Cleanup Goals for Florida[6] Residential/ Industrial
Volatile Organic Compounds (µg/kg)							
Methylene chloride	4/14	6 to 68.5	120 to 240	170	--	[7]8,500/760,000	16,000/23,000
Carbon disulfide	4/14	6 to 12	3 to 39	14	--	[8]780,000/ 20,000,000	5,200/34,000
Toluene	1/14	6 to 12	1	1	--	[8]1,600,000/ 41,000,000	520,000/ 3,500,000
Xylenes (total)	4/14	6 to 12	4 to 11	6	--	[8]16,000,000/ 410,000,000	13,000,000/ 92,000,000
Semivolatile Organic Compounds (µg/kg)							
Butylbenzylphthalate	1/14	360 to 11,000	39	39	--	[8]1,600,000/ 41,000,000	15,000,000/ 310,000,000
bis(2-Ethylhexyl)phthalate	9/14	360 to 11,000	42 to 2,600	816	80.3	[7]46,000/410,000	48,000/110,000
Benzo(b)fluoranthene	1/14	360 to 11,000	100	100	--	--/--	1,400/5,000
Benzo(k)fluoranthene	1/14	360 to 11,000	110	110	--	--/--	14,000/48,000
Pesticides and PCBs (µg/kg)							
Dieldrin	6/14	3.6 to 270	2.1 to 120	47.4	--	[7]40/360	70/300
4,4'-DDE	6/14	3.6 to 270	2.3 to 100	43.6	--	[7]1,900/17,000	3,000/11,000
alpha-Chlordane	6/14	1.8 to 1,300	1.3 to 68	29.2	--	[7]1,800/16,000	800/3,000
gamma-Chlordane	5/14	1.8 to 1,300	1.4 to 76	34.1	--	[7]1,800/16,000	800/3,000
Aroclor-1260	4/14	36 to 2,700	340 to 1,400	738	--	[7]8,000/72,000	900/3,500

See notes at end of table.

Table 5-12 (Continued)
Comparison of Analytes Detected in Site 31C Surface Soil Samples to Background Screening and Benchmark Concentrations

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Naval Air Station Whiting Field
Milton, Florida

Analyte	Frequency of Detection[1]	Range of Detection Limits	Range of Detected Concentrations[2]	Mean of Detected Concentrations[3]	Background Screening Values[4]	USEPA Region III RBCs[5] Residential/ Industrial	Soil Cleanup Goals for Florida[6] Residential/ Industrial
Inorganic Analytes (mg/kg)							
Aluminum	14/14	40	1,670 to 16,800	4,818	15,848	[8]7,800/200,000	75,000/--
Antimony	4/14	12	3.1 to 7.1	5.1	8	3.1/82	26/220
Arsenic	14/14	2	0.59 to 1.7	1.1	3.2	[7]0.43/3.8	[9]0.8/[12]4.6
Barium	14/14	40	2.7 to 534	83.2	23.2	[8]550/14,000	5,200/84,000
Beryllium	4/14	1	0.3 to 1.3	0.65	0.36	[7]16/410	0.2/1.0
Cadmium	7/14	1	0.22 to 26.8	9.6	0.58	[8]3.9/100	37/600
Calcium	14/14	1,000	93.3 to 4,160	825	396	--/--	--/--
Chromium	14/14	2	1.4 to 295	46	11	[8]39/1,000	[12]290/430
Cobalt	8/14	10	0.83 to 3.1*	1.3	3	[8]470/12,000	4,700/110,000
Copper	7/14	5	29.8 to 948	307	9.4	[8]310/8,200	[10]2,900/72,000
Iron	14/14	20	645 to 22,500	4,704	8,832	[8]2,300/61,000	--/--
Lead	14/14	0.6 to 1	1.8 to 1,890	277	11.4	[11]400	500/1,000
Magnesium	14/14	1,000	40.3 to 1,120	247	268	--/--	--/--
Manganese	14/14	3	1.9 to 170	51.7	392	[8]160/4,100	370/5,500
Mercury	8/14	0.1	0.13 to 8.8	2.7	0.12	[8]2.3/61	23/480
Nickel	8/14	8	1.5 to 8.6	4	7.2	[8]160/4,100	1,500/26,000
Potassium	9/14	134 to 1,000	73.5 to 134	94.9	177	--/--	--/--
Selenium	10/14	1	0.15 to 4.9	1.2	0.46	[8]39/1,000	390/9,900
Silver	8/14	2	0.97 to 154	51.8	0.70	[8]39/1,000	380/9,900
Sodium	14/14	1,000	179 to 294	202	406	--/--	--/--
Vanadium	14/14	10	2.3 to 12.1	5.4	21.8	[8]55/1,400	490/4,800
Zinc	12/14	4	3.6 to 346	99.6	15.4	[8]2,300/61,000	23,000/560,000
Cyanide	14/14	0.05 to 1	0.09 to 1.1	0.3	0.28	--/--	1,600/40,000

See notes at end of table.

Table 5-12 (Continued)
Comparison of Analytes Detected in Site 31C Surface Soil Samples to Background Screening and Benchmark Concentrations

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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] Value indicated by an asterisk is the average of a sample and its duplicate. If the target analyte is not detected in either the environmental sample or associated duplicate, the value used for the nondetection is one-half the reporting limit.
[3] The mean of detected concentrations is the arithmetic mean of all environmental samples in which the analyte was detected; it includes a single value for an environmental sample and associated duplicate. The arithmetic mean does not include those environmental samples in which the analyte was not detected.
[4] The background screening value for organics is the mean detected concentration and will not be used for screening purposes in the risk assessment. The background screening value for inorganics is two times the mean detected background concentration and will be used for screening purposes in the risk assessment.
[5] Source: Memorandum dated February 17, 1997, from Roy L. Smith, Technical Support Section, USEPA Region II, to RBC Table Mailing List. Subject: Risk-Based Concentrations Table.
[6] Source: Memorandum dated September 29, 1995a, from John M. Ruddell, Director, Division of Waste Management to District Directors, Waste Program, Florida Department of Environmental Protection (FDEP). Subject: Soil Cleanup Goals for Florida.
[7] The values correspond to a human cancer risk level of 1 in 1,000,000.
[8] The calculated values correspond to a noncancer hazard quotient of 0.1.
[9] Source: Updated Memorandum dated January 19, 1996, from John M. Ruddell, Director, Division of Waste Management to District Directors, Waste Program, FDEP. Subject: Applicability of Soil Cleanup Goals for Florida.
[10] Source: Updated Memorandum dated April 5, 1995, from Ligia Mora Applegate, Director, Technical Review Section, Bureau of Waste Cleanup, FDEP, to Tim Bahr, Technical Review Section, Bureau of Waste Cleanup. Subject: Cleanup Goals for Military Sites in Florida.
[11] USEPA (1994) Office of Solid Waste and Emergency Response Directive No. 9355.4-12, Revised Interim Recommended Soil Cleanup for CERCLA and RCRA Sites.
[12] Values are for hexavalent chromium.

Notes: USEPA = U.S. Environmental Protection Agency.
RBC = risk-based concentration.
μg/kg = micrograms per kilogram.
– = criteria not available.
PCB = polychlorinated biphenyl.
DDE = dichlorodiphenyldichloroethene.
mg/kg = milligrams per kilogram.
* = average of a sample and its duplicate.

TCL SVOCs. Four SVOCs (butylbenzylphthalate, bis(2-ethylhexyl)phthalate, benzo(b)fluoranthene, and benzo(k)fluoranthene) were detected in surface soil samples collected at Site 31C. The detected concentrations were below the residential and industrial values for the soil cleanup goals for Florida and the USEPA Region III RBCs.

Bis(2-ethylhexyl)phthalate is a commonly recognized field-or laboratory-derived contaminant according to the USEPA's *Contract Laboratory Program Functional Guidelines for Organic Data Review* (USEPA, 1994a).

Pesticides and PCBs. Four pesticide compounds (dieldrin, 4,4'-DDE, alpha-chlordane, and gamma-chlordane) and one PCB compound (Aroclor-1260) were detected in surface soil samples collected at Site 31C. Dieldrin was detected in two samples at concentrations exceeding the residential and industrial values of the soil cleanup goals for Florida and USEPA Region III RBCs.

TAL Metals and (Total) Cyanide. Twenty-three inorganic analytes (including cyanide) were detected in the surface soil samples. Seventeen TAL metals (aluminum, barium, beryllium, cadmium, calcium, chromium, cobalt, copper, iron, lead, magnesium, mercury, nickel, selenium, silver, zinc, and cyanide) were detected in one or more sample at concentrations exceeding their respective background screening values. Six of the inorganic analytes that exceeded the background screening concentration also exceeded the residential values for either the USEPA Region III RBCs or soil cleanup goals for Florida. Lead was detected at concentrations exceeding the industrial values for the soil cleanup goals for Florida and the USEPA Region III RBCs. Beryllium exceeded the industrial values for the soil cleanup goals for Florida in some surface soil samples.

5.3.4 Site 31D Table 5-13 summarizes the analytical results for organic and inorganic analytes detected in two surface soil samples at Site 31D. The sample locations are shown on Figure 3-2.

Table 5-14 summarizes the frequency of detection, range of detection limits, range of detection concentrations, mean of detected concentrations, and background screening values for Site 31D surface soil samples.

TCL VOCs. Xylene was the only VOC detected in one surface soil sample (31-SL-16). The detected concentration was below the residential and industrial values for the soil cleanup goals for Florida and the USEPA Region III RBCs.

TCL SVOCs. SVOCs were not detected in the surface soil samples collected at Site 31D.

Pesticides and PCBs. Pesticide and PCB compounds were not detected in the surface soil samples collected at Site 31D.

TAL Metals and (Total) Cyanide. Eighteen TAL metals were detected in the surface soil samples. Potassium was detected in one sample at a concentration in slight exceedence of the background screening value. Arsenic, iron, and manganese were detected at concentrations exceeding the residential values of the soil cleanup goals for Florida. Detected concentrations of arsenic also exceeded the residential values for the USEPA Region III RBCs.

Table 5-13
Organic and Inorganic Analytes Detected in Site 31D Surface Soil Samples

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Milton, Florida

Location Identifier:	31-SL-16	31S014
Sample Identifier:	31-SL-16	31S01401
Collection Date:	18-AUG-92	12-DEC-95
Laboratory Sample No.:	22527004	G8924004
Volatile Organic Compounds (µg/kg)		
Xylenes (total)	3 J	--
Semivolatile Organic Compounds (µg/kg)		
None detected		
Pesticides and PCBs (µg/kg)		
None detected		
Inorganic Analytes (mg/kg)		
Aluminum	4,360	5,620
Arsenic	0.66 J	0.87 J
Barium	4.6 J	10.6 J
Beryllium	0.07 J	--
Calcium	248 J	156 J
Chromium	3.6	3.9
Cobalt	--	0.7 J
Copper	3.7 J	--
Iron	2,590	2,660
Lead	4.4	3.6
Magnesium	86.6 J	141 J
Manganese	33.1	196
Mercury	--	0.01 J
Nickel	--	3.2 J
Potassium	--	183 J
Sodium	127 J	--
Vanadium	6.6 J	6.8 J
Zinc	8.6	4.4 J

Notes: µg/kg = micrograms per kilogram.
J = estimated value.
-- = analyte, if present, was less than the detection limit.
PCB = polychlorinated biphenyl.
mg/kg = milligrams per kilogram.

Table 5-14
Comparison of Analytes Detected in Site 31D Surface Soil Samples to Background Screening and Benchmark Concentrations

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Site 31, Sludge Drying Beds and Disposal Areas
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Milton, Florida

Analyte	Frequency of Detection[1]	Range of Detection Limits	Range of Detected Concentrations[2]	Mean of Detected Concentrations[3]	Background Screening Values[4]	USEPA Region III RBCs[5] Residential/ Industrial	Soil Cleanup Goals for Florida[6] Residential/ Industrial
Volatile Organic Compounds (µg/kg)							
Xylenes (total)	1/2	5 to 11	3	3	--	16,000,000/ 100,000,000	13,000,000/ 19,000,000
Semivolatile Organic Compounds (µg/kg)							
None detected							
Pesticides and PCBs (µg/kg)							
None detected							
Inorganic Analytes (mg/kg)							
Aluminum	2/2	40	4,360 to 5,620	4,990	15,334	[8]7,800/100,000	75,000/--
Arsenic	2/2	2	0.66 to 0.87	0.77	3.1	[7]0.43/3.8	[9]0.8/3.7
Barium	2/2	40	4.6 to 10.6	7.6	23.7	[8]550/14,000	5,200/84,000
Beryllium	1/2	1	0.07	0.07	0.36	[7]0.15/1.3	0.2/1.0
Calcium	2/2	1,000	156 to 248	202	404	--/--	--/--
Chromium	2/2	2	3.6 to 3.9	3.8	10.7	[8]39/1,000	[12]290/430
Cobalt	1/2	0.34 to 10	0.7	0.7	2.87	[8]470/12,000	4,700/110,000
Copper	1/2	5	3.7	3.7	9.4	[8]310/8,200	[10]2,900/72,000
Iron	2/2	20	2,590 to 2,660	2,625	8,588	[8]2,300/61,000	--/--
Lead	2/2	0.6 to 1	3.6 to 4.4	4	11.5	[11]400	500/1,000
Magnesium	2/2	1,000	86.6 to 141	114	258	--/--	--/--
Manganese	2/2	3	33.1 to 196	115	403	[8]180/4,700	370/5,500
Mercury	1/2	0.05 to 0.1	0.01	0.01	0.12	[8]2.3/61	23/480

See notes at end of table.

Table 5-14 (Continued)
Comparison of Analytes Detected in Site 31D Surface Soil Samples to Background Screening and Benchmark Concentrations

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Site 31, Sludge Drying Beds and Disposal Areas
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Analyte	Frequency of Detection[1]	Range of Detection Limits	Range of Detected Concentrations[2]	Mean of Detected Concentrations[3]	Background Screening Values[4]	USEPA Region III RBCs[5] Residential/ Industrial	Soil Cleanup Goals for Florida[6] Residential/ Industrial
Inorganic Analytes (mg/kg) (Continued)							
Nickel	1/2	2.3 to 8	3.2	3.2	7.2	[8]160/4,100	1,500/26,000
Potassium	1/2	131 to 1,000	183	183	177	--/--	--/--
Sodium	1/2	1,000	127	127	382	--/--	--/--
Vanadium	2/2	10	6.6 to 6.8	6.7	21.2	[8]55/1,400	23,000/560,000
Zinc	2/2	4	4.4 to 8.6	6.5	15.4	[8]2,300/61,000	640/550,000

[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] If the target analyte is not detected in either the environmental sample or associated duplicate, the value used for the nondetection is one-half the reporting limit.
[3] The mean of detected concentrations is the arithmetic mean of all environmental samples in which the analyte was detected; it includes a single value for an environmental sample and associated duplicate. The arithmetic mean does not include those environmental samples in which the analyte was not detected.
[4] The background screening value for organics is the mean detected concentration and will not be used for screening purposes in the risk assessment. The background screening value for inorganics is two times the mean detected background concentration and will be used for screening purposes in the risk assessment.
[5] Source: Memorandum dated February 17, 1997, from Roy L. Smith, Technical Support Section, USEPA Region II, to RBC Table Mailing List. Subject: Risk-Based Concentrations Table.
[6] Source: Memorandum dated September 29, 1995a, from John M. Ruddell, Director, Division of Waste Management to District Directors, Waste Program, Florida Department of Environmental Protection (FDEP). Subject: Soil Cleanup Goals for Florida.
[7] The values correspond to a human cancer risk level of 1 in 1,000,000.
[8] The calculated values correspond to a noncancer hazard quotient of 0.1.
[9] Source: Updated Memorandum dated January 19, 1996, from John M. Ruddell, Director, Division of Waste Management to District Directors, Waste Program, FDEP. Subject: Applicability of Soil Cleanup Goals for Florida.
[10] Source: Updated Memorandum dated April 5, 1995, from Ligia Mora Applegate, Director, Technical Review Section, Bureau of Waste Cleanup, FDEP, to Tim Bahr, Technical Review Section, Bureau of Waste Cleanup. Subject: Cleanup Goals for Military Sites in Florida.
[11] USEPA (1994) Office of Solid Waste and Emergency Response Directive No. 9355.4-12, Revised Interim Recommended Soil Cleanup for CERCLA and RCRA Sites.
[12] Values are for hexavalent chromium.

Notes: USEPA = U.S. Environmental Protection Agency.
RBC = risk-based concentration.
μg/kg = micrograms per kilogram.
-- = criteria not available.
PCB = polychlorinated biphenyl.
mg/kg = milligrams per kilogram.

5.3.5 Site 31E Table 5-15 summarizes the analytical results for organic and inorganic analytes detected in six surface soil samples (and two duplicates) at Site 31E. The sample locations are shown on Figure 3-3. Table 5-16 summarizes the frequency of detection, range of detection limits, range of detection concentrations, mean of detected concentrations, and background screening values for Site 31E surface soil samples.

TCL VOCs. Two VOCs (2-hexanone and xylene) were detected in the surface soil samples collected at Site 31E. The detected concentrations were below residential and industrial soil cleanup goals for Florida and USEPA Region III RBCs.

TCL SVOCs. One SVOC (bis(2-ethylhexyl)phthalate) was detected in the surface soil samples collected at Site 31E. The detected concentration was below the residential and industrial values for the soil cleanup goals for Florida and the USEPA Region III RBCs. Bis(2-ethylhexyl)phthalate is a commonly recognized field-or laboratory-derived contaminant according to the USEPA's *Contract Laboratory Program Functional Guidelines for Organic Data Review* (USEPA, 1994a).

Pesticides and PCBs. Pesticide and PCB compounds were not detected in any surface soil samples collected at Site 31E.

TAL Metals and (Total) Cyanide. Nineteen inorganic analytes were detected in the surface soil samples. Three analytes (magnesium, potassium, and silver) were detected at concentrations exceeding their respective background screening values. Arsenic, beryllium, and manganese exceeded the residential values of the soil cleanup goals for Florida and the USEPA Region III RBCs but did not exceed the background screening criteria. Cyanide (total), if present, was not detected in the samples at concentrations exceeding the IDL.

5.3.6 Site 31F Table 5-17 summarizes the analytical results for organic and inorganic analytes detected in seven surface soil samples at Site 31F. The sample locations are shown on Figure 3-3.

Table 5-18 summarizes the frequency of detection, range of detection limits, range of detection concentrations, mean of detected concentrations, and background screening values for Site 31F surface soil samples.

TCL VOCs. Two VOCs (carbon disulfide and xylenes) were detected in the seven surface soil samples. The detected concentrations were below their respective residential and industrial values of the soil cleanup goals for Florida and the USEPA Region III RBCs. Carbon disulfide is a commonly recognized field-or laboratory-derived contaminant according to the USEPA's *Contract Laboratory Program Functional Guidelines for Organic Data Review* (USEPA, 1994a).

TCL SVOCs. Two SVOCs (bis(2-ethylhexyl)phthalate and di-*n*-octylphthalate) were detected in the surface soil samples collected at Site 31F. The detected concentrations were below their respective residential and industrial values of the soil cleanup goals for Florida and the USEPA Region III RBCs. However, all of the concentrations were below the background screening level. Bis(2-ethylhexyl)phthalate is a commonly recognized field-or laboratory-derived contaminant according to the USEPA's *Contract Laboratory Program Functional Guidelines for Organic Data Review* (USEPA, 1994a).

Table 5-15
Organic and Inorganic Analytes Detected in Site 31E Surface Soil Samples

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Milton, Florida

Location Identifier:	31-SL-05	31-SL-06	31-SL-07	31-SL-07 Duplicate Sample	31-SL-08	31S015	31S015 Duplicate Sample	31S016
Sample Identifier:	31-SL-05	31-SL-06	31-SL-07	31-SL-07A	31-SL-08	31S01501	31S01501D	31S01601
Collection Date:	17-AUG-92	18-AUG-92	17-AUG-92	17-AUG-92	17-AUG-92	13-DEC-95	13-DEC-95	13-DEC-95
Laboratory Sample No.:	22515005	22527003	22515007	22515008	22515009	G8938002	G8938003	G8938004
Volatile Organic Compounds (µg/kg)								
2-Hexanone	--	1 J	--	--	--	--	--	--
Xylenes (total)	--	3 J	2 J	2 J	2 J	--	--	--
Semivolatile Organic Compounds (µg/kg)								
bis(2-Ethylhexyl)phthalate	190 J	--	--	--	--	--	--	--
Pesticides and PCBs (µg/kg)								
None detected								
Inorganic Analytes (mg/kg)								
Aluminum	9,190	7,870	6,550	6,480	6,840	9,620	8,270	5,920
Arsenic	1.6 J	1.1 J	0.89 J	0.99 J	0.87 J	1.4 J	1.9 J	1.5 J
Barium	10.7 J	22.8 J	12.2 J	12.5 J	11 J	14.6 J	12.2 J	7.2 J
Beryllium	0.1 J	0.1 J	0.09 J	0.11 J	0.09 J	--	--	--
Calcium	107 J	281 J	169 J	188 J	168 J	112 J	103 J	122 J
Chromium	6.6	4	4.4	5	5.2	6.7	6	5.4
Cobalt	0.97 J	0.95 J	0.68 J	1.2 J	1.1 J	0.8 J	1.2 J	--
Copper	5.4 J	4 J	5.4 J	4.8 J	4.4 J	5.5 J	--	--
Iron	4,490	3,980	2,980	3,010	3,270	4,730	4,380	3,010
Lead	5.6	4.4	4.2	5.7	4	5.3	5.4	5.2
Magnesium	104 J	119 J	121 J	119 J	109 J	154 J	114 J	105 J
Manganese	194	399	212	210	279 J	183	172	60.3

See notes at end of table.

Table 5-15 (Continued)
Organic and Inorganic Analytes Detected in Site 31E Surface Soil Samples

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Site 31, Sludge Drying Beds and Disposal Areas
Naval Air Station Whiting Field
Milton, Florida

Location Identifier:	31-SL-05	31-SL-06	31-SL-07	31-SL-07 Duplicate Sample	31-SL-08	31S015	31S015 Duplicate Sample	31S016
Sample Identifier:	31-SL-05	31-SL-06	31-SL-07	31-SL-07A	31-SL-08	31S01501	31S01501D	31S01601
Collection Date:	17-AUG-92	18-AUG-92	18-AUG-92	18-AUG-92	17-AUG-92	13-DEC-95	13-DEC-95	13-DEC-95
Laboratory Sample No.:	22515005	22527003	22515007	22515008	22515009	G8938002	G8938003	G8938004
Inorganic Analytes (mg/kg) (Continued)								
Mercury	--	--	--	--	--	0.01 J	0.01	--
Nickel	--	3.6 J	--	2.4 J	--	3.9 J	3.4 J	4.1 J
Potassium	--	--	--	146 J	--	--	197 J	149 J
Silver	2.8	--	6.6	2.6	2.5	--	--	--
Sodium	180 J	135 J	142 J	179 J	166 J	--	--	--
Vanadium	12.2	9.9 J	8.1 J	8.6 J	8.8	12.8	11.3	8.6 J
Zinc	8 J	6	10.6	7.8 J	8.4	6.8	5	3.6 J

Note: μg/kg = micrograms per kilogram.
-- = analyte, if present, was less than the detection limit.
J = estimated value.
PCB = polychlorinated biphenyl.
mg/kg = milligrams per kilogram.

Table 5-16
Comparison of Analytes Detected in Site 31E Surface Soil Samples to Background Screening and Benchmark Concentrations

Remedial Investigation Report
Site 31, Sludge Drying Beds and Disposal Areas
Naval Air Station Whiting Field
Milton, Florida

Analyte	Frequency of Detection[1]	Range of Detection Limits	Range of Detected Concentrations[2]	Mean of Detected Concentrations[3]	Background Screening Values[4]	USEPA Region III RBCs[5] Residential/ Industrial	Soil Cleanup Goals for Florida[6] Residential/ Industrial
Volatile Organic Compounds (µg/kg)							
2-Hexanone	1/6	11	1	1	--	--/--	--/--
Xylenes (total)	3/6	5 to 11	2* to 3	2.3	--	16,000,000/ 100,000,000	13,000,000/ 19,000,000
Semivolatile Organic Compounds (µg/kg)							
bis(2-Ethylhexyl)phthalate	1/6	360 to 370	190	190	80.3	46,000/410,000	48,000/110,000
Pesticides and PCBs (µg/kg)							
None detected							
Inorganic Analytes (mg/kg)							
Aluminum	6/6	40	5,920 to 9,190	7,547	15,848	[8]7,800/100,000	75,000/--
Arsenic	6/6	2	0.87 to 1.65*	1.3	3.2	[7]0.43/3.8	[9]0.8/3.7
Barium	6/6	40	7.2 to 22.8	12.9	23.2	[8]550/14,000	5,200/84,000
Beryllium	4/6	1	0.09 to 0.1	0.1	0.36	[7]0.15/1.3	0.2/1.0
Calcium	6/6	1,000	107 to 281	161	396	--/--	--/--
Chromium	6/6	2	4 to 6.6	5.4	11	[8]39/1,000	[12]290/430
Cobalt	5/6	10	0.94* to 1.1	0.99	3	[8]470/12,000	4,700/110,000
Copper	5/6	5	4 to 5.4	4.6	9.4	[8]310/8,200	[10]2,900/72,000
Iron	6/6	20	2,995* to 4,555*	3,717	8,832	[8]2,300/61,000	--/--
Lead	6/6	0.6 to 1	4 to 5.6	4.9	11.4	[11]400	500/1,000
Magnesium	6/6	1,000	104 to 134*	115	268	--/--	--/--
Manganese	6/6	3	60.3 to 399	220	392	[8]180/4,700	370/5,500
Mercury	1/6	0.04 to 0.1	0.01*	0.01	0.12	[8]2.3/61	23/480

See notes at end of table.

Table 5-16 (Continued)
Comparison of Analytes Detected in Site 31E Surface Soil Samples to Background Screening and Benchmark Concentrations

Remedial Investigation Report
Site 31, Sludge Drying Beds and Disposal Areas
Naval Air Station Whiting Field
Milton, Florida

Analyte	Frequency of Detection[1]	Range of Detection Limits	Range of Detected Concentrations[2]	Mean of Detected Concentrations[3]	Background Screening Values[4]	USEPA Region III RBCs[5] Residential/ Industrial	Soil Cleanup Goals for Florida[6] Residential/ Industrial
Inorganic Analytes (mg/kg) (Continued)							
Nickel	4/6	2.3 to 8	1.8* to 4.1	3.3	7.2	[8]160/4,100	1,500/26,000
Potassium	3/6	131 to 1,000	106* to 348.5*	201	177	--/--	--/--
Silver	3/6	0.33 to 2	2.5 to 4.6*	3.3	0.70	[8]39/1,000	380/9,900
Sodium	4/6	1,000	135 to 180	160	406	--/--	--/--
Vanadium	6/6	10	8.35* to 12.2	10	21.8	[8]55/1,400	23,000/560,000
Zinc	6/6	4	3.6 to 9.2*	6.9	15.4	[8]2,300/861,000	640/550,000

[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] Value indicated by an asterisk is the average of a sample and its duplicate. If the target analyte is not detected in either the environmental sample or associated duplicate, the value used for the nondetection is one-half the reporting limit.
[3] The mean of detected concentrations is the arithmetic mean of all environmental samples in which the analyte was detected; it includes a single value for an environmental sample and associated duplicate. The arithmetic mean does not include those environmental samples in which the analyte was not detected.
[4] The background screening value for organics is the mean detected concentration and will not be used for screening purposes in the risk assessment. The background screening value for inorganics is two times the mean detected background concentration and will be used for screening purposes in the risk assessment.
[5] Source: Memorandum dated February 17, 1997, from Roy L. Smith, Technical Support Section. USEPA Region II to RBC Table Mailing List. Subject: Risk-Based Concentrations Table.
[6] Source: Memorandum dated September 29, 1995a, from John M. Ruddell, Director, Division of Waste Management to District Directors, Waste Program, Florida Department of Environmental Protection (FDEP). Subject: Soil Cleanup Goals for Florida.
[7] The values correspond to a human cancer risk level of 1 in 1,000,000.
[8] The calculated values correspond to a noncancer hazard quotient of 0.1.
[9] Source: Updated Memorandum dated January 19, 1996, from John M. Ruddell, Director, Division of Waste Management to District Directors, Waste Program, FDEP. Subject: Applicability of Soil Cleanup Goals for Florida.
[10] Source: Updated Memorandum dated April 5, 1995, from Ligia Mora Applegate, Director, Technical Review Section, Bureau of Waste Cleanup, FDEP, to Tim Bahr, Technical Review Section, Bureau of Waste Cleanup. Subject: Cleanup Goals for Military Sites in Florida.
[11] USEPA (1994) Office of Solid Waste and Emergency Response Directive No. 9355.4-12, Revised Interim Recommended Soil Cleanup for CERCLA and RCRA Sites.
[12] Values are for hexavalent chromium.

Notes: USEPA = U.S. Environmental Protection Agency.
RBC = risk-based concentration.
μg/kg = micrograms per kilogram.
-- = criteria not available.
* = average of a sample and its duplicate.
PCB = polychlorinated biphenyl.
mg/kg = milligrams per kilogram.

Table 5-17
Organic and Inorganic Analytes Detected in Site 31F Surface Soil Samples

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Site 31, Sludge Drying Beds and Disposal Areas
Naval Air Station Whiting Field
Milton, Florida

Location Identifier:	31-SL-01	31-SL-02	31-SL-03	31-SL-04	31S017	31S018	31S019
Sample Identifier:	31-SL-01	31-SL-02	31-SL-03	31-SL-04	31S01701	31S01801	31S01901
Collection Date:	17-AUG-92	17-AUG-92	17-AUG-92	17-AUG-92	13-DEC-95	13-DEC-95	13-DEC-95
Laboratory Sample No.:	22515001	22527002	22515004	22515003	G8938005	G8938006	G8938007
Volatile Organic Compounds (µg/kg)							
Carbon disulfide	--	3 J	--	--	--	--	--
Xylenes (total)	--	3 J	--	2 J	--	--	--
Semivolatile Organic Compounds (µg/kg)							
bis(2-Ethylhexyl)phthalate	--	--	81 J	230 J	--	--	--
Di-*n*-octylphthalate	--	--	--	--	--	220 J	--
Pesticides and PCBs (µg/kg)							
None detected							
Inorganic Analytes (mg/kg)							
Aluminum	10,700	9,930	6,600	5,800	5,010	5,490	5,490
Arsenic	1.9 J	1.3 J	0.7 J	0.98 J	1.1 J	0.72 J	0.72 J
Barium	24.5 J	21.1 J	11.2 J	13.4 J	10.6 J	12.8 J	12.8 J
Beryllium	0.15 J	0.11 J	0.08 J	0.09 J	--	--	--
Calcium	216 J	126 J	962 J	138 J	223 J	78.7	78.7
Chromium	7.1	5.8	4.6	3.9	5	4.1	4.1
Cobalt	1.1 J	1.4 J	0.66 J	0.93 J	0.71 J	0.97 J	--
Copper	5.6 J	17.9 J	4.6 J	5.5	--	--	--
Iron	5,380	4,800	3,060	2,850	2,580	3,180	3,180
Lead	6.4	5.5	2.9	4.5	4.4	4.8	4.8
Magnesium	164 J	154 J	549 J	98.6 J	134 J	113 J	130 J
Manganese	456	410	290	295	231	122	150

See notes at end of table.

Table 5-17 (Continued)
Organic and Inorganic Analytes Detected in Site 31F Surface Soil Samples

Remedial Investigation Report
Site 31, Sludge Drying Beds and Disposal Areas
Naval Air Station Whiting Field
Milton, Florida

Location Identifier:	31-SL-01	31-SL-02	31-SL-03	31-SL-04	31S017	31S018	31S019
Sample Identifier:	31-SL-01	31-SL-02	31-SL-03	31-SL-04	31S01701	31S01801	31S01901
Collection Date:	17-AUG-92	17-AUG-92	17-AUG-92	17-AUG-92	13-DEC-95	13-DEC-95	13-DEC-95
Laboratory Sample No.:	22515001	22527002	22515004	22515003	G8938005	G8938006	G8938007
Inorganic Analytes (mg/kg) (Continued)							
Mercury	--	--	--	--	0.01 J	0.02 J	0.02 J
Nickel	--	6.9 J	--	--	3.2 J	4 J	4 J
Selenium	--	--	0.52 J	--	--	--	--
Silver	2.4	--	4.1	3.7	--	--	0.68 J
Sodium	183 J	133 J	190 J	233 J	--	--	--
Vanadium	14.2	12.3	8.3	7.3 J	6.5 J	7.8 J	7.8 J
Zinc	9.9	23.1	7.9 J	7.9 J	4.7	3.5	--

Notes: μg/kg = micrograms per kilogram.
-- = analyte, if present, was less than the detection limit.
J = estimated value.
PCB = polychlorinated biphenyl.
mg/kg = milligrams per kilogram.

Table 5-18
Comparison of Analytes Detected in Site 31F Surface Soil Samples to Background Screening and Benchmark Concentrations

Remedial Investigation Report
Site 31, Sludge Drying Beds and Disposal Areas
Naval Air Station Whiting Field
Milton, Florida

Analyte	Frequency of Detection[1]	Range of Detection Limits	Range of Detected Concentrations[2]	Mean of Detected Concentrations[3]	Background Screening Values[4]	USEPA Region III RBCs[5] Residential/ Industrial	Soil Cleanup Goals for Florida[6] Residential/ Industrial
Volatile Organic Compounds (µg/kg)							
Carbon disulfide	1/7	5 to 11	3	3	--	7,800,000/ 200,000,000	5,200/34,000
Xylenes (total)	2/7	5 to 11	2 to 3	2.5	--	16,000,000/ 100,000,000	13,000,000/ 19,000,000
Semivolatile Organic Compounds (µg/kg)							
bis(2-Ethylhexyl)phthalate	2/7	360 to 380	81 to 230	156	80.3	46,000/410,000	48,000/110,000
Di-*n*-octylphthalate	1/7	360 to 380	220	220	--	1,600,000/ 41,000,000	1,500,000/ 32,000,000
Pesticides and PCBs (µg/kg)							
None detected							
Inorganic Analytes (mg/kg)							
Aluminum	7/7	40	5,010 to 10,700	7,003	15,848	[8]7,800/100,000	75,000/--
Arsenic	7/7	2	0.7 to 1.9	1.1	3.2	[7]0.43/3.8	[9]0.8/3.7
Barium	7/7	40	10.6 to 24.5	15.2	23.2	[8]550/14,000	5,200/84,000
Beryllium	4/7	1	0.08 to 0.15	0.11	0.36	[7]0.15/1.3	0.2/1.0
Calcium	7/7	1,000	78.7 to 962	260	396	--/--	--/--
Chromium	7/7	2	3.9 to 7.1	4.9	11	[8]39/1,000	[12]290/430
Cobalt	6/7	10	0.66 to 1.4	0.96	3	[8]470/12,000	4,700/110,000
Copper	4/7	5	4.6 to 17.9	8.4	9.4	[8]310/8,200	[10]2,900/72,000
Iron	7/7	20	2,580 to 5,380	3,576	8,832	[8]2,300/61,000	--/--
Lead	7/7	0.6 to 1	2.9 to 6.4	4.8	11.4	[11]400	500/1,000
Magnesium	7/7	1,000	98.6 to 549	192	268	--/--	--/--
Manganese	7/7	3	122 to 456	279	392	[8]180/4,700	370/5,500
Mercury	3/7	0.05 to 0.1	0.01 to 0.02	0.02	0.12	[8]2.3/61	23/480
Nickel	4/7	2.3 to 8	3.2 to 6.9	4.5	7.2	[8]160/4,100	1,500/26,000

See notes at end of table.

Table 5-18 (Continued)
Comparison of Analytes Detected in Site 31F Surface Soil Samples to Background Screening and Benchmark Concentrations

Remedial Investigation Report
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Naval Air Station Whiting Field
Milton, Florida

Analyte	Frequency of Detection[1]	Range of Detection Limits	Range of Detected Concentrations[2]	Mean of Detected Concentrations[3]	Background Screening Values[4]	USEPA Region III RBCs[5] Residential/ Industrial	Soil Cleanup Goals for Florida[6] Residential/ Industrial
Inorganic Analytes (mg/kg) (Continued)							
Selenium	1/7	0.46 to 1	0.52	0.52	0.46	[8]39/1,000	390/9,900
Silver	4/7	0.33 to 2	0.68 to 4.1	2.7	0.70	[8]39/1,000	380/9,900
Sodium	4/7	1,000	133 to 233	185	406	--/--	--/--
Vanadium	7/7	10	6.5 to 14.2	9.2	21.8	[8]55/1,400	23,000/560,000
Zinc	6/7	4	3.5 to 23.1	9.5	15.4	[8]2,300/61,000	640/550,000

[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] If the target analyte is not detected in either the environmental sample or associated duplicate, the value used for the nondetection is one-half the reporting limit.
[3] The mean of detected concentrations is the arithmetic mean of all environmental samples in which the analyte was detected; it includes a single value for an environmental sample and associated duplicate. The arithmetic mean does not include those environmental samples in which the analyte was not detected.
[4] The background screening value for organics is the mean detected concentration and will not be used for screening purposes in the risk assessment. The background screening value for inorganics is two times the mean detected background concentration and will be used for screening purposes in the risk assessment.
[5] Source: Memorandum dated February 17, 1997, from Roy L. Smith, Technical Support Section, USEPA Region II, to RBC Table Mailing List. Subject: Risk-Based Concentrations Table.
[6] Source: Memorandum dated September 29, 1995a, from John M. Ruddell, Director, Division of Waste Management to District Directors, Waste Program, Florida Department of Environmental Protection (FDEP). Subject: Soil Cleanup Goals for Florida.
[7] The values correspond to a human cancer risk level of 1 in 1,000,000.
[8] The calculated values correspond to a noncancer hazard quotient of 0.1.
[9] Source: Updated Memorandum dated January 19, 1996, from John M. Ruddell, Director, Division of Waste Management to District Directors, Waste Program, FDEP. Subject: Applicability of Soil Cleanup Goals for Florida.
[10] Source: Updated Memorandum dated April 5, 1995, from Ligia Mora Applegate, Director, Technical Review Section, Bureau of Waste Cleanup, FDEP, to Tim Bahr, Technical Review Section, Bureau of Waste Cleanup. Subject: Cleanup Goals for Military Sites in Florida.
[11] USEPA (1994) Office of Solid Waste and Emergency Response Directive No. 9355.4-12, Revised Interim Recommended Soil Cleanup for CERCLA and RCRA Sites.
[12] Values are for hexavalent chromium.

Notes: USEPA = U.S. Environmental Protection Agency.
RBC = risk-based concentration.
μg/kg = micrograms per kilogram.
-- = criteria not available.
PCB = polychlorinated biphenyl.
mg/kg = milligrams per kilogram.

Pesticides and PCBs. Pesticide and PCB compounds were not detected in surface soil samples collected at Site 31F.

TAL Metals and (Total) Cyanide. Nineteen inorganic analytes were detected in the surface soil samples. Eight analytes (barium, calcium, copper, magnesium, manganese, selenium, silver, and zinc) were detected in one or more samples at concentrations exceeding their respective background screening values. Of the analytes detected at concentrations exceeding the background screening concentrations only manganese was reported at concentrations exceeding the residential values of the soil cleanup goals for Florida and the USEPA Region III RBCs. Cyanide (total), if present, was not detected in the samples at concentrations exceeding the IDL.

5.4 SUBSURFACE SOIL ASSESSMENT. Subsurface soil samples were collected at Sites 31A and 31C during Phase IIB of the RI. The analytical results for each disposal area are presented in the subsections below.

5.4.1 Site 31A Table 5-19 summarizes the analytical results for organic and inorganic analytes detected in five subsurface soil samples (and one duplicate) at Site 31A. One subsurface sample location (31B005) is located upgradient to the sludge drying beds and was collected as a local background sample (31B00501). The soil boring location for the samples is shown on Figure 3-1. Table 5-20 summarizes the frequency of detection, range of detection limits, range of detection concentrations, mean of detected concentrations, and background screening values for Site 31A subsurface soil samples.

TCL VOCs. TCL VOCs were not detected in the subsurface soil samples collected from the soil borings at Site 31A.

TCL SVOCs. One SVOC (bis(2-ethylhexyl)phthalate) was detected in the subsurface soil samples collected at Site 31A. All detected concentrations were below the industrial values of the soil cleanup goals for Florida and the USEPA Region III RBCs. Bis(2-ethylhexyl)phthalate is a commonly recognized field-or laboratory derived contaminant according to the USEPA's *Contract Laboratory Program Functional Guidelines for Organic Data Review* (USEPA, 1994a).

Pesticides and PCBs. Pesticide and PCB compounds were not detected in the subsurface soil samples collected at Site 31A.

TAL Metals and (Total) Cyanide. Twenty-two inorganic analytes were detected in the subsurface soil samples from Site 31A. Seven of the analytes (beryllium, cobalt, copper, manganese, mercury, sodium, and thallium) exceeded the background screening values. However, all of the inorganic analytes detected in the subsurface soil samples were below their respective industrial values of the soil cleanup goals for Florida and the USEPA Region III RBCs. Cyanide (total), if present, was not detected in the samples at concentrations exceeding the detection limit.

5.4.2 Site 31C Table 5-21 summarizes the analytical results for organic and inorganic analytes detected in fifteen subsurface soil samples (and one duplicate) collected from three soil borings at Site 31C. The soil boring locations for the samples is shown on Figure 3-2. Table 5-22 summarizes the frequency of detection, range of detection limits, range of detection concen-

Table 5-19
Organic and Inorganic Analytes Detected in Site 31A Subsurface Soil Samples

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Sample Location:	31B001	31B002	31B002 Duplicate Sample	31B003	31B004	31B005
Sample Identifier:	31B00101	31B00201	31B00201D	31B00301	31B00401	31B00501
Sample Depth Interval (feet bls):	1.5 to 2.7	1.5 to 2.7	1.5 to 2.7	1.5 to 2.7	1.5 to 2.7	1.5 to 3.0
Collection Date:	11-JAN-96	11-JAN-96	11-JAN-96	11-JAN-96	11-JAN-96	11-JAN-96
Laboratory Sample No.:	RA870016	RA870014	RA870015	RA870013	RA870012	RA870017
Volatile Organic Compounds (µg/kg)						
None detected						
Semivolatile Organic Compounds (µg/kg)						
bis(2-Ethylhexyl)phthalate	52 J	--	48 J	--	38 J	--
Pesticides and PCBs (µg/kg)						
None detected						
Inorganic Analytes (mg/kg)						
Aluminum	3,720 J	4,360 J	4,050	6,010	3,740	5,620
Arsenic	1.2 J	1 J	1.2 J	2.9	0.93 J	1.3 J
Barium	5.7 J	4.7 J	4.3 J	6.6 J	9.3 J	11.2 J
Beryllium	0.05 J	0.05 J	--	0.05 J	0.05 J	0.05 J
Cadmium	0.32 J	0.21 J	0.34 J	--	--	0.21 J
Calcium	137 J	107 J	121 J	133 J	139 J	643 J
Chromium	2.4	2.6	2.1 J	3.9 J	3.3	3.8
Cobalt	--	0.76 J	--	--	1.2 J	0.9 J
Copper	10.9	8.5	8.4	8	--	--
Iron	2,560	2,960	2,750	3,690	2,850	3,490

See notes at end of table.

Table 5-19 (Continued)
Organic and Inorganic Analytes Detected in Site 31A Subsurface Soil Samples

Remedial Investigation Report
Site 31, Sludge Drying Beds and Disposal Areas
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Milton, Florida

Sample Location:	31B001	31B002	31B002 Duplicate Sample	31B003	31B004	31B005
Sample Identifier:	31B00101	31B00201	31B00201D	31B00301	31B00401	31B00501
Sample Depth Interval (feet bls):	1.5 to 2.7	1.5 to 2.7	1.5 to 2.7	1.5 to 2.7	1.5 to 2.7	1.5 to 3.0
Collection Date:	11-JAN-96	11-JAN-96	11-JAN-96	11-JAN-96	11-JAN-96	11-JAN-96
Laboratory Sample No.:	RA870016	RA870014	RA870015	RA870013	RA870012	RA870017
Inorganic Analytes (mg/kg) (Continued)						
Lead	3.2	2.9	2.9	4.1	5.3	3.5
Magnesium	79 J	81.1 J	72 J	118 J	74.1 J	137 J
Manganese	7.8	8	7.5	13.8	70.9 J	155
Mercury	0.1 J	0.04 J	0.04 J	-- R	0.04 J	0.05 J
Nickel	1.5 J	1.8 J	1.6 J	1.7 J	2.4 J	3.5 J
Potassium	--	88.8 J	114 J	127 J	96.1 J	129 J
Selenium	--	--	--	0.17 J	0.16 J	--
Silver	0.43 J	--	--	--	--	--
Sodium	192 J	175 J	183 J	179 J	177 J	168 J
Thallium	0.13 J	--	--	0.19 J	--	--
Vanadium	5.2 J	6 J	5.3 J	8.8 J	5.7 J	7.7 J
Zinc	9.3	7.1	6.4	6.6	--	8.5

Notes: bls = below land surface.
D = duplicate sample.
μg/kg = micrograms per kilogram.
J = estimated value.
-- = analyte, if present, is at a concentration less than the detection limit.
PCB = polychlorinated biphenyl.
mg/kg = milligrams per kilogram.
R = value was rejected during data validation.

Table 5-20
Comparison of Analytes Detected in Site 31A Subsurface Soil Samples to Background Screening and Benchmark Concentrations

Remedial Investigation Report
Site 31, Sludge Drying Beds and Disposal Areas
Naval Air Station Whiting Field
Milton, Florida

Analyte	Frequency of Detection[1]	Range of Detection Limits	Range of Detected Concentrations[2]	Mean of Detected Concentrations[3]	Background Screening Values[4]	USEPA Region III RBCs[5] Industrial	Soil Cleanup Goals for Florida Industrial[6]
Volatile Organic Compounds (µg/kg)							
None detected							
Semivolatile Organic Compounds (µg/kg)							
bis(2-Ethylhexyl)phthalate	3/4	360 to 380	38 to 116.5*	68.8	80.3	410,000	110,000
Pesticides and PCBs (µg/kg)							
None detected							
Inorganic Analytes (mg/kg)							
Aluminum	4/4	40	3,720 to 6,010	4,419	27,834	[8]100,000	--
Arsenic	4/4	2	0.93 to 2.9	1.5	6.2	[7]3.8	[9]3.7
Barium	4/4	40	4.5 to 9.3	6.5	15.8	[8]14,000	84,000
Beryllium	4/4	1	0.05 to 0.275*	0.11	0.26	[7]1.3	1.0
Cadmium	2/4	1	0.275* to 0.32	0.3	0.92	[8]100	600
Calcium	4/4	1,000	114* to 139	131	444	--	--
Chromium	4/4	2	2.35* to 3.9	3	22.8	[8]1,000	[13]430
Cobalt	2/4	10	1.2 to 2.88*	2	1.48	[8]12,000	110,000
Copper	3/4	5	8 to 10.9	9.1	8.8	[8]8,200	[10]72,000
Iron	4/4	20	2,560 to 3,690	2,989	18,100	[8]61,000	--
Lead	4/4	0.6	2.9* to 5.3	3.9	8.4	[11]400	1,000
Magnesium	4/4	1,000	74.1 to 118	86.9	272	--	--
Manganese	4/4	3	7.75* to 70.9	25.1	42.6	[8]4,700	5,500
Mercury	3/[12]3	0.1	0.04* to 0.1	0.06	ND	610	480
Nickel	4/4	8	1.5 to 2.4	1.8	5.0	4,100	26,000
Potassium	3/4	1,000	96.1 to 127	108	181	--	--
Selenium	2/4	1	0.16 to 0.17	0.17	0.30	1,000	9,900
Silver	1/4	2	0.43	0.43	1.12	[8]1,000	9,000

See notes at end of table.

Table 5-20 (Continued)
Comparison of Analytes Detected in Site 31A Subsurface Soil Samples to Background Screening and Benchmark Concentrations

Remedial Investigation Report
Site 31, Sludge Drying Beds and Disposal Areas
Naval Air Station Whiting Field
Milton, Florida

Analyte	Frequency of Detection[1]	Range of Detection Limits	Range of Detected Concentrations[2]	Mean of Detected Concentrations[3]	Background Screening Values[4]	USEPA Region III RBCs[5] Industrial	Soil Cleanup Goals for Florida Industrial[6]
Inorganic Analytes (mg/kg) (Continued)							
Sodium	4/4	1,000	177 to 192	182	ND	--	--
Thallium	2/4	2	0.13 to 0.19	0.16	ND	--	--
Vanadium	4/4	10	5.2 to 8.8	6.3	45	[8]1,400	4,800
Zinc	3/4	4	6.6 to 9.3	7.6	15.6	[8]61,000	550,000

[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] Value indicated by an asterisk is the average of a sample and its duplicate. If the target analyte is not detected in either the environmental sample or associated duplicate, the value used for the nondetection is one-half the reporting limit.
[3] The mean of detected concentrations is the arithmetic mean of all environmental samples in which the analyte was detected; it includes a single value for an environmental sample and associated duplicate. The arithmetic mean does not include those environmental samples in which the analyte was not detected.
[4] The background screening value for organics is the mean detected concentration and will not be used for screening purposes in the risk assessment. The background screening value for inorganics is two times the mean detected background concentration and will be used for screening purposes in the risk assessment.
[5] Source: Memorandum dated February 17, 1997, from Roy L. Smith, Technical Support Section. USEPA Region II to RBC Table Mailing List. Subject: Risk-Based Concentrations Table.
[6] Source: Memorandum dated September 29, 1995a, from John M. Ruddell, Director, Division of Waste Management to District Directors, Waste Program, Florida Department of Environmental Protection (FDEP). Subject: Soil Cleanup Goals for Florida.
[7] The values correspond to a human cancer risk level of 1 in 1,000,000.
[8] The calculated values correspond to a noncancer hazard quotient of 0.1.
[9] Source: Updated Memorandum dated January 19, 1996, from John M. Ruddell, Director, Division of Waste Management to District Directors, Waste Program, FDEP. Subject: Applicability of Soil Cleanup Goals for Florida.
[10] Source: Updated Memorandum dated April 5, 1995, from Ligia Mora Applegate, Director, Technical Review Section, Bureau of Waste Cleanup, FDEP, to Tim Bahr, Technical Review Section, Bureau of Waste Cleanup. Subject: Cleanup Goals for Military Sites in Florida.
[11] USEPA (1994) Office of Solid Waste and Emergency Response Directive No. 9355.4-12, Revised Interim Recommended Soil Cleanup for CERCLA and RCRA Sites.
[12] Sample 31B00301 had rejected data for mercury. See Table 5-19.
[13] Values are for hexavalent chromium.

Notes: USEPA = U.S. Environmental Protection Agency.
RBC = risk-based concentration.
μg/kg = micrograms per kilogram.
* = average of a sample and its duplicate.
PCB = polychlorinated biphenyl.
mg/kg = milligrams per kilogram.
-- = criteria not available.
ND = not detected.

Table 5-21
Organic and Inorganic Analytes Detected in Site 31C Subsurface Soil Samples

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Site 31, Sludge Drying Beds and Disposal Areas
Naval Air Station Whiting Field
Milton, Florida

Sample Location:	31B006	31B006 Duplicate Sample	31B006	31B006	31B006	31B006
Sample Identifier:	31B00601	31B00601D	31B00602	31B00603	31B00604	31B00605
Sample Depth Interval (feet bls):	5 to 7	5 to 7	10 to 12	15 to 17	20 to 22	25 to 27
Collection Date:	21-MAY-96	21-MAY-96	21-MAY-96	21-MAY-96	21-MAY-96	21-MAY-96
Laboratory Sample No.:	RB592001	RB592006	RB592002	RB592003	RB592004	RB592005
Volatile Organic Compounds (µg/kg)						
Methylene chloride	--	--	2 J	1 J	--	--
Acetone	--	--	--	--	--	--
Semivolatile Organic Compounds (µg/kg)						
None detected						
Pesticides and PCBs (µg/kg)						
gamma-Chlordane	1.5 J	1.1 J	--	--	--	--
Inorganic Analytes (mg/kg)						
Aluminum	1,580	1,760	1,500	2,260	587	1,690
Arsenic	0.44 J	0.29 J	0.5 J	0.22 J	0.11 J	0.13 J
Barium	7.4 J	9.6 J	7.2 J	3.2 J	2.1 J	2.1 J
Beryllium	0.07 J	0.07 J	0.1 J	0.07 J	0.08 J	--
Cadmium	0.52 J	0.68 J	0.61 J	--	--	--
Calcium	237 J	297 J	253 J	225 J	215 J	184 J
Chromium	3.9	5.4	7.4	5.3	7	5.8
Cobalt	--	--	--	--	--	--
Copper	11.4	13.6 J	11.6	--	--	--
Iron	1,120	1,310	1,210	1,030	413	782
Lead	6.3 J	7 J	6.2 J	1.1 J	1 J	0.61 J
Magnesium	83.5 J	98.7 J	73.5 J	64.4 J	50.7 J	55.9 J
Manganese	9.2	11.3	8.6	4.2	2.9 J	2 J
Mercury	0.07	0.08	0.08	--	--	--
Nickel	--	--	1.7 J	--	1.9 J	--
Potassium	--	--	--	--	--	--
Selenium	0.14 J	--	--	--	--	--
Silver	1.1 J	1.7 J	1.1 J	--	--	--
Sodium	--	--	--	--	--	--
Thallium	--	--	--	--	--	--
Vanadium	2.2 J	2.4 J	3.1 J	4 J	1.7 J	3.6 J
Zinc	11	15.9	17	--	--	--
Cyanide	0.1 J	--	0.13 J	--	0.1 J	--

See notes at end of table.

Table 5-21 (Continued)
Organic and Inorganic Analytes Detected in Site 31C Subsurface Soil Samples

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Sample Location:	31B007	31B007	31B007	31B007	31B007
Sample Identifier:	31B00701	31B00702	31B00703	31B00704	31B00705
Sample Depth Interval (feet bls):	5 to 7	10 to 12	15 to 17	20 to 22	25 to 27
Collection Date:	21-MAY-96	21-MAY-96	21-MAY-96	21-MAY-96	21-MAY-96
Laboratory Sample No.:	RB592010	RB592011	RB592012	RB592013	RB592014
Volatile Organic Compounds (µg/kg)					
Methylene chloride	--	--	--	--	--
Acetone	--	--	--	--	--
Semivolatile Organic Compounds (µg/kg)					
None detected					
Pesticides and PCBs (µg/kg)					
gamma-Chlordane	--	--	--	--	--
Inorganic Analytes (mg/kg)					
Aluminum	940	5,800	5,060	1,410	1,300
Arsenic	0.29 J	2 J	0.58 J	0.21 J	0.2 J
Barium	3.6 J	9.5 J	4.8 J	3.9 J	4.3 J
Beryllium	--	0.16 J	--	--	0.08 J
Cadmium	--	0.78 J	--	--	--
Calcium	--	--	--	--	--
Chromium	--	13.1	--	--	--
Cobalt	--	--	--	--	--
Copper	--	9.8	3 J	--	--
Iron	697	5,440	2,200	643	376
Lead	9.5 J	12.8 J	2.8 J	1.9 J	1.8 J
Magnesium	--	103 J	73 J	--	67.1 J
Manganese	6.7	19.9	5.8	4.8	5.2
Mercury	--	0.09	--	--	--
Nickel	--	1.8 J	--	--	--
Potassium	--	--	--	92.1 J	--
Selenium	--	--	--	--	--
Silver	--	2.5	--	--	--
Sodium	--	--	--	--	--
Thallium	--	--	--	--	--
Vanadium	1.4 J	16.3	7.5 J	4.5 J	3.8 J
Zinc	--	15.8	--	--	--
Cyanide	1.1 J	0.28	0.16 J	--	--

See notes at end of table.

Table 5-21 (Continued)
Organic and Inorganic Analytes Detected in Site 31C Subsurface Soil Samples

Remedial Investigation Report
Site 31, Sludge Drying Beds and Disposal Areas
Naval Air Station Whiting Field
Milton, Florida

Sample Location:	31B008	31B008	31B008	31B008	31B008
Sample Identifier:	31B00801	31B00802	31B00803	31B00804	31B00805
Sample Depth Interval (feet bls):	5 to 7	10 to 12	15 to 17	20 to 22	25 to 27
Collection Date:	21-MAY-96	21-MAY-96	21-MAY-96	21-MAY-96	21-MAY-96
Laboratory Sample No.:	RB592015	RB592016	RB592017	RB592018	RB592019
Volatile Organic Compounds (μg/kg)					
Methylene chloride	--	--	--	--	--
Acetone	970 J	--	770 J	480 J	--
Semivolatile Organic Compounds (μg/kg)					
None detected					
Pesticides and PCBs (μg/kg)					
gamma-Chlordane	--	--	--	--	--
Inorganic Analytes (mg/kg)					
Aluminum	1,500	1,500	2,120	1,070	1,020
Arsenic	0.31 J	0.29 J	0.47 J	0.36 J	0.37 J
Barium	3.6 J	3.6 J	5.9 J	3.2 J	3 J
Beryllium	--	--	--	--	--
Cadmium	--	--	--	--	--
Calcium	--	--	--	--	--
Chromium	--	--	--	--	--
Cobalt	--	--	--	--	--
Copper	--	--	--	--	--
Iron	935	897	1,260	479	654
Lead	0.64 J	1.3 J	1.6 J	1.2 J	1.1 J
Magnesium	84.5 J	83.2 J	80 J	73.9 J	--
Manganese	5.1	9	--	--	--
Mercury	--	--	0.05 J	--	--
Nickel	--	--	--	--	--
Potassium	--	--	--	--	--
Selenium	--	--	--	--	--
Silver	--	--	--	--	--
Sodium	--	--	--	--	--
Thallium	--	--	--	--	--
Vanadium	1.8 J	2 J	4.5 J	4 J	6.5 J
Zinc	--	--	--	--	--
Cyanide	--	--	0.11 J	--	0.17 J

Notes: bls = below land surface.
D = duplicate sample.
μg/kg = micrograms per kilogram.
-- = analyte, if present, is at a concentration less than the detection limit.
J = estimated value.
PCB = polychlorinated biphenyl.
mg/kg = milligrams per kilogram.

trations, mean of detected concentrations, and background screening values for Site 31C subsurface soil samples.

TCL VOCs. Two TCL VOCs (methylene chloride and acetone) were detected in the subsurface soil samples collected from the soil boring at Site 31C. The detected concentrations were below their respective industrial values of the soil cleanup goals for Florida and the USEPA Region III RBCs. Methylene chloride and acetone are commonly recognized field-or laboratory-derived contaminants according to the USEPA's *Contract Laboratory Program Functional Guidelines for Organic Data Review* (USEPA, 1994a).

TCL SVOCs. SVOCs were not detected in the subsurface soil samples collected at Site 31C.

Pesticides and PCBs. One pesticide compound (gamma-chlordane) was detected in one sample and the associated duplicate sample (31B00601 and 31B00601D) collected from soil boring 31B006 at Site 31C (Figure 3-2). The detected concentration was below the industrial values of the soil cleanup goals for Florida and the USEPA Region III RBCs.

TAL Metals and (Total) Cyanide. Twenty inorganic analytes (including cyanide) were detected in the subsurface soil samples from Site 31C. Six of the analytes (copper, lead, mercury, silver, zinc, and cyanide) exceeded the background screening values. However, all of the inorganic analytes detected in the subsurface soil samples were below their respective industrial values of the soil cleanup goals for Florida and the USEPA Region III RBCs.

5.5 GROUNDWATER ASSESSMENT. Table 5-23 presents field parameter data and Table 5-24 presents the analytical results for groundwater samples collected at Site 31C. The locations of the Site 31C monitoring wells are shown on Figure 3-4. Below is a discussion of the analytical results for the Phase IIB sampling events.

Field Parameters. Representative measurements of the field parameters obtained during the purging of the monitoring wells are presented in Table 5-23. The pH values for groundwater samples collected at Site 31C ranged from 4.59 to 5.27 SUs. The pH values were below the lower range for the Florida secondary drinking water requirement of 6.5 SUs; however, they were within the range of values observed in background groundwater samples collected for NAS Whiting Field.

Temperature measurements ranged from 22.0 to 28.0 degrees Celsius, and the specific conductance ranged from 5 to 40 micromhos per centimeter. Turbidity measurements from groundwater samples, collected using low-flow sampling methods, ranged from 1.07 to 18.0 NTUs. All of the groundwater samples except one (WHF-31-2S) had turbidity measurements below 10 NTUs.

Reduction oxidation (redox) measurements ranged from 278.9 to 341.7 millivolts. Dissolved oxygen measurements ranged from 6.7 to 13.6 milligrams per liter.

Phase IIB Sampling Event. Table 5-25 provides basic statistical parameters of detected analyte concentrations in Site 31C Phase IIB groundwater samples including the frequency of detection, range of detected analytes, mean analyte concentration, and screening value. The range of analyte concentrations in

Table 5-22
Comparison of Analytes Detected in Site 31C Subsurface Soil Samples to Background Screening and Benchmark Concentrations

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Milton, Florida

Analyte	Frequency of Detection[1]	Range of Detection Limits	Range of Detected Concentrations[2]	Mean of Detected Concentrations[3]	Background Screening Values[4]	USEPA Region III RBCs[5] Industrial	Soil Cleanup Goals for Florida[6] Industrial
Volatile Organic Compounds (µg/kg)							
Acetone	3/15	10 to 170	480 to 970	740	ND	200,000,000	1,800,000
Methylene chloride	2/15	10 to 12	1 to 2	1.5	ND	760,000	2,300
Semivolatile Organic Compounds (µg/kg)							
None detected							
Pesticides and PCBs (µg/kg)							
gamma-Chlordane	1/15	1.8 to 2.1	1.3*	1.3	ND	4,400	300
Inorganic Analytes (mg/kg)							
Aluminum	15/15	40	587 to 5,800	1,962	27,834	[8]100,000	--
Arsenic	15/15	2	0.11 to 2	0.43	6.2	[7]3.8	[9]3.7
Barium	15/15	40	2.1 to 9.5	4.6	15.8	[8]14,000	84,000
Beryllium	6/15	0.06 to 0.07	0.07* to 0.16	0.09	0.26	[7]1.3	1.0
Cadmium	3/15	0.25 to 0.29	0.6* to 0.78	0.66	0.92	[8]100	600
Calcium	5/15	180 to 274	184 to 267*	229	444	--	--
Chromium	6/15	2 to 9.6	4.65* to 13.1	7.2	22.8	[8]1,000	[12]430
Copper	4/15	0.67 to 2.3	3 to 12.5*	9.2	8.8	[8]8,200	[10]72,000
Iron	15/15	20	376 to 5,440	1,215	18,100	[8]61,000	--
Lead	15/15	0.6	0.61 to 12.8	3.3	8.4	[11]400	1,000
Magnesium	12/15	56.5 to 65.6	50.7 to 103	75	272	--	--
Manganese	12/15	2.1 to 3.8	2 to 19.9	7	42.6	[8]4,700	5,500
Mercury	4/15	0.03	0.05 to 0.09	0.07	ND	[8]610	480
Nickel	3/15	1.5 to 1.8	1.7 to 1.9	1.8	5.0	[8]4,100	26,000
Potassium	1/15	65.4 to 77.2	92.1	92.1	181	--	--

See notes at end of table.

Table 5-22 (Continued)
Comparison of Analytes Detected in Site 31C Subsurface Soil Samples to Background Screening and Benchmark Concentrations

Remedial Investigation Report
Site 31, Sludge Drying Beds and Disposal Areas
Naval Air Station Whiting Field
Milton, Florida

Analyte	Frequency of Detection[1]	Range of Detection Limits	Range of Detected Concentrations[2]	Mean of Detected Concentrations[3]	Background Screening Values[4]	USEPA Region III RBCs[5] Industrial	Soil Cleanup Goals for Florida[6] Industrial
Inorganic Analytes (mg/kg) (Continued)							
Selenium	1/15	0.065 to 0.14	0.10*	0.1	0.3	[8]1,000	9,900
Silver	3/15	0.52 to 0.61	1.1 to 2.5	1.7	1.12	[8]1,000	9,900
Vanadium	15/15	10	1.4 to 16.3	4.5	45	[8]1,400	560,000
Zinc	3/15	1.3 to 4.9	13.45* to 17	15.4	15.6	[8]61,000	550,000
Cyanide	8/15	0.04 to 0.09	0.07* to 1.1	0.27	ND	[8]41,000	40,000

[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] Value indicated by an asterisk is the average of a sample and its duplicate. If the target analyte is not detected in either the environmental sample or associated duplicate, the value used for the nondetection is one-half the reporting limit.
[3] The mean of detected concentrations is the arithmetic mean of all environmental samples in which the analyte was detected; it includes a single value for an environmental sample and associated duplicate. The arithmetic mean does not include those environmental samples in which the analyte was not detected.
[4] The background screening value for organics is the mean detected concentration and will not be used for screening purposes in the risk assessment. The background screening value for inorganics is two times the mean detected background concentration and will be used for screening purposes in the risk assessment.
[5] Source: Memorandum dated February 17, 1997, from Roy L. Smith, Technical Support Section, USEPA Region II, to RBC Table Mailing List. Subject: Risk-Based Concentrations Table.
[6] Source: Memorandum dated September 29, 1995a, from John M. Ruddell, Director, Division of Waste Management to District Directors, Waste Program, Florida Department of Environmental Protection (FDEP). Subject: Soil Cleanup Goals for Florida.
[7] The values correspond to a human cancer risk level of 1 in 1,000,000.
[8] The calculated values correspond to a noncancer hazard quotient of 0.1.
[9] Source: Updated Memorandum dated January 19, 1996, from John M. Ruddell, Director, Division of Waste Management to District Directors, Waste Program, FDEP. Subject: Applicability of Soil Cleanup Goals for Florida.
[10] Source: Updated Memorandum dated April 5, 1995, from Ligia Mora Applegate, Director, Technical Review Section, Bureau of Waste Cleanup, FDEP, to Tim Bahr, Technical Review Section, Bureau of Waste Cleanup. Subject: Cleanup Goals for Military Sites in Florida.
[11] USEPA (1994) Office of Solid Waste and Emergency Response Directive No. 9355.4-12, Revised Interim Recommended Soil Cleanup for CERCLA and RCRA Sites.
[12] Values are for hexavalent chromium.

Notes: USEPA = U.S. Environmental Protection Agency.
RBC = risk-based concentration.
μg/kg = micrograms per kilogram.
ND = not detected.
PCB = polychlorinated biphenyl.
* = average of a sample and its duplicate.
mg/kg = milligrams per kilogram.
-- = criteria not available.

Table 5-23
Summary of Groundwater Field Parameters, Site 31C

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Monitoring Well Designation	Date Sampled	pH (SU)	Temperature (°C)	Specific Conductance (μmhos/cm)	Turbidity (NTU)	Redox (mV)	DO (mg/ℓ)
WHF-31-1S	15-JUL-97	5.24	26.0	5	9.6	318.7	8.7
WHF-31-2S	30-OCT-96	5.27	25.0	39	18.0	323.0	9.7
WHF-31-2S	21-JUL-97	5.10	28.0	40	3.56	382.4	8.3
WHF-31-3S	31-OCT-96	5.03	23.3	20	2.1	341.0	8.1
WHF-31-3S	16-JUL-97	5.11	27.0	25	5.03	341.7	6.7
WHF-31-4S	16-JUL-97	4.59	25.0	28	3.5	278.9	7.6
WHF-31-4I	31-OCT-96	4.95	22.1	12	1.6	366.0	8.4
WHF-31-4I	16-JUL-97	4.69	25.0	25	1.07	341.0	9.0
WHF-31-4D	01-NOV-96	5.17	22.0	12	7.2	302.0	8.4
WHF-31-4D	16-JUL-97	5.04	25.0	22	9.7	305.9	13.6

Notes: SU = standard unit.
°C = degrees Celsius.
μmhos/cm = micromhos per centimeter.
NTU = nephelometric turbidity unit.
Redox = oxidation reduction potential.
mV = millivolt.
DO = dissolved oxygen.
mg/ℓ = milligrams per liter.

Table 5-24
Organic, Inorganic, and Water Quality Parameters Measured in Groundwater Samples at Site 31C

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Milton, Florida

Location Identifier:	WHF-31-1S	WHF-31-1S Duplicate Sample	WHF-31-2S	WHF-31-2S Filtered Sample	WHF-31-2S	WHF-31-3S	WHF-31-3S
Sample Identifier:	31G00101	31G00101D	31G00201	31G00201F	31G00201	31G00301	31G00301
Collection Date:	15-JUL-97	15-JUL-97	30-OCT-96	30-OCT-96	21-JUL-97	31-JUL-96	16-JUL-97
Laboratory Sample No.:	ME241003	ME241004	MC262005	MC262006	ME303001	MC284002	ME260004
Volatile Organic Compounds (µg/ℓ)							
Methylene chloride	--	--	--	--	NA	--	--
Trichloroethene	--	--	--	--	NA	--	--
Semivolatile Organic Compounds (µg/ℓ)							
None detected				NA	NA		NA
Pesticides and PCBs (µg/ℓ)							
None detected				NA	NA		NA
Inorganic Analytes (µg/ℓ)							
Aluminum	96 J	91.1 J	--	--	NA	--	NA
Barium	22.6 J	22.5 J	55.4 J	53.9 J	NA	31.2 J	NA
Calcium	857 J	851 J	2.090 J	2,060 J	NA	1,960 J	NA
Chromium	--	--	--	8.5 J	NA	--	NA
Cobalt	--	--	--	1.6 J	NA	--	NA
Copper	--	1.4 J	--	--	NA	--	NA
Iron	120	103	--	57 J	NA	--	NA
Magnesium	662 J	675 J	1,450 J	1,470 J	NA	920 J	NA
Manganese	9.7 J	9.9 J	20.9 J	22.2 J	NA	--	NA
Nickel	--	--	2 J	2.1 J	NA	--	NA
Potassium	1,910 J	2,200 J	--	--	NA	--	NA

See notes at end of table.

Table 5-24 (Continued)
Organic, Inorganic, and Water Quality Parameters Measured in Groundwater Samples at Site 31C

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Site 31, Sludge Drying Beds and Disposal Areas
Naval Air Station Whiting Field
Milton, Florida

Location Identifier:	WHF-31-1S	WHF-31-1S Duplicate Sample	WHF-31-2S	WHF-31-2S Filtered Sample	WHF-31-2S	WHF-31-3S	WHF-31-3S
Sample Identifier:	31G00101	31G00101D	31G00201	31G00201F	31G00201	31G00301	31G00301
Collection Date:	15-JUL-97	15-JUL-97	30-OCT-96	30-OCT-96	21-JUL-97	31-OCT-96	16-JUL-97
Laboratory Sample No.:	ME241003	ME241004	MC262005	MC262006	ME303001	MC284002	ME260004
Inorganic Analytes ($\mu g/\ell$) (Continued)							
Sodium	1,760 J	1,890 J	--	--	NA	--	NA
Vanadium	1.8 J	--	--	--	NA	--	NA
Zinc	--	--	9.4 J	8.2 J	NA	--	NA
Cyanide	--	--	--	--	NA	7.9	NA
Groundwater Quality (mg/ℓ)							
Alkalinity as $CaCO_3$	4	NA	--	NA	--	--	--
Ammonia-N	--	NA	--	NA	--	--	--
Chloride	2.7	NA	1.6	NA	1.8	2.3	2.2
Hardness as $CaCO_3$	--	NA	22	NA	--	14	--
Nitrate-nitrite	0.31	NA	1.68	NA	1.53	1.41	0.98
Phosphorous-P (total)	--	NA	--	NA	--	--	--
Sulfate	--	NA	3.7	NA	6.2	--	--
Sulfide	--	NA	--	NA	--	--	--
Total dissolved solids	27	NA	18	NA	33	14	12
Total Kjeldahl nitrogen	0.2	NA	--	NA	--	--	0.3
Total organic carbon	--	NA	--	NA	--	--	1
Dissolved organic carbon	--	NA	--	NA	--	1.3	--

See notes at end of table.

Table 5-24 (Continued)
Organic, Inorganic, and Water Quality Parameters Measured in Groundwater Samples at Site 31C

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Location Identifier:	WHF-31-4S	WHF-31-4I	WHF-31-4I	WHF-31-4D	WHF-31-4D
Sample Identifier:	31G00401	31G00402	31G00402	31G00403	31G00403
Collection Date:	16-JUL-97	31-OCT-96	16-JUL-97	01-NOV-96	16-JUL-97
Laboratory Sample No.:	ME261002	MC284003	ME261003	MC284004	ME261004
Volatile Organic Compounds (µg/ℓ)					
Methylene chloride	--	--	1 J	--	--
Trichloroethene	--	--	--	--	2 J
Semivolatile Organic Compounds (µg/ℓ)					
None detected			NA		NA
Pesticides and PCBs (µg/ℓ)					
None detected			NA		NA
Inorganic Analytes (µg/ℓ)					
Aluminum	93.7 J	--	NA	--	NA
Barium	30.8 J	9.8 J	NA	9.6 J	NA
Calcium	697 J	545 J	NA	548 J	NA
Chromium	--	--	NA	--	NA
Cobalt	--	--	NA	--	NA
Copper	3.8 J	--	NA	--	NA
Iron	41.6 J	--	NA	61.5 J	NA
Magnesium	731 J	335 J	NA	339 J	NA
Manganese	5.4 J	11.6 J	NA	9.2 J	NA
Nickel	--	--	NA	1.4 J	NA
Potassium	--	--	NA	--	NA

See notes at end of table.

Table 5-24 (Continued)
Organic, Inorganic, and Water Quality Parameters Measured in Groundwater Samples at Site 31C

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Location Identifier:	WHF-31-4S	WHF-31-4I	WHF-31-4I	WHF-31-4D	WHF-31-4D
Sample Identifier:	31G00401	31G00402	31G00402	31G00403	31G00403
Collection Date:	16-JUL-97	31-OCT-96	16-JUL-97	01-NOV-96	16-JUL-97
Laboratory Sample No.:	ME261002	MC284003	ME261003	MC284004	ME261004
Inorganic Analytes (μg/ℓ) (Continued)					
Sodium	1,110 J	1,830 J	NA	1,930 J	NA
Vanadium	--	--	NA	--	NA
Zinc	--	--	NA	--	NA
Cyanide	--	1.3 J	NA	--	NA
Groundwater Quality (mg/ℓ)					
Alkalinity as $CaCO_3$	4	4	18	4	--
Ammonia-N	--	--	--	--	--
Chloride	2.5	2.4	2.2	2.3	2.5
Hardness as $CaCO_3$	--	12	--	6	--
Nitrate-nitrite	0.65	0.37	0.67	0.43	0.46
Phosphorous-P (total)	--	--	--	--	--
Sulfate	--	--	--	--	--
Sulfide	--	--	--	--	--
Total dissolved solids	17	35	16	14	24
Total Kjeldahl nitrogen	0.2	--	--	--	0.1
Total organic carbon	1.8	--	--	--	--
Dissolved organic carbon	--	--	--	2.9	--

Notes: D = duplicate sample.
F = filtered sample.
μg/ℓ = micrograms per liter.
-- = analyte, if present, is at a concentration less than the detection limit.
$CaCO_3$ = calcium carbonate.
PCB = polychlorinated biphenyl.
NA = not analyzed.
J = estimated value.
mg/ℓ = milligrams per liter.

Table 5-25
Comparison of Analytes Detected in Site 31C Groundwater Samples to Background Screening and Benchmark Concentrations

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Analyte	Frequency of Detection[1]	Range of Detected Analyte Concentration[2]	Mean Analyte Concentration	Background Screening Values[3]	Federal MCLs[4]	Florida Groundwater Guidance	
						Concentration[5]	Basis[6]
Volatile Organic Compounds (µg/ℓ)							
Methylene chloride	1/6	1	1	--	5	5	P
Trichloroethene	1/6	2	2	--	5	3	P
Semivolatile Organic Compounds (µg/ℓ)							
None detected							
Pesticides and PCBs (µg/ℓ)							
None detected							
Inorganic Analytes (µg/ℓ)							
Aluminum	2/6	93.55* to 93.7	93.6	654	[8]200	200	S
Barium	6/6	8.9 to 55.4	26.4	72.6	2,000	2,000	P
Calcium	6/6	545 to 2,090	1,120	3,316	NA	NA	
Copper	2/6	3.8 to 7.0*	5.4	10.8	[8]1,000/[7]1,300	1,000	S
Iron	3/6	41.6 to 112*	71.5	964	[8]300	300	S
Magnesium	6/6	335 to 1,450	741	2,426	NA	NA	
Manganese	5/6	5.4 to 20.9	11.4	42.8	[8]50	50	S
Nickel	2/6	1.4 to 2	1.7	42.8	100	100	P
Potassium	1/6	2,060*	2,060	1,530	NA	NA	
Sodium	4/6	1,110 to 1,930	1,674	4,770	[9]NA	160,000	P
Vanadium	1/6	13.4*	13.4	3.8	NA	49	T
Zinc	1/6	9.4	9.4	200	[8]5,000	5,000	S
Cyanide	2/6	1.3 to 7.9	4.6	7	200	200	P

See notes at end of table.

Table 5-25 (Continued)
Comparison of Analytes Detected in Site 31C Groundwater Samples to Background Screening and Benchmark Concentrations

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[1] Frequency of detection is the fraction of total samples analyzed in which the analyte was detected.
[2] Value indicated by an asterisk is the average of the sample and its duplicate. If the target analyte was not detected in either the environmental sample or associated duplicate, the value used for the nondetection is one-half the reporting limit.
[3] Background screening values for organic compounds are the arithmetic mean concentrations; for inorganic analytes it is two times the arithmetic mean concentrations. The latter values are used for analyte screening in risk assessment.
[4] Federal MCLs are maximum permissible concentrations of contaminants in water delivered to a user by a public water system.
[5] Source: Groundwater Guidance Concentrations, Florida Department of Environmental Protection, June 1994.
[6] The concentrations are based on a number of enforceable and nonenforceable State of Florida regulations:
P = primary drinking water standards based on Chapter 17-550.310, .320, Florida Administrative Code (FAC);
S = secondary drinking water standards based on Chapter 17-550.310, .320, FAC; and
T = systemic toxicants based on Chapter 17-520.400 (1)(d), FAC.
[7] Treatment technique requirement for drinking water distribution system.
[8] Secondary MCL.
[9] No MCL has been determined for sodium but a reporting limit of 20,000 $\mu g/\ell$ has been established.

Notes: MCL = maximum contaminant level.
$\mu g/\ell$ = micrograms per liter.
-- = criteria not available.
PCB = polychlorinated biphenyl.
* = average of a sample and its duplicate.
NA = no applicable standard currently exists.

Site 31 groundwater samples were compared in Table 5-25 to Federal and State applicable or relevant and appropriate requirement (ARARs), including Federal maximum contaminant levels (MCLs) and Florida groundwater guidance concentrations.

Volatile Organic Compounds. Two VOCs (methylene chloride and TCE) were each detected in a groundwater sample collected from monitoring wells WHF-31-4I and WHF-31-4D, respectively. The detected concentrations did not exceed the Florida MCLs or Federal MCL. Methylene chloride is a commonly recognized field-or laboratory-derived contaminant according to USEPA's *Contract Laboratory Program Functional Guidelines for Organic Data Review* (USEPA, 1994a).

Semivolatile Organic Compounds. SVOCs were not detected in the groundwater samples collected from monitoring wells at Site 31C.

Pesticides and PCBs. Pesticide and PCB compounds were not detected in the groundwater samples collected from monitoring wells at Site 31C.

Inorganic Analytes. Thirteen inorganic analytes were detected in groundwater samples collected from Site 31C monitoring wells. Three analytes (potassium, vanadium, and cyanide) were detected at concentrations exceeding the background screening values. However, none of the inorganic analytes were detected at concentrations exceeding their respective Federal and State MCLs.

Water Quality Parameters. Table 5-24 also presents the groundwater quality parameters measured in the groundwater samples collected during Phase IIB of the RI. These parameters were within the range of values expected for the sand and gravel aquifer (Florida Geological Survey, 1992).

Filtered Groundwater Samples. One filtered sample for TAL inorganics (metals only) was collected from monitoring well WHF-31-2S during the October 30, 1996 sampling event because of higher turbidity (18 NTUs). Table 5-24 also contains a summary of analytes detected in the filtered sample (sample identifier 31G00201F). Comparison of the analytical results between the filtered sample and the corresponding unfiltered sample (31G00201) indicates similar analytes and concentrations were detected in both samples. This suggests that the unfiltered sample is representative of the groundwater conditions at the site.

CHAPTER 6.0

6.0 HUMAN HEALTH RISK ASSESSMENT

An HHRA has been conducted as part of the RI/FS for Site 31 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 Florida Department of Environmental Protection (FDEP) guidance:

- Soil Cleanup Goals for Florida (FDEP, 1995a),
- Applicability of Soil Cleanup Goals for Florida (FDEP, 1996), and
- Florida Groundwater Guidance Concentrations (FDEP, 1994).

The methodology for the HHRA is described in Chapter 2 of the GIR (HLA, 1998). The HHRA methodology presented in the GIR (HLA, 1998) consists of the following steps:

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

Site 31 is a single site designation including multiple disposal areas along the South Field perimeter road of NAS Whiting Field. Site 31 includes the sludge drying beds located near the wastewater treatment plant (Site 31A), three disposal areas at the southwest perimeter of Runway 4 (Sites 31B, 31C, and 31D), and two sludge disposal areas at the northwest perimeter of Runway 4 (Sites 31E and 31F). For the purpose of this HHRA, Sites 31B and 31D (Site 31BD) and Sites 31E and 31F (Sites 31EF) were combined and evaluated as single exposure areas due to their close proximity. Sites 31A and 31C were retained as a separate exposure area because of increased exposure point concentrations (EPCs). The location, physical description, and history associated with Site 31 are described in Chapter 1 of this report. During the RI, surface soil, subsurface soil, and groundwater were collected from Site 31. Sampling locations and the sampling rationale are presented in Chapter 3.0 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 31 were divided into the following categories: surface soil, subsurface soil, groundwater, and background for each media for the four exposure areas (31A, 31BD, 31C, and 31EF).

SQLs are compared to USEPA Region III RBCs and Florida screening values. Surface and subsurface soil SQLs were compared to Region III RBCs and Florida soil cleanup goals for residential and industrial scenarios, respectively. Groundwater SQLs were compared to Florida groundwater guidance concentrations and USEPA Region III tap water RBCs. 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 this 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. The human health chemicals of potential concern (HHCPCs) were selected per the methodology described in Section 2.5 of the GIR (HLA, 1998). This HHCPC methodology considers 1) frequency of detection, 2) consistency with background conditions, 3) a comparison to regulatory and risk-based screening values, and 4) a comparison to essential nutrient levels.

In selecting HHCPCs, USEPA Region IV criteria were used (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. If an analyte 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, it is not selected as an HHCPC. This criterion is not used if there are less than 20 environmental samples for a specific medium; therefore, it was not employed in this HHRA.

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). The background screening values for surface soil, subsurface soil, and groundwater are identified below.

- A representative surface soil background data set consisting of Troup Loamy Sand is used for background screening of Site 31 surface soil samples with the exception of Sites 31B and 31D, which used a combined data set consisting of Bonifay Loamy Sand, Dothan Fine Sandy Loam, and Troup Loamy Sand. Site 31B soil was consistent with the Bonifay Loamy Sand/Troup Loamy Sand background soil type and Site 31D was consistent with Troup Loamy Sand/Dothan soil type. Since the same background sample was used for the Bonifay Loamy Sand and Dothan Fine Sandy Loam, the combined data set is identical for Sites 31B and 31D. Sample locations are identified on Figure 3-10 and are discussed in Subsection

3.3.1 of the GIR (HLA, 1998). The background surface soil data used for screening surface soils at Site 31 are presented in Tables 3-8, 3-9 and 3-14 of the GIR (HLA, 1998).

- Background subsurface soil sample locations are identified on Figure 3-11 and discussed in Subsection 3.3.2 (HLA, 1998). Tables 3-15 through 3-17 present the background screening data and Table 3-18 presents summary statistics for screening subsurface soil at Site 31.

- Background groundwater sample locations are identified on Figure 3-12 and discussed in Subsection 3.3.3 of the GIR (HLA, 1998). Tables 3-21 through 3-23 of the GIR (HLA, 1998) present background screening data for groundwater. Table 3-24 of the GIR (HLA, 1998) presents the summary statistics used for screening the groundwater at Site 31.

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 USEPA Region III RBC (USEPA, 1997a), and less than Federal and Florida standards and guidelines, the analyte is not selected as an HHCPC (USEPA, 1995b). 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, 1995b).

The residential soil RBCs are used for surface soil. The industrial soil RBCs are used for subsurface soil. No RBC is available for lead in soil due to a lack of toxicity data. Based on USEPA recommendation, a screening level of 400 milligrams per kilogram (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 are also compared to residential Florida Soil Cleanup Goals (FDEP, 1995a). The maximum detected concentration of any organic analyte in surface soil also detected in groundwater (above a standard or guideline) is compared to the Florida Leaching Value (FDEP, 1996) for that analyte.

Tap water RBCs (USEPA, 1997a), Federal MCLs (USEPA, 1996b) and Florida Groundwater Guidance Concentrations (FDEP, 1994) are used as screening criteria for the 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 Appendix C-1 of the GIR.

HHCPCs were not screened using the iron essential nutrient value; the RBC was used instead. However, if iron is determined to be a risk driver, a comparison of the risk concentrations against the essential nutrient level for iron will be presented in the uncertainty 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 an 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 F 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 media is presented below in Subsections 6.2.1 through 6.2.6.

6.2.1 Surface Soil Site 31A Twelve samples and two duplicates were collected from Site 31A (listed in the footnotes of Table 6-1). The sample locations and individual sample analytical data are presented on Figure 3-1 and Table 3-1, respectively. The HHRA for 31A surface soil includes four samples identified as subsurface soil in the RI sections of this report. The basis for this conservative decision is that the subsurface soil sampling interval begins as 1.5 feet, which is within FDEP's definition of surface soil. Because a potential receptor could contact soil at a depth of 1.5 feet, these four samples (31B00101, 31B00201, 31B00301, and 31B00401, as well as a duplicate sample, 31B00201D) were combined with the shallower surface soil samples and the combined data set was evaluated as 31A surface soil.

VOCs, SVOCs, pesticides, PCBs, and inorganic analyte data from all of the samples are evaluated in this HHRA. Table 6-1 presents the HHCPC selection for surface soil at Site 31A. No analytes were selected as HHCPCs in the surface soil.

6.2.2 Surface Soil, Sites 31B and 31D Eight surface soil samples were collected from Sites 31B and 31D (listed in footnotes of Table 6-2). The sample locations and individual sample analytical data are presented on Figure 3-1 and Table 3-1, respectively. VOCs, SVOCs, pesticides, PCBs, and inorganic analyte data from these sample are evaluated in this HHRA. Table 6-2 presents the HHCPC selection for surface soil at Sites 31B and 31D. No analytes were selected as HHCPCs in the surface soil.

6.2.3 Surface Soil, Site 31C Fourteen surface soil samples and one duplicate sample were collected from Site 31C (listed in footnotes of Table 6-3). The sample locations and individual sample analytical data are presented on Figure 3-1 and Table 3-1, respectively. VOCs, SVOCs, pesticides, PCBs, and inorganic analyte data from these samples are evaluated in this HHRA. Table 6-3 identifies Aroclor-1260, dieldrin, and eight inorganic analytes (aluminum, beryllium, cadmium, chromium, iron, lead, mercury, and silver) as HHCPCs for surface soil in Site 31C.

6.2.4 Surface Soil, Sites 31E and 31F Thirteen surface soil samples and two duplicate samples were collected from Sites 31E and 31F (listed in footnotes of Table 6-4). The sample locations and individual sample analytical data are presented on Figure 3-1 and Table 3-1, respectively. VOCs, SVOCs, pesticides, PCBs, and inorganic analyte data from these sample are evaluated in this HHRA. Table 6-4 identifies one inorganic analyte (manganese) as an HHCPC for surface soil in Sites 31E and 31F.

6.2.5 Subsurface Soil, Site 31C The only exposure area with subsurface soil data available was 31C. Although subsurface soil data was collected at Site 31A, the data were evaluated as surface soil based on the depth of collection (see Subsection 6.2.1). Six subsurface soil samples and one duplicate sample were collected from Site 31C (listed in footnotes of Table 6-5). The sample locations

Table 6-1
Selection of Human Health Chemicals of Potential Concern for Surface Soil at Site 31A

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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]
Volatile Organic Compounds (µg/kg)								
1,1-Dichloroethene	1/12	5 to 12	2.3*	2.3	NA	100	No	S
Benzene	1/12	5 to 12	1.8*	1.8	NA	1,400	No	S
Chlorobenzene	1/12	5 to 12	1.8*	1.8	NA	44,000	No	S
Toluene	1/12	5 to 12	2.3*	2.3	NA	520,000	No	S
Trichloroethene	1/12	5 to 12	2.3*	2.3	NA	6,500	No	S
Xylenes (total)	6/12	5 to 12	1 to 6	3	NA	13,000,000	No	S
Semivolatile Organic Compounds (µg/kg)								
bis(2-Ethylhexyl)phthalate	3/12	340 to 380	38 to 120*	70	NA	46,000	No	S
Pesticides and PCBs (µg/kg)								
4,4-DDD	1/12	3.6 to 17	1.6	1.6	NA	2,700	No	S
4,4-DDE	1/12	3.6 to 17	3.2	3.2	NA	1,900	No	S
Dieldrin	1/12	3.6 to 17	1.3	1.3	NA	40	No	S
alpha-Chlordane	2/12	1.9 to 84	1.7 to 1.9	1.8	NA	800	No	S
gamma-Chlordane	2/12	1.9 to 84	2.3 to 4	3.2	NA	800	No	S
Inorganic Analytes (mg/kg)								
Aluminum	12/12	40	154 to 6,010	1,630	15,336	7,800	No	B,S
Arsenic	4/12	0.21 to 2	0.93 to 2.9	1.5	3	0.43	No	B
Barium	12/12	40	1.2 to 9.3	4	23	550	No	B,S
Beryllium	4/12	0.05 to 1	0.05 to 0.28*	0.11	0.3	0.15	No	B

See notes at end of table.

Table 6-1 (Continued)
Selection of Human Health Chemicals of Potential Concern for Surface Soil at Site 31A

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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)								
Cadmium	2/12	0.57 to 1	0.28* to 0.32	0.3	0.52	3.9	No	B,S
Calcium	11/12	109 to 1,000	68 to 139	102	494	1,000,000	No	B,S
Chromium	11/12	1.95 to 2	0.75 to 3.9	2	10.6	39	No	B,S
Cobalt	2/12	0.32 to 10	1.2 to 2.9*	2	3	470	No	B,S
Copper	11/12	4.7 to 5	3.1 to 10.9	6.1	9.4	27,000	No	S
Iron	12/12	20	284 to 3,690	1,330	8,626	2,300	No	B
Lead	11/12	0.6 to 5.8	2.7 to 10.8	5	10.8	400	No	B,S
Magnesium	11/12	10 to 1,000	13.2 to 118	40.8	268	460,468	No	B,S
Manganese	12/12	3	0.92* to 70.9	9.4	384	180	No	B,S
Mercury	4/11	0.04 to 0.1	0.04* to 0.14	0.08	0.12	2.3	No	S
Nickel	5/12	2.2 to 8	1.5 to 6	2.7	7.2	160	No	B,S
Potassium	3/12	124.5 to 1,000	96.1 to 127	108	197.2	1,000,000	No	B,S
Selenium	2/12	0.43 to 1	0.16 to 0.17	0.17	0.46	39	No	B,S
Silver	8/12	0.74 to 2	0.39 to 1.3	0.79	0.7	39	No	S
Sodium	11/12	149 to 1,000	123 to 192	161	398	1,000,000	No	B,S
Thallium	3/12	0.33 to 2	0.13 to 0.36	0.23	1.16	0.63	No	B,S
Vanadium	10/12	0.27 to 10	0.33 to 8.8	2.9	21	55	No	B,S
Zinc	10/12	4 to 6.15	4.3 to 27.1	8.5	15.6	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 at Site 31A

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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 Goals (Florida Department of Environmental Protection, 1996) was used for screening. Values from the USEPA Region III RBC Tables, dated October 22, 1997, are based on an excess lifetime cancer risk of 1×10^{-6} or an adjusted hazard quotient of 0.1. 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 C 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.

Notes: The average of a sample and its duplicate is used for all table calculations.
Samples: 31-SL-17, 31-SL-18, 31-SL-19, 31-SL-20, 31-SL-21, 31-SL-22 31-SL-23, 31-SL-24, 31B00101, 31B00201, 31B00301, 31B00401.
Sample duplicates: 31-SL-22A, 31B00201D.
Background samples: BKG-SL-02, BKG-SL-06, BKG-SL-07, BKG-SL-08, BKS00101, BKS00201, BKS00401, BKS00501, and 31B00501.
Background duplicate sample: BKS00201D.

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

Table 6-2
Selection of Human Health Chemicals of Potential Concern for Surface Soil at Sites 31B and 31D

Remedial Investigation Report
Site 31, Sludge Drying Beds and Disposal Areas
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]
Volatile Organic Compounds (µg/kg)								
Xylenes (total)	3/8	5 to 11	2 to 4	3	NA	13,000,000	No	S
Pesticides and PCBs (µg/kg)								
4,4'-DDD	1/8	3.6 to 35	4.9	4.9	NA	2,700	No	S
4,4'-DDT	1/8	3.6 to 35	10	10	NA	1,900	No	S
Inorganic Analytes (mg/kg)								
Aluminum	8/8	40	4,360 to 10,900	7,480	15,334	7,800	No	B
Arsenic	8/8	2	0.66 to 2.3	1.3	3.1	0.43	No	B
Barium	8/8	40	4.6 to 16.8	9.7	23.7	550	No	B,S
Beryllium	4/8	1	0.07 to 0.15	0.1	0.36	0.15	No	B,S
Calcium	8/8	1,000	43.2 to 354	222	404	1,000,000	No	B,S
Chromium	8/8	2	3.6 to 8.9	5.7	10.7	39	No	B,S
Cobalt	5/8	0.34 to 10	0.67 to 1.2	0.87	2.87	470	No	B,S
Copper	4/8	5	3.7 to 13.1	6.7	9.4	27,000	No	S
Iron	8/8	20	2,590 to 6,290	4,020	8,588	2,300	No	B
Lead	8/8	0.6 to 1	2.9 to 7.1	4.2	11.5	400	No	B,S
Magnesium	8/8	1,000	86.6 to 250	146	258	460,468	No	B,S
Manganese	8/8	3	33.1 to 250	148	403	180	No	B
Mercury	6/8	0.05 to 0.1	0.01 to 0.37	0.09	0.12	2.3	No	S
Nickel	3/8	2.3 to 8	3.2 to 5.1	4.3	7.2	160	No	B,S
Potassium	2/8	129 to 1,000	168 to 183	176	177	1,000,000	No	S
Selenium	1/8	0.45 to 1	0.37	0.37	0.44	39	No	B,S

See notes at end of table.

Table 6-2 (Continued)
Selection of Human Health Chemicals of Potential Concern for Surface Soil at Sites 31B and 31D

Remedial Investigation Report
Site 31, Sludge Drying Beds and Disposal Areas
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)								
Silver	3/8	0.33 to 2	3.6 to 5.9	4.6	0.7	39	No	S
Sodium	4/8	1,000	127 to 202	167	388	1,000,000	No	B,S
Vanadium	8/8	10	6.6 to 18.7	10.5	21.2	55	No	B,S
Zinc	8/8	4	3.8 to 12	7.5	15.4	2,300	No	B,S

[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 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 Goals (Florida Department of Environmental Protection, 1996) was used for screening. Values from the USEPA Region III RBC Tables, dated October 22, 1997, are based on an excess lifetime cancer risk of 1×10^{-6} or an adjusted hazard quotient of 0.1. 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 C 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 selected 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: 31-SL-09, 31-SL-10, 31-SL-11, 31-SL-16, 31S00101, 31S00201, 31S00301, 31S01401.
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.
PCB = polychlorinated biphenyl.
DDD = dichlorodiphenyldichloroethane.
DDT = dichlorodiphenyltrichloroethane.
mg/kg = milligrams per kilogram.

Table 6-3
Selection of Human Health Chemicals of Potential Concern for Surface Soil at Site 31C

Remedial Investigation Report
Site 31, Sludge Drying Beds and Disposal Areas
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]
Volatile Organic Compounds (µg/kg)								
Carbon disulfide	4/14	6 to 12	3 to 39	14	NA	5,200	No	S
Methylene chloride	4/14	6 to 68.5	120 to 240	170	NA	16,000	No	S
Toluene	1/14	6 to 12	1	1	NA	520,000	No	S
Xylenes (total)	4/14	6 to 12	4 to 11	6	NA	13,000,000	No	S
Semivolatile Organic Compounds (µg/kg)								
Benzo(b)fluoranthene	1/14	360 to 11,000	100	100	NA	880	No	S
Benzo(k)fluoranthene	1/14	360 to 11,000	110	110	NA	8,800	No	S
Butylbenzylphthalate	1/14	360 to 11,000	39	39	NA	1,600,000	No	S
bis(2-Ethylhexyl)phthalate	9/14	360 to 11,000	42 to 2,600	816	NA	46,000	No	S
Pesticides and PCBs (µg/kg)								
4,4-DDE	6/14	3.6 to 270	2.3 to 100	43.6	NA	1,900	No	S
Aroclor-1260	4/14	36 to 2,700	340 to 1,400	738	NA	320	Yes	
Dieldrin	6/14	3.6 to 270	2.1 to 120	47.4	NA	40	Yes	
alpha-Chlordane	6/14	1.8 to 1,300	1.3 to 68	29.2	NA	800	No	S
gamma-Chlordane	5/14	1.8 to 1,300	1.4 to 76	34.1	NA	800	No	S
Inorganic Analytes (mg/kg)								
Aluminum	14/14	NA	1,670 to 16,800	4,818	15,848	7,800	Yes	
Antimony	4/14	12	3.1 to 7.1	5.1	8	3.1	No	B
Arsenic	14/14	NA	0.59 to 1.7	1.1	3.2	0.43	No	B
Barium	14/14	NA	2.7 to 534	83.2	23.2	550	No	S

See notes at end of table.

Table 6-3 (Continued)
Selection of Human Health Chemicals of Potential Concern for Surface Soil at Site 31C

Remedial Investigation Report
Site 31, Sludge Drying Beds and Disposal Areas
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)								
Beryllium	4/14	1	0.3 to 1.3	0.65	0.36	0.15	Yes	
Cadmium	7/14	1	0.22 to 26.8	9.6	0.58	3.9	Yes	
Calcium	14/14	NA	93.3 to 4,160	825	396	1,000,000	No	S
Chromium	14/14	NA	1.4 to 295	46	11	39	Yes	
Cobalt	8/14	10	0.83 to 3.1*	1.3	3	470	No	S
Copper	7/14	5	29.8 to 948	307	9.4	27,000	No	S
Cyanide	14/14	NA	0.09 to 1.1	0.3	0.28	160	No	S
Iron	14/14	NA	645 to 22,500	4,700	8,832	2,300	Yes	
Lead	14/14	NA	1.8 to 1,890	277	11.4	400	Yes	
Magnesium	14/14	NA	40.3 to 1,120	247	268	460,468	No	S
Manganese	14/14	NA	1.9 to 170	51.7	392	180	No	B,S
Mercury	8/14	0.1	0.13 to 8.8	2.7	0.12	2.3	Yes	
Nickel	8/14	8	1.5 to 8.6	4	7.2	160	No	S
Potassium	9/14	134 to 1,000	73.5 to 134	94.9	177	1,000,000	No	B,S
Selenium	10/14	1	0.15 to 4.9	1.2	0.46	39	No	S
Silver	8/14	2	0.97 to 154	51.8	0.7	39	Yes	
Sodium	14/14	NA	179 to 294	202	406	1,000,000	No	B,S
Vanadium	14/14	NA	2.3 to 12.1	5.4	21.8	55	No	B,S
Zinc	12/14	4	3.6 to 346	99.6	15.4	2,300	No	S

See notes at end of table.

Table 6-3 (Continued)
Selection of Human Health Chemicals of Potential Concern
for Surface Soil at Site 31C

Remedial Investigation Report
Site 31, Sludge Drying Beds and Disposal Areas
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] 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 Goals (Florida Department of Environmental Protection, 1996) was used for screening. Values from the USEPA Region III RBC Tables, dated October 22, 1997, are based on an excess lifetime cancer risk of 1×10^{-6} or an adjusted hazard quotient of 0.1. 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 C 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.

Notes: The average of a sample and its duplicate is used for all table calculations.
Samples: 31-SL-12, 31-SL-13, 31-SL-14, 31-SL-15, 31S00401, 31S00501, 31S00601, 31S00701, 31S00801, 31S00901, 31S01001, 31S01101, 31S01201, 31S01201R, 31S01301.
Sample duplicates: 31S00501D.
Background samples: BKG-SL-02, BKG-SL-06, BKG-SL-07, BKG-SL-08, BKS00101, BKS00201, BKS00401, and BKS00501.
Background duplicate sample: BKS00201D.

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.
* = average of a sample and its duplicate.

Table 6-4
Selection of Human Health Chemicals of Potential Concern for Surface Soil at Site 31E and 31F

Remedial Investigation Report
Site 31, Sludge Drying Beds and Disposal Areas
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]
Volatile Organic Compounds (µg/kg)								
2-Hexanone	1/13	11	1	1	NA	310,000	No	S
Carbon disulfide	1/13	5 to 11	3	3	NA	5,200	No	S
Xylenes (total)	5/13	5 to 11	2 to 3	2.5	NA	13,000,000	No	S
Semivolatile Organic Compounds (µg/kg)								
Di-*n*-octylphthalate	1/13	360 to 380	220	220	NA	160,000	No	S
bis(2-Ethylhexyl)phthalate	3/13	360 to 380	81 to 230	167	NA	46,000	No	S
Inorganic Analytes (mg/kg)								
Aluminum	13/13	NA	5,010 to 10,700	7,250	15,848	7,800	No	B
Arsenic	13/13	NA	0.7 to 1.9	1.2	3.2	0.43	No	B
Barium	13/13	NA	7.2 to 24.5	14.1	23.2	550	No	S
Beryllium	8/13	1	0.08 to 0.15	0.1	0.36	0.15	No	B,S
Calcium	13/13	NA	78.7 to 962	214	396	1,000,000	No	S
Chromium	13/13	NA	3.9 to 7.1	5.1	11	39	No	B,S
Cobalt	11/13	10	0.66 to 1.4	0.98	3	470	No	B,S
Copper	9/13	5	4 to 17.9	6.3	9.4	27,000	No	S
Iron	13/13	NA	2,580 to 5,380	3,640	8,832	2,300	No	B
Lead	13/13	NA	2.9 to 6.4	4.8	11.4	400	No	B,S
Magnesium	13/13	NA	98.6 to 349	156	268	460,468	No	S
Manganese	13/13	NA	60.3 to 456	252	392	180	Yes	
Mercury	4/13	0.04 to 0.1	0.01* to 0.02	0.02	0.12	2.3	No	B,S
Nickel	8/13	2.3 to 8	1.8* to 6.9	3.9	7.2	160	No	B,S
Potassium	3/13	128 to 1,000	106 to 349*	201	177	1,000,000	No	S
Selenium	1/13	0.46 to 1	0.52	0.52	0.46	39	No	S

See notes at end of table.

Table 6-4 (Continued)
Selection of Human Health Chemicals of Potential Concern for Surface Soil at Site 31E and 31F

Remedial Investigation Report
Site 31, Sludge Drying Beds and Disposal Areas
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)								
Silver	7/13	0.33 to 2	0.68 to 4.6*	3	0.7	39	No	S
Sodium	8/13	1,000	133 to 233	173	406	1,000,000	No	B,S
Vanadium	13/13	NA	6.5 to 14.2	9.5	21.8	55	No	B,S
Zinc	12/13	4	3.5 to 23.1	8.2	15.4	2,300	No	S

[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 Goals (Florida Department of Environmental Protection, 1996) was used for screening. Values from the USEPA Region III RBC Tables, dated October 22, 1997, are based on an excess lifetime cancer risk of 1×10^{-6} or an adjusted hazard quotient of 0.1. 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 C 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.

Notes: The average of a sample and its duplicate is used for all table calculations.
Samples: 31-SL-01, 31-SL-02, 31-SL-03, 31-SL-04, 31-SL-05 31-SL-06, 31-SL-07, 31-SL-08, 31S01501, 31S01601, 31S01701, 31S01801, 31S01901.
Sample duplicates: 31-SL-07A, 31S01501D.
Background samples: BKG-SL-02, BKG-SL-06, BKG-SL-07, BKG-SL-08, BKS00101, BKS00201, BKS00401, and BKS00501.
Background duplicate sample: BKS00201D.

HHCPC = human health chemical of potential concern.
μg/kg = micrograms per kilogram.
NA = not applicable.
mg/kg = milligrams per kilogram.
* = average of a sample and its duplicate.

Table 6-5
Selection of Human Health Chemicals of Potential Concern for Subsurface Soil at Site 31C

Remedial Investigation Report
Site 31, Sludge Drying Beds and Disposal Areas
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/kg)								
Acetone	1/6	10 to 170	970	970	NA	1,800,000	No	S
Methylene chloride	1/6	10 to 11	2	2	NA	23,000	No	S
Pesticides and PCBs (µg/kg)								
gamma-Chlordane	1/6	1.8 to 2	1.3*	1.3	NA	3,000	No	S
Inorganic Analytes (mg/kg)								
Aluminum	6/6	40	940 to 5,800	2,150	27,834	100,000	No	B,S
Arsenic	6/6	2	0.29 to 2	0.63	6.2	3.7	No	B,S
Barium	6/6	40	3.6 to 9.5	6	15.8	14,000	No	B,S
Beryllium	3/6	0.06	0.07* to 0.16	0.11	0.26	1.0	No	B,S
Cadmium	3/6	0.25	0.6* to 0.78	0.66	0.92	100	No	B,S
Calcium	2/6	180 to 274	253 to 267*	260	444	1,000,000	No	B,S
Chromium	3/6	2 to 3.1	4.7* to 13.1	8.4	22.8	430	No	B,S
Copper	3/6	0.96 to 2.1	9.8 to 12.5*	11.3	8.8	100,000	No	S
Cyanide	4/6	0.04 to 0.08	0.07* to 1.1	0.4	ND	4,100	No	S
Iron	6/6	20	697 to 5,440	1,730	18,110	61,000	No	B,S
Lead	6/6	0.6	0.64 to 12.8	6.2	8.4	400	No	S
Magnesium	5/6	56.5 to 65.6	73.5 to 103	87.1	272	460,468	No	B,S
Manganese	6/6	2.1 to 3.8	5.1 to 19.9	9.9	42.6	4,700	No	B,S
Mercury	3/6	0.03	0.08* to 0.09	0.08	ND	61	No	S
Nickel	2/6	1.5	1.7 to 1.8	1.8	5	4,100	No	B,S
Selenium	1/6	0.065 to 0.14	0.10*	0.1	0.3	1,000	No	B,S
Silver	3/6	0.52 to 0.61	1.1 to 2.5	1.7	1.12	1,000	No	S

See notes at end of table.

Table 6-5 (Continued)
Selection of Human Health Chemicals of Potential Concern for Subsurface Soil at Site 31C

Remedial Investigation Report
Site 31, Sludge Drying Beds and Disposal Areas
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 (mg/kg) (Continued)								
Vanadium	6/6	10	1.4 to 16.3	4.5	45	1,400	No	B,S
Zinc	3/6	3.1 to 4.1	13.5* to 17	15.4	15.6	61,000	No	S

[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), 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 Goals industrial scenario (Florida Department of Environmental Protection, 1996) were used for screening. For analytes that are HHCPCs in groundwater, the Florida Soil Cleanup Goals based on leachability are used for screening. There were four HHCPCs selected in groundwater at Site 13, however, trichloroethene was not detected in subsurface soil at Site 13 and no Florida Soil Cleanup Goals are available for arsenic, iron, or manganese. Actual values are taken from the USEPA Region III RBC Tables dated October 22, 1997, and are based on an excess lifetime cancer risk of 1×10^{-6} or an adjusted hazard quotient of 0.1. 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 C of this 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; 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: 31B00601, 31B00602, 31B00701, 31B00702, 31B00801, and 31B00802.
Duplicate samples: 31B00601D.
Background samples: BKB00101, BKB00102, BKB00201, BKB00202, BKB00301, BKB00302, BKB00401, BKB00402, BKB00501, BKB00502, BKB00601, BKB00602, BKB00701, and 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.
* = average of a sample and its duplicate.
mg/kg = milligrams per kilogram.
ND = not detected in any background sample.

and individual sample analytical data are presented on Figure 3-2 and Table 3-2, respectively. VOCs, SVOCs, pesticides, PCBs, and inorganic analyte data from these samples are evaluated in this HHRA. Table 6-5 presents the HHCPCs selection for subsurface soil at Site 31C. No analytes were selected as HHCPCs in the subsurface soil.

6.2.6 Groundwater Site 31C Six groundwater samples and one duplicate sample were collected from Site 31C (samples are identified in the notes of Table 6-6). The sample locations and individual sample analytical data are presented on Figure 3-3 and Table 3-3, respectively. VOCs, SVOCs, pesticides, PCBs, and inorganic analyte data from these samples are evaluated in this HHRA. Table 6-6 identifies one VOC (TCE) as an HHCPC for groundwater in Site 31.

6.3 EXPOSURE ASSESSMENT. The exposure assessment methodology is described in Subsection 2.5.3 of the GIR (HLA, 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
- 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 31 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 provided in Table 6-7, 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 C to the GIR (HLA, 1998). Risk calculation spreadsheets in Appendix F to this RI report also contain the assumptions for exposure parameters and quantitation of exposures.

6.3.1 Surface Soil No humans currently reside or work at Site 31. There is, however, a current exposure potential for a trespasser (adult or adolescent) and a site maintenance worker. Therefore, these two receptors will be evaluated as a current exposure scenario.

Site 31 could be developed eventually for residential land use in the future; therefore, the residential receptor will be evaluated as part of the hypothetical future land-use scenario. Also there are no buildings currently at the site; therefore, exposure of occupational workers will be only considered as part of the 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.

Table 6-6
Selection of Human Health Chemicals of Potential Concern for Unfiltered Groundwater at Site 31C

Remedial Investigation Report
Site 31, Sludge Drying Beds and Disposal Areas
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)								
Methylene chloride	1/6	10	1	1	NA	4.1	No	S
Trichloroethene	1/6	10	2	2	NA	1.6	Yes	
Inorganic Analytes (μg/ℓ)								
Aluminum	2/6	16.5 to 200	93.6* to 93.7	93.6	654	50	No	B
Barium	6/6	NA	8.9 to 55.4	26.4	72.6	260	No	B,S
Calcium	6/6	NA	545 to 2,090	1,120	3,316	1,055,398	No	B,S
Copper	2/6	1.7 to 25	3.8 to 7.0*	5.4	10.8	1,000	No	B,S
Cyanide	2/6	0.83 to 10	1.3 to 7.9	4.6	7	73	No	S
Iron	3/6	31.8 to 100	41.6 to 112*	71.5	964	300	No	B,S
Magnesium	6/6	NA	335 to 1,450	741	2,426	118,807	No	B,S
Manganese	5/6	4.9 to 15	5.4 to 20.9	11.4	42.8	50	No	B,S
Nickel	2/6	1.2 to 40	1.4 to 2	1.7	42.8	73	No	S
Potassium	1/6	745 to 5,000	2,060*	2,060	1,528	297,016	No	S
Sodium	4/6	949 to 5,000	1,110 to 1,930	1,674	4,772	160,000	No	B,S
Vanadium	1/6	0.58 to 50	13.4*	13.4	3.8	26	No	S
Zinc	1/6	2.8 to 20	9.4	9.4	200	1,100	No	B,S

See notes at end of table.

Table 6-6 (Continued)
Selection of Human Health Chemicals of Potential Concern for Unfiltered Groundwater at Site 31C

Remedial Investigation Report
Site 31, Sludge Drying Beds and Disposal Areas
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] 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, the lesser of the U.S. Environmental Protection Agency (USEPA), Region III Risk-Based Concentration (RBC) table for tap water exposure or the Florida Groundwater Guidance Concentration (Florida Department of Environmental Protection, 1994) was used for screening. Actual values are taken from the USEPA Region III RBC Tables dated October 22, 1997, and are based on an excess lifetime cancer risk of 1×10^{-6} or an adjusted hazard quotient of 0.1. For the essential nutrients, screening values were derived based on recommended daily allowances. Values are presented in Appendix C.
[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.

Notes: Samples: 31G00101, 31G00201, 31G00301, 31G00401, 31G00402, 31G00403.
Sample duplicate: 31G00101D.
Background samples: BKG00101 through BKG00103, BKG00201 through BKG00203, and BKG00301.
Background duplicate sample: BKG00101D.

HHCPC = human health chemical of potential concern.
μg/kg = micrograms per kilogram.
NA = not applicable.
* = average of a sample and its duplicate.

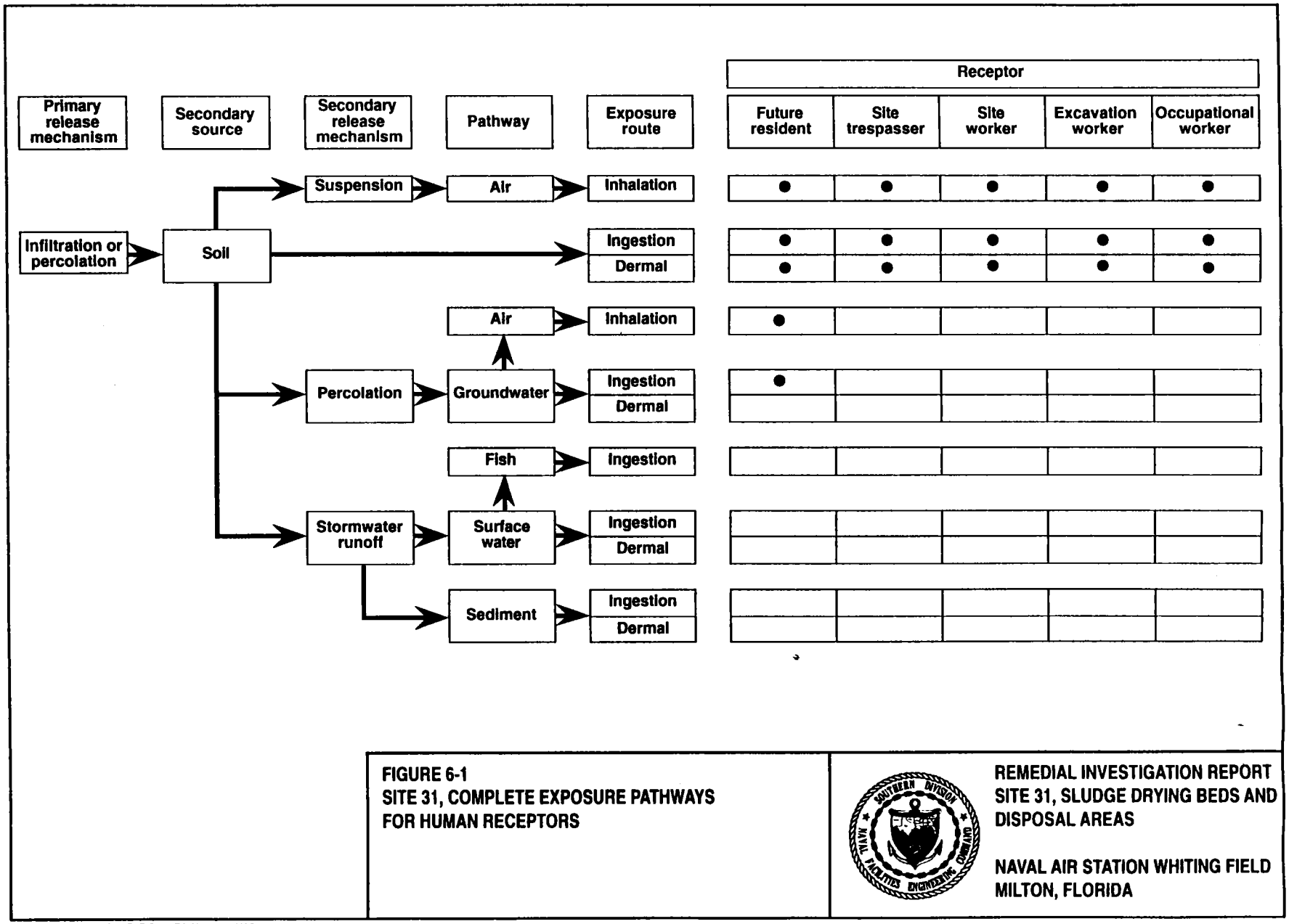


FIGURE 6-1
SITE 31, COMPLETE EXPOSURE PATHWAYS FOR HUMAN RECEPTORS

REMEDIAL INVESTIGATION REPORT
SITE 31, SLUDGE DRYING BEDS AND DISPOSAL AREAS

NAVAL AIR STATION WHITING FIELD
MILTON, FLORIDA

2534-09 WHITING SITE 31RI FIG 6-1 FINAL 050198HAS

Table 6-7
Summary of Potential Exposure Pathways

Remedial Investigation Report
Site 31, Sludge Drying Beds and Disposal Areas
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 at Site 31. 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 (adult)	No	There are no excavation activities currently at Site 31. Additionally, there are no human health chemicals of potential concern (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 31 is developed, residents, trespassers, occupational workers, site maintenance workers, and excavation workers could be exposed to chemicals in surface soil.
Subsurface soil	Dermal contact with soil, ingestion of soil, and inhalation of fugitive dust.	Excavation worker (adult)	Yes	Although it is possible 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.

Exposures of hypothetical future residents (adult and child), hypothetical future occupational workers, hypothetical future and current site maintenance workers, hypothetical future excavation workers, and hypothetical future and current 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 31. Additionally, there are no HHCPCs identified in subsurface soil. Therefore, subsurface soil exposure pathways are not evaluated as current or potential future (hypothetical) exposure pathways in this HHRA.

6.3.3 **Groundwater** Currently, groundwater at Site 31 is not used for any potable or nonpotable purpose, nor are there plans to use the water resource in the foreseeable future. However, if that Site 31 or areas hydraulically downgradient of Site 31 are developed, the exposure pathway to analytes in groundwater could become complete. Therefore, hypothetical future residential use of groundwater ingestion and inhalation of volatiles while showering (adult residents only) is evaluated in this HHRA as a worst-case estimate of hypothetical future receptors.

6.3.4 **Exposure Point Concentrations** EPCs are calculated for all HHCPCs in surface soil and groundwater according to Paragraph 2.5.3.3 of the GIR (HLA, 1998). The EPC of each HHCPC in soil is the lesser of the maximum detected concentration or the 95 percent upper confidence limit (UCL) of the arithmetic mean concentration for soils. The EPC of each HHCPC in groundwater is the lesser of the maximum detected concentration and the arithmetic mean of the samples collected within the groundwater plume. The EPC quantification process involves developing assumptions regarding exposure conditions and exposure scenarios for each receptor to estimate the total amount of contaminants 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 resulting in the most intense level of exposure that may "reasonably" be expected to occur under current and future site conditions (USEPA, 1989b).

The EPCs for HHCPCs in surface soil for Sites 31C, 31E and 31F are presented in Tables 6-8 and 6-9, respectively; groundwater is presented in Table 6-10. The EPCs were used with receptor-specific exposure parameters to quantify exposures to the HHCPCs, as shown in the risk calculation spreadsheets in Appendix F to this report.

6.4 **TOXICITY ASSESSMENT**. The toxicity assessment methodology is described in Subsection 2.5.4 of the GIR (HLA, 1998). The toxicity assessment evaluates the available evidence on the hypothetical adverse effects associated with exposure to each HHCPC. This information is used to developed 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

Table 6-8
Exposure Point Concentrations for Human Health Chemicals of Potential Concern for Surface Soil at Site 31C

Remedial Investigation Report
Site 31, Sludge Drying Beds and Disposal Areas
Naval Air Station Whiting Field
Milton, Florida

Analyte	Frequency of Detection[1]	Maximum Detected Concentration	95% UCL[2]	Exposure Point Concentration[3]
Pesticides and PCBs (μg/kg)				
Aroclor-1260	4/14	1,400	1,350	1,350
Dieldrin	6/14	120	118	118
Inorganic Analytes (mg/kg)				
Aluminum	14/14	16,800	7,480	7,480
Beryllium	4/14	1.3	0.63	0.63
Cadmium	7/14	26.8	31.2	26.8
Chromium	14/14	295	412	295
Iron	14/14	22,500	9,410	9,410
Lead	14/14	1,890	21,600	1,890
Mercury	8/14	8.8	26.3	8.8
Silver	8/14	154	590	154

[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% upper confidence limit (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.
PCB = polychlorinated biphenyl.
μg/kg = micrograms per kilogram.
mg/kg = milligrams per kilogram.

Table 6-9
Exposure Point Concentrations for Human Health Chemicals of Potential Concern for Surface Soil at Sites 31E and 31F

Remedial Investigation Report
Site 31, Sludge Drying Beds and Disposal Areas
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)				
Manganese	13/13	456	376	376

[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% upper confidence limit (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.
mg/kg = milligrams per kilogram.

Table 6-10
Exposure Point Concentrations for Human Health Chemicals of Potential Concern for Groundwater at Site 31C

Remedial Investigation Report
Site 31, Sludge Drying Beds and Disposal Areas
Naval Air Station Whiting Field
Milton, Florida

Analyte	Frequency of Detection[1]	Maximum Detected Concentration	Arthimetic Mean[2]	Exposure Point Concentration[3]
Volatile Organic Compounds (μg/ℓ)				
Trichloroethene	1/6	2	4.5	2

[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).
excluding rejected values).
[2] Arithmetic mean of all samples calculated using one-half the contract-required quantitation limit/contract-required detection limit for nondetects.
[3] Exposure point concentration is the lower of either the mean concentration or maximum detected concentration.

Note: μg/ℓ = micrograms per liter.

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 dose-response values are used to estimate the incidence of adverse effects as a function of human exposure to a chemical.

Appendix F to this report contains brief toxicity summaries for HHCPCs identified in surface soil and groundwater at Site 31. Appendix F to this report also contains dose-response information for the HHCPCs (Tables F-4 through F-9). Dose-response values used in this HHRA were current as of February 1998 for Integrated Risk Information System (IRIS) (USEPA, 1998) 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 (HLA, 1998).

Risk estimates for hypothetical exposures to surface soil and groundwater under current and hypothetical future land-use scenarios are discussed below in Subsections 6.5.1 through 6.5.3. These risk estimates are then compared to Federal USEPA and FDEP carcinogenic and noncarcinogenic target risk levels.

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

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

Tables 6-11 and 6-12 summarize the cancer and noncancer risk under current and hypothetical future land-use scenarios, respectively, for Site 31C. Tables 6-13 and 6-14 summarize the cancer and noncancer risk under current and hypothetical future land-use scenarios, respectively, for Sites 31E and 31F.

Table 6-11
Risk Summary, Current Land Use at Site 31C

Remedial Investigation Report
Site 31, Sludge Drying Beds and Disposal Areas
Naval Air Station Whiting Field
Milton, Florida

Land Use	Exposure Route	HI[1]	ELCR[1]
Current Land Use			
Surface Soil			
Adult Trespasser:	Incidental ingestion	0.04	4×10^{-7}
	Dermal contact	0.06	1×10^{-6}
	Inhalation of particulates	0.000001	2×10^{-8}
	Total Adult Trespasser:	0.1	1×10^{-6}
Adolescent Trespasser:	Incidental ingestion	0.07	3×10^{-7}
	Dermal contact	0.07	6×10^{-7}
	Inhalation of particulates	0.000002	1×10^{-8}
	Total Adolescent Trespasser:	0.1	9×10^{-7}
	Total Risk to Trespasser (Adult and Adolescent) Exposed to Surface Soil:	NC	2×10^{-6}
Site Maintenance Worker:	Incidental ingestion	0.02	2×10^{-7}
	Dermal contact	0.04	8×10^{-7}
	Inhalation of particulates	0.000006	8×10^{-8}
	Total Site Maintenance Worker:	0.06	1×10^{-6}

[1] Receptor totals may vary from spreadsheets due to rounding algorithm.

Notes: HI = hazard index.
ELCR = excess lifetime cancer risk.
NC = not calculated because child and adult HIs are not additive.

Table 6-12
Risk Summary, Future Land Use at Site 31C

Remedial Investigation Report
Site 31, Sludge Drying Beds and Disposal Areas
Naval Air Station Whiting Field
Milton, Florida

Land Use	Exposure Route	HI[1]	ELCR[1]
Future Land Use			
Surface Soil			
Adult Trespasser:	Incidental ingestion	0.04	4×10^{-7}
	Dermal contact	0.06	1×10^{-6}
	Inhalation of particulates	0.000001	2×10^{-8}
	Total Adult Trespasser:	0.1	1×10^{-6}
Adolescent Trespasser:	Incidental ingestion	0.07	3×10^{-7}
	Dermal contact	0.07	6×10^{-7}
	Inhalation of particulates	0.000002	1×10^{-8}
	Total Adolescent Trespasser:	0.1	9×10^{-7}
	Total Risk to Trespasser (Adult and Adolescent) Exposed to Surface Soil:	NC	2×10^{-6}
Adult Resident:	Incidental ingestion	0.3	3×10^{-6}
	Dermal contact	0.3	9×10^{-6}
	Inhalation of particulates	0.00004	6×10^{-7}
	Total Adult Resident:	0.6	1×10^{-5}
Child Resident:	Incidental ingestion	3	8×10^{-6}
	Dermal contact	0.7	4×10^{-6}
	Inhalation of particulates	0.0002	8×10^{-7}
	Total Child Resident:	4	1×10^{-5}
	Total Risk to Resident (Adult and Child) Exposed to Surface Soil:	NC	2×10^{-5}
Occupational Worker:	Incidental ingestion	0.1	1×10^{-6}
	Dermal contact	0.2	3×10^{-6}
	Inhalation of particulates	0.00002	2×10^{-7}
	Total Occupational Worker:	0.3	4×10^{-6}

See notes at end of table.

Table 6-12 (Continued)
Risk Summary, Future Land Use at Site 31C

Remedial Investigation Report
Site 31, Sludge Drying Beds and Disposal Areas
Naval Air Station Whiting Field
Milton, Florida

Land Use	Exposure Route	HI[1]	ELCR[1]
Future Land Use (Continued)			
Site Maintenance Worker:	Incidental ingestion	0.02	2×10^{-7}
	Dermal contact	0.04	8×10^{-7}
	Inhalation of particulates	0.000006	8×10^{-8}
	Total Site Maintenance Worker:	0.06	1×10^{-6}
Excavation Worker:	Incidental ingestion	0.1	6×10^{-8}
	Dermal contact	0.03	3×10^{-8}
	Inhalation of particulates	0.000006	3×10^{-9}
	Total Excavation Worker:	0.1	9×10^{-8}
Groundwater:			
Adult Resident:	Ingestion of groundwater as drinking water	0.009	1×10^{-7}
	Inhalation of volatiles while showering	ND	5×10^{-8}
	Total Adult Resident:	ND	2×10^{-7}
Child Resident:	Ingestion of groundwater as drinking water	0.02	7×10^{-8}
	Total Child Resident:	ND	7×10^{-8}
	Total Risk to Resident (Adult and Child) Exposed to Groundwater:	NC	3×10^{-7}
	Total Risk to Resident (Adult and Child) Exposed to Groundwater and Surface Soil:	NC	2×10^{-5}

[1] Receptor totals may vary from spreadsheets due to rounding algorithm.

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 6-13
Risk Summary, Current Land Use at Sites 31E and 31F

Remedial Investigation Report
Site 31, Sludge Drying Beds and Disposal Areas
Naval Air Station Whiting Field
Milton, Florida

Land Use	Exposure Route	HI[1]	ELCR[1]
Current Land Use			
Surface Soil			
Adult Trespasser:	Incidental ingestion	0.001	NE
	Dermal contact	0.002	NE
	Inhalation of particulates	0.0001	NE
	Total Adult Trespasser:	0.003	NE
Adolescent Trespasser:	Incidental ingestion	0.002	NE
	Dermal contact	0.002	NE
	Inhalation of particulates	0.0001	NE
	Total Adolescent Trespasser:	0.005	NE
	Total Risk to Trespasser (Adult and Adolescent) Exposed to Surface Soil:	NC	NE
Site Maintenance Worker:	Incidental ingestion	0.0005	NE
	Dermal contact	0.001	NE
	Inhalation of particulates	0.0005	NE
	Total Site Maintenance Worker:	0.002	NE

[1] Receptor totals may vary from spreadsheets due to rounding algorithm.

Notes: HI = hazard index.
ELCR = excess lifetime cancer risk.
NE = not evaluated; no carcinogenic human health chemical of potential concern selected.
NC = not calculated because child and adult HIs are not additive.

Table 6-14
Risk Summary, Future Land Use at Sites 31E and 31F

Remedial Investigation Report
Site 31, Sludge Drying Beds and Disposal Areas
Naval Air Station Whiting Field
Milton, Florida

Land Use	Exposure Route	HI[1]	ELCR[1]
Future Land Use			
Surface Soil			
Adult Trespasser:	Incidental ingestion	0.001	NE
	Dermal contact	0.002	NE
	Inhalation of particulates	0.0001	NE
	Total Adult Trespasser:	0.003	NE
Adolescent Trespasser:	Incidental ingestion	0.002	NE
	Dermal contact	0.002	NE
	Inhalation of particulates	0.0001	NE
	Total Adolescent Trespasser:	0.005	NE
	Total Risk to Trespasser (Adult and Adolescent) Exposed to Surface Soil:	NC	NE
Adult Resident:	Incidental ingestion	0.01	NE
	Dermal contact	0.02	NE
	Inhalation of particulates	0.004	NE
	Total Adult Resident:	0.03	NE
Child Resident:	Incidental ingestion	0.1	NE
	Dermal contact	0.02	NE
	Inhalation of particulates	0.02	NE
	Total Child Resident:	0.1	NE
	Total Risk to Resident (Adult and Child) Exposed to Surface Soil:	NC	NE
Occupational Worker:	Incidental ingestion	0.004	NE
	Dermal contact	0.004	NE
	Inhalation of particulates	0.001	NE
	Total Occupational Worker:	0.008	NE

See notes at end of table.

Table 6-14 (Continued)
Risk Summary, Future Land Use at Sites 31E and 31F

Remedial Investigation Report
Site 31, Sludge Drying Beds and Disposal Areas
Naval Air Station Whiting Field
Milton, Florida

Land Use	Exposure Route	HI[1]	ELCR[1]
Future Land Use (Continued)			
Site Maintenance Worker:	Incidental ingestion	0.0005	NE
	Dermal contact	0.001	NE
	Inhalation of particulates	0.0005	NE
	Total Site Maintenance Worker:	0.002	NE
Excavation Worker:	Incidental ingestion	0.005	NE
	Dermal contact	0.001	NE
	Inhalation of particulates	0.0005	NE
	Total Excavation Worker:	0.006	NE

[1] Receptor totals may vary from spreadsheets due to rounding algorithm.

Notes: HI = hazard index.
ELCR = excess lifetime cancer risk.
NE = not evaluated; no carcinogenic human health chemical of potential concern selected.
NC = not calculated because child and adult HIs are not additive.

6.5.1 Surface Soil

6.5.1.1 Site 31C Surface Soil The risk calculations for surface soil exposure are shown in Tables F-10 through F-23 in Appendix F 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 1×10^{-6} for a site maintenance worker. Both receptors cancer risk values are at or below the USEPA acceptable cancer risk range of 1 in 10,000 to 1 in 1,000,000; however, the hypothetical trespasser risk exceeds the Florida level of concern of 1×10^{-6} (mainly due to beryllium). The noncancer risks associated with surface soil ingestion, dermal contact, and fugitive dust inhalation under current land use (adolescent trespasser, adult trespasser, and site worker) are below USEPA's target HI of 1. Figures 6-2 and 6-3 present summaries of cancer risks and HIs, respectively, associated with exposure scenarios under current land use.

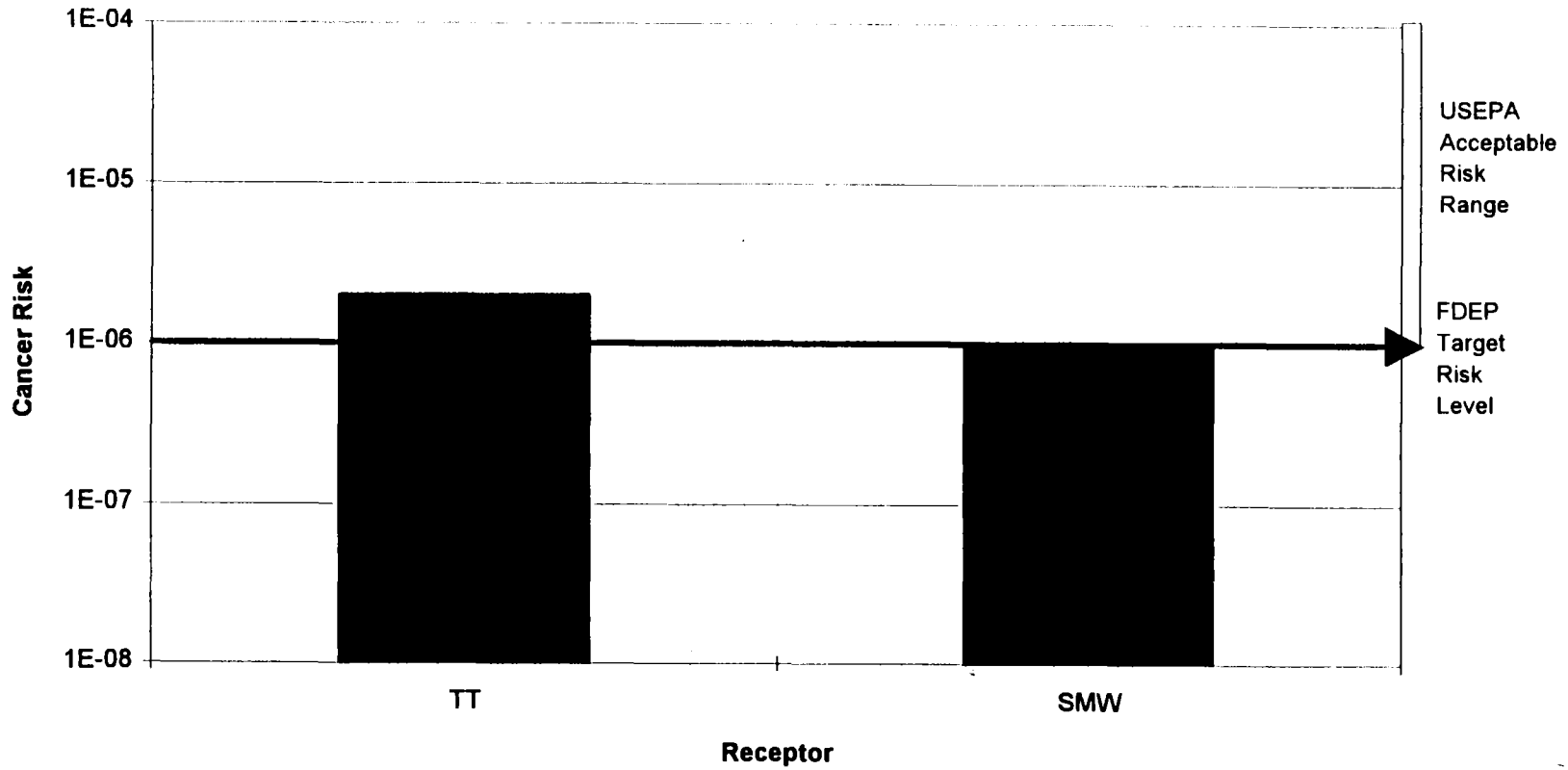
The cancer risks associated with exposure to surface soil ingestion, dermal contact, and fugitive dust inhalation under hypothetical future land use are 2×10^{-5} for an aggregate resident (combined adult and child), 2×10^{-6} for an aggregate trespasser (combined adult and adolescent), 4×10^{-6} for an occupational worker, 1×10^{-6} for a site maintenance worker, and 9×10^{-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, trespasser, and occupational worker risk exceeds the Florida level of concern of 1×10^{-6} (due to Aroclor-1260, dieldrin, and beryllium).

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 target HI of 1, except for the child resident. The child resident (HI of 4) exceeds the USEPA's and the FDEP's target HI of 1, although no individual HHCPCs exceed this threshold. The major contributors to this HI are Aroclor-1260, aluminum, cadmium, chromium, iron, mercury, and silver. Figure 6-5 presents a summary of HIs associated with exposure scenarios under future land use.

6.5.1.2 Sites 31E and 31F Surface Soil The risk calculations for surface soil exposure are shown in Tables F-24 through F-37 in Appendix F to this report. Since there are no carcinogenic HHCPCs selected for surface soil, there is no potential future receptor carcinogenic risk summary figure.

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 target HI of 1. Figures 6-6 and 6-7 present a summary of HIs associated with exposure scenarios under current and future land use, respectively.

6.5.2 Site 31C Groundwater The risk calculations for groundwater exposure are shown in Tables F-38 and F-41 in Appendix F 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.



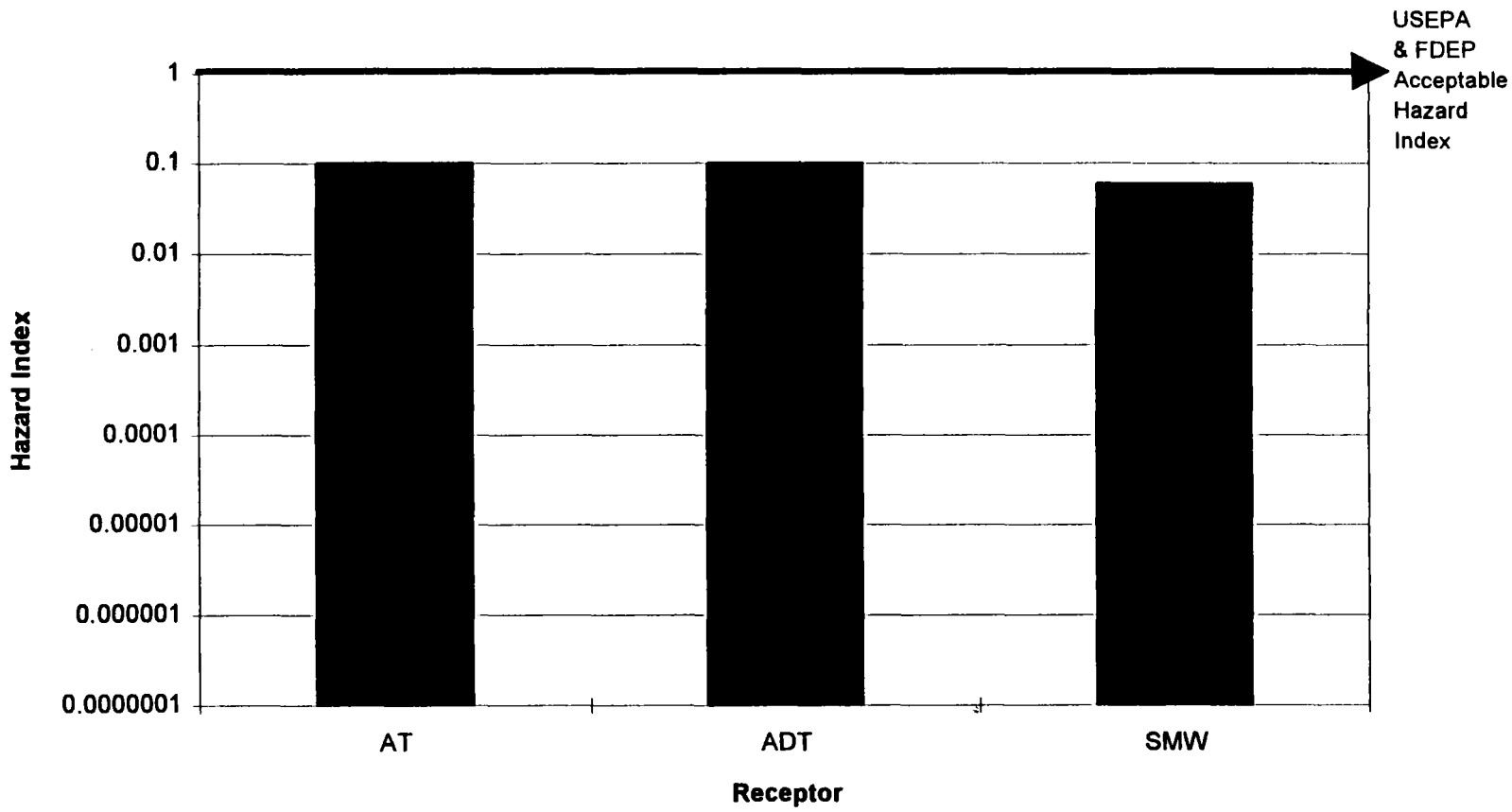
NOTES:
USEPA = U.S. Environmental Protection Agency
FDEP = Florida Department of Environmental Protection
TT = Total trespasser
SMW = Site maintenance worker

FIGURE 6-2
CANCER RISK SUMMARY
CURRENT LAND USE FOR SURFACE SOIL AT SITE 31C

REMEDIAL INVESTIGATION REPORT
SITE 31, SLUDGE DRYING BEDS AND DISPOSAL AREAS

NAVAL AIR STATION WHITING FIELD
MILTON, FLORIDA

H:\HEIDI\WHITING\SITE31\FIG6-2 PM5 FIGS31B.XLS 050498HAS



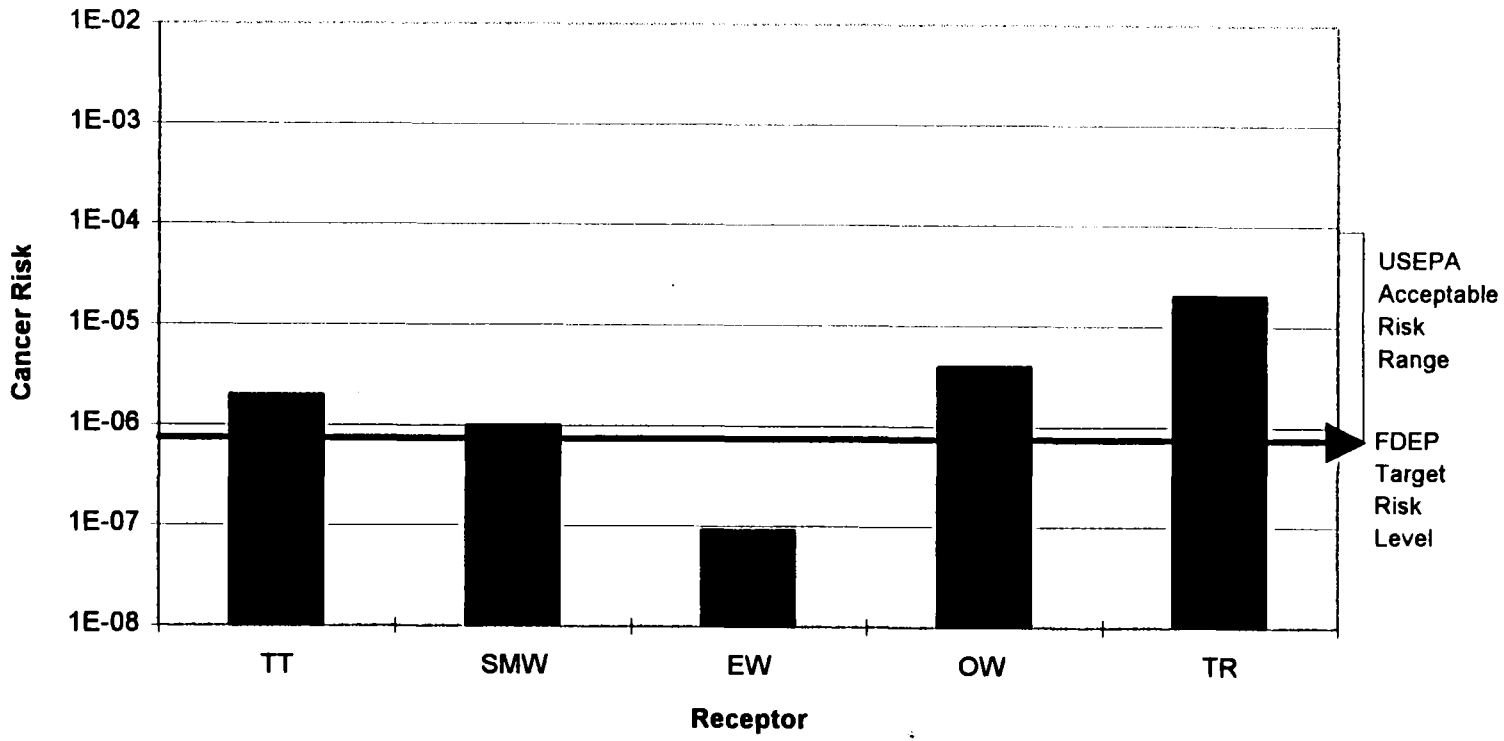
NOTES:
USEPA = U.S. Environmental Protection Agency
FDEP = Florida Department of Environmental Protection
AT = Adult trespasser
ADT = Adolescent trespasser
SMW = Site maintenance worker

FIGURE 6-3
NONCANCER RISK SUMMARY
CURRENT LAND USE FOR SURFACE SOIL AT SITE 31C

REMEDIAL INVESTIGATION REPORT
SITE 31, SLUDGE DRYING BEDS AND DISPOSAL AREAS

NAVAL AIR STATION WHITING FIELD
MILTON, FLORIDA

H:\HEIDI\WHITING\SITE31\FIG6-3 PM5 FIGS318.XLS 050498HAS



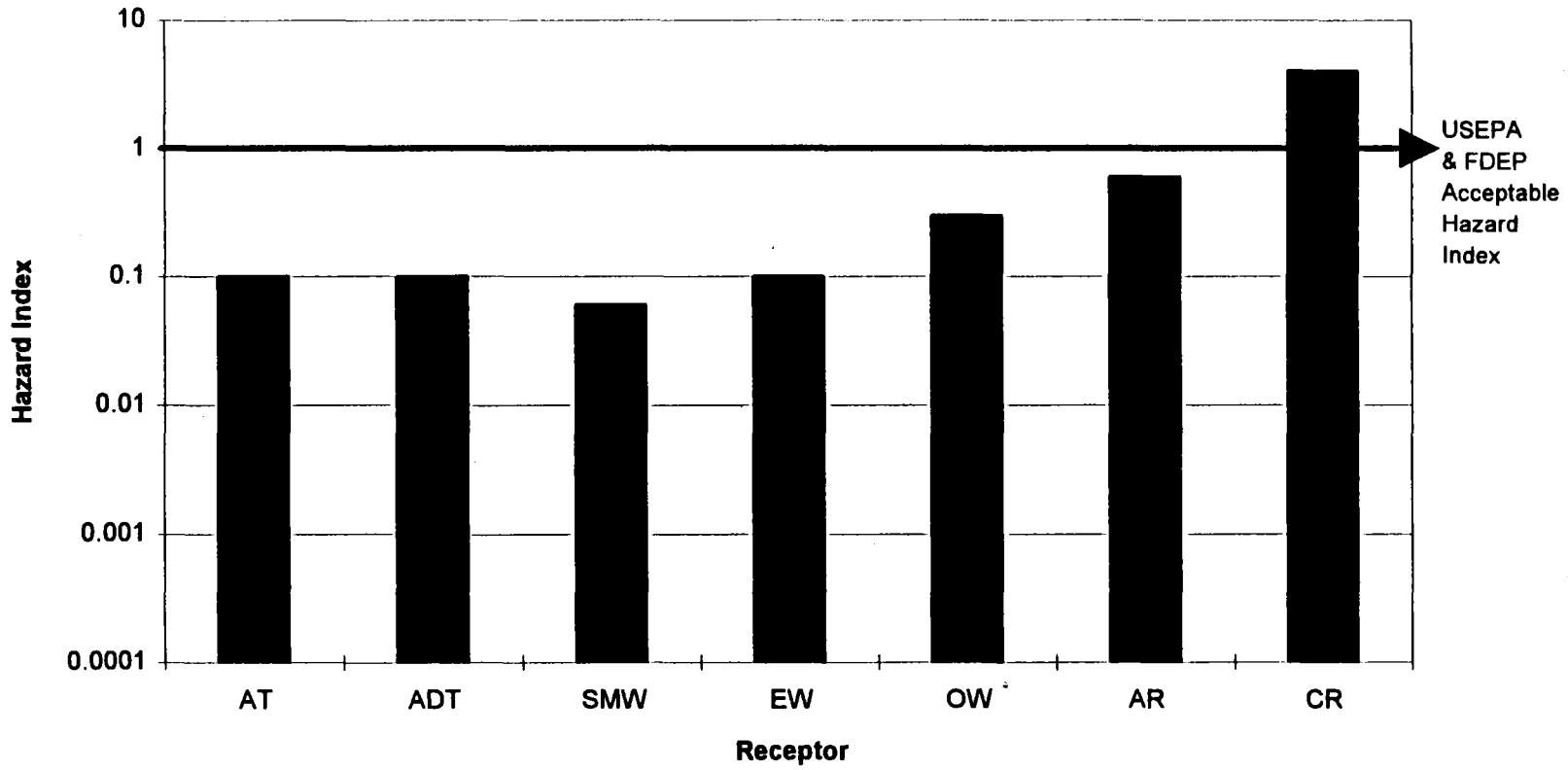
NOTES:
USEPA = U.S. Environmental Protection Agency
FDEP = Florida Department of Environmental Protection
TT = Total trespasser
SMW = Site maintenance worker
EW = Excavation worker
OW = Occupational worker
TR = Total resident

FIGURE 6-4
CANCER RISK SUMMARY
FUTURE LAND USE FOR SURFACE SOIL AT SITE 31C

REMEDIAL INVESTIGATION REPORT
SITE 31, SLUDGE DRYING BEDS AND DISPOSAL AREAS

NAVAL AIR STATION WHITING FIELD
MILTON, FLORIDA

H:\HEID\WHITING\SITE31\FIG6-4 PM5 FIGS31B XLS 050498HAS



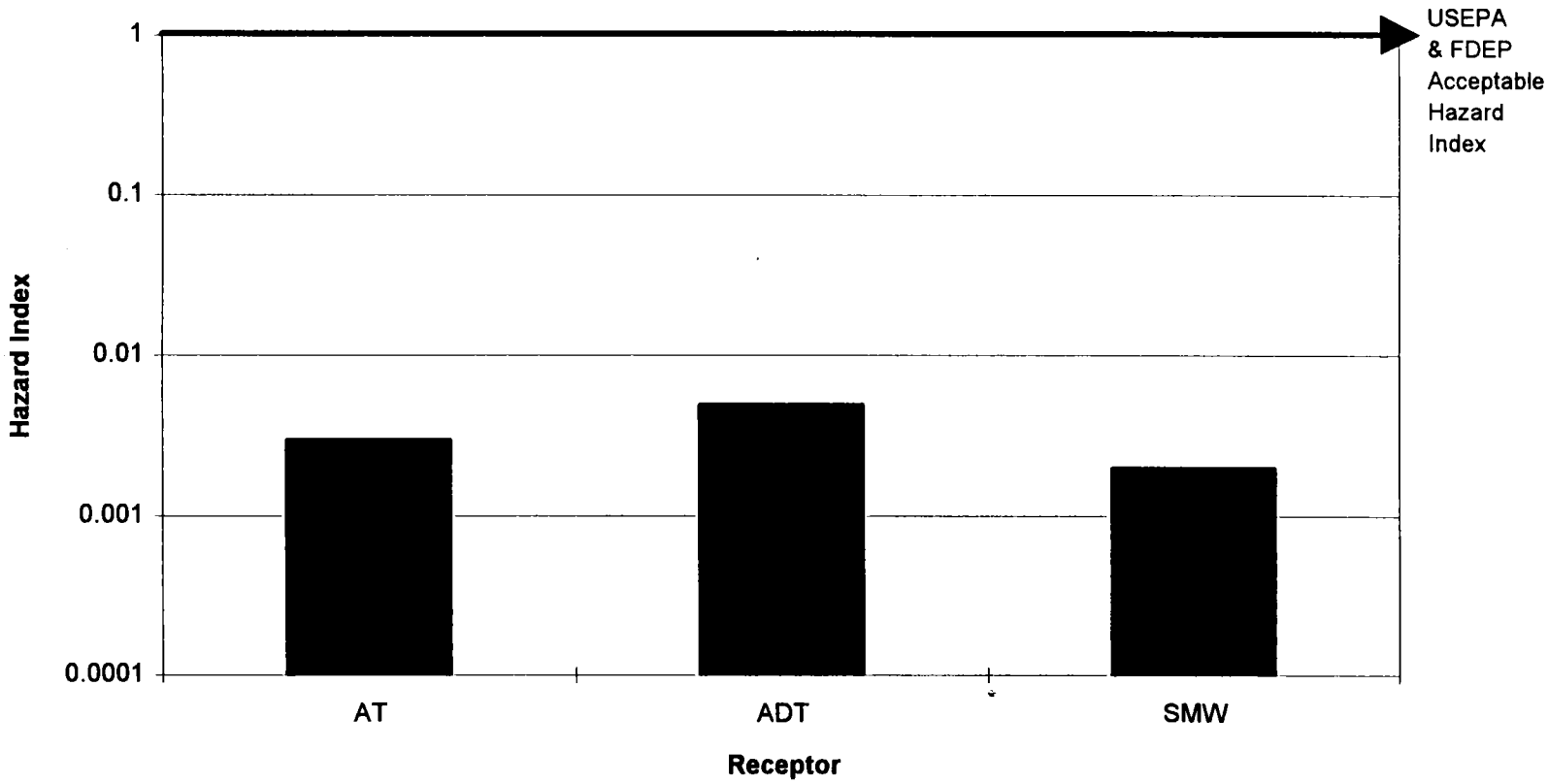
NOTES:
USEPA = U.S. Environmental Protection Agency
FDEP = Florida Department of Environmental Protection
AT = Adult trespasser
ADT = Adolescent trespasser
SMW = Site maintenance worker
EW = Excavation worker
OW = Occupational worker
AR = Adult resident
CR = Child resident

FIGURE 6-5
NONCANCER RISK SUMMARY
FUTURE LAND USE FOR SURFACE SOIL AT SITE 31C

REMEDIAL INVESTIGATION REPORT
SITE 31, SLUDGE DRYING BEDS AND DISPOSAL AREAS

NAVAL AIR STATION WHITING FIELD
MILTON, FLORIDA

H:\HEIDI\WHITING\SITE31\FIG6-5 PM5 FIGS31B.XLS 050408HAS



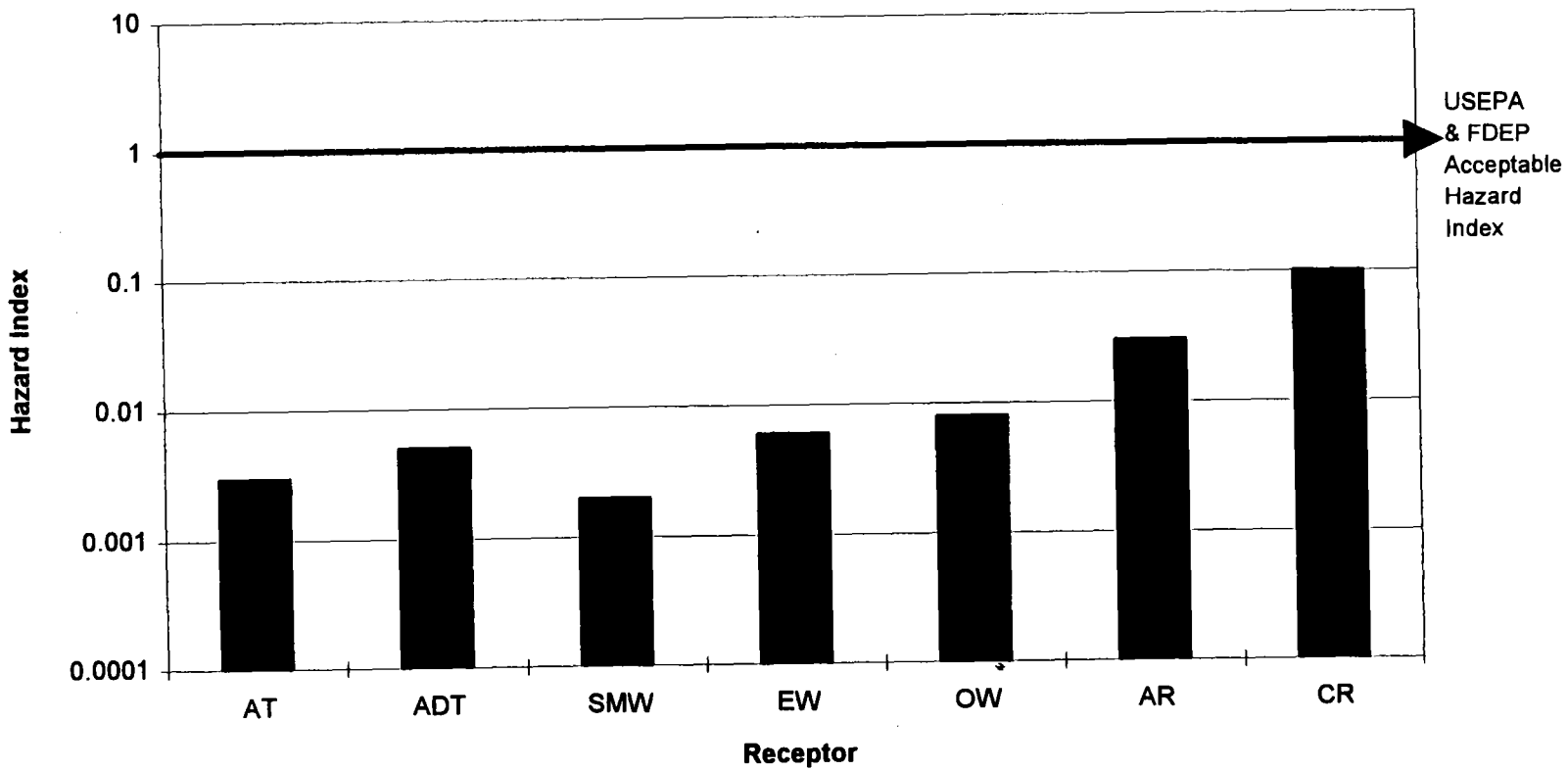
NOTES:
USEPA = U.S. Environmental Protection Agency
FDEP = Florida Department of Environmental Protection
AT = Adult trespasser
ADT = Adolescent trespasser
SMW = Site maintenance worker

FIGURE 6-6
NONCANCER RISK SUMMARY
CURRENT LAND USE FOR SURFACE SOIL
AT SITES 31E AND 31F

REMEDIAL INVESTIGATION REPORT
SITE 31, SLUDGE DRYING BEDS AND DISPOSAL AREAS

NAVAL AIR STATION WHITING FIELD
MILTON, FLORIDA

H:\HEIDI\WHITING\SITE31\FIG6-6 PM5 GW31b2.XLS 090898HAS



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

FIGURE 6-7
NONCANCER RISK SUMMARY
FUTURE LAND USE FOR SURFACE SOIL
AT SITES 31E AND 31F

REMEDIAL INVESTIGATION REPORT
SITE 31, SLUDGE DRYING BEDS AND DISPOSAL AREAS

NAVAL AIR STATION WHITING FIELD
MILTON, FLORIDA

H:\HEIDI\WHITING\SITE31\FIG6-7 PM5 GW31b2.XLS 091098HAS

The cancer risks associated with exposure to groundwater ingestion under hypothetical future land use are 3×10^{-7} for an aggregate resident (combined adult and child). Figure 6-8 presents a summary of cancer risk associated with exposure scenarios under future land use. The hypothetical future residential receptor risk is below both the USEPA acceptable cancer risk range and the Florida level of concern of 1×10^{-6}. The hypothetical future residential noncancer risk is below the USEPA and FDEP target threshold of 1. Figure 6-9 presents a summary of the hypothetical future noncancer risks.

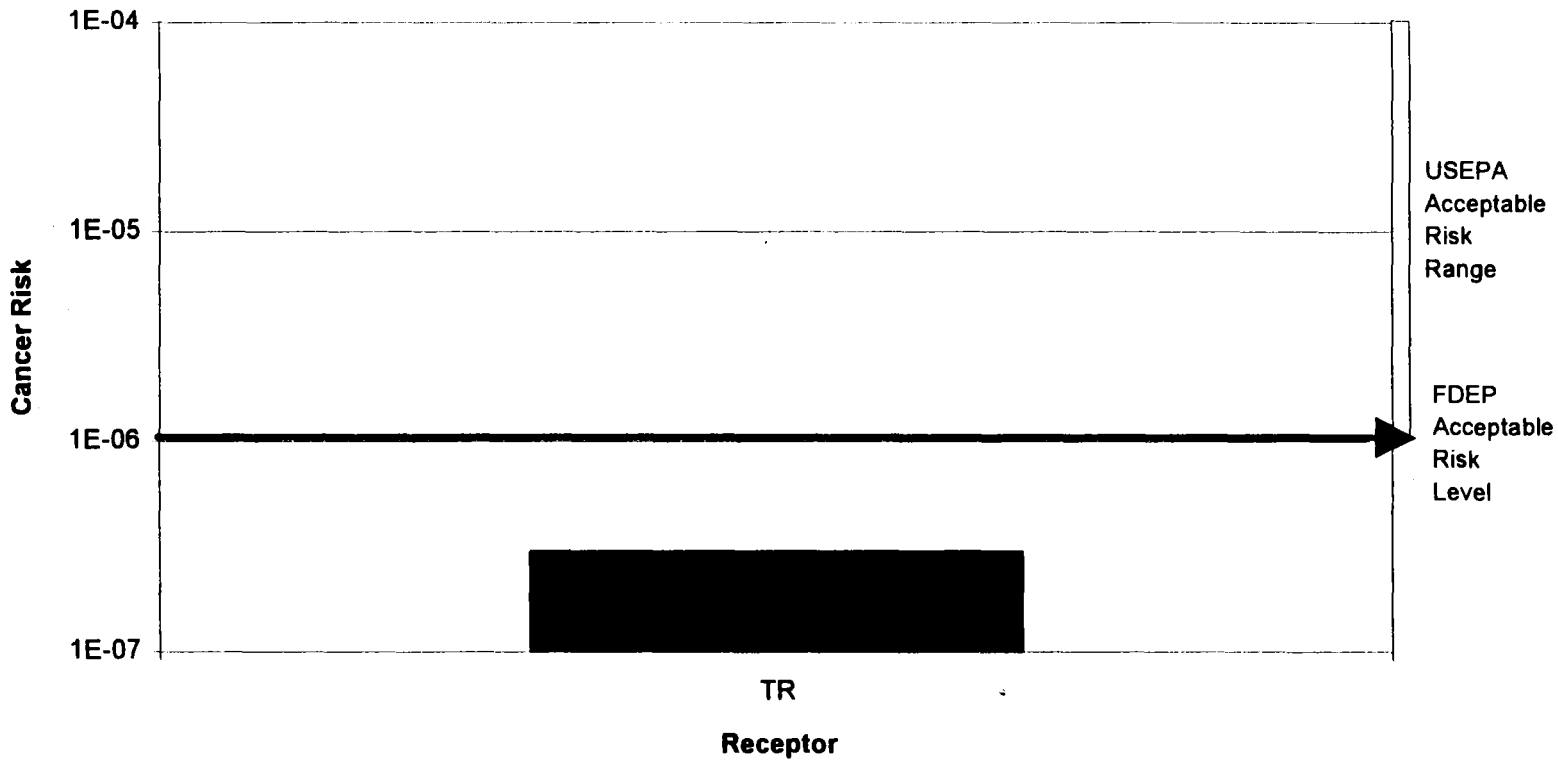
6.5.3 **Cumulative Risk Summary** USEPA Region IV guidance requires an assessment of a cumulative receptor risk. In this HHRA, the hypothetical future and current trespasser could potentially be exposed to all Site 31 soil exposure areas and the hypothetical future residential receptor could potentially be exposed to Site 31 surface soils and groundwater. The cumulative trespasser risk is equal to the risk from Site 31C (2×10^{-6}) because no carcinogenic HHCPCs were identified at Sites 31E and 31F. The cumulative risk to hypothetical future residents of 2×10^{-5} is within the USEPA acceptable cancer risk range; however, it exceeds the FDEP target level of concern. This risk exceedance is primarily due to surface soil.

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 (HLA, 1998). Site-specific uncertainties that are important for the interpretation of the calculated risk estimates for surface soil, and groundwater at Site 31 are discussed below.

- 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 31; however, these noncancer risks are not likely to be significant when compared to oral risks that are fully characterized.

- 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 or not 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 exceeding its screening criteria are antimony (Site 31C), Aroclor-1260 (Site 31C), arsenic (Site 31A), beryllium (Sites 31A, 31B, 31C, 31E and 31F), benzo(b)fluoranthene (Site 31C), benzo(k)fluoranthene (Site 31C), chlordane (Site 31C), dieldrin (Site 31C) in surface soil, and aluminum, methylene chloride, TCE, and vanadium in groundwater. However, because the laboratory equipment was able to detect below the SQL for all these chemicals, the SQLs were considered adequate for this HHRA.

- Some uncertainty is associated with the representativeness of the groundwater data used to complete the risk evaluation at Site 31. Generally, because the low-flow purging and sampling method was used, turbidity in the unfiltered groundwater samples was minimal. However, the analytical results for some of the unfiltered samples may be biased high for inorganic constituents as a result of suspended solids.



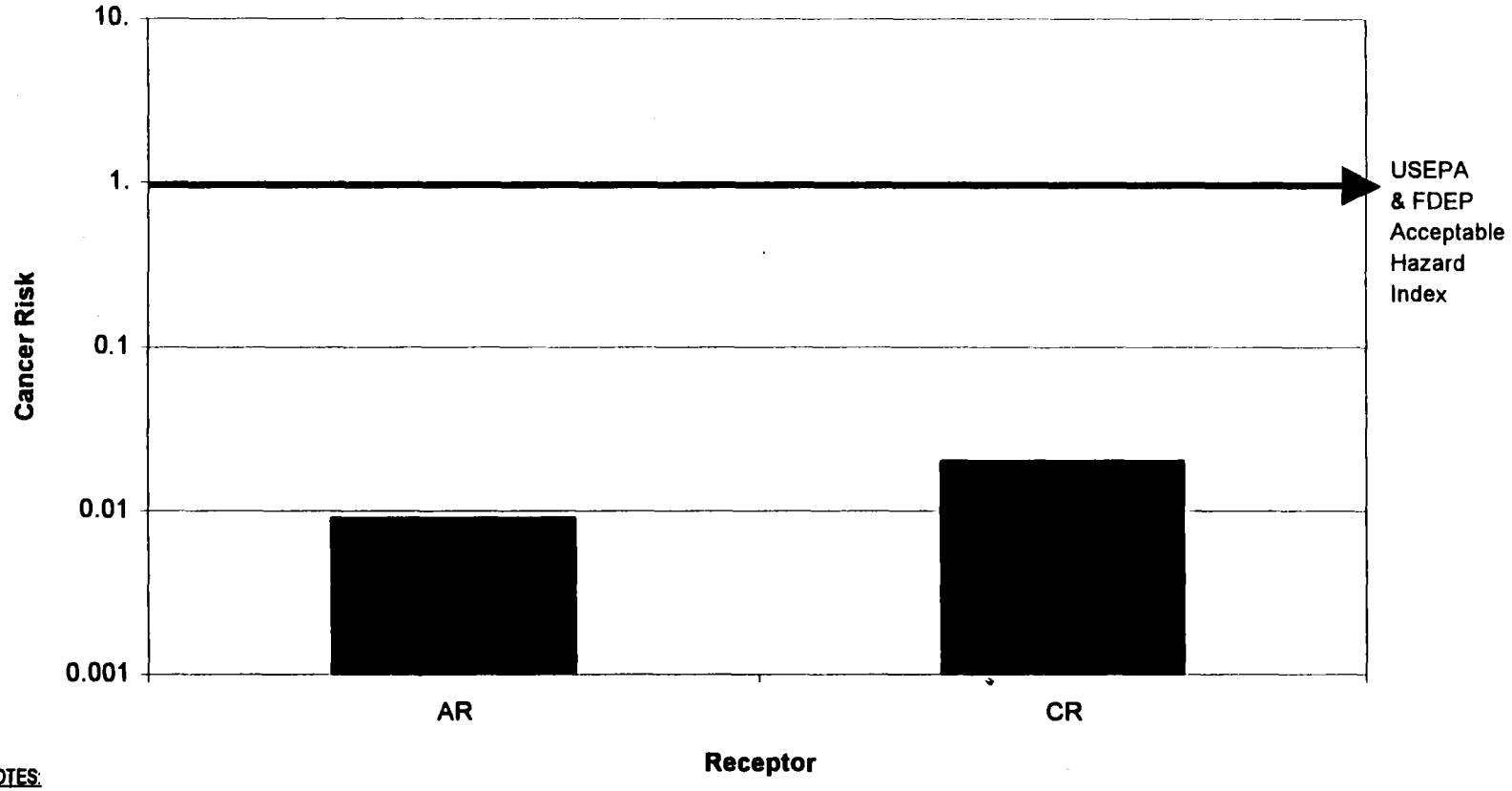
NOTES:
USEPA = U.S. Environmental Protection Agency
FDEP = Florida Department of Environmental Protection
TR = Total resident

FIGURE 6-8
CANCER RISK SUMMARY
FUTURE LAND USE FOR GROUNDWATER
AT SITE 31C

REMEDIAL INVESTIGATION REPORT
SITE 31, SLUDGE DRYING BEDS AND DISPOSAL AREAS

NAVAL AIR STATION WHITING FIELD
MILTON, FLORIDA

H:\HEID\WHITING\SITE31\FIG6-8 PM5 GW31b.XLS 050498HAS



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

FIGURE 6-9
NONCANCER RISK SUMMARY
FUTURE LAND USE FOR GROUNDWATER
AT SITE 31C

REMEDIAL INVESTIGATION REPORT
SITE 31, SLUDGE DRYING BEDS AND DISPOSAL AREAS

NAVAL AIR STATION WHITING FIELD
MILTON, FLORIDA

H:\HEID\WHITING\SITE31\FIG6-9 PM5 GW31b.XLS 050498HAS

- According to the methodology described in the GIR (HLA, 1998) (Paragraph 2.5.3.3), central tendency (CT) carcinogenic risk to hypothetical future receptors with risks exceeding Florida levels of concern was evaluated. The CT evaluation involved using the UCL of the mean concentration and reasonable but less conservative exposure parameters designed to provide a probable risk level (USEPA, 1995b).

  The hypothetical current and future trespassers, and occupational workers, as well as future residents carcinogenic risk exceeded the FDEP target of 1×10^{-6}. The CT carcinogenic risk results for hypothetical trespasser, future residential and occupational receptors and the CT exposure parameters are presented in Table F-42 through F-46 in Appendix F of this report. Only CT ingestion and dermal exposures were characterized, because the contribution from inhalation was insignificant compared to the total risk. The CT aggregate residential risk exposed to surface soil is 3×10^{-6}.

  The CT aggregate trespasser risk exposed to surface soil is 2×10^{-7}. The CT occupational worker risk exposed to surface soil is 6×10^{-7}.

  The risk range 3×10^{-6} to 2×10^{-5} presented by the reasonable maximum exposure (RME) and CT exposure scenarios for hypothetical future residential receptors are useful as information to provide perspective for the risk manager and compliance with Agency guidance (USEPA, 1995a).

6.7 REMEDIAL GOAL OPTIONS. Remedial goal option (RGOs) tables are presented for each medium with a total excess lifetime cancer risk (ELCR) greater than 1×10^{-6} (Florida target risk level) or an HI greater than 1. The RGO concentrations are calculated using the scenario representing the highest estimated risk for a given medium (USEPA, 1995b). 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 regulatory and FDEP risk-based criteria are intended to provide the basis for the development of remedial alternatives in the FS. The RGO values are not actual or proposed cleanup levels, but are provided to assist risk-management decision making in the FS.

Table 6-15 presents the RGOs for surface soil for Site 31C. RGOs are presented for Aroclor-1260, dieldrin, and beryllium based on cancer risks for the adult and child resident at Site 31C. Aroclor-1260, aluminum, cadmium, chromium, iron, mercury, and silver are presented based on noncancer risk. Arsenic and lead are presented because the maximum detected concentration exceeded the Florida soil cleanup goal for a residential scenario.

Table 6-16 presents the RGO for manganese because it exceeded the FDEP soil cleanup goal.

Table 6-15
Summary of Remedial Goal Options for Surface Soil at Site 31C

Remedial Investigation Report
Site 31, Sludge Drying Beds and Disposal Areas
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 Goal (Residential)[1]	Florida Soil Cleanup Goal (Leaching)[2]	Background Screening Concentration
			10^{-4}	10^{-5}	10^{-6}	3	1	0.1			
Pesticides and PCBs (μg/kg)											
Aroclor-1260	340 to 1,400	1,350	NR	NR	250	NR	NR	142	900	44,000	NA
Dieldrin	2.1 to 120	118	NR	NR	26.8	NA	NA	NA	70	20	NA
Inorganics (mg/kg)											
Aluminum	1,670 to 16,800	7,480	NA	NA	NA	NR	NR	7,480	75,000	NC	7,800
Arsenic	0.59 to 1.7	1.7	NA	NA	NA	NA	NA	NA	0.8	NC	3.2
Beryllium	0.3 to 1.3	0.63	NR	0.44	0.044	NA	NA	NA	0.2	NC	0.36
Cadmium	0.22 to 26.8	26.8	NA	NA	NA	NR	NR	4	37	NC	0.58
Chromium	1.4 to 295	295	NA	NA	NA	NR	NR	36	290	NC	11
Iron	645 to 22,500	9,410	NA	NA	NA	NR	NR	1,590	NSC	NC	8,632
Lead	1.8 to 1,890	1,890	NA	NA	NA	NA	NA	NA	500	NC	11.4
Mercury	0.13 to 8.8	8.8	NA	NA	NA	NR	NR	2.3	23	NC	0.12
Silver	0.97 to 154	154	NA	NA	NA	NR	NR	38	390	NC	0.7

[1] Values are for residential soil, from Florida Department of Environmental Protection memoranda entitled Soil Cleanup Goals for Florida, dated September 29, 1995, and Applicability of Soil Cleanup Goals for Florida, dated January 19, 1996.
[2] Values are from the Florida Department of Environmental Protection memorandum entitled Soil Cleanup Goals for Florida, dated September 29, 1995.

Notes: PCB = polychlorinated biphenyl.
μg/kg = micrograms per kilogram.
NR = not reported because the calculated remedial goal option exceeds the exposure point concentration.
NA = not applicable.
mg/kg = milligrams per kilograms.
NC = not calculated.
NSC = no screening concentration available.

Table 6-16
Summary of Remedial Goal Options for Surface Soil at Sites 31E and 31F

Remedial Investigation Report
Site 31, Sludge Drying Beds and Disposal Areas
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 Goal (Residential)[1]	Florida Soil Cleanup Goal (Leaching)[2]	Background Screening Concentration
			10^{-4}	10^{-5}	10^{-6}	3	1	0.1			
Inorganic Analytes (mg/kg)											
Manganese	60.3 to 456	376	NA	NA	NA	NR	NR	290	370	NC	392

[1] Values are for residential soil, from Florida Department of Environmental Protection memoranda entitled Soil Cleanup Goals for Florida, dated September 29, 1995, and Applicability of Soil Cleanup Goals for Florida, dated January 19, 1996.
[2] Values are from the Florida Department of Environmental Protection memorandum entitled Soil Cleanup Goals for Florida, dated September 29, 1995.

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

6.8 SUMMARY OF HHRA FOR SITE 31. HHCPCs were identified and risks were estimated for surface soil and groundwater associated with Site 31. The following conclusions were drawn based on this HHRA:

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

- The groundwater risks levels are below both the USEPA target cancer risk range and the FDEP target level of concern.

- Noncancer risk levels for groundwater meet the USEPA and FDEP target HI of one.

- The total ELCR at Site 31C, associated with ingestion of soil by a hypothetical future resident, current and hypothetical future trespasser, and hypothetical future occupational worker exceeded Florida's target risk level of concern 1×10^{-6} due primarily to Aroclor-1260, dieldrin, arsenic, and beryllium.

- The CT risks to a hypothetical future trespasser and occupational worker were below the Florida level of concern (1×10^{-6}) for Site 31C. CT and RME residential risks provide the risk managers and decision makers with a perspective of the true hypothetical risk range to future residents.

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 31, the Sludge Drying Beds and Disposal Areas, at NAS Whiting Field. Site 31 includes the Sludge Drying Beds (Site 31A) and five additional disposal areas (Sites 31B, 31C, 31D, 31E, and 31F) located along the South Field Perimeter Road. The ERA for Site 31 follows the methodologies described in the NAS Whiting Field GIR (HLA, 1998), and current guidance materials for ERAs at Superfund sites including the following:

- *Risk Assessment Guidance for Superfund Environmental Evaluation Manual* (USEPA, 1989d)
- *Ecological Assessment of Hazardous Waste Sites: A Field and Laboratory Reference* (USEPA, 1989c)
- *Framework for Ecological Risk Assessment* (USEPA, 1992b)
- *Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments* (USEPA, 1997c)
- *Supplemental Guidance to RAGS: Region 4 Bulletins, Ecological Risk Assessment* (USEPA, 1995a)
- *Proposed Guidelines for Ecological Risk Assessment* (USEPA, 1996c)

Additional risk assessment guidance included in the ERA are the USEPA "ECO Update" bulletins (1991d, 1992e, and 1992f) and recent publications (e.g., Maughan, 1993; Suter, 1993).

This ERA was conducted to determine if ecological receptors are potentially exposed to contaminants from Site 31 at concentrations that could cause adverse ecological effects. The Site 31 ERA consists of the following eight sections:

- Site Characterization (Section 7.1) describes current ecological conditions at the sites,
- 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 Ecological Chemicals of Potential Concern (ECPCs) (Section 7.3) reviews the analytical data and identifies chemicals present at the sites 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 likelihood estimate of adverse effects,

- Uncertainty Section (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. As previously mentioned, NAS Whiting Field Site 31 encompasses six separate areas including Site 31A, the Sludge Drying Beds, and Sites 31B through 31F where sludge material from the wastewater treatment plant was disposed of. Table 2-1 summarizes the Site 31 designations and their locations. Liquid sludge was dried at Site 31A from the 1940s until 1990. Dried sludge was transported and spread at Sites 31B, 31C, and 31D. Also, liquid sludge was periodically sprayed from tanker truck over areas of Sites 31B, 31C, 31D, 31E, and 31F. A description of each of the Site 31 areas is provided below.

Site 31A is a sludge drying bed unit located near the wastewater treatment plant (Figure 2-1). The unit, which is approximately 0.2 acres in size (92 feet long by 80 feet wide), consists of four sludge drying beds surrounded by containment walls 2.5 to 3.0 feet high. Each sludge drying bed contains a cover of coarse-grained sand and fine gravel mixture. Wet sludge from the wastewater treatment plant was placed in the sludge drying beds. In addition to the municipal waste, anecdotal reports indicate that the sludge may have contained hazardous substances, such as methylene chloride and heavy metals. Dried sludge from Site 31 was periodically hauled to Sites 31B, 31C, and 31D for disposal. The sludge drying beds (Site 31A) were last used in 1990. As shown on Figure 7-1, the area surrounding Site 31A is characterized as maintained field.

Sites 31B, 31C, and 31D are located on the southwestern slopes of the South Field Runway (Figure 2-2). Because these areas are adjacent to the runway, the slopes have been contoured with surface water retention berms to reduce soil erosion, and the grasses are periodically mowed to a height of 6 to 8 inches. Besides dried sludge received from Site 31A, these areas also received liquid sludge sprayed from tanker trucks. As shown on Figure 7-2, all three areas are characterized as maintained field. Only Site 31C contains areas of stressed vegetation, primarily in the southern and central portions of the site. These areas of stressed vegetation were observed by HLA ecologists during a 1995 site characterization of NAS Whiting Field and are discussed in the GIR (HLA, 1998).

Site 31C is located southwest of South Field Runway just east of the man-made "W" drainage ditch (Figure 2-2). Although Site 31C is located in close proximity to the ditch, overland transport of surface water runoff from the site to the ditch is not expected because the surface slopes to the southwest. Overland transport of surface water runoff toward Clear Creek, (located 2000 feet to the southwest) is possible; however, most of the on-site rainfall infiltrates directly into the soil due to the silty sand at the site.

Sites 31E and 31F are located northeast of Runway 4 along the eastern boundary of NAS Whiting Field. Liquid sludge from the wastewater treatment plant was sprayed on the east (Site 31F) and west (Site 31E) sides of Perimeter Road (Figure 2-3). The exact location and coverage of the disposal area are unknown;

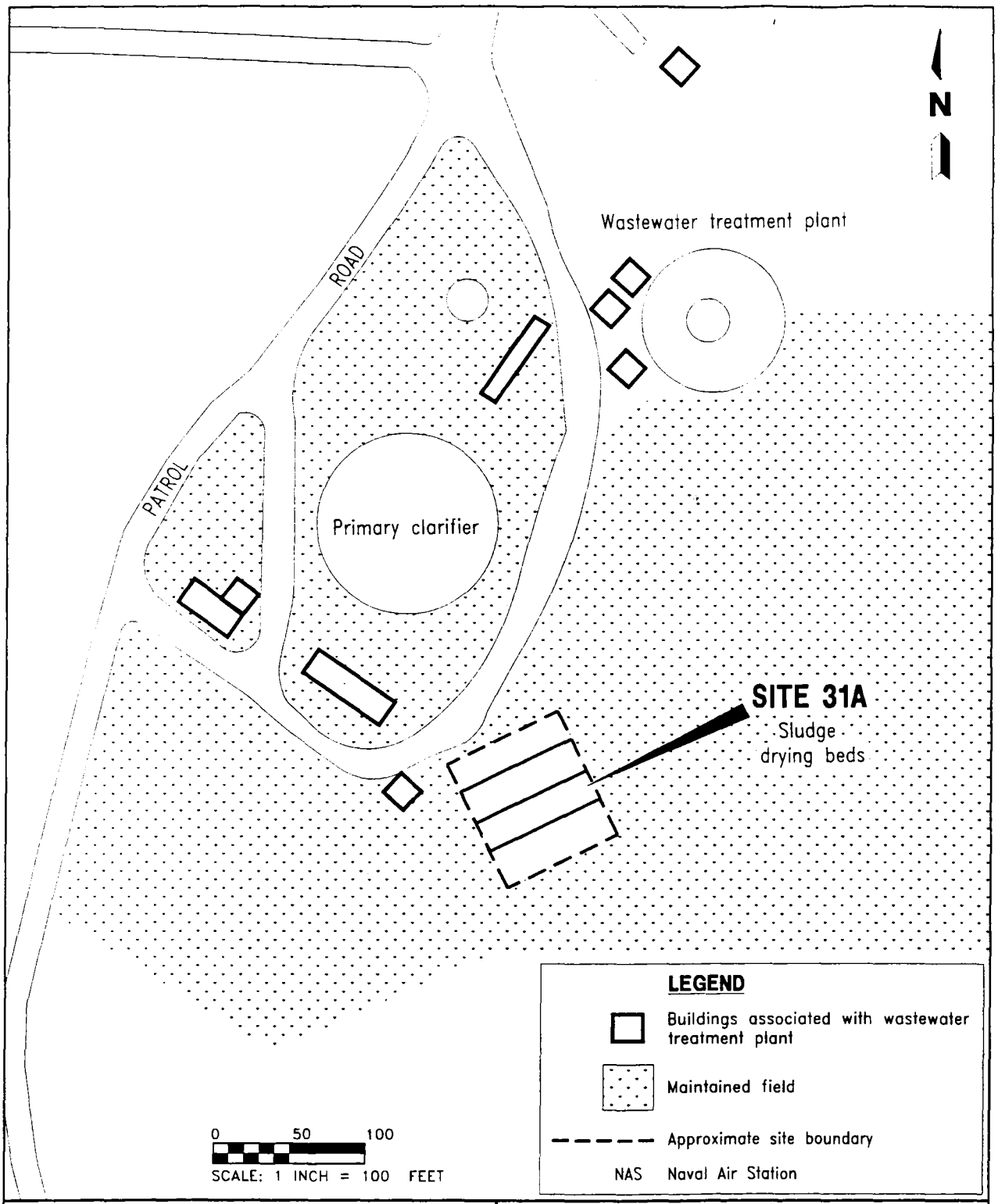


FIGURE 7-1
SITE 31A, SLUDGE DRYING BEDS, VEGETATIVE COVER MAP

REMEDIAL INVESTIGATION REPORT
SITE 31, SLUDGE DRYING BEDS AND DISPOSAL AREAS

NAS WHITING FIELD
MILTON, FLORIDA

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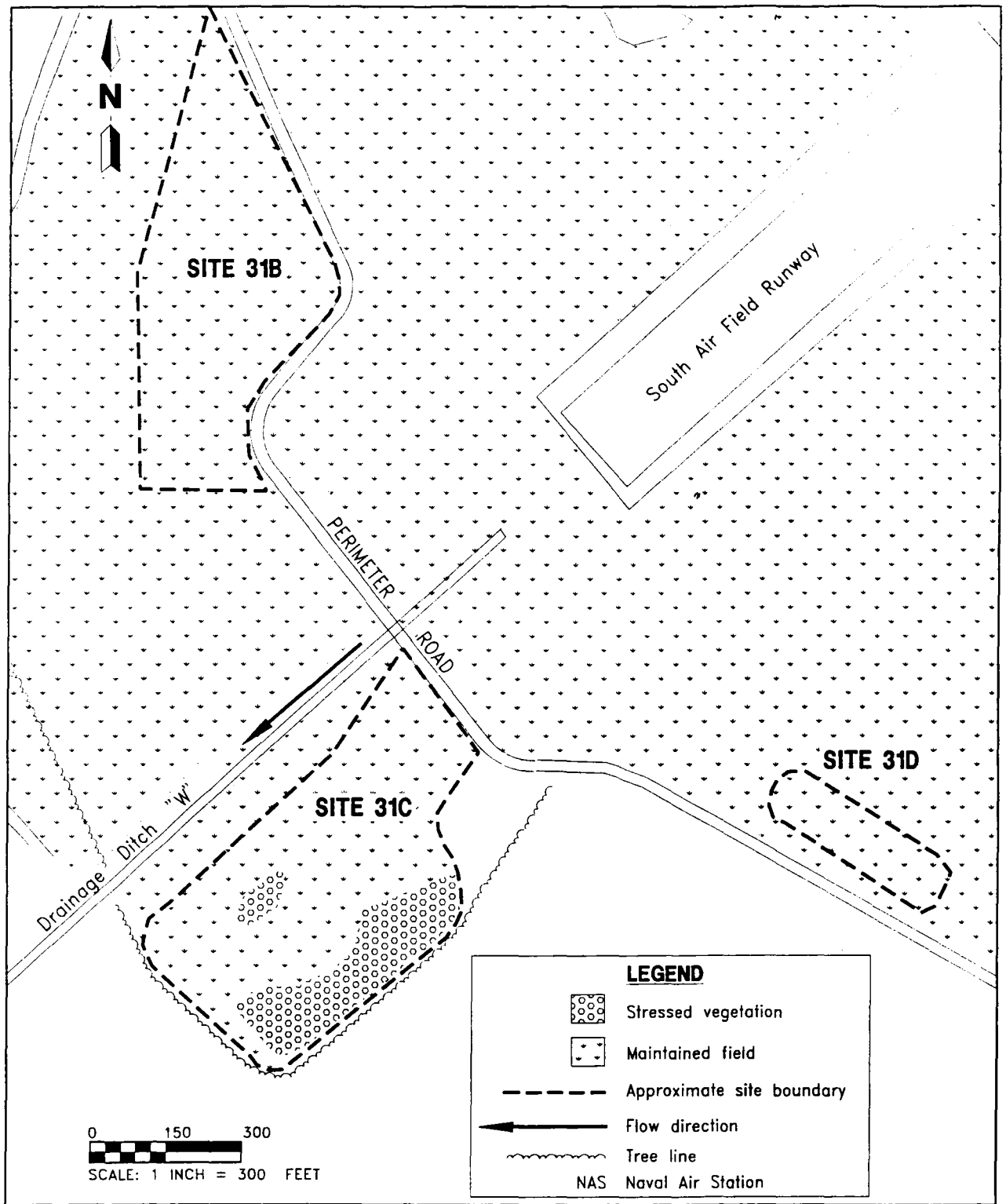

FIGURE 7-2
SITES 31B, 31C, AND 31D
VEGETATIVE COVER MAP

REMEDIAL INVESTIGATION REPORT
SITE 31, SLUDGE DRYING BEDS
AND DISPOSAL AREAS

NAS WHITING FIELD
MILTON, FLORIDA

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however, the total area of Sites 31E and 31F is estimated at 13.8 acres. As shown on Figure 7-3, Sites 31E and 31F are characterized as maintained field.

As shown in the vegetative cover maps for Sites 31B through 31F (Figures 7-2 and 7-3), each site consists primarily of maintained areas. The regular mowing of the grass at the sites prevents ecological succession of vegetative communities; however, the following herbaceous species were observed during the 1995 site characterization: buttermint (*Hyptis mutabilis*), morning glory (*Ipomoea cordatotriloba*), lantana (*lantana* sp.), mimosa (*Mimosa strigillosa*), cut-leaf evening primrose (*Oenothera laciniata*), prickly-pear catcus (*Opuntia* sp.), yellow wood sorrel (*Oxalis sticta*), goldenaster (*Pityopsis graminifolia*), southern plantain (*Plantago virginica*), rustweed (*Polypremum procumbens*), ragweed (*Ambrosia* sp.), broomsedge (*Andropogon* sp.), silvery aster (*Aster concolor*), partridge pea (*Chamaecrista fasciculata*), goldenaster (*Chrysopsis* sp.), rattlebox (*Crotalaria lanceolata*), dog fennel (*Eupatorium capillifolium*), pineweed (*Hypericum gentianoides*), Mexican clover (*Richardia brasiliensis*), blackberry vine (*Rubus* sp.), and greenbrier (*Smilax* sp.). A complete list of the vegetative species occurring at Sites 31B through F is provided in Appendix G of the GIR (HLA, 1998). No plants were observed at in the sludge drying beds of Site 31A.

As previously mentioned, the only ecological community at Site 31 is mowed grass. Given the limited cover provided by the maintained fields and the site's proximity to the south field taxiway, Perimeter Road, and the wastewater treatment plant, the occurrence of ecological receptors foraging in these areas is expected to be minimal. Large predatory mammals (e.g., foxes, owls, and hawks) are not expected to occur in the vicinity of the sites; however, small mammals and birds may be found foraging at the sites.

With the exception of a gopher tortoise burrow, which was found near Site 31E, no evidence of terrestrial wildlife including mammals and birds was observed during the 1995 site characterization. Small mammals and birds that may occur in the maintained grassy areas of Site 31 include the eastern cottontail rabbit (*Sylvilagus floridanus*), the hispid cotton rat (*Sigmodon hispidus*), cotton mouse (*Peromyscus gossypinus*), short-tailed shrew (*Blarina brevicauda*), American robin (*Turdus migratorius*), eastern meadowlark (*Sturnella magna*), and the mourning dove (*Zenaida macroura*).

Although no aquatic habitat is present at any of the Site 31 areas, groundwater from Sites 31A, 31B, 31C, and 31D may discharge off site into Clear Creek, while groundwater from Sites 31E and 31F may discharge off site into Big Coldwater Creek. Groundwater discharge to surface water is not evaluated as part of the ERA for Site 31 because both Clear Creek and Big Coldwater Creek receive groundwater discharge and storm water runoff from multiple sources of potential contamination at NAS Whiting Field. In addition, groundwater data are available only for Site 31C. Detected concentrations of contaminants in Site 31C groundwater are low enough that they are not a concern for current and future discharges to surface water. Except for methylene chloride (1 $\mu g/\ell$) and trichloroethene (2 $\mu g/\ell$) (both chemicals were detected only once), no other organic constituent was detected in groundwater. Also, most of the inorganic constituents were detected at concentrations below the background screening values. Background screening values are equal to twice the average detected inorganic concentration in background samples and are presented in Section 3.3 of the GIR (HLA, 1998).

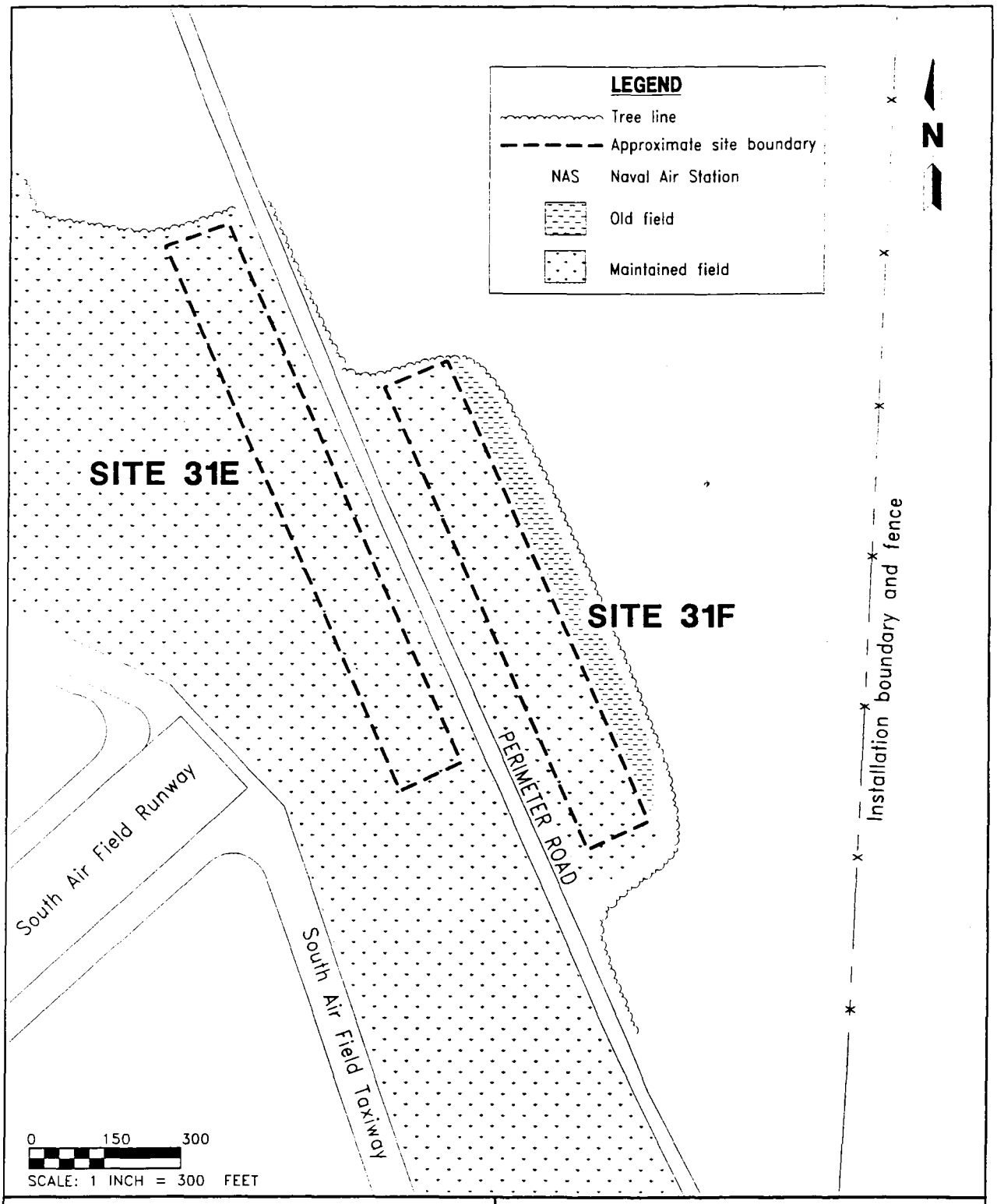

FIGURE 7-3
SITES 31E AND 31F, VEGETATIVE COVER MAP

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REMEDIAL INVESTIGATION REPORT
SITE 31, SLUDGE DRYING BEDS AND DISPOSAL AREAS

NAS WHITING FIELD
MILTON, FLORIDA

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

7.2.1 Identification of Receptors Ecological receptors potentially utilizing the available maintained grassy field habitat at Site 31 include terrestrial wildlife (i.e., mammals, birds, reptiles, and adult amphibians), terrestrial plants, and invertebrates. Terrestrial flora and fauna potentially using NAS Whiting Field are identified in the GIR (HLA, 1998). Aquatic receptors are not evaluated in the ERA because no aquatic habitats exist at Site 31.

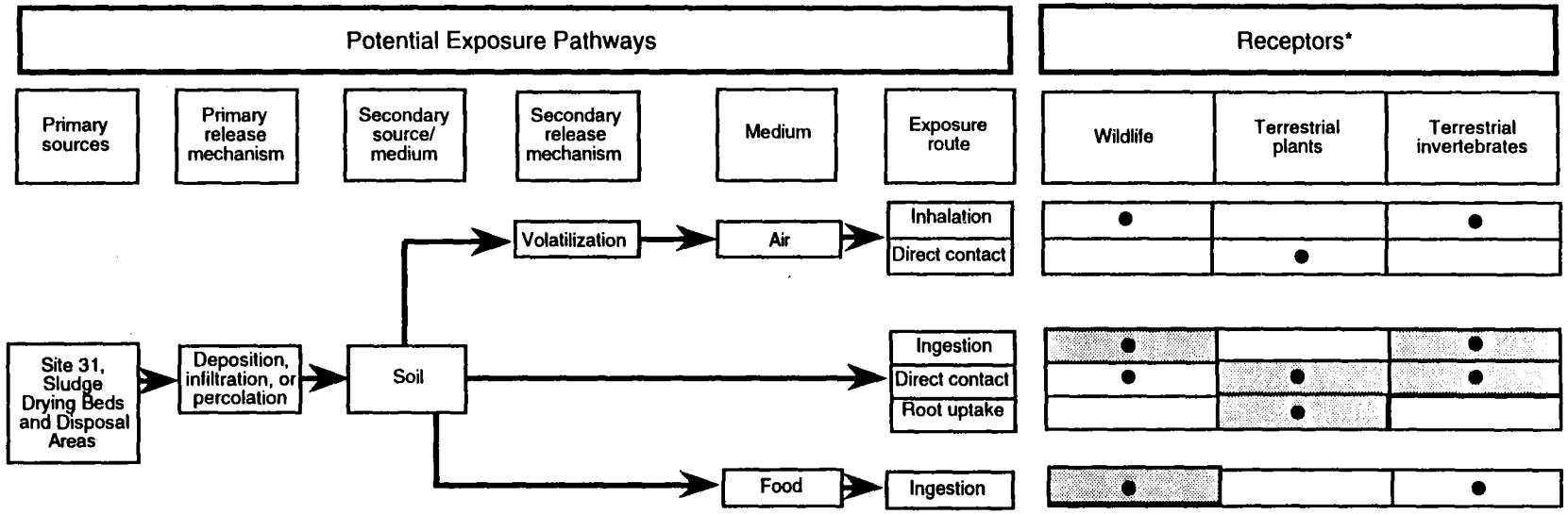
Certain species potentially residing at NAS Whiting Field are protected by Federal and/or State laws. A list of state and federally protected species is provided in the GIR (HLA, 1998). During the 1995 site characterization of Site 31, a gopher tortoise burrow was observed at Site 31E. These observations were confirmed during an ecological survey of NAS Whiting Field (Nature Conservency, 1997). The gopher tortoise is the only state or federally listed rare, threatened, or endangered species or species of concern known or likely to inhabit Site 31.

7.2.2 Identification of Exposure Pathways Exposure pathways are identified for three groups of receptors (terrestrial wildlife, terrestrial plants, and soil invertebrates). 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 7-4.

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 quantitatively evaluated and those qualitatively discussed. This limitation is necessary to focus the risk evaluation on those pathways with the highest contaminant exposures or the pathways 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 three groups of receptors is explained below.

Terrestrial Wildlife. Terrestrial wildlife is potentially exposed to contaminants in surface soil and food items contaminated as a result of ingestion, dermal adsorption, and inhalation of fugitive dust and volatile emissions. Because surface water is not present at Site 31, only terrestrial wildlife exposures associated with ingestion of surface soil and potentially contaminated foods are evaluated in the Site 31 ERA.

Dermal adsorption is considered a negligible exposure pathway because the presence of fur, feathers, or 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 potentially ingested during grooming or preening activities and is evaluated during the ERA as part of the direct ingestion exposure pathway.



NOTES:
NAS = Naval Air Station
ERA = ecological risk assessment

* Shading indicates the exposure pathways that are quantitatively evaluated for receptors in Site 31 ERA. Nonshaded pathways are evaluated qualitatively. They were not evaluated quantitatively due to the lack of toxicity information or because they were not considered a significant pathway.

FIGURE 7-4
CONTAMINANT PATHWAY MODEL FOR SITE 31 ECOLOGICAL RECEPTORS

REMEDIAL INVESTIGATION REPORT SITE 31, SLUDGE DRYING BEDS AND DISPOSAL AREAS

NAS WHITING FIELD
MILTON, FLORIDA

2534-09 SITE31 FIG 7-4 FINAL 061898HAS

Exposure via inhalation of fugitive dust is also not likely to be a significant exposure pathway because the vegetation at Site 31 would limit the release of fugitive dust. Although volatile constituents were detected in the surface soil of Site 31, exposures associated with VOCs are not evaluated in the ERA because of the low frequency and concentration detected in the surface soil.

Potential contaminant exposures for reptiles and adult amphibians exist at NAS Whiting Field; however, ingestion toxicity data and bioaccumulation factors (BAFs) are generally not available for these receptors. Therefore, potential risks associated with ingestion of affected surface soil and food items to reptiles and amphibians will be qualitatively addressed in the Uncertainties Section (Section 7.7) of the ERA.

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 31 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 75 to 100 feet bls, well below the root zone of Site 31 plants, it is unlikely that terrestrial plants will be exposed to potential groundwater contamination.

7.2.3 Identification of Endpoints. The assessment and measurement endpoints selected for the Site 31 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 31 ERA is survival and maintenance of receptor populations and communities at Site 31. The measurement endpoints used to gauge the likelihood of terrestrial wildlife population- and community-level effects for Sites 31A through 31F are chemical-specific toxicological benchmark values. These benchmark values are obtained from the literature and are based on laboratory-measured survival, growth, and reproductive effects. For terrestrial plants and invertebrates at Sites 31A, 31B, 31D, 31E, and 31F, the assessment endpoints are benchmark values derived from the literature. For terrestrial plants and invertebrates at Site 31C, the assessment endpoints are based on the survival and growth of earthworms *(Eisenia foetida)* and germination rates of lettuce seeds (*Lactuca sativa)* in tests using surface soil samples from Site 31C. Table 7-1 presents the assessment endpoint, endpoint species, measurement endpoint, and decision point (i.e., the level at which additional evaluation is warranted).

Four hypotheses were developed to gauge potential risks associated with exposure to Site 31 surface soil. These hypotheses are designed for multiple species and trophic levels and represent both individual and community dynamics. Hypotheses for the Site 31 ERA are listed below.

1. Are ECPCs present in the surface soil at concentrations sufficiently high as to reduce plant or soil invertebrate biomass or plant cover availability such that small mammal and bird populations could be affected?

Table 7-1
Endpoints Selected for Site 31 Ecological Risk Assessment

Remedial Investigation Report
Site 31, Sludge Drying Beds and Disposal Areas
Naval Air Station Whiting Field
Milton, Florida

Assessment Endpoint	Receptor	Measurement Endpoint	Decision Point
• Reduction in the biomass of terrestrial plants used as forage material.	Terrestrial plants	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.
• Survival and growth of plant communities.		Germination of lettuce seeds exposed to surface soil samples from Site 31C in laboratory toxicity tests.	Significant differences ($p \geq 0.05$) in germination of lettuce seeds exposed to Site 31C surface soil samples as compared to control samples.
• Reduction in the abundance of earthworms used as forage material.	Terrestrial invertebrates	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 growth of terrestrial invertebrate communities.		Survival and growth of earthworms exposed to surface soil samples from Site 31C in laboratory toxicity tests.	Significant differences ($p \geq 0.05$) in survival and/or growth of earthworms exposed to Site 31C surface soil samples as compared to control samples.
• 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.

Notes:
mg/kg = milligrams per kilogram.
ECPC = ecological chemical of potential concern.
RTV = relative toxicity value.
p = probability.
≥ = greater than or equal to.
LC_{50} = lethal concentration to 50 percent of a test population.
BW/day = body weight per day.
NOAEL = no observable 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.

2. Are ECPCs present in the surface soil at concentrations sufficiently high as to reduce the survivability and growth of terrestrial plants and soil invertebrates?

3. Are ECPC concentrations in plants and invertebrates sufficiently high as to adversely affect foraging by small mammal or bird populations following consumption of contaminated prey?

4. Are bioaccumulating chemicals sufficiently high as to reduce survivability, growth, or reproduction in top predators (i.e., foxes and owls)?

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) that are considered in the ERA and could present a potential risk for ecological receptors. The process for selecting ECPCs is depicted on Figure 7-5. Additional details regarding the ECPC selection process are provided in Subsection 2.4.2 of the GIR (HLA, 1998). Analytical data for Site 31 were evaluated for use in risk assessment pursuant to national guidance, *Guidance for Data Useability in Risk Assessment (Parts A and B)* (USEPA, 1992c).

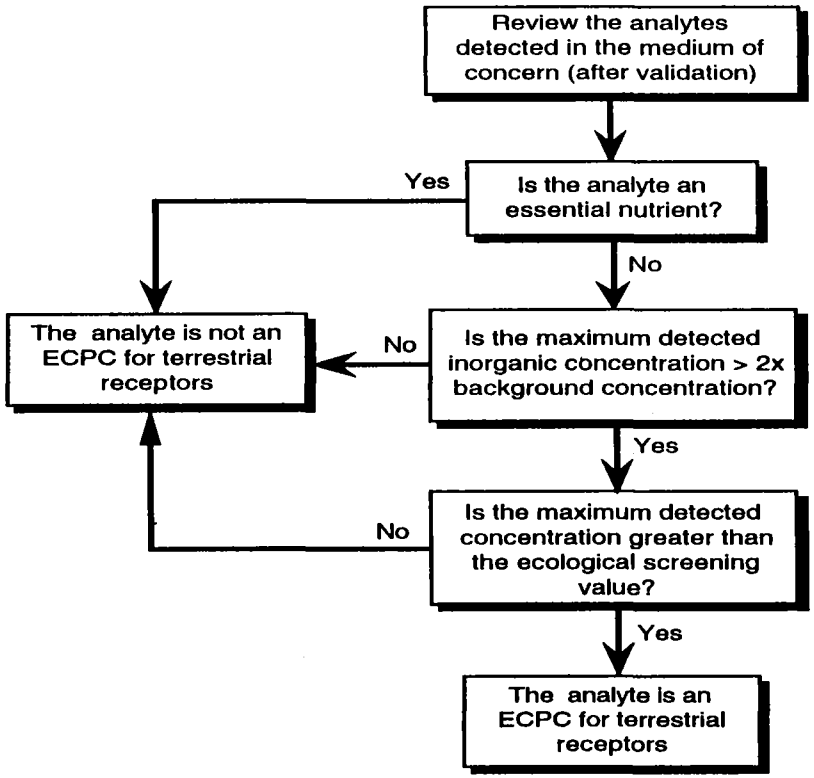
Due to similarities in the ecological habitat, disposal practices, and proximity of the sites, the surface soil analytical data for several of the Site 31 areas were combined to create a single data set. Analytical data from Sites 31B and 31D and Sites 31E and 31F were combined for the ERA. Analytical data from Sites 31A and 31C were evaluated individually because of differences in the types and concentrations of detected constituents and habitat types (i.e., Site 31A is the Sludge Drying Bed Area and Site 31C contains areas of stressed vegetation). In summary, ecological risks were evaluated for the following four areas:

- Site 31A,
- Sites 31B and 31D,
- Site 31C, and
- Sites 31E and 31F.

Calcium, iron, magnesium, potassium, and sodium were excluded as ECPCs for surface soil. These analytes are considered essential nutrients and not toxic. The rationale for eliminating essential nutrients as ECPCs is provided in the GIR (HLA, 1998).

Inorganic chemicals representative of background conditions are not selected as ECPCs. In accordance with USEPA Region IV guidance (USEPA, 1991c), an inorganic analyte is not selected as an ECPC if the maximum detected concentration is less than twice the average detected inorganic concentration in background samples. Background screening consists of comparing the maximum detected concentration for each analyte detected at the site against a representative site-specific background surface soil concentration (twice the average background concentration).

A site-specific background investigation of surface soil was conducted at NAS Whiting Field, and the findings are presented in Subsections 3.3.1 and 3.3.3 of the GIR, respectively (HLA, 1998). The site-specific background study used



NOTES:
ECPC = ecological chemical of potential concern
> = greater than
x = times

FIGURE 7-5
ECOLOGICAL CHEMICAL OF POTENTIAL CONCERN SELECTION PROCESS

REMEDIAL INVESTIGATION REPORT SITE 31, SLUDGE DRYING BEDS AND DISPOSAL AREAS

NAVAL AIR STATION WHITING FIELD MILTON, FLORIDA

2534-09 WHITING RI 31 FIG 7-5 FINAL 061798MAW

to establish background screening values for Site 31 surface soil consists of eight surface soil samples (BKG-SL-02, BKG-SL-06, BKG-SL-07, BKG-SL-08, BKS00101, BKS00201, BKS00401, and BKS00501) and one duplicate sample (BKS00201D) collected from the Troup Loamy Sand soil type. Background soil at Site 31B and 31D included one additional sample (BKS00301) from an area containing Dothan/Lucy/-Bonifay soil types, which are also present at Site 31B.

Analytes that exceed background screening concentrations and are not essential nutrients are also screened against ecological screening values for surface soil. The surface soil ecological screening values used in the ERA are the Dutch Soil Criteria "A", which refer to background concentrations in surface soil issued by the U.S. Fish and Wildlife Service (Beyer, 1990). 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.

Tables 7-2 through 7-5 present a summary of the respective surface soil analytical data for Site 31A, Sites 31B and 31D, Site 31C, and Sites 31E and 31F and include 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 UCLs (if 10 or more samples were collected), and selected ECPCs.

7.3.1 Site 31A Eight samples (31-SL-17 through 31-SL-24) were collected from the sludge drying beds at Site 31A (see Figure 3-1). As shown in Table 7-2, only one inorganic constituent (silver) was selected as an ECPC for Site 31A.

7.3.2 Sites 31B and 31D A total of eight samples (31-SL-09, 31-SL-10, 31-SL-11, 31-SL-16, 31S00101, 31S00201, 31S00301, and 31S01401) was collected at Sites 31B and 31D (see Figure 3-2). As shown in Table 7-3, only one inorganic constituent (silver) was selected as an ECPC for Sites 31B and 31D.

7.3.3 Site 31C Fourteen samples (31-SL-12 through 31-SL-15 and 31SS00401 through 31S01301) were collected at Site 31C (see Figure 3-3). Table 7-4 presents the ECPCs selected for the surface soil samples collected at Site 31C. ECPCs for Site 31C include three VOCs (acetone, carbon disulfide, and methylene chloride), four SVOCs (benzo(b)fluoranthene, benzo(k)fluoranthene, butylbenzyl-phthalate, and bis(2-ethylhexyl)phthalate), three pesticides and PCBs (Aroclor-1260, dieldrin, and 4,4'-DDE), and twelve inorganic constituents (aluminum, barium, beryllium, cadmium, chromium, copper, cyanide, lead, mercury, selenium, silver, and zinc).

7.3.4 Sites 31E and 31F A total of thirteen samples (31-SL-01 through 31-SL-08 and 31S01501 through 31S01901) was collected at Sites 31F and 31F (see Figure 3-4). Table 7-5 presents the ECPCs selected for the surface soil samples collected at Site 31E and 31F. ECPCs for Sites 31E and 31F include two VOCs (2-hexanone and carbon disulfide), two SVOCs (di-*n*-octylphthalate and bis(2-ethylhexyl)phtha-late), and three inorganic constituents (manganese, selenium, and silver).

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

Table 7-2
Selection of Ecological Chemicals of Potential Concern for Surface Soil Associated with Site 31A

Remedial Investigation Report
Site 31, Sludge Drying Beds and Disposal Areas
Naval Air Station Whiting Field
Milton, Florida

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]	Average of All Samples[7]	Exposure Point Concentration	
									RME[8]	CT[9]
Volatiles Organic Compounds (μg/kg)										
1,1-Dichloroethene	1/8	5	2.25*	2.3	ND	100	No[10]			
Benzene	1/8	5	1.75*	1.8	ND	100	No[10]			
Chlorobenzene	1/8	5	1.75*	1.8	ND	50	No[10]			
Toluene	1/8	5	2.25*	2.3	ND	50	No[10]			
Trichloroethene	1/8	5	2.25*	2.3	ND	100	No[10]			
Xylenes (total)	6/8	5	1 to 6	3	ND	50	No[10]			
Pesticides and PCBs (μg/kg)										
4,4-DDD	1/8	16 to 17	1.6	1.6	ND	100	No[10]			
4,4-DDE	1/8	16 to 17	3.2	3.2	ND	100	No[10]			
Dieldrin	1/8	16 to 17	1.3	1.3	ND	100	No[10]			
alpha-Chlordane	2/8	82 to 84	1.7 to 1.9	1.8	ND	100	No[10]			
gamma-Chlordane	2/8	82 to 84	2.3 to 4	3.2	ND	100	No[10]			
Inorganic Analytes (mg/kg)										
Aluminum	8/8	40	154 to 307	242	15,848	NA	No[11]			
Barium	8/8	40	1.2 to 4.95*	2.8	23.2	200	No[10,11]			
Calcium	7/8	109.15 to 1,000	68 to 135	84.8	396	NA	No[11,12]			
Chromium	7/8	1.95 to 2	0.75 to 2.2	1.4	11	100	No[10,11]			
Copper	8/8	4.7 to 5	3.1 to 7	4.9	9.4	50	No[10,11]			
Iron	8/8	20	284 to 576	495	8,832	NA	No[11,12]			
Lead	7/8	1 to 5.8	2.7 to 10.8	5.7	11.4	50	No[10]			

See notes at end of table.

Table 7-2 (Continued)
Selection of Ecological Chemicals of Potential Concern for Surface Soil Associated with Site 31A

Remedial Investigation Report
Site 31, Sludge Drying Beds and Disposal Areas
Naval Air Station Whiting Field
Milton, Florida

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]	Average of All Samples[7]	Exposure Point Concentration	
									RME[8]	CT[9]
Inorganic Analytes (mg/kg) (Continued)										
Magnesium	7/8	10 to 1,000	13.2 to 17	14.5	268	NA	No[11,12]			
Manganese	8/8	3	0.92* to 2.6	1.6	392	NA	No[11]			
Mercury	1/8	0.04 to 0.1	0.14	0.14	0.12	0.5	No[10]			
Nickel	1/8	2.2 to 8	6	6	7.2	50	No[10,11]			
Silver	7/8	0.74 to 2	0.39 to 1.3	0.85	0.7	NA	Yes	0.79	1.3	0.79
Sodium	7/8	149 to 1,000	123 to 189	149	406	NA	No[11,12]			
Thallium	1/8	0.33 to 2	0.36	0.36	1.16	NA	No[11]			
Vanadium	6/8	0.27 to 10	0.33 to 1	0.53	21.8	NA	No[11]			
Zinc	7/8	4 to 6.15	4.3 to 27.1	8.9	15.4	200	No[10]			

[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 ecological chemicals of potential concern).
[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.
[7] The average of all samples assigns a value of one-half of the detection limit as a surrogate concentration for nondetect values.
[8] The RME exposure point concentration (EPC) is equal to the maximum detected concentration.
[9] The CT EPC is equal to the lesser of the average of all samples or the reasonable maximum EPC.
[10] The maximum detected concentration is less than the ecological screening value.
[11] The maximum detected concentration is less than the background screening concentration.
[12] The analyte is an essential nutrient and not considered toxic.
(Notes continued on following page.)

Table 7-2 (Continued)
Selection of Ecological Chemicals of Potential Concern
for Surface Soil Associated with Site 31A

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Site 31, Sludge Drying Beds and Disposal Areas
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Notes: Samples: 31-SL-17, 31-SL-18, 31-SL-19, 31-SL-20, 31-SL-21, 31-SL-22, 31-SL-23, and 31-SL-24.
Duplicate samples: 31-SL-22A
Background samples: BKG-SL-02, BKG-SL-06, BKG-SL-07, BKG-SL-08, BKS00101, BKS00201, BKS00401, and BKS00501.
Background duplicate samples: BKS00201D.

RME = reasonable maximum exposure.
CT = central tendency
μg/kg = micrograms per kilogram.
* = average of a sample and its duplicate.
ND = not detected in any background sample.
PCB = polychlorinated biphenyl.
DDD = dichlorodiphenyldichloroethane.
DDE = dichlorodiphenyldichloroethene.
mg/kg = milligrams per kilogram.
NA = not available.

Table 7-3
Selection of Ecological Chemicals of Potential Concern for Surface Soil Associated with Sites 31B and 31D

Remedial Investigation Report
Site 31, Sludge Drying Beds and Disposal Areas
Naval Air Station Whiting Field
Milton, Florida

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]	Average of All Samples[7]	Exposure Point Concentration	
									RME[8]	CT[9]
Volatile Organic Compounds (µg/kg)										
Xylenes (total)	3/8	5 to 11	2 to 4	3	ND	50	No[10]			
Pesticides and PCBs (µg/kg)										
4,4-DDD	1/8	3.6 to 35	4.9	4.9	ND	100	No[10]			
4,4-DDT	1/8	3.6 to 35	10	10	ND	100	No[10]			
Inorganic Analytes (mg/kg)										
Aluminum	8/8	40	4,360 to 10,900	7,478	15,334	NA	No[11]			
Arsenic	8/8	2	0.66 to 2.3	1.3	3.1	20	No[10,11]			
Barium	8/8	40	4.6 to 16.8	9.7	23.7	200	No[10,11]			
Beryllium	4/8	1	0.07 to 0.15	0.1	0.36	NA	No[11]			
Calcium	8/8	1,000	43.2 to 354	222	404	NA	No[11,12]			
Chromium	8/8	2	3.6 to 8.9	5.7	10.7	100	No[10,11]			
Cobalt	5/8	0.34 to 10	0.67 to 1.2	0.87	2.87	20	No[10,11]			
Copper	4/8	5	3.7 to 13.1	6.7	9.4	50	No[10]			
Iron	8/8	20	2,590 to 6,290	4,019	8,588	NA	No[11,12]			
Lead	8/8	0.6 to 1	2.9 to 7.1	4.2	11.5	50	No[10,11]			
Magnesium	8/8	1,000	86.6 to 250	146	258	NA	No[11,12]			
Manganese	8/8	3	33.1 to 250	148	403	NA	No[11]			
Mercury	6/8	0.05 to 0.1	0.01 to 0.37	0.09	0.12	0.5	No[10]			
Nickel	3/8	2.3 to 8	3.2 to 5.1	4.3	7.2	50	No[10,11]			
Potassium	2/8	129 to 1,000	168 to 183	176	177	NA	No[12]			
Selenium	1/8	0.45 to 1	0.37	0.37	0.44	NA	No[11]			

See notes at end of table.

Table 7-3 (Continued)
Selection of Ecological Chemicals of Potential Concern for Surface Soil Associated with Sites 31B and 31D

Remedial Investigation Report
Site 31, Sludge Drying Beds and Disposal Areas
Naval Air Station Whiting Field
Milton, Florida

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]	Average of All Samples[7]	Exposure Point Concentration	
									RME[8]	CT[9]
Inorganic Analytes (mg/kg) (Continued)										
Silver	3/8	0.33 to 2	3.6 to 5.9	4.6	0.7	NA	Yes	2.2	5.9	2.2
Sodium	4/8	1,000	127 to 202	167	388	NA	No[11,12]			
Vanadium	8/8	10	6.6 to 18.7	10.5	21.2	NA	No[11]			
Zinc	8/8	4	3.8 to 12	7.5	15.4	200	No[10,11]			

[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. Because the soil types at Sites 31B and 31D are different, the lesser of the background screening values from the two soil types was used to select ecological chemicals of potential concern (ECPCs). 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.
[7] The average of all samples assigns a value of one-half of the detection limit as a surrogate concentration for nondetect values.
[8] The reasonable maximum exposure (RME) exposure point concentration (EPC) is equal to the maximum detected concentration.
[9] The central tendency (CT) EPC is equal to the lesser of the average of all samples or the RME concentration.
[10] The maximum detected concentration is less than the ecological screening value.
[11] The maximum detected concentration is less than the background screening concentration.
[12] 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: 31-SL-09, 31-SL-10, 31-SL-11, 31-SL-16, 31S00101, 31S00201, 31S00301, and 31S01401.
Duplicate samples: None.
Background samples for Site 31 (Troup and Dothan/Lucy/Bonifay soil types): BKG-SL-02, BKG-SL-06, BKG-SL-07, BKG-SL-08, BKS00101, BKS00201, BKS00301, BKS00401, and BKS00501.

µg/kg = micrograms per kilogram.
ND = not detected in any background sample.
PCB = polychlorinated biphenyl.
DDD = dichlorodiphenyldichloroethane.
DDT = dichlorodiphenyltrichloroethane.
mg/kg = milligrams per kilogram
NA = not available.

Table 7-4
Selection of Ecological Chemicals of Potential Concern for Surface Soil Associated with Site 31C

Remedial Investigation Report
Site 31, Sludge Drying Beds and Disposal Areas
Naval Air Station Whiting Field
Milton, Florida

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	1/14	11 to 17	11*	11	ND	NA	Yes	7.3	6.5	7.3	6.5
Carbon disulfide	4/14	6 to 12	3* to 26*	14.1	ND	NA	Yes	10.9	8	10.9	8
Methylene chloride	4/14	6 to 68.5	112.5* to 475*	209	ND	100	Yes	351	63.8	351	63.8
Toluene	1/14	6 to 12	1	1	ND	50	No[11]				
Xylenes (total)	4/14	6 to 12	5* to 10*	7.1	ND	50	No[11]				
Semivolatile Organic Compounds (µg/kg)											
Benzo(b)fluoranthene	1/14	360 to 11,000	100	100	ND	[12]100	Yes	1,541	784	100	100
Benzo(k)fluoranthene	1/14	360 to 11,000	110	110	ND	[12]100	Yes	1,525	785	110	110
Butylbenzylphthalate	1/14	360 to 11,000	39	39	ND	NA	Yes	1,772	779	39	39
bis(2-Ethylhexyl)phthalate	9/14	360 to 11,000	42 to 2,600	816	80.3	NA	Yes	1,808	589	1,808	589
Pesticides and PCBs (µg/kg)											
4,4-DDE	6/14	3.6 to 270	2.3 to 100	43.6	ND	100	Yes	98.5	19.7	98.5	19.7
Aroclor-1260	4/14	36 to 2,700	340 to 1,400	738	ND	50	Yes	1,353	224	1,353	224
Dieldrin	6/14	3.6 to 270	2.1 to 120	47.4	ND	100	Yes	118	21.4	118	21.4
alpha-Chlordane	6/14	1.8 to 1,300	1.3 to 68	29.2	ND	100	No[11]				
gamma-Chlordane	5/14	1.8 to 1,300	1.4 to 76	34.1	ND	100	No[11]				
Inorganic Analytes (mg/kg)											
Aluminum	14/14	40	1,670 to 16,800	4,818	15,848	NA	Yes	7,480	4,818	7,480	4,818
Antimony	4/14	12	3.1 to 7.1	5.1	8	NA	No[13]				
Arsenic	14/14	2	0.59 to 1.7	1.1	3.2	20	No[11,13]				
Barium	14/14	40	2.7 to 534	83.2	23.2	200	Yes	765	83.2	534	83.2

See notes at end of table.

Table 7-4 (Continued)
Selection of Ecological Chemicals of Potential Concern for Surface Soil Associated with Site 31C

Remedial Investigation Report
Site 31, Sludge Drying Beds and Disposal Areas
Naval Air Station Whiting Field
Milton, Florida

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)											
Beryllium	4/14	1	0.3 to 1.3	0.65	0.36	NA	Yes	0.63	0.54	0.63	0.54
Cadmium	7/14	1	0.22 to 26.8	9.6	0.58	1	Yes	31.2	5.1	26.8	5.1
Calcium	14/14	1,000	93.3 to 4,160	825	396	NA	No[14]				
Chromium	14/14	2	1.4 to 295	46	11	100	Yes	412	46	295	46
Cobalt	8/14	10	0.83 to 3.1*	1.3	3	20	No[11]				
Copper	7/14	5	29.8 to 948	307	9.4	50	Yes	11,968	155	948	155
Cyanide	14/14	0.5 to 1	0.09 to 1.1	0.3	0.28	NA	Yes	0.54	0.3	0.54	0.3
Iron	14/14	20	645 to 22,500	4,704	8,832	NA	No[14]				
Lead	14/14	0.6 to 1	1.8 to 1,890	277	11.4	50	Yes	21,590	277	1,890	277
Magnesium	14/14	1,000	40.3 to 1,120	247	268	NA	No[14]				
Manganese	14/14	3	1.9 to 170	51.7	392	NA	No[13]				
Mercury	8/14	0.1	0.13 to 8.8	2.7	0.12	0.5	Yes	26.3	1.6	8.8	1.6
Nickel	8/14	8	1.5 to 8.6	4	7.2	50	No[11]				
Potassium	9/14	134 to 1,000	73.5 to 134	94.9	177	NA	No[14]				
Selenium	10/14	1	0.15 to 4.9	1.2	0.46	NA	Yes	2	1	2	1
Silver	8/14	2	0.97 to 154	51.8	0.7	NA	Yes	590	30	154	30
Sodium	14/14	1,000	179 to 294	202	406	NA	No[14]				
Vanadium	14/14	10	2.3 to 12.1	5.4	21.8	NA	No[13]				
Zinc	12/14	4	3.6 to 346	99.6	15.4	200	Yes	1,339	85.6	346	85.6

See notes at end of table.

Table 7-4 (Continued)
Selection of Ecological Chemicals of Potential Concern for Surface Soil Associated with Site 31C

Remedial Investigation Report
Site 31, Sludge Drying Beds and Disposal Areas
Naval Air Station Whiting Field
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] 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 ecological chemicals of potential concern).
[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.
[7] The 95 percent upper confidence limit (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.* (USEPA, 1992d)
[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 reasonable maximum exposure (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 maximum detected concentration is less than the ecological screening value.
[12] The ecological screening value of benzo (a) pyrene is used as a surrogate 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: Samples: 31-SL-12 through 31-SL-15 and 31S00401 through 31S01301.
Duplicate samples: 31S00501D.
Background samples: BKG-SL-02, BKG-SL-06, BKG-SL-07, BKG-SL-08, BKS00101, BKS00201, BKS00401, and BKS00501.
Background duplicate samples: BKS00201D.

% = percent.
μg/kg = micrograms per kilogram.
* = average of a sample and its duplicate.
ND = not detected in any background sample.
NA = not available.
PCB = polychlorinated biphenyl.
DDE = dichlorodiphenyldichloroethene.
mg/kg = milligrams per kilogram.

Table 7-5
Selection of Ecological Chemicals of Potential Concern for Surface Soil Associated with Sites 31E and 31F

Remedial Investigation Report
Site 31, Sludge Drying Beds and Disposal Areas
Naval Air Station Whiting Field
Milton, Florida

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]
Volatiles Organic Compounds (µg/kg)											
2-Hexanone	1/13	11	1	1	ND	NA	Yes	7.2	5.2	1	1
Carbon disulfide	2/13	5 to 11	2* to 3.5*	2.8	ND	NA	Yes	4.8	3.7	3.5	3.5
Xylenes (total)	5/13	5 to 11	2 to 3.5*	2.5	ND	50	No[11]				
Semivolatile Organic Compounds (µg/kg)											
Di-*n*-octylphthalate	1/13	360 to 380	220 to 220	220	ND	NA	Yes	NC	186	220	186
bis(2-Ethylhexyl)phthalate	3/13	360 to 380	81 to 230	167	ND	NA	Yes	206	181	206	181
Inorganic Analytes (mg/kg)											
Aluminum	13/13	40	5,010 to 10,700	7,250	15,848	NA	No[12]				
Arsenic	13/13	2	0.7 to 1.9	1.2	3.2	20	No[11,12]				
Barium	13/13	40	7.2 to 24.5	14.1	23.2	200	No[11]				
Beryllium	8/13	1	0.08 to 0.15	0.1	0.36	NA	No[12]				
Calcium	13/13	1,000	78.7 to 962	214	396	NA	No[13]				
Chromium	13/13	2	3.9 to 7.1	5.1	11	100	No[11,12]				
Cobalt	11/13	10	0.66 to 1.4	0.98	3	20	No[11,12]				
Copper	9/13	5	4 to 17.9	6.3	9.4	50	No[11]				
Iron	13/13	20	2,580 to 5,380	3,640	8,832	NA	No[13]				
Lead	13/13	0.6 to 1	2.9 to 6.4	4.8	11.4	50	No[11,12]				
Magnesium	13/13	1,000	98.6 to 549	156	268	NA	No[13]				
Manganese	13/13	3	60.3 to 456	252	392	NA	Yes	376	252	376	252
Mercury	4/13	0.04 to 0.1	0.01* to 0.02	0.02	0.12	0.5	No[11,12]				
Nickel	8/13	2.3 to 8	1.8* to 6.9	3.9	7.2	50	No[11,12]				

See notes at end of table

Table 7-5 (Continued)
Selection of Ecological Chemicals of Potential Concern for Surface Soil Associated with Sites 31E and 31F

Remedial Investigation Report
Site 31, Sludge Drying Beds and Disposal Areas
Naval Air Station Whiting Field
Milton, Florida

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)											
Potassium	3/13	128 to 1,000	106* to 348.5*	201	177	NA	No[13]				
Selenium	1/13	0.46 to 1	0.52	0.52	0.46	NA	Yes	0.45	0.36	0.45	0.36
Silver	7/13	0.33 to 2	0.68 to 4.6*	3	0.7	NA	Yes	6.1	1.9	4.6	1.9
Sodium	8/13	1,000	133 to 233	173	406	NA	No[12,13]				
Vanadium	13/13	10	6.5 to 14.2	9.5	21.8	NA	No[12]				
Zinc	12/13	4	3.5 to 23.1	8.2	15.4	200	No[11]				

[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 ecological chemicals of potential concern).
[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.
[7] The 95th percent upper confidence limit (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." (USEPA,1992d)
[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 reasonable maximum exposure (RME) exposure point concentration (EPC) is equal to the lesser of the maximum detected concentration or the 95th percent UCL.
[10] The central tendency (CT) EPC is equal to the lesser of the average of all samples or the maximum exposure point concentration.
[11] The maximum detected concentration is less than the ecological screening value.
[12] The maximum detected concentration is less than the background screening concentration.
[13] The analyte is an essential nutrient and not considered toxic.
(Notes continued on following page.)

Table 7-5 (Continued)
Selection of Ecological Chemicals of Potential Concern
for Surface Soil Associated with Sites 31E and 31F

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Milton, Florida

Notes: Samples: 31-SL-01 through 31-SL-08, 31S01501, 31S01601, 31S01701, 31S01801, and 31S01901.
Duplicate samples: 31-SL-07D and 31S01501D.
Background samples: BKG-SL-02, BKG-SL-06, BKG-SL-07, BKG-SL-08, BKS00101, BKS00201, BKS00401, and BKS00501.
Background duplicate samples: BKS00201D.

% = percent.
μg/kg = micrograms per kilogram.
ND = not detected in any background sample.
NA = not available.
* = average of a sample and its duplicate.
mg/kg = milligrams per kilogram.

be exposed. The following subsections briefly describe how contaminant exposures are estimated or measured for wildlife, terrestrial plants, and invertebrates at Site 31. The contaminant pathway model (Figure 7-4) provides a summary of the potential exposure pathways that exist at Site 31 for each group of receptors. Additional details regarding the exposure assessment are provided in the GIR (HLA, 1998).

7.4.1 Calculation of EPCs The EPC is a representative concentration used for evaluating risks throughout this ERA. RME and CT concentrations are derived for each ECPC. If the sample size for the surface soil data set is ten or greater (i.e., Sites 31C and Sites 31E and 31F), 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, 1992c). For a sample having no reported analyte concentration, one-half of the detection limit is used as a surrogate concentration to calculate the 95 percent UCL. If the sample size for the surface soil data set is less than ten (i.e., Site 31A and Sites 31B and 31D), the RME value is equal to the maximum detected concentration. If potential risks are predicted based on the RME scenario, then the CT exposure scenario is also evaluated. The CT exposure concentration is represented by the arithmetic mean of all samples. One-half of the detection limit is used as a surrogate value for a sample with an analytical result that is below the detection limit. Tables 7-2 through 7-5 presents the RME and CT EPCs for selected surface soil ECPCs.

7.4.2 Terrestrial Wildlife Exposure routes for wildlife receptors include direct and indirect ingestion of soil and ingestion of food items containing site-related chemicals. The actual amount of an ECPC taken in by wildlife species (i.e., ingestion dose in mg/kg per 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 7-6 and the methodologies described in the GIR (HLA, 1998).

Wildlife species from different trophic guilds that may be present at Site 31 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 open maintained fields at Site 31. The representative wildlife species considered in the ERA are summarized in Table 7-7 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 acres. The cotton mouse represents the small mammal herbivore community at Site 31.

- **Short-tailed shrew** (*Blarina brevicauda*). The short-tailed shrew finds suitable habitat in forests, fields, marshes, and brush. 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 because of their voracious appetites. The shrew represents the small omnivorous mammals that may be found in the open fields of Site 31.

Table 7-6
Estimation of Potential Chemical Exposures for Representative Wildlife Species

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Naval Air Station Whiting Field
Milton, Florida

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 (ECPCs) is used 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 is used when the sample size is ≥ 10.

Soil Exposure Concentration:

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

Primary Prey Item Concentration (T_N):

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

Secondary Prey Item Concentration (T_N):

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

where BAF = Bioaccumulation Factor (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 the explanation of the PDE term below and in the *General Information Report* (Harding Lawson Associates, 1998).

See notes at end of table.

Table 7-6 (Continued)
Estimation of Potential Chemical Exposures for Representative Wildlife Species

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Site 31, Sludge Drying Beds and Disposal Areas
Naval Air Station Whiting Field
Milton, Florida

Estimation of Chemical Exposures Related to Surface Soil

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/kg BW-day),
P_N = percent of diet composed of food item N,
T_N = tissue concentration in food item of species N (mg/kg),
N = species of concern,
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.
BAF = bioaccumulation factors.
inv = invertebrate species.
mam = mammal species.
mg/kg BW-day = milligrams per kilogram of body weight per day.
kg = kilograms.

Table 7-7
Ecological Receptors Evaluated
For Surface Soil

Remedial Investigation Report
Site 31, Sludge Drying Beds and Disposal Areas
Naval Air Station Whiting Field
Milton, Florida

Receptor Evaluated		Method of Evaluation
Common Name	Scientific Name	
Terrestrial plants	NA	Benchmark comparison for Sites 31A, 31B, 31D, 31E, and 31F. Toxicity testing using germination rates of lettuce seeds exposed to Site 31C soil.
Terrestrial invertebrate	NA	Benchmark comparison for Sites 31A, 31B, 31D, 31E, and 31F. Toxicity testing using survival and growth of earthworms exposed to Site 31C soil.
Cotton mouse	*Peromyscus gossypinus*	Food-web model
Short-tailed shrew	*Blarina brevicauda*	Food-web model
Mourning dove	*Zenaida marcroura*	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

Notes: NA = not applicable.

- **Mourning dove** (*Zenaida macroura*). The mourning dove forages by ground-gleaning in railroad right-of-ways, roadsides, and open fields with scattered shrubs and trees. It feeds almost entirely on seeds, with an occasional insect or snail. Gravel is sometimes ingested to facilitate seed digestion (Terres, 1980). The mourning dove will nest in a variety of man-made or natural structures. The mourning dove estimated home range is 5 acres. The dove represents herbivorous avian receptors at Site 31.

- **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 areas of Site 31.

- **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 Grossenheider, 1976). The red fox has an estimated home range of approximately 250 acres and represents the large predatory mammal guild at Site 31.

- **Red-tailed Hawk** (*Buteo jamaicensis*). The red-tailed hawk forages in open country, particularly if woodland edges are present. It consumes primarily small mammals, but its diet may also include invertebrates, reptiles, and small birds. 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 the forested areas adjacent to Site 31 and feed on species that have been exposed to surface soil ECPCs at Site 31.

Parameters for quantitatively evaluating exposures to wildlife include body weight, food ingestion rates, home range, and relative consumption of food items. Exposure assumptions for each of the representative wildlife species for Site 31 are provided in Table 7-8 and Tables G-6, G-10, G-14, G-21 in Appendix G. In addition to these parameters, the species foraging habits and bioaccumulation of ECPCs 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 the site area (reported in acres) relative to the receptor's home range multiplied by 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. 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.

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

Table 7-8
Exposure Parameters for Representative Wildlife Species Selected for Site 31

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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 & snails, fungi, insects, and vegetation. [c]	78% Invertebrates 12% Plants 10% Soil [c]	0.0024 [e]	0.96 ± 0.09 [c]
Mourning dove (*Zenaida marcroura*)	0.13 [h]	Seeds, waste grains from agriculture, some insects, and occasionally snails. [i]	94% plants 1% Invertebrates 5% Soil [h]	0.0154 [j]	5 [i]
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 [j]	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 [i]	Primarily small mammals; also birds, snakes, turtles, frogs, crickets, beetles, crayfish, and carp. [c]	70% Small mammals 27% Small birds 3% Soil [c]	0.113 [j]	800 [c]

See notes at end of table.

Table 7-8 (Continued)
Exposure Parameters for Representative Wildlife Species Selected for Site 31

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[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).
[d] Deer mouse value used for cotton mouse based on similarities in diet. 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] DeGraaf and Rudis (1986).
[j] 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 = kilogram.
% = percent.
kg/day = kilograms per day.

in several reference materials (Suter, 1993; Maughan, 1993), the ERA assumes that VOCs do not bioaccumulate in prey tissue. The general approach used to select BAFs for Site 31 is summarized in Table 7-9.

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 ECPC evaluated at Site 31 are included in Table G-1 in Appendix G.

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 31 surface soil. The Site 31 ERA assumes that exposures to terrestrial plants and invertebrates 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 68 to 105 feet bls (see hydrogeological discussion in Chapter 5 of this report).

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 Section 2.4 of the GIR (HLA, 1998).

Wildlife receptors, terrestrial plants, and terrestrial invertebrates are potentially exposed to ECPCs in surface soil at Site 31. 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 open areas of Site 31. 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 Tables G-2 in Appendix G.

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*, Interim Final (USEPA, 1997c). 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

Table 7-9
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 bioaccumulation factors (BAFs).
	Structural Activities Relationship (SAR)	When literature values were not available, plant BAFs for semivolatile organic compounds (SVOCs) were calculated using a regression equation based on the relationship between plant bioconcentration factors and the *n*-octanol-water partition coefficient for soil (K_{ow}s) of analytes (Travis and Arms, 1988).[1] The study found that bioconcentration factors for vegetation are inversely proportional to the square root of the K_{ow}s of an analyte.
	Extrapolation and Empirical Data	When literature values were not available, plant BAFs for inorganic compounds were obtained from Baes et al. (1984).[2]
	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 was 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.
	SAR	When literature values were not available for SVOCs, BAFs for soil invertebrates were estimated using a regression equation based on the uptake of organic chemicals into beef tissue from Travis and Arms (1988).[1]
	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 was 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.
	SAR	When literature values were not available for SVOCs, BAFs for small mammals were estimated using a regression equation based on the uptake of organic chemicals into beef tissue from Travis and Arms (1988).[1]
	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 was assumed that small mammals do not bioaccumulate VOCs.

See notes at end of table.

Table 7-9 (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.
	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 was assumed that birds do not bioaccumulate VOCs.
	No Information	BAFs were not obtained for SVOCs or for inorganic compounds as there is little bioaccumulation data available for birds. It was assumed that small birds do not accumulate VOCs.

[1] BTFs were converted to a BAFs (mg/kg tissue divided by mg/kg food) by multiplying by a food ingestion rate of 12 kg (dry weight) per day (average intake for lactating and nonlactating cattle reported in Travis and Arms, 1988).
[2] 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.

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

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 that are protective of survival, growth, and reproduction of terrestrial wildlife populations. Lethal RTVs are developed using the following data hierarchy discussed in items 1, 2, and 3, while sublethal RTVs are derived using the methodology discussed in 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 an NOAEL value. 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 LD_{50} (oral dose [in mg/kg body weight-day] lethal to 50 percent of a test population) was used to derive the lethal RTV if an NOAEL or LOAEL value (based on lethal effects) was 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, 1986a). 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 G-3 in Appendix G.

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 at Sites 31A, 31B, 31D, 31E, and 31F are reduction in the biomass of terrestrial plants and abundance of soil invertebrates. Site-specific toxicity data for plants and invertebrates at these areas are not available; therefore, the results of toxicity studies from the literature relating 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 G, Tables G-4 (plants) and G-5 (invertebrates).

The assessment endpoints selected for terrestrial plants and soil invertebrates at Site 31C are survival and growth of these communities. The toxicity of surface soil at Site 31C was measured using two laboratory toxicity tests: a 14-

day survival and a 30-day growth test with earthworms (*E. foetida*) and a 120-hour lettuce seed (*L. sativa*) germination test.

Surface soil samples were collected for toxicity testing from two locations at Site 31C (31N01201 and 31N01301) and two reference soil samples collected from uncontaminated areas at NAS Whiting Field (BKN00101 and BKN00301 and its duplicate BKN00301D). Toxicity test samples for Site 31C and reference surface soil samples were collected concurrently with surface soil samples (31S01201, 31S01301, BKS00101, and BKS00301, respectively) collected for chemical analyses and represent split samples. Therefore, the results of the chemical analyses can be used to establish contaminant exposure concentrations and provide the means to interpret responses in the bioassays. If adverse effects were observed in the bioassays, simple linear regressions were completed to determine if a correlation(s) exists between the concentration of an analyte and the adverse response measured in the bioassay.

The results of the earthworm and lettuce seed toxicity tests using surface soil samples from Site 31C are presented in Table 7-10. Additional information on the toxicity tests using Site 31C surface soil with *E. foetida* and *L. sativa* is included in Appendix F of the GIR (HLA, 1998).

Table 7-10
Results of Site 31C Surface Soil Toxicity Testing

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Sample Location	Earthworms (*Eisenia foetida*)		Lettuce seed (*Lactuca sativa*)
	Survival After 14 days (30 days) (%)	Weight Change (%)[1]	Germination After 120 Hours (%)
31N01201	100 (100)	30.8	[2]77
31N01301	100 (100)	18.6	[2]60
Laboratory Control[3]	100 (100)	13	[3]91
BKN00301 (Reference)	100 (100)	10.9	97
BKN00301D (Reference)	100 (100)	5.0	90
BKN00101 (Reference)	100 (100)	29.1	[2]43

[1] Growth of *E. foetida* is expressed as mean individual wet weight.
[2] Significantly different ($p \leq 0.05$) from the laboratory control group and reference BKN00301.
[3] The laboratory control results present the average of several laboratory control samples.

Notes: % = percent.
p = probability
≤ = less than or equal to.

Site-related toxicity data were evaluated by a statistical comparison of mean survival, growth (as wet weight), or germination rates with the reference samples (BKN00101 and the average of BKN00301 and its duplicate BKN00301D) and the two Site 31C samples (31N01201 and 31N01301).

In the two surface soil samples collected from Site 31C, survival of *E. foetida* after 14 and 30 days was 100 percent, indicating no acute or chronic lethal toxicity. Growth rates of *E. foetida* in the laboratory control and reference samples (BKN00301 and its duplicate) were not significantly different ($P \leq 0.05$) from growth rates in soil from Site 31C, indicating that surface soil from 31C is unlikely to have adverse effects on soil invertebrates.

Soil collected from both Site 31C locations inhibited germination of lettuce seeds. Germination of lettuce seeds, *L. sativa*, in the laboratory control and reference sample, BKN00301, was significantly different ($P \leq 0.05$) from surface soil collected from Site 31C locations 31N01201 and 31N01301. Germination in the reference samples was 97 and 90 percent (for samples BKN00301 and BKN00301D, respectively) as compared to 77 percent in sample 31N01201 and 60 percent in sample 31N01301.

7.6 RISK CHARACTERIZATION. This section presents the risk characterization for ecological receptors exposed to surface soil at Site 31. Potential risks associated with exposures to ECPCs in surface soil at Site 31 are discussed separately for wildlife, terrestrial plants, and soil invertebrates.

Risks to wildlife are characterized by comparing the PDE concentrations (based on RME and CT exposure concentrations) for each surface soil ECPC with its respective RTV (estimated threshold dose for toxicity). Risks for terrestrial plants and soil invertebrates for Sites 31A, 31B, 31D, 31E and 31F are evaluated by comparing toxicity benchmark values to RME and CT exposure concentrations. Risks for terrestrial plants and soil invertebrates for 31C are evaluated using results from site-specific toxicity tests.

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 < 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 CT concentrations of ECPCs are evaluated.

This hazard ranking scheme 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, 1989a). 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 G-6 through G-24 in Appendix G present the HQ and HI calculations. A summary of calculated risks to representative wildlife receptors for Site 31A, 31B and 31D, 31C, and 31E and 31F is provided in Tables 7-11 through 7-14, respectively.

Summary HIs for representative wildlife species exposed to Site 31A, 31B and 31D, and 31E and 31F surface soil RME concentrations of ECPCs for lethal and sublethal effects are less than 1; therefore, risks are not predicted for these receptors (i.e., bioaccumulating chemicals are not sufficiently high as to reduce survivability, growth, or reproduction in terrestrial wildlife populations at these sites).

Except for the cotton mouse and the short-tailed shrew, HIs for all-
species exposed to Site 31C RME and CT concentrations of ECPCs for lethal effects are less than 1. Although HIs based on RME concentrations exceeded 1 for both the cotton mouse (RME HI of 5) and the short-tailed shrew (RME HI of 3.6), HIs based on CT exposure concentrations are less than 1. The primary risk driver for the lethal RME HI is cadmium. As shown in Table 7-15, further examination of the Site 31C surface soil data show elevated concentrations of cadmium ranging from 11.6 to 26.8 mg/kg were detected in the four Phase I samples collected in August 1992. The Phase I samples were collected from areas believed to have received the most disposal material. The more recent Phase II surface soil data collected in January 1996 show cadmium was detected in only three of ten samples at concentrations ranging from 0.22 to 1.6 mg/kg. These samples were collected on a modified grid pattern to best characterize site conditions. Because Phase II characterize non-hot-spot conditions at Site 31C, the Phase II samples were used to recalculate risk exposure representative of post hot-spot removal conditions. Recalculated HIs based on the maximum detected concentration of cadmium in the ten Phase II samples are less than 1 for all representative wildlife species. The recalculated HI values are presented in Tables G-25 through G-28 of Appendix G. Because lethal HI values based on the 1996 Phase II data are well below 1, it is unlikely that the survivability of terrestrial wildlife populations would be reduced at Site 31C.

With the exception of the red-tailed hawk, the sublethal HIs for Site 31C RME and CT concentrations are greater than 1. A summary of the sublethal HIs for representative wildlife species at Site 31C is provided in Table 7-13. The primary risk drivers for small mammals include Aroclor-1260, dieldrin, cadmium, copper, lead, and zinc. For small birds, the risk drivers are cadmium, lead, and mercury. Aroclor-1260 is the only risk driver for the fox. As shown in Table 7-15, further examination of the 1992 Phase I and 1996 Phase II Site 31C surface soil data indicates detected concentrations of all of the primary sublethal risk drivers are significantly lower in the samples collected in 1996 as compared to those collected in 1992. Detected concentrations of the primary risk contributors in the 1996 Phase II samples are generally less than their respective ecological screening values. As shown in Tables G-25 through G-28 of Appendix G, recalculated sublethal HI values based on the maximum detected concentration of ECPCs in the ten Phase II surface soil samples continue to exceed 1 for the cotton mouse (HI of 5), short-tailed shrew (HI of 2.5), mourning dove (HI of 4.8), and eastern meadowlark (HI of 3). The primary risk drivers for small mammals are cadmium and copper. For small birds, cadmium and mercury are the primary risk contributors. Based on the 1996 Phase II surface soil data, reductions in the growth and reproduction of small mammal and bird populations at Site 31C are possible.

Table 7-11
Summary of Hazard Indices for Terrestrial Wildlife[1]
Associated with Exposure to Site 31A Surface Soil

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Ecological Receptors	Lethal Effects from Exposure to Reasonable Maximum EPCs	Sublethal Effects from Exposure to Reasonable Maximum EPCs
Cotton mouse	0.0028	NA
Mourning dove	NA	NA
Short-tailed shrew	0.0012	NA
Eastern meadowlark	NA	NA
Red fox	0.00000058	NA
Red-tailed hawk	NA	NA

[1] Hazard indices are presented in Tables G-6 through G-9 in Appendix G.

Notes: EPC = exposure point concentration.
NA = not available

Table 7-12
Summary of Hazard Indices for Terrestrial Wildlife[1]
Associated with Exposure to Site 31B and 31D Surface Soil

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Ecological Receptors	Lethal Effects from Exposure to Reasonable Maximum EPCs	Sublethal Effects from Exposure to Reasonable Maximum EPCs
Cotton mouse	0.013	NA
Mourning dove	NA	NA
Short-tailed shrew	0.027	NA
Eastern meadowlark	NA	NA
Red fox	0.000051	NA
Red-tailed hawk	NA	NA

[1] Hazard indices are presented in Tables G-10 through G-13 in Appendix G.

Notes: EPC = exposure point concentration.
NA = not available

Table 7-13
Summary of Hazard Indices for Terrestrial Wildlife[1]
Associated with Exposure to Site 31C Surface Soil

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Ecological Receptors	Lethal Effects from Exposure to Reasonable Maximum EPCs	Lethal Effects from Exposure to Central Tendency EPCs	Sublethal Effects from Exposure to Reasonable Maximum EPCs	Sublethal Effects from Exposure to Central Tendency EPCs
Cotton mouse	5	0.97	69	13
Mourning dove	0.55	0.23	77	14
Short-tailed shrew	3.6	0.75	31	5.9
Eastern meadowlark	0.96	0.31	49	9.2
Red fox	0.41	0.0038	7.5	1.3
Red-tailed hawk	0.003	0.00066	0.38	0.072

[1] Hazard indices are presented in Tables G-14 through G-20 in Appendix G.

Note: EPC = exposure point concentration.

Table 7-14
Summary of Hazard Indices for Terrestrial Wildlife[1]
Associated with Exposure to Site 31E and 31F Surface Soil

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Ecological Receptors	Lethal Effects from Exposure to Reasonable Maximum EPCs	Sublethal Effects from Exposure to Reasonable Maximum EPCs
Cotton mouse	0.086	0.25
Mourning dove	0.013	0.0098
Short-tailed shrew	0.16	0.44
Eastern meadowlark	0.14	0.11
Red fox	0.0011	0.0031
Red-tailed hawk	0.00076	0.00057

[1] Hazard indices are presented in Tables G-21 through G-24 in Appendix G.

Note: EPC = exposure point concentration.

Table 7-15
Comparison of Phase I and Phase II Site 31C Surface Soil Data

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Risk Drivers	1992 Phase I Data		1996 Phase II Data	
	FOD	Range of Detected Concentrations (mg/kg)	FOD	Range of Detected Concentrations (mg/kg)
Aroclor-1260	4/4	0.34 to 1.4	0/10	ND
Cadmium	4/4	11.6 to 26.8	3/10	0.22 to 1.6
Copper	4/4	248 to 948	3/10	29.8 to 118
Lead	4/4	344 to 1890	10/10	2.9 to 28.5
Mercury	4/4	2.4 to 8.8	4/10	0.13 to 0.64
Zinc	4/4	186 to 346	8/10	3.6 to 50

Notes: FOD = frequency of detection.
mg/kg = milligrams per kilogram.
ND = not detected.

7.6.2 Terrestrial Plants Risks for terrestrial plants at Sites 31A, 31B and 31D, and 31E and 31F are evaluated by comparing the selected phytotoxicity RTVs to the RME and CT exposure concentrations. The results of this comparison are summarized in Tables 7-16 through 7-18 and are discussed in Paragraphs 7.6.2.1, 7.6.2.2, and 7.6.2.4, respectively. Risks to plants at Site 31C are evaluated based on the results from site-specific toxicity tests using the germination rates of lettuce seeds. Paragraph 7.6.2.3 discusses potential risks to terrestrial plants at 31C.

7.6.2.1 **Site 31A** Silver was the only ECPC identified at Site 31A. As shown in Table 7-16, the silver RME concentration (1.3 mg/kg) is less than the phytotoxicity benchmark value, indicating no reduction in plant biomass and/or plant cover is expected at Site 31A.

7.6.2.2 **Sites 31B and 31D** Silver, which was the only ECPC identified at Sites 31B and 31D, was detected at Site 31B only in three out of eight samples. Although the RME (RME of 5.9 mg/kg) and CT (CT of 2.2 mg/kg) concentrations slightly exceed the RTV of 2 mg/kg, the occurrence of silver in only three samples at Site 31B suggests detected concentrations of silver may be localized. Also, if should be noted that Will and Suter (Will and Suter, 1995) expressed a low confidence in the silver phytotoxicity benchmark value of 2 mg/kg because it is based on a single report that did not indicate the type of toxic effect observed. In addition, the RME silver concentration at Sites 31B and 31D is less than the Site 31C RME concentration of 154 mg/kg, where site-specific toxicity tests were performed. Due to the close proximity and similarities in soil types between Sites 31B and 31D and Site 31C, the results of the Site 31C toxicity tests are used to support the assessment endpoint of reduction in plant biomass. The results of the toxicity test show no correlation between silver concentrations at Site 31C and plant germination and growth rates. Because detected concentrations of silver are substantially less at Site 31B as compared

Table 7-16
Ecological Risk for Plants and Invertebrates in Surface Soil at Site 31A

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Milton, Florida

Analyte	Exposure Point Concentration[1]		RTV		RTV Exceeded? (by RME/by CT)	
	Reasonable Maximum Exposure	Central Tendency Exposure	Plant[2]	Invertebrate[2]	Plant[3]	Invertebrate[3]
Inorganic Analytes (mg/kg)						
Silver	1.3	0.79	2	NA	No/No	NA

[1] Exposure Point Concentrations (EPCs) are presented in Table 7-2. The RME EPCs are equal to the maximum detected concentration and CT EPCs are equal to the mean of all concentrations. When the mean is greater than the RME EPC, then the RME EPC is used for both the RME and CT concentrations.
[2] Plant and invertebrate RTVs are presented in Appendix G, Table G-4 and G-5, respectively. Generally, the plant RTVs are the lowest observed effect concentration from among growth studies on plants in solid media. Invertebrate RTVs are the lowest concentration lethal to 50 percent of a test population (i.e., *Eisenia foetida*). 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 over CT EPC to RTV.

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

Table 7-17
Ecological Risk for Plants and Invertebrates in Surface Soil at Sites 31B and 31D

Remedial Investigation Report
Site 31, Sludge Drying Beds and Disposal Areas
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Analyte	Exposure Point Concentration[1]		RTV		RTV Exceeded? (by RME/by CT)	
	Reasonable Maximum Exposure	Central Tendency Exposure	Plant[2]	Invertebrate[2]	Plant[3]	Invertebrate[3]
Inorganic Analytes (mg/kg)						
Silver	5.9	2.2	2	NA	Yes/Yes	NA

[1] Exposure Point Concentrations (EPCs) are presented in Table 7-3. The RME EPCs are equal to the maximum detected concentration and CT EPCs are equal to the mean of all concentrations. When the mean is greater than the RME EPC, then the RME EPC is used for both the RME and CT concentrations.
[2] Plant and invertebrate RTVs are presented in Appendix G, Table G-4 and G-5, respectively. Generally, the plant RTVs are the lowest observed effect concentration from among growth studies on plants in solid media. Invertebrate RTVs are the lowest concentration lethal to 50 percent of a test population (i.e., *Eisenia foetida*). 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 over CT EPC to RTV.

Notes: RTV = reference toxicity value.
RME = reasonable maximum exposure.
CT = central tendency.
mg/kg = milligrams per kilogram.
NA = not available.
= shading indicates exceedances.

Table 7-18
Ecological Risk for Plants and Invertebrates in Surface Soil at Sites 31E and 31F

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Site 31, Sludge Drying Beds and Disposal Areas
Naval Air Station Whiting Field
Milton, Florida

Analyte	Exposure Point Concentration[1]		RTV		RTV Exceeded? (by RME/by CT)	
	Reasonable Maximum Exposure	Central Tendency Exposure	Plant[2]	Invertebrate[2]	Plant[3]	Invertebrate[3]
Volatile Organic Compounds (mg/kg)						
2-Hexanone	0.001	0.001	NA	NA	NA	NA
Carbon disulfide	0.0035	0.0035	NA	NA	NA	NA
Semivolatile Organic Compounds (mg/kg)						
Di-*n*-octylphthalate	0.22	0.186	200	478	No/No	No/No
bis(2-Ethylhexyl)phthalate	0.206	0.181	1000	478	No/No	No/No
Inorganic Analytes (mg/kg)						
Manganese	376	252	500	NA	No/No	NA
Selenium	0.45	0.36	1	NA	No/No	NA
Silver	4.6	1.9	2	NA	Yes/No	NA

[1] Exposure Point Concentrations (EPCs) are presented in Table 7-5. 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 mean of all concentrations. When the mean is greater than the RME EPC, then the RME EPC is used for both the RME and CT concentrations.
[2] Plant and invertebrate RTVs are presented in Appendix G, Table G-4 and G-5, respectively. Generally, the plant RTVs are the lowest observed effect concentration from among growth studies on plants in solid media. Invertebrate RTVs are the lowest concentration lethal to 50 percent of a test population (i.e., *Eisenia foetida*). 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 over CT EPC to RTV.

Notes: RTV = reference toxicity value.
RME = reasonable maximum exposure.
CT = central tendency.
mg/kg = milligrams per kilogram.
NA = not available.
= shading indicates exceedances.

to Site 31C, and the results of the toxicity tests from Site 31C show no correlation between detected concentrations of silver in surface soil and adverse effects to lettuce seeds, it is unlikely that detected concentrations of silver would cause a reduction in plant biomass and/or plant cover at Site 31B. In addition, no areas of stressed vegetation were observed at Sites 31B or 31D during the site characterization.

7.6.2.3 **Site 31C** Two surface soil samples were collected for toxicity testing from areas having visually stressed vegetation. The results of the toxicity tests show surface soil from sampling locations 31N01201 and 31N01301 inhibited germination of lettuce seed, as compared to the reference sample, BKN00301, and laboratory control. Appendix H presents a series of simple linear regression analyses evaluating the statistical relationships between biological effects observed in the surface soil bioassays and concentrations of selected analytes in Site 31C surface soil. Although germination of lettuce seeds was slightly inhibited by the two Site 31 surface soil samples, no correlation between germination inhibition and ECPC concentrations was observed (Appendix H). It is possible that the reduced germination observed at 31N01201 and 31N01301 was either the result of synergistic effects of multiple contaminants or not related to site contamination. Nonmeasured physical, biological, or chemical factors may be responsible for the observed reduction in lettuce seed germination rates (i.e., ECPC exposure concentrations may not be responsible for the observed effect). The total area of stressed vegetation at Site 31C is relatively small, suggesting localized or limited reduction in plant biomass or cover. Given the small area of stressed vegetation, it is unlikely that ECPCs in surface soil at Site 31C are present in concentrations sufficiently high to reduce plant biomass or plant cover variability such that small mammals and bird populations would be affected.

7.6.2.4 **Sites 31E and 31F** A comparison of phytotoxicity benchmark values and RME and CT exposure concentrations are provided for Site 31E and 31F in Table 7-18. Phytotoxicity RTVs are not available for 2-hexanone and carbon disulfide. With the exception of silver, RME and CT exposure concentrations of all other surface soil ECPCs at Site 31E and 31F are well below their respective phytotoxicity benchmark values. The silver RME concentration of 4.6 mg/kg exceeds the 2 mg/kg phytotoxicity RTV; however, the CT exposure concentration of 1.9 mg/kg is less than the benchmark value. As previously discussed, the results of the toxicity tests at Site 31C indicate no correlation between lettuce seed germination and silver concentrations detected in surface soil. The RME concentration of silver at Site 31C is 154 mg/kg as compared to 4.6 mg/kg at Sites 31E and 31F. Because detected concentrations of silver are substantially less at Sites 31E and 31F as compared to Site 31C, and the results of the toxicity tests from Site 31C show no correlation between detected concentrations of silver in surface soil and adverse effects to lettuce seeds, it is unlikely that detected concentrations of silver would cause a reduction in plant biomass and/or plant cover at Sites 31E and 31F. In addition, no areas of stressed vegetation were observed at Sites 31E or 31F during the site characterization.

7.6.3 Terrestrial Invertebrates Risks for terrestrial invertebrates at Sites 31A, 31B and 31D, and 31E and 31F are evaluated by comparing invertebrate toxicity benchmark values to RME and CT exposure concentrations. The results of this comparison are presented in Tables 7-16 through 7-18 and are summarized in Paragraphs 7.6.3.1, 7.6.3.2, and 7.6.3.4, respectively. Risks to soil invertebrates at Site 31C are evaluated based on the results of site-specific

toxicity tests using earthworm survival and growth rates. Paragraph 7.6.3.3 discusses potential risks to soil invertebrates at Site 31C.

7.6.3.1 **Site 31A** Invertebrate toxicity benchmark values are not available for silver; therefore, risks of terrestrial invertebrates exposure to silver in Site 31A surface soil can not be quantified. However, given the close proximity and similarities in soil type between Site 31A and Site 31C, the results of the Site 31C toxicity tests are used to qualitatively evaluate potential risks to terrestrial invertebrates at Site 31A. As discussed below in Paragraph 7.6.3.3, no mortality or reduction in earthworm growth rates was observed in the Site 31C toxicity study. The RME concentration of silver at Site 31A is 1.3 mg/kg, well below the Site 31C RME concentration of 154 mg/kg; therefore, a reduction in invertebrate biomass at Site 31A is not expected to occur.

7.6.3.2 **Sites 31B and 31D**. As previously discussed, the results of the Site 31C toxicity tests show no mortality or reduction in the growth rate of earthworms exposed to RME silver concentrations of 154 mg/kg. Because the RME concentration of silver at Sites 31B and 31D is 5.9 mg/kg, well below the RME concentration at Site 31C, reduction in invertebrate biomass at Sites 31B and 31D is not expected to occur.

7.6.3.3 **Site 31C** The results of the toxicity testing show surface soil samples collected from Site 31C are unlikely to affect the survival of terrestrial invertebrate communities. After 14 and 30 days of exposure to Site 31 surface soil, survival of earthworms in the toxicity test was 100 percent. Also, after 30 days of exposure to Site 31C surface soil, earthworm growth rates, as measured by percent weight change, were not significantly different ($P \leq 0.05$) from the laboratory control and reference sample BKN00301. Therefore, exposure to Site 31C surface soil is unlikely to impact the survival and growth of the terrestrial invertebrate community at Site 31C.

7.6.3.4 **Site 31E and 31F** Seven ECPCs (2-hexanone, carbon disulfide, di-*n*-octylphthalate, bis(2-ethylhexyl)phthalate, manganese, selenium, and silver) were identified at Sites 31E and 31F. Invertebrate benchmark values are available for only di-*n*-octylphthalate and bis(2-ethylhexyl)phthalate. The RME and CT concentrations for these phthalates are below the RTV concentrations, indicating a reduction in earthworm biomass is unlikely. Three of the remaining five ECPCs, carbon disulfide, selenium, and silver, were also identified as ECPCs at Site 31C. The RME and CT concentrations for each of the chemicals were much lower at Sites 31E and 31F than at Site 31C. As discussed in Paragraph 7.6.3.3, there was no mortality or reduction in growth rates in the invertebrate toxicity tests performed using surface soil from Site 31C, indicating carbon disulfide, selenium, and silver concentrations at Site 31E and 31F are unlikely to result in a reduction in earthworm biomass. Because 2-hexanone was detected in only one out of thirteen samples, reduction in invertebrate biomass at Site 31E and 31F is unlikely. The RME concentration of manganese (376 mg/kg) is less than the background screening concentration, suggesting the manganese concentrations at Sites 31E and 31F are approximately the same as the background concentration, thus they are unlikely to adversely affect soil invertebrates. In summary, ECPCs in the surface soil at Sites 31E and 31F are unlikely to cause a reduction in the biomass of terrestrial invertebrate communities.

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. (HLA, 1998).

Specific uncertainties associated with exposure to surface soil at Site 31 include the following:

- Risks to avian species may have been underestimated because bioaccumulation 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 Sites 31A, 31B, 31D, 31E, and 31F surface soil are not available. Phytotoxicity and invertebrate benchmark values used in the risk assessment for these sites were designed for risk screening purposes only and may not be relevant to the specific conditions of the surface soil at Site 31. The conservative nature of these screening tools may overestimate the actual risk to terrestrial plants and invertebrates at Site 31. However, plant and invertebrate benchmark values for several analytes are not available, potentially resulting in an underestimation of risk for terrestrial plants and soil invertebrates.

- As previously discussed , site-specific toxicity data for Sites 31A, 31B, 31D, 31E, and 31F are not available. Invertebrate and plant benchmark values were also not available for several ECPCs in surface soil; therefore the results of the earthworm and lettuce seed germination toxicity tests from Site 31C were used to draw conclusion regarding the risk characterization for terrestrial invertebrates and plants at other sites. If surface soil conditions at 31C are not similar to Sites 31A, 31B, 31D, 31E, or 31F, the risks to terrestrial invertebrates and plants may be underestimated.

- An assumption has been made that organisms evaluated in the toxicity tests are representative of species at the site. Depending on the sensitivities of terrestrial plants and invertebrates occurring at Site 31C, risks may be over or underestimated.

- The RTV for mercury was selected assuming that this constituent is present in its most toxic form at Site 31C. Although chemical

speciation of this ECPC was not conducted, the available evidence suggests that site conditions are unlikely to result in the conversion of inorganic mercury to organic mercury (e.g., methyl mercury). Methylation of mercury commonly occurs in aquatic environments, which are not present at Site 31C. Therefore, risks to terrestrial wildlife associated with exposures to mercury may be overestimated.

- BAFs for plant material are based on the assumption that plants are 80 percent water. This assumption applies to terrestrial and leafy vegetables, but does not apply to grains, which have a moisture content of only 10 percent. Since the diet of the cotton mouse and the mourning dove consists primarily of grains, the risks to these receptors may be underestimated.

- There is uncertainty associated with the ingestion toxicity data derived from the IRIS and Registry of Toxic Effects of Chemical Substances (RTECS) database. The IRIS and RTECS data were obtained in 1993 and 1995, respectively, and the primary literature citation was not provided; therefore, the primary literature for these studies was not reviewed. This may have resulted in the selection of RTVs that may overestimate or underestimate potential risks to wildlife receptors. RTVs for carbon disulfide and di-*n*-octylphthalate were obtained from IRIS, and RTVs for 2-hexanone, acetone, methyl chloride, butylbenzylphthalate, bis(2-ethylhexyl)phthalate, cadmium, and lead were obtained from RTECS.

- The data set used to evaluate ecological risks at Site 31C is composed of surface soil collected from 1992 and 1996. The 1992 data set represents areas containing the highest concentrations and may be suitable for removal. The Phase II sample locations, collected in 1996, were selected on a grid and represent conditions similar those that will remain after remediation. It is believed that inclusion of the 1992 surface soil data into the data set used to evaluate potential effects to terrestrial wildlife may result in an over estimation of exposure concentrations. Therefore, HI values were recalculated using only the ten samples collected in 1996 and conclusion of the risk characterization for terrestrial wildlife at Site 31C was based on the more recent data.

7.8 SUMMARY OF ECOLOGICAL ASSESSMENT FOR SITE 31. Potential risks for ecological receptors were evaluated for ECPCs in surface soil at Site 31. Site 31 consists of six different areas identified as Sites 31A through 31F. Sites that are similar in geology and analytes detected are discussed together and are presented in the following grouping of sites: 31A, 31B and 31D, 31C, and 31E and 31F.

Risks associated with exposures to ECPCs in Site 31 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 with 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 at Sites 31A, 31B, 31D, 31E, and

31F; therefore, reductions in the survivability, growth, and reproduction of wildlife receptor populations at these locations are not expected to occur. Lethal and sublethal risks were identified for representative wildlife species at Site 31C based on the combined surface soil data collected in 1992 and 1996. Four surface soil samples were collected in 1992 to represent the potential hot-spot areas. Ten additional samples were collected in 1996 along a modified grid pattern and represent non-hot spot areas. Further examination of the data indicates detected concentrations of the primary risk drivers (cadmium, copper, lead, mercury, zinc, and Aroclor-1260) are, on the average, an order of magnitude lower in those samples collected in 1996, as compared to those collected in 1992. The spatial distribution of the 1996 surface soil samples at Site 31C covers the site area and is believed to be more representative of current site conditions than the four samples collected in 1992. Therefore, lethal and sublethal HI values were recalculated to represent non-hot spot site conditions. The recalculated lethal HI values were less than 1 for all representative wildlife species, indicating reductions in the survivability of terrestrial wildlife populations at Site 31C are not expected to occur. However, sublethal risks (i.e., reductions in growth and reproduction) to small mammal and bird populations at Site 31C are possible. The primary risk drivers associated with sublethal risks to small mammals and birds are cadmium, copper, and mercury.

Risks for terrestrial plants at Sites 31A, 31B and 31D, and 31E and 31F were evaluated by comparing the selected phytotoxicity benchmark values to RME and CT exposure concentrations. Risks to plants at Site 31C were evaluated based on the results of site-specific toxicity tests using lettuce seed germination rates as the endpoint.

Based on the results of the benchmark comparison and interpretation of the site-specific toxicity tests, reduction in plant biomass and/or plant cover is not expected at Sites 31A, 31B and 31C, and 31E and 31F. Site-specific toxicity tests were completed on two samples collected from Site 31C in areas showing stressed vegetation. The results of the toxicity tests showed a reduction in lettuce seed germination; however, there was no significant correlation between lettuce seed germination rates and concentrations of ECPCs detected in the surface soil from Site 31C. This suggests that other nonmeasured physical, biological, or chemical factors or a combination of factors may be responsible for the observed reduction in lettuce seed germination. The total area of stressed vegetation at Site 31C is relatively small, suggesting localized or limited reduction in plant biomass or cover. Given the small area of stressed vegetation, it is unlikely that ECPCs in surface soil at Site 31C are present in concentrations sufficiently high as to reduce plant biomass or plant cover availability such that small mammal and bird populations would be affected.

Risks for soil invertebrates at Sites 31A, 31B and 31D, and 31E and 31F were evaluated by comparing invertebrate toxicity benchmark values to RME and CT exposure concentrations. Risks to soil invertebrates at Site 31C were evaluated based on the results of site-specific toxicity tests using earthworm survival and growth rates as endpoints. Based on the results of the benchmark comparison and interpretation of the site-specific toxicity tests, reduction in the abundance of earthworms used as forage material is not expected at Sites 31A, 31B and 31C, and 31E and 31F. The results of the site-specific toxicity tests at Site 31C show no mortality or reduction in growth rate of earthworms; therefore, reduction in the survival and growth of terrestrial invertebrate communities at Site 31C is not expected.

In summary, the results of the ERA suggest reductions in the growth and reproduction of small mammal and bird populations at Site 31C are possible. The other assessment endpoints discussed in Subsection 7.2.3 (i.e., reduction in the survivability of terrestrial wildlife populations, reduction in the biomass of plants/invertebrates, or reduction in plant cover availability) are not expected to be impacted at any of the Site 31 areas.

CHAPTER 8.0

8.0 CONTAMINANT FATE AND TRANSPORT

This chapter discusses the fate and transport of human health and ecological chemicals of potential concern detected in soil and groundwater samples at Site 31. 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 compounds and inorganics were detected in soil and groundwater sampled at Site 31. 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 31. 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, as complexes, as pure-phase liquids, or as 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 controlling 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 31. Subsection 8.2.3 discusses contaminant transport for Site 31.

8.2.1 Processes The persistence and fate of chemical constituents in the environment depend 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, complexation, 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, redox potential (Eh), 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 forms 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 affecting 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 complexing agents and/or other cations and anions (USEPA, 1979). Because various metallic species exhibit differential aqueous solubilities and differential mobilities within soils and/or sediments (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, 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 soils 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 soils and/or sediments 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 as the organism generates an enzyme capable of digesting the chemical. Cometabolism 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 31 CPCs This section discusses the persistence and fate characteristics for CPCs detected at Site 31. 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) present above relevant standards will be addressed. These constituents are summarized below by medium for Site 31.

Human Health Assessment Constituents

- Surface soil: Aroclor-1260, dieldrin, aluminum, beryllium, cadmium, chromium, iron, lead, manganese, mercury, and silver
- Groundwater: TCE

Ecological Assessment Constituents

- Surface soil: Acetone, carbon disulfide, methylene chloride, 2-hexanone, benzo(b)fluoranthene, benzo(k)fluoranthene, bis(2-ethylhexyl)phthalate, butylbenzylphthalate, di-*n*-octylphthalate, Aroclor-1260, 4,4'-DDE, dieldrin, aluminum, barium, beryllium, cadmium, chromium, copper, cyanide, lead, manganese, mercury, selenium, silver, and zinc.

The fate and persistence characteristics of these constituents is summarized below by analytical fraction.

VOCs. Acetone is very mobile in the environment and can move easily from soil to water or air. Acetone's solubility in water is infinite (i.e., it is miscible in water) and it does not partition strongly onto soil. The primary fate of acetone released into the environment is migration to water or volatilization into the atmosphere (if water is not present in soil). In water, acetone is highly susceptible to biodegradation and will also volatilize. Acetone is not persistent in the environment (Howard, 1990).

Carbon disulfide is a natural product of anaerobic biodegradation and is released to the atmosphere from oceans and land masses. Geothermal sources also contribute to carbon disulfide emissions. It may also be released as emissions and in wastewater during its production and use, in the production of viscose rayon, cellophane, and carbon tetrachloride, and as a solvent and fumigant. If released on land, carbon disulfide will be primarily lost by volatilization. It may adsorb to the soil and biodegrade. It may also readily leach into the ground where it may biodegrade. If released into water, carbon disulfide will be primarily lost due to volatilization. Adsorption to sediment and bioconcentration in fish should not be significant. In the atmosphere, carbon disulfide degrades by reacting with oxygen and photochemically produced hydroxyl radicals.

Volatilization is the major transport process for removal of methylene chloride from aquatic systems. Once in the troposphere, methylene chloride is attacked by hydroxyl radicals with the subsequent formation of carbon dioxide, carbon monoxide, and phosgene as principal, initial products. Any unreacted methylene chloride that reaches the stratosphere will undergo photodissociation (USEPA, 1979).

2-Hexanone is known by the synonyms butyl methyl ketone, methyl butyl ketone, and propyl acetone. It is a colorless liquid that is soluble in alcohol and ether and slightly soluble in water. Production data for 2-hexanone are limited and it may not be currently manufactured on an industrial scale in the United States. 2-Hexanone is used as a medium-evaporating solvent for nitrocellulose, acrylates, vinyl, and alkyd coatings.

2-Hexanone appears to be readily degradable in air, water, and soil; it is not likely to be a persistent environmental contaminant. If released to the atmosphere, 2-hexanone is expected to exist in the vapor phase where it will degrade by reaction with the sunlight-formed HO radical. If released to the aquatic environment, 2-hexanone may degrade by biodegradation or be physically removed by volatilization.

Volatilization is the major transport process for removal of TCE from aquatic systems. Once in the troposphere, TCE is attacked by hydroxyl radicals with the subsequent formation of dichloroacetyl chloride and phosgene as principal, initial products. Due to the relatively high reactivity of TCE with hydroxyl radicals in the troposphere, it is unlikely that unreacted TCE will reach the stratosphere. Although volatilization appears to be the most significant transport process of TCE, there is some evidence of bioaccumulation of TCE in marine organisms, but no evidence for biomagnification in food chains. In addition, no evidence was found of selective concentrations of TCE in marine sediments, thus indicating that adsorption may not be an important transport process (USEPA, 1979).

SVOCs. Three esters of phthalic acid were identified as CPCs. These phthalates are bis(2-ethylhexyl)phthalate, butylbenzylphthalate, and di-*n*-octylphthalate. Phthalates are principally used as plasticizers 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. Phthalate have also been used as a solvent, an acaracide in orchards, and as an inert ingredient in pesticide products (Agency for Toxic Substances and Disease Registry [ATSDR], 1991a).

Phthalates are widely used chemicals that enter the environment primarily through the disposal of industrial and municipal wastes in landfills. Phthalates tend to adsorb strongly to soil and sediments 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, 1991a).

Phthalates have a strong tendency to be adsorbed to atmospheric particulate matter, soils, and sediments. Phthalate biodegradation in soil is slow since strong adsorption reduces the availability for degradation. Biodegradation is expected to occur under aerobic conditions. Phthalates may slowly volatilize into air. In air, direct photolysis and photooxidation are not likely (ATSDR, 1991a).

Phthalates are relatively insoluble; however, they may leach to the groundwater in the presence of common organic solvents such as alcohols and ketones. Phthalates in the water will undergo biodegradation under aerobic conditions. Chemical hydrolysis occurs too slowly to be important (ATSDR, 1991a).

It should be noted that since many phthalates are ubiquitous laboratory contaminants, it is very difficult to accurately determine the low levels of this compound that are usually present in the environment. Laboratory contamination often undermines the credibility of the data, and reported concentrations of many phthalates in environmental samples must be viewed with caution (ATSDR, 1991a).

Two polynuclear aromatic hydrocarbons (PAHs) were identified as CPCs (benzo(b)-fluoranthene and benzo(k)fluoranthene) at Site 31. PAHs are a group of chemicals that are formed during the incomplete burning of coal, oil, gas, wood, garbage, or other organic substances. PAHs can either be man-made or occur naturally. A few of the PAHs are used in medicines and to make dyes, plastics, and pesticides, while others are contained in asphalt used in road construction. There are more than 100 different PAH compounds (ATSDR, 1993).

In air, PAHs are found sorbed to particulates and as gases. Particle-bound PAHs can be transported long distances and are removed from the atmosphere through precipitation and dry deposition. PAHs are transported in surface water by volatilization and sorption to settling particles. The compounds are transformed in surface water by photooxidation, chemical oxidation, and microbial metabolism. Sorption of PAHs to soil and sediment increases with increasing organic content and is also directly dependant upon particle size. Microbial metabolism is the major process for degradation of PAHs in soil environments. PAHs have relatively low solubilities, but if transported through soils by either leaching or colloidal movement, PAHs can enter groundwater and be transported within an aquifer (ATSDR, 1993).

Pesticides and PCBs. Dieldrin ($C_{12}H_8C_{16}O$) was first produced with aldrin in the United States in 1948. It was used as an insecticide by direct application to soils in the corn and citrus industry, in preservation and termite-proofing of wood, and in termite-proofing of plastic and rubber coverings for electrical and telecommunications cables. It was also inserted directly into the subsurface soil for termite control. It was not produced in the United States after 1974 and was only imported for limited applications until 1985. Aldrin and dieldrin have not been used since 1985 (ATSDR, 1991b).

Aldrin is readily converted to dieldrin in the environment. Dieldrin is ubiquitous in the environment and found at low concentrations in all media since it is resistant to biotransformation and degradation. Past agricultural uses have resulted in the wide and persistent presence of dieldrin and uptake in a wide range of crops. Dieldrin bioconcentrates through various food chains. Dieldrin is present in many homes due to its use as a termicide (ATSDR, 1991b).

Like chlordane, dieldrin readily binds to the soil and is usually transported while bound to particulates in the atmosphere or to sediments in surface water runoff. Dieldrin does not move through subsurface soils very well and does not leach to groundwater. Dieldrin has a relatively low volatilization rate from soils due to its low vapor pressure (ATSDR, 1991b).

4,4'-DDE was first synthesized in 1874 along with DDT but not used as an insecticide until 1939. DDE and DDT were used extensively to control insect transmitted diseases such as malaria and typhus and as an insecticide in agriculture. In the United States, it was used mainly on cotton crops and to some extent on peanut and soybean crops as an insecticide. DDE and DDT were not used after 1972 except in cases of public health emergencies to control insect-transmitted diseases. U.S. companies no longer manufacture DDE and DDT; however, it is still manufactured and used in other parts of the world (ATSDR, 1992a).

In the U.S., large amounts of DDE and DDT were released to the soil by direct application of the pesticide or by direct or indirect releases during manufacture, formulation, storage, or disposal. DDE and DDT have also been released directly to surface water during the control of insect-transmitted diseases. A large source of DDE and DDT release to air occurred during these applications. There is a continued source of DDE and DDT into the air from other areas of the world where its use is substantial (ATSDR, 1992a).

DDE and DDT may be transported from one medium to another by the process of solubilization, adsorption, bioaccumulation, or volatilization. DDE and DDT have a prolonged persistence in soil and adsorb extensively to soil particles. DDE and DDT are only slightly soluble in water. Once bound to the soil, DDE and DDT are not easily displaced from the area of application except by erosion. DDE and DDT do not leach to groundwater and are most likely to move via transport of sediments to which they are bound. There, they are available for ingestion by organisms, such as bottom feeders. Volatilization of DDE and DDT can occur in soil and surface water to release it into the atmosphere. Particulates can also carry DDE and DDT or their degradation products through the atmosphere until they are removed by precipitation (ATSDR, 1992a).

Aroclor-1260 is a trade name for one of the many mixtures classified as PCBs. PCBs are a class of compounds in which 1-10 chlorine atoms are attached to the

biphenyl structure. Aroclor-1260 (mostly $C_{12}H_4Cl_6$ and $C_{12}H_3Cl_7$)is a PCB mixture with a chlorine content of 60 percent (ATSDR, 1991c).

PCBs were produced commercially in the United States from 1929 until 1977. PCBs were used in electrical components such as capacitors and transformers and also used in plasticizers, surface coatings, inks, adhesives, pesticide extenders, and carbonless duplicating paper. PCBs still have a limited use as a slide-mounting medium for microscopes (ATSDR, 1991c).

The production of PCBs in the U.S. is prohibited and the use of PCB-containing materials still in service is restricted. In the past, Aroclor production has caused some PCB releases to air, municipal sewers, and land. Transformer and capacitor producers also discharged PCB-containing wastes. Currently, hazardous waste sites with PCB contaminated soils and disposal of electrical components containing PCBs represent the greatest sources of PCBs to the environment. PCBs are disposed of by incineration or placement in an off-site chemical-waste landfill (ATSDR, 1991c).

PCBs adsorb strongly to the soil and sediment and usually persist in the environment. Leaching of PCBs is very slow; however, they are very soluble in organic compounds. PCBs resist chemical and biological degradation in the environment. Volatilization and biodegradation, while slow, account for the major route of removal of PCBs from water and soil. PCBs are especially persistent in the atmosphere and will transport far. Vapor-phase PCBs are removed from the atmosphere by photolysis and particulate-phase PCBs are removed by wet and dry deposition (ATSDR, 1991c).

Inorganics. Aluminum is the third most common element in the environment, though it 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}, represent the predominant transport mechanisms for aluminum in the environment (USEPA, 1979).

Barium is a dense alkaline earth metal that occurs naturally in ore deposits and makes up 0.05 percent of the earth's crust. Barium is found in igneous rocks, sandstone, shale, and coal. Barium enters the environment naturally through the weathering of rocks and minerals and is found in most soils and surface water (ATSDR, 1990).

Barium and its compounds may be found in nature or produced industrially for various uses. The largest natural source of barium is barite ore. Barite ore is utilized in paint, glass, and rubber products. Barium compounds are also used in the brick, ceramic, photographic, and chemical manufacturing industries (ATSDR, 1990).

Under natural conditions, barium is stable in the +2 valence state and is found primarily in the form of inorganic complexes. Conditions such as pH, Eh, cation exchange capacity, and the presence of sulfate, carbonate, and metal oxides will affect the partitioning of barium and its compounds in the environment. The major features of the biogeochemical cycle of barium include wet and dry deposition to land and surface water, leaching from geological formations to

groundwater, adsorption to soil and sediment particulates, and biomagnification in terrestrial and aquatic food chains (ATSDR, 1990).

Beryllium has a very low solubility and is probably adsorbed onto soils as rainwater water moves downward through the vadose zone. Complexing agents may solubilize beryllium, but water quality data suggest that the concentration of this metal in heavily polluted water is low. Beryllium is generally found in the environment in particulate rather than dissolved form (USEPA, 1979). Though little information is available regarding the bioaccumulation of beryllium, studies have shown the beryllium does bioaccumulate at relatively low rates (USEPA, 1979).

Cadmium is relatively mobile in the environment compared to other heavy metals and is commonly transported by complexes, both organic and inorganic, or by hydrated cations. When available to the environment, cadmium is generally sorbed to sediment and soils, carried in solution by complexes, or bioaccumulated. Cadmium is generally present in the Cd^{+2} valence state when dissolved in water, thus the Eh potential has relatively little influence on the fate of dissolved cadmium. The pH of the system does effect the rate and nature of the complexing of cadmium, specifically with reference to humic acids (USEPA, 1979).

The nature of the sorption of cadmium is important in determining the disposition of cadmium to remobilization in the environment. Cadmium sorbed to carbonate minerals, precipitated as a stable solid compound, or coprecipitated with hydrous iron oxides is less likely to be mobilized by resuspension of sediments or biological activity. Cadmium sorbed to mineral surfaces or organic materials is more easily bioaccumulated or released in the dissolved state when sediments are disturbed (USEPA, 1979). Cadmium also is known to bioaccumulate to relatively high concentrations as compared to ambient concentrations in groundwater or surface water.

Chromium is present in minerals predominantly as Cr^{3+}. Dissolved chromium may be present as trivalent cations or as anions in which the oxidation state is Cr^{6+} (hexavalent). Six different ionic forms of chromium are considered to be stable in aqueous systems. The reduced forms are Cr^{3+}, $CrOH^{2+}$, $CrOH^{2+}$, $Cr(OH)_2^{+}$, and $Cr(OH)^{4-}$. Anionic forms present under oxidizing conditions include dichromate $Cr_2O_7^{2-}$ and chromate CrO_4^{2-}. The dissolved forms that predominate in reduced systems between pH 5 and pH 9 probably are $CrOH^{2+}$ and $Cr(OH)_2^{+}$. Concentrations of chromium in natural waters that have not been affected by waste disposal are commonly less than 10 $\mu g/\ell$ (Hem, 1992).

Copper occurs naturally in the Earth's crust as the free native metal, Cu^0, or in Cu^+ or Cu^{2+} minerals. Copper forms rather stable sulfide minerals. Copper may occur in solution in either Cu^{2+} or Cu^{1+} oxidation states, but the redox conditions in oxygenated water and the tendency of Cu^+ to disproportionate ($2Cu^+ \rightarrow Cu^0 + Cu^{2+}$) favor the more oxidized form. Cupric ions form complexes with many different ligands. Concentrations of copper in groundwater are generally below predicted levels as a result of coprecipitation by oxides or adsorption on mineral surfaces (Hem, 1992).

Cyanide is represented by a diverse group of compounds whose fate in the environment may vary widely. Hydrogen cyanide, the most common and most toxic form of cyanide, may biodegrade, volatilize or adsorb to sediment. Once in solution, photodecomposition of the cyanide may occur. Cyanide also may be

adsorbed by sediment, primarily clay, biological solids, and activated carbon (USEPA, 1979); however, cyanide appears to be fairly mobile in soil, indicating that adsorption may not pose a significant control on mobility. Volatilization of cyanide has been shown to be the dominant fate in activated sludge treatment systems (USEPA, 1979). Biodegradation of cyanide also is a common fate in natural waters. The importance of this process varies according to the concentration of cyanide present, pH, temperature, the concentration and acclimation of microbes to cyanide, and the availability of nutrients (USEPA, 1979). In organisms, cyanide interferes with the enzymes associated with cellular oxidation, thus cyanide is quickly metabolized or the organism dies; therefore, little potential for bioaccumulation of hydrogen cyanide exists.

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.

The predominant fate of lead in the environment is adsorption to inorganic solids, hydrous iron and manganese oxides, and organic material in sediments and soils. Adsorption represents a major sink for lead in the environment and tends to increase lead concentrations in sediments and soils. Sorbed lead may be remobilized by biomethylation, which generates tetramethyl lead. This lead compound may be volatilized or oxidized. The predominant form of lead in the environment is in the Pb^{+2} valence state; this form of lead readily complexes with OH^- and CO_3^{+2} ligands (USEPA, 1979). Bioaccumulation also is a common fate process for lead.

Manganese concentrations of all chemical species are reduced through the natural processes of dilution and dispersion. The common oxyhydroxide form of Mn^{+4} forms a precipitate that can be trapped by intergranular filtration in groundwater while Mn^{+2} readily forms organic complexes. In addition, significant activity coefficient depression with increased concentrations allows a solution to carry a higher concentration than thermodynamically predicted (Hem, 1992). Adsorption and desorption onto mineral grains and organic material moderate quick swings in manganese concentrations, but these are reversible reactions. Dissolution and precipitation also are reversible reactions that can change the form of manganese in the system, but not the total amount.

Oxidation-reduction reactions tend to reach equilibrium slower with manganese than similar iron reactions, potentially due to the effects of organic complexes of manganese and bacterial influences. Manganese readily forms complexes with organic materials, though no reports of correlation between Mn^{+2} manganese concentrations and organic color exist (Hem, 1992).

Mercury occurs naturally as a mineral and is distributed throughout the environment. Mercury has three valence states and is found in the environment in the form of various inorganic and organic complexes and as the elemental

metal. The major features of the biogeochemical cycle of mercury include degassing of mineral mercury from the lithosphere and hydrosphere, long-range transport in the atmosphere, wet and dry deposition to land and water surface, sorption to soil and sediment particulates, and bioaccumulation in terrestrial and aquatic food chains (ATSDR, 1992b).

Selenium is considered to be a nonmetal, and it is a member of the group IV elements. Selenium occurs in igneous rocks in concentrations of approximately 0.05 parts per million (ppm); in shale, 0.6 ppm; in sandstone, 0.05 ppm; and in limestone, 0.08 ppm. Most of the selenium found in natural waters results from the weathering of seleniferous rock.

Selenium exists in the environment in four oxidation states (elemental form, +6, +4, and -2) depending on the Eh or pH. In aerobic waters, selenium is present in the selenite or selenate oxidation state of +4 or +6. These chemical species are very soluble, and most of the selenium discharged into the aquatic environment is probably transported in these forms to the oceans. Under reducing conditions, selenium can form metal selenides either by direct reaction with metals or through substitution of sulfur in metal sulfides. Most of the metal selenides have a very low solubility in water (USEPA, 1979).

Selenium has a sorptive affinity for hydrous metal oxides, clays, and organic materials. Sorption by bed sediments or suspended solids can result in enrichment of selenium concentrations in the bed sediments. Sorption or precipitation with hydrous iron oxides is probably the major control on mobility of selenium in aerobic waters (USEPA, 1979).

Selenium can be methylated by a variety of organisms, including benthic microflora. In a reducing environment, hydrogen selenide may be formed. Methylated selenide and hydrogen selenide are both volatile and may escape into the atmosphere. Formation of volatile selenium compounds in the sediments can remobilize sorbed selenium (USEPA, 1979).

Silver is a rare element occurring in concentrations of about 0.1 ppm in the Earth's crust. Silver occurs primarily in the form of the sulfide (argentite), or is intimately associated with other metal sulfides, especially those of lead and copper. Silver is also commonly associated in nature with gold.

Sorption and precipitation processes are effective in reducing the concentration of dissolved silver and result in higher concentrations in the sediments than in the water. Sorption by manganese dioxide and precipitation with halides are probably the dominant controls on the mobility of silver in the aquatic environment. Organic materials also adsorb silver. Some silver is bioaccumulated, and the remainder is transported in solution to the oceans (USEPA, 1979).

Zinc is a natural element found in soil. Zinc is also deposited in soils 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 (ATSDR, 1988).

8.2.3 Transport of Contaminants This section discusses the transport of chemicals in various media at Site 31. 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 vegetation present at Sites 31B, 31C, 31D, 31E, and 31F. Vegetative cover is an effective means of limiting wind erosion of soil. There is some potential for transport via wind at Site 31A because the drying beds have little or no vegetation; however, wind transport is unlikely because a 3.5-foot-high concrete wall surrounds each drying bed. 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 the areas associated with Site 31, human activity is not a major transport mechanism for the CPCs in soils. This condition may change based on the future use of each area associated with Site 31.

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 31A because the drying beds are surrounded by concrete walls to contain the sludge during drying. Soil erosion is considered a major potential mechanism for the transport of the CPCs in soil at Sites 31B, 31C, and 31D because of the high grade (slope) of the land surface at these sites and the nature of the constituents remaining in the soil at the sites.

During the period of reported active disposal (1940 to 1990) at Sites 31B, 31C, and 31D, the potential for physical transport of both soil and CPCs via runoff does appear to be a significant mechanism for transport. These sites have a strong slope toward the Clear Creek Floodplain. Erosion control measures (terracing and grass seeding) have been taken at these sites to minimize runoff away from the sites.

Soil erosion is currently not considered a major mechanism for the transport of the CPCs in soil at Sites 31E and 31F 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.

The majority of the inorganic analytes detected in the soil at Site 31 are likely to remain attached to the soil because most metal analytes adsorb readily to or are natural constituents of clays and other minerals.

Surface Water. There are no permanent surface water bodies associated with Site 31. Infiltration directly into the soil is presumed to occur during all rain events at Sites 31A, 31E, and 31F.

Currently, transport of the CPCs at Sites 31B, 31C, and 31D via runoff is considered possible because of the high slope of the land surface at these site; however, erosion control measures, the high infiltration capacity of soil at the site, the vegetation cover at the sites, and the tendency of the surface soil contaminants to remain attached to clays in the soil may reduce runoff.

Sediment. The transport of sediment at Site 31 by the action of humans is not currently a significant transport mechanism, as very little human activity occurs on the site. Transport of sediment in water (by saltation, traction, and suspension) are unlikely means of sediment transport at Site 31.

Groundwater. The groundwater samples collected during Phase IIB are thought to be representative of groundwater conditions at Site 31C. It is probable that particulate material of larger than colloidal size 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 31.

Hydrogeology at Site 31 is discussed in Section 5.2 of this report. The aquifer present at the site is the surficial (sand and gravel) aquifer. The CPC identified for groundwater is associated with the surficial aquifer system. Recharge of the surficial aquifer at Site 31 occurs primarily by rainfall on the site. Groundwater flow direction in the surficial aquifer at Sites 31A, 31B, 31C, and 31D is primarily to the southwest. Clear Creek acts as a point of discharge west of Site 31A (1,400 feet), Site 31B (2,600 feet), Site 31C (2,000 feet), and Site 31D (2,700 feet). Groundwater flow direction in the surficial aquifer at Sites 31E and 31F is primarily to the east-southeast. Big Coldwater Creek acts as a point of discharge approximately 9,000 feet east of Sites 31E and 31F.

Hydraulic data from a well cluster (WHF-31-4D and WHF-31-4S) completed at Site 31C indicate vertical gradient in this area was downward during the August 1997 survey. Hydraulic data from well clusters completed near Sites 31A, 31B, 31D, 31E and 31F indicate the vertical gradient in these areas changes over time in intensity and direction. The upper (approximately) 144 feet of material is a sand with varying amounts of silt and clay and also several significant clay layers, which may not act as a single hydraulic unit.

Horizontal hydraulic gradient estimates have been developed for the areas associated with Site 31. The gradient was calculated for the period between January 1997 and August 1997 and averaged (Table 5-2). The average hydraulic gradient in the surficial aquifer is 0.0061 ft/ft in a west-southwest direction for the Southwest Disposal Area, which is thought to be representative of Sites 31A, 31B, 31C, and 31D. The hydraulic gradient measured at Site 31C in August 1997 was 0.00063 ft/ft. The average hydraulic gradient in the surficial aquifer is 0.0030 ft/ft in a south-southeast direction for the Southeast Disposal Area, which is thought to be representative of Sites 31E and 31F.

Hydraulic conductivity testing was completed on monitoring wells in the Southwest Disposal Area near Sites 31A, 31B, 31C, and 31D. The average hydraulic conductivity value for this area is 0.0080 feet per minute (ft/min) or 11.45 ft/day (Table 5-4).

Hydraulic conductivity testing was completed on monitoring wells in the Southeast Disposal Area near Sites 31E and 31F. The average hydraulic conductivity value for this area is 0.0058 ft/min or 8.38 ft/day (Table 5-4).

Horizontal groundwater seepage velocity calculations have been completed for the surficial aquifer system at Site 31 using available hydraulic information (Section 5.2). A seepage velocity of 84 ft/yr was calculated using the average hydraulic conductivity from monitoring wells in the Southwest Disposal Area (0.23

ft/day), an average horizontal gradient of 0.0061 ft/ft for these monitoring wells, and an estimated effective porosity of 0.35. Disposal activities at Sites 31A, 31B, 31C, and 31D may have begun releasing contaminants to the aquifer approximately 50 years ago. Using the seepage velocity calculated above and a 50-year time frame, the total distance of potential contaminant migration was estimated to be approximately 4,200 feet.

A seepage velocity of 29 ft/yr was calculated using the average hydraulic conductivity from monitoring wells in the Southeast Disposal Area (0.08 ft/day), an average horizontal gradient of 0.0030 ft/ft for these monitoring wells, and an estimated effective porosity of 0.35. Disposal activities at Sites 31E and 31F may have begun releasing contaminants to the aquifer approximately 50 years ago. Using the seepage velocity calculated above and a 50-year time frame, the total distance of potential contaminant migration was estimated to be approximately 1,450 feet.

The use of the seepage velocity or the calculated distance presented above would most likely overestimate the transport of potential contaminants from the sites because it does not account for dilution, advection, dispersion, or adsorption. Dividing either the seepage velocity or the distance by a correction factor of 1.4 (USEPA, 1988b) may provide a more accurate estimate for potential contaminant migration of 3,000 feet for Sites 31A, 31B, 31C, and 31D. Similarly, potential contaminant migration of 1,036 feet is estimated for Sites 31E and 31F.

The calculated estimate of 3,000 feet (Sites 31A through 31D) and 1,036 feet (Sites 31E and 31F) 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, 1989). If the hydraulic conductivity value used in the calculation was decreased by an order of magnitude, a total migration of only 300 feet (Sites 31A through 31D) and 103 feet (Sites 31E and 31F) would be expected for the 50-year history of the sites.

Clear Creek is likely the final point of discharge for groundwater from the surficial aquifer at Sites 31A, 31B, 31C, and 31D. Clear Creek is located approximately 1,400 to 2,700 feet west of the areas associated with Site 31. Big Coldwater Creek is likely the final point of discharge for groundwater from the surficial aquifer at Sites 31E and 31F. Big Coldwater Creek is located approximately 9,000 feet east of Sites 31E and 31F.

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 Sites 31A, 31B, 31C, and 31D do not conclusively support any impact to surface water quality of Clear Creek from past Site 31 activities (ABB-ES, 1992). The results of surface water and sediment sampling are presented in the RI/FS *Technical Memorandum No. 4, Surface Water and Sediments* (ABB-ES, 1992) and will also be presented in the concurrent Remedial Investigation Report for Site 39, Clear Creek Floodplain.

CHAPTER 9.0

9.0 CONCLUSIONS AND RECOMMENDATIONS

9.1 CONCLUSIONS. The following is a summary based on the RI at Site 31, Sludge Drying Beds and Disposal Areas, NAS Whiting Field.

Surface Soil Summary

- Site 31A: Two inorganic analytes (mercury and silver) were detected in surface soil samples at concentrations exceeding their respective background screening values. No compounds or analytes exceeded the residential or industrial soil cleanup goals for Florida and the USEPA Region III RBCs.

- Site 31B: Three inorganic analytes (copper, mercury, and silver) were detected in surface soil samples at concentrations exceeding their respective background screening values. No compounds or analytes exceeded their respective residential and industrial soil cleanup goals for Florida and the USEPA Region III RBCs.

- Site 31C: One pesticide compound (dieldrin) was detected in surface soil samples at concentrations exceeding the residential values of soil cleanup goals for Florida and the USEPA Region III RBCs. Seventeen inorganic analytes (aluminum, barium, beryllium, cadmium, calcium, chromium, cobalt, copper, iron, lead, magnesium, mercury, nickel, selenium, silver, zinc, and cyanide) were detected in samples at concentrations exceeding their respective background screening values. Concentrations of six of these analytes (aluminum, cadmium, chromium, copper, iron, and mercury) exceeded the residential values for either the soil cleanup goals for Florida or USEPA Region III RBCs. Beryllium exceeded the industrial soil cleanup goals for Florida in some surface soils. Lead was detected at concentrations exceeding the industrial cleanup goals for soils for Florida and the USEPA Region III RBCs.

- Site 31D: One inorganic analyte (potassium) was detected in a sample at a concentration slightly exceeding the background screening value. Arsenic exceeded the residential soil cleanup goals for Florida and the USEPA Region III RBCs.

- Site 31E: Three inorganic analytes (magnesium, potassium, and silver) were detected in samples at concentrations exceeding their respective background screening values. Arsenic, beryllium, and manganese exceeded their respective residential values of the soil cleanup goals for Florida and the USEPA Region III RBCs.

- Site 31F: Eight inorganic analytes (barium, calcium, copper, magnesium, manganese, selenium, silver, and zinc) were detected in samples at concentrations exceeding their respective background screening values. Aluminum, arsenic, iron, and manganese exceeded their respective residential values of the soil cleanup goals or the USEPA Region III RBCs. Arsenic and manganese also exceeded their respective residential values of the soil cleanup goals for Florida.

Subsurface Soil Summary

- Site 31A: Seven inorganic analytes (beryllium, cobalt, copper, manganese, mercury, sodium, and thallium) were detected in subsurface soil samples at concentrations exceeding their respective background screening values. The inorganic analytes did not exceed their respective residential and industrial soil cleanup goals for Florida or the USEPA Region III RBCs.

- Site 31C: Six inorganic analytes (copper, lead, mercury, silver, zinc, and cyanide) were detected in subsurface soil samples at concentrations exceeding the background screening values. The inorganic analytes did not exceed their respective residential and industrial soil cleanup goals for Florida or the USEPA Region III RBCs.

Groundwater Summary

- Site 31C: Three analytes (potassium, vanadium, and cyanide) were detected at concentrations exceeding the background screening values in groundwater samples collected from monitoring wells. No analytes were detected at concentrations exceeding their respective Federal and State MCLs.

- The pH values of groundwater samples collected from Site 31C monitoring wells were below the lower range for Federal and State secondary MCLs; however, these values were within the range observed in facility-specific background groundwater samples collected at NAS Whiting Field (HLA, 1998).

Hydrogeologic Summary

- The groundwater flow direction is to the southwest for Sites 31A, 31B, 31C, and 31D and likely discharges at Clear Creek, located from 1,400 to 2,700 feet west of these sites. The groundwater flow direction is to the east-southeast for Sites 31E and 31F and likely discharges to Big Coldwater Creek, located approximately 9,000 feet east of these sites.

- Based on a 50-year site history and an evaluation of hydrogeologic data, a potential migration distance for CPCs is estimated to be approximately 4,200 feet for Site 31C; however, there is no evidence of any chemical migrating from the site.

Human Health Risk Assessment Summary

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

- The groundwater risks levels are below both the USEPA target cancer risk range and the FDEP target level of concern.

- Noncancer risk levels for groundwater meet the USEPA and FDEP target HI of one.

- The total ELCR at Site 31C, associated with ingestion of soil by a hypothetical future resident, current and hypothetical future trespasser, and hypothetical future occupational worker exceeded Florida's target risk level of concern of 1×10^{-6} due primarily to Aroclor-1260, dieldrin, arsenic, and beryllium.

- The CT risks to a hypothetical future trespasser and occupational worker were below the Florida level of concern (1×10^{-6}) for Site 31C.

Ecological Risk Assessment Summary

- Lethal and sublethal risks were identified for representative wildlife species at Site 31C based on the combined surface soil data collected in 1992 and 1996. Four surface soil samples were collected in 1992 to represent the potential hot spot areas. Ten additional samples were collected in 1996 along a modified grid pattern and represent non-hot spot areas. Further examination of the data indicates detected concentrations of the primary risk drivers (cadmium, copper, lead, mercury, zinc, and Aroclor-1260) are, on the average, an order of magnitude lower in those samples collected in 1996 as compared to those collected in 1992. The spatial distribution of the 1996 surface soil samples at Site 31C covers the site area and is believed to be more representative of current site conditions than the four samples collected in 1992. Therefore, lethal and sublethal HI values were recalculated to represent non-hot spot site conditions. The recalculated lethal HI values were less than 1 for all representative wildlife species, indicating reductions in the survivability of terrestrial wildlife populations at Site 31C are not expected to occur. However, sublethal risks (i.e., reductions in growth and reproduction) to small mammal and bird populations at Site 31C are possible. The primary risk drivers associated with sublethal risks to small mammals and birds are cadmium, copper, and mercury.

- Risks were not identified for terrestrial wildlife resulting from exposure to ECPCs in surface soil at Sites 31A, 31B, 31D, 31E, and 31F; therefore, reductions in the survivability, growth, and reproduction of wildlife receptor populations at these locations is not expected to occur.

- Based on the results of the benchmark comparison and interpretation of the site-specific toxicity tests, reduction in plant biomass and/or plant cover is not expected at Sites 31A, 31B and 31C, and 31E and 31F. Site-specific toxicity tests were completed on two samples collected from Site 31C in areas showing stressed vegetation. The results of the toxicity tests showed a reduction in lettuce seed germination; however, there was no significant correlation between lettuce seed germination rates and concentrations of ECPCs detected in the surface soil from Site 31C. This suggests other nonmeasured physical, biological, or chemical factors or a combination of factors may be responsible for the observed reduction in lettuce seed germination.

- Based on the results of the benchmark comparison and interpretation of the site-specific toxicity tests, reduction in the abundance of earthworms used as forage material is not expected at Sites 31A, 31B and 31C, and 31E and 31F. The results of the site-specific toxicity tests at Site 31C show no mortality or reduction in growth rate of earthworms; therefore, reduction in the survival and growth of terrestrial invertebrate communities at Site 31C is not expected.

9.2 RECOMMENDATIONS. Based on the interpretation of findings from the remedial investigation activities, No Further Action (NFA) is proposed for Sites 31A (Sludge Drying Beds) and Sites 31B, 31D, 31E, and 31F (Sludge Disposal Areas). Because of the recommendation for NFA, an FS does not need to be conducted for these areas.

Based on the interpretation of findings from the RI activities, a focused FS is recommended for Site 31C (Sludge Disposal Area) to address potential risk of a surface soil exposure by a hypothetical future resident, current and hypothetical future trespasser, and hypothetical future occupational worker. The calculated risk to a hypothetical resident (2×10^{-5}) exceeded Florida's target level due to Aroclor-1260, dieldrin, arsenic, and beryllium.

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 differing 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 31, Sludge Drying Beds and Disposal Areas, 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.

Michael J. Williams
Professional Geologist
P.G. No. 344

Date

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REFERENCES

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November 30, 1998

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RE: Final Draft Remedial Investigation Report, Site 31, Sludge Drying Beds and Disposal Areas, NAS Whiting Field

Dear Ms. Martin:

I have reviewed the subject document dated October 1998 (received October 6, 1998). In preparing the final draft, the Navy should adequately address the following comments:

1. An Executive Summary would improve the document.

2. Figures 2-2 and 3-2 (and perhaps others) should be revised to show enough detail to enable a reviewer to understand the character of the sites. For instance, Site 31C extends beyond the delineated boundary (Figure 3-2) in at least one place. The most notable site characteristic, a deep ravine, is not shown; this should be shown, including the area extending down gradient to Clear Creek, since overland flow could easily be a dominant characteristic of the site and on the contaminants which were discharged on the surface of the site. Finally, there are areas at Site 31C which contain numerous pine trees; is this within the site? Additionally, a large area of sludge emplacement is shown to extend beyond the boundary of the site. Is there a reason for extending the contaminated area beyond the supposed site boundary? Please depict the site correctly on the revised figures; even better, include a larger scale figure for Site 31C.

3. In Section 2.2 the presence of a rubble pile in the southwest area of Site 31C consisting of concrete, asphalt and metal is described; Figure 3-2 shows a rubble pile southeast of the indicated site. Where is the southwest rubble pile and, were samples obtained near or in the vicinity of the pile?

4. Soil Sampling: it is difficult to determine the location of subsurface soil sampling points. Please prepare a table and associated figure (if a larger scale figure is prepared subsequent to comment #2, it may be suitable) which depicts and describes the surface and subsurface samples, their depths and other information, or at least modify Figure 3-2 to note that surface soil sample locations 31B006, 31B007 and 31B008 are also locations of

subsurface soil locations at Site 31C. It seems that in any case, since an IM is planned for Site 31C, better site maps are in order.

5. Please justify why, of the six separate sites that comprise Site 31, ground water was sampled only at Site 31C. Include in that justification the high detection limits, notably those above TCLs.

6. As we have previously discussed for other sites at NAS Whiting Field, please insure that the soil, surface water and ground water data are evaluated with respect to the soil, surface and ground water (Table 3b) values in Chapter 62-785, F.A.C. Please note that the evaluation for soil should be the lower of either the direct exposure I or the appropriate leachability level, if ground water is indicated to be contaminated. Please modify the appropriate tables to reflect this change. Please reevaluate the existing COPC, risk evaluations, etc., as necessary to also reflect this change. Finally, the outdated Soil Cleanup Goals Memorandum from Mr. John Ruddell and the memorandum from Ms. Ligia Mora-Applegate dated April 5, 1995 should not be used. Use of the TCLs from Chapter 62-785, F.A.C. will eliminate the errors such as those seen in copper, vanadium (and others) in Table 5-7, and others.

7. As related to the previous comments, I am having difficulty understanding how Table 5-24 should be interpreted. There are six sets of sampling data presented; one is duplicated and one was a filtered sample. In order to properly evaluate the soil contamination, one must refer to the ground water samples in order to determine if the leachability values are applicable. In many of the ground water sample data sheets in Appendix C, many of the detection limits are above the State TCLs; however, those data are reported in Table 5-24 as non-detects, leading to erroneous conclusions. As an example, the detection limit for benzene was 10 ug/L, which was reported as non-detect. This is in error, since the State ground water TCL is 1 ug/L; hence, the ground water data are insufficient to characterize the site, especially since the ground water only at Site 31C was sampled. We need to discuss this problem and reach agreement as to how the Navy can reconcile it. In a manner similar to the preceding example, all data and resulting conclusions should be reconciled for appropriate adequacy.

8. Section 3.1 and Figure 3-2: a method of surface soil sampling is described with respect to two distinct phases and a "random" sampling method is described. Inspection of sample points on Figure 3-2 seems to indicate very little, if any, random sampling at Site 31C. Please discuss the sampling regime at this site in enough detail to enable the reviewer to understand the method and results. In addition, please indicate the locations of the subsurface soil samples. Finally, discuss and justify why the Navy feels that the site has been adequately characterized. In all the previous aspects, remember that comment #2 potentially enlarged the site boundaries, including down to Clear Creek and the apparent lack of adequate ground water data, given the few number of samples and the preponderance of high detection limits.

9. Human Health Risk Assessment, Section 6.0: Please correct the errors in the FDEP risk level on Figure 6-4. Please insure that the tables and information in this section reflect the use of Chapter 62-785, F.A.C.

10. Please reconsider the conclusions and recommendations in Section 9.0, based on the use of Chapter 62-785, F.A.C. for site evaluations.

If you have any questions or need further clarification, please feel free to contact me at 850-921-4230.

Sincerely,

James H. Cason, P.G.
Remedial Project Manager

cc: Craig Benedikt, EPA Region IV, Atlanta
Jim Holland, NAS Whiting Field
Rao Angara, HLA, Tallahassee

TJB TB ESN JJC ESN