N60200.AR.005613
NAS CECIL FIELD
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REMEDIAL ACTION PLAN SOUTH FUEL FARM NAS CECIL FIELD FL
10/1/1996
ABB ENVIRONMENTAL SERVICES INC

NASCF Jacksonville
N60200_000005
10/1/1996 56

REMEDIAL ACTION PLAN

SOUTH FUEL FARM

NAVAL AIR STATION CECIL FIELD
JACKSONVILLE, FLORIDA

UNIT IDENTIFICATION CODE: N60200
CONTRACT NO.: N62467-89-D-0317/090

OCTOBER 1996

SOUTHERN DIVISION
NAVAL FACILITIES ENGINEERING COMMAND
NORTH CHARLESTON, SOUTH CAROLINA
29419-9010

PRINTED ON RECYCLED PAPER

ABB

8520-3159

October 28, 1996

Florida Department of Environmental Regulation
Twin Towers Office Building
2600 Blairstone Road
Tallahassee, Florida 32399-2400
Attention: Mr. Eric Nuzie

Subject: Remedial Action Plan
South Fuel Farm
NAS Cecil Field, Jacksonville, Florida
Contract No. N62467-89-D-0317/090

Dear Eric:

On behalf of Southern Division, Naval Facilities Engineering Command (SOUTHNAVFACENGCOM), ABB Environmental Services, Inc. is pleased to forward two copies of the subject document for your review and approval.

To conserve paper and report binders and reduce document reproduction costs, the enclosed South Fuel Farm Remedial Action Plan consists of the report covers, revised text and appendices. Directions for completing the RAP are also enclosed.

Comments or questions you may have concerning this document should be directed to Mr. Bryan Kizer at SOUTHNAVFACENGCOM (803-820-5896) within 45 calendar days.

Very truly yours,

ABB ENVIRONMENTAL SERVICES, INC.

Rao Angara
Installation Manager

cc: B. Kizer, SDIV (2 copies)
S. Wilson, SDIV
D. Kruzicki, NASCF (2 copies)
H. Bauer, BEI
L. Routhier, ABB-ES
D. Vaughn-Wright, USEPA
file

Sponsor Special Olympics World Games Connecticut 1995

ABB Environmental Services Inc.

Berkeley Building
2590 Executive Center Circle East
Tallahassee, Florida 32301

Telephone (904) 656-1293
Fax (904) 877-0742

ASEA BROWN BOVERI

Directions for Completing the South Fuel Farm Remedial Action Plan NAS Cecil Field Jacksonville, Florida October 1996

1. Replace the existing (May 1996) RAP text with the enclosed revised RAP text.

2. Replace existing (May 1996) appendices D through G with the enclosed revised appendices.

3. Replace the front cover and the spine with the enclosed green RAP report cover and spine.

ABB

8520-3160

October 28, 1996

Mr. Michael Deliz, P.G.
Florida Department of Environmental Protection
Bureau of Waste Cleanup
2600 Blair Stone Road
Tallahassee, Florida 32399-2400

Re: Alternate Procedures Request, South Fuel Farm, NAS Cecil Field, Jacksonville, Florida
Contract No. N62467-89-D-0317/090

Dear Mr. Deliz:

A Remedial Action Plan (RAP) for the South Fuel Farm was prepared by ABB-ES based on data collected during the Contamination Assessment Report Addendum (April through November 1995). The RAP addressed the entire site and was prepared based on data that indicated no free product was present at the site.

In October of this year free product was observed on the ground surface south of Day Tank 2. This occurred after a period of heavy rains. On October 9, 1996 several site piezometers and monitoring wells were checked for depth-to-water and depth-to-product. Free product was found in one monitoring well (CEF-043-41) and one piezometer (CEF-043-PZ2) at apparent thicknesses of 0.12 ft and 0.78 ft, respectively. Since free product was found and the initial event did not target all "probable" locations, a second event was conducted on October 18, 1996. This second event found free product in two monitoring wells and three piezometers at an apparent thickness ranging from 0.91 ft to 6.51 ft. The free product was bailed by ABB-ES on October 18th and will continue to be recovered via bailing on a weekly basis. Recovery via test pitting, by Bechtel Environmental, Inc., the Navy's Response Action Contractor, will also be performed.

The remedies proposed for the areas north of Day Tank 2, bioventing and biosparging, are not affected by presence of free product south of Day Tank 2. Since the free product contaminated areas are hydraulically downgradient from the north side, these remedies will not change based on any future assessment of the areas affected by free product. The Base Realignment and Closure (BRAC) team and support staff teleconferenced on October 23rd and agreed to:

1) implement the remedial action described in the RAP for the northern portion of the site as an APR,

2) initiate free product recovery,

3) investigate the extent of free product during the Day Tank 2 Contamination Assessment, scheduled for early 1997, and

4) incorporate this APR and a final design for the southern portion of the site in a final RAP.

The remedial action identified in this APR, and described in the October 1996 RAP, will be implemented prior to the complete delineation of the southern portion of the site.

ALTERNATE PROCEDURES REQUEST

Florida Administrative Code (F.A.C.) Chapter 62-770.700 (1) states that "Within two (2) months of approval of a Contamination Assessment Report or a Risk Assessment Report, two copies of the Remedial Action Plan shall be submitted to the Department for approval prior to implementation." Since the Navy is requesting to perform remedial action in the northern portion of the site without an approved RAP, this APR is being prepared.

The following information is required and has been provided to obtain approval of alternative procedures and requirements in accordance with Rule 62-770.890(2a-f), F.A.C.

(2a) **Site Name:** South Fuel Farm; NAS Cecil Field; Jacksonville, FL.

(2b) **Provisions of Chapter 62-770, F.A.C., from which an exemption is sought:**

Bioventing and biosparging would be considered a remedial action, and since the site does not have an approved RAP, this would be contrary to the aforementioned Rule 62-770.770 (1).

(2c) **Basis for the exception:**

This remedial action would expedite the cleanup of contaminated groundwater and soil in the northern portion of the site, while concurrently implementing a contamination assessment in the southern portion. This would initiate the cleanup process and allow the flexibility to make any modifications to the system in the final design for the southern portion.

(2d) **The alternative procedure for which approval is sought:**

Biosparging and bioventing to remediate contaminated groundwater and soil.

(2e) **Demonstration of an equivalent or greater degree of protection for the lands, surface waters, or groundwaters of the state as the established procedure or requirement:**

The alternative selected will reduce the concentrations of petroleum contamination in vadose zone soils; thereby reducing a potential continuing source to groundwater. This alternative will also help remediate the groundwater plume in the northern portion of the site by facilitating the biodegradation of dissolved-phase hydrocarbons.

ABB

(2f) **Demonstration that the alternate procedure or requirement is at least as effective as the established procedure or requirement:**

Since this alternate procedure was initially developed as a RAP, the design of the bioventing and biosparging systems were based on the requirements stated in Rule 62-770.700 (2).

This APR is for the bioventing and biosparging systems for the northern portion of the site. The implementation of an oxygen barrier wall and intrinsic remediation for the southern portion of the site is subject to change based on future data. Also, there are four proposed bioventing wells located in the southern portion of the site; these will not be constructed as part of this APR.

Should you have any questions concerning this document please feel free to contact myself of Bob Lunardini.

Very truly yours,

ABB ENVIRONMENTAL SERVICES, INC.

Rao Angara
Principal Task Order Manager

Robert C. Lunardini, Jr., P.E.
Principal Engineer

cc: Dave Kruzicki, NAS Cecil Field
Steve M. Wilson, P.E., SOUTHDIV
Bryan Kizer, SOUTHDIV
Herman Bauer, BEI
Lisa Routhier, ABB-ES
Debbie Vaughn-Wright, EPA
file

REMEDIAL ACTION PLAN
SOUTH FUEL FARM

NAVAL AIR STATION CECIL FIELD
JACKSONVILLE, FLORIDA

Unit Identification Code: N60200

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

Prepared by:

ABB Environmental Services, Inc.
2590 Executive Center Circle, East
Tallahassee, Florida 32301

Prepared for:

Department of the Navy, Southern Division
Naval Facilities Engineering Command
2155 Eagle Drive
North Charleston, South Carolina 29418

Bryan Kizer, Code 1842, Engineer-in-Charge

October 1996

CERTIFICATION OF TECHNICAL
DATA CONFORMITY (MAY 1987)

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

DATE: October 28, 1996

NAME AND TITLE OF CERTIFYING OFFICIAL: Rao Angara
Task Order Manager

NAME AND TITLE OF CERTIFYING OFFICIAL: Robert C. Lunardini, Jr., P.E.
Project Technical Lead

(DFAR 252.227-7036)

The engineering design and professional opinions rendered in the set of planning documents that describe the South Fuel Farm, Remedial Action Plan, Naval Air Station Cecil Field, Jacksonville, Florida, were conducted or developed in accordance with commonly accepted procedures consistent with applicable standards of practice. These planning documents are intended to be implemented by Southern Division, Naval Facilities Engineering Command's Response Action Contract Contractor or Comprehensive Long-term Environmental Action, Navy Contractor. The plan for remediating this site is based on the assessment information collected between December 1993 and December 1995 and engineering detailed in the text and appended to this report. If conditions are determined to exist differently than those described, the undersigned professional engineer should be notified to evaluate the effects of any additional information on the design described in this report.

Robert C Lunardini Jr
10/28/96

Robert C. Lunardini, Jr.
Professional Engineer No. 46657
Expires February 28, 1997

FOREWORD

Subtitle I of the Hazardous and Solid Waste Amendments of 1984 to the Solid Waste Disposal Act of 1965 established a national regulatory program for managing underground storage tanks (USTs) containing hazardous materials, especially petroleum products. Hazardous wastes stored in USTs were already regulated under the Resource Conservation and Recovery Act of 1976. Subtitle I requires that the U.S. Environmental Protection Agency (USEPA) promulgate UST regulations. The program was designed to be administered by individual states, which were allowed to develop more stringent, but not less stringent, standards. Local governments were permitted to establish regulatory programs and standards that are more stringent, but not less stringent, than either State or Federal regulations. The USEPA UST regulations are found in the Code of Federal Regulations, Title 40, Part 280 (40 CFR 280) (*Technical Standards and Corrective Action Requirements for Owners and Operators of Underground Storage Tanks*) and 40 CFR 281 (*Approval of State Underground Storage Tank Programs*). 40 CFR 280 was revised and published on September 23, 1988, and became effective December 22, 1988.

The Navy's UST program policy is to comply with all Federal, State, and local regulations pertaining to USTs. This report was prepared to satisfy the requirements of Chapter 62-770 (formerly Chapter 17-770), Florida Administrative Code (State Underground Petroleum Environmental Response) regulations on petroleum contamination in Florida's environment as a result of spills or leaking tanks or pipes.

Questions regarding this report should be addressed to the Commanding Officer, Naval Air Station Cecil Field, or to Southern Division, Naval Facilities Engineering Command, Code 1842, at 803-743-0596 (AUTOVON 563-0596).

product will be recovered by weekly bailing the affected monitoring wells and piezometers. Final remediation at the SFF will be addressed in the RAP for Day Tank 2.

The purpose of this RAP is to present a plan for remediation of petroleum contamination at the SFF. The RAP presented herein is designed for implementation at the SFF and, when implemented, will result in a reduction of the level of petroleum-related contamination in the soil and groundwater in accordance with the requirements of Chapter 62-770, FAC.

A remedial system has been designed to reduce soil and groundwater contaminant concentrations to below target levels. The system was designed so that its construction and operation would have minimal effects on site activities.

This RAP presents the rationale for the remedial actions to be implemented at the SFF. Implementation of remedial actions described in this RAP will include the tasks below.

1. Bioventing. A regenerative centrifugal blower connected to a piping system that feeds 13 biovent wells will be used to inject air directly into vadose zone soils located within the 50 parts per million organic vapor analyzer soil contaminant contour.

2. Biosparging. A screw compressor with air dryer connected to a piping system that feeds 23 biosparge wells will be used to inject air directly into groundwater located within the 1,000 micrograms per liter total volatile organic compounds contaminant contour. The objective of biosparging is to treat the most contaminated portion of the plume until the source remediation is complete.

3. Oxygen Barrier Wall. To oxygenate groundwater before it discharges to the storm drain, an oxygen release compound (ORC™) slurry will be placed into a line of 95 1-inch-diameter boreholes, each 15 feet deep, on 9-foot centers. This is a passive method of introducing oxygen into the groundwater to enhance biological activity.

4. Intrinsic Remediation. Once the bioventing is complete and it has been proven that the oxygen barrier wall is working, groundwater remediation will revert to intrinsic remediation. At that time, a workplan will be developed to implement intrinsic remediation.

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Jacksonville, Florida

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ASCF Jacksonville

N60200-000007

11/1/1996

REMEDIAL INVESTIGATION
OPERABLE UNIT 4

NAVAL AIR STATION CECIL FIELD
JACKSONVILLE, FLORIDA

Unit Identification Code: N60200

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

Prepared by:

ABB Environmental Services, Inc.
2590 Executive Center Circle, East
Tallahassee, Florida 32301

Prepared for:

Department of the Navy, Southern Division
Naval Facilities Engineering Command
2155 Eagle Drive
North Charleston, South Carolina 29418

Alan Shoultz, Code 1875, Engineer-in-Charge

November 1996

ABB

8500-3162

November 19, 1996

Ms. Debbie Vaughn-Wright
Remedial Project Manager
Federal Facilities Branch
Waste Management Division, 10th Floor
USEPA Region IV
100 Alabama St. N.W.
Atlanta, Georgia 30303

Subject: Final Remedial Investigation Report
Operable Unit 4, Site 10
Naval Air Station Cecil Field, Jacksonville, Florida
Contract No. N62467-89D-0317/090

Dear Ms. Vaughn-Wright:

On behalf of Southern Division, Naval Facilities Engineering Command, ABB Environmental Services, Inc. is pleased to forward three copies of the subject document.

To conserve paper and report binders and reduce document reproduction costs, the enclosed RI report consists of the report covers, revised text, and appendices. Directions for completing the Final RI report are also enclosed.

Comments or questions you may have concerning this document should be directed to Mr. Mark Davidson at (803) 820-5526.

Sincerely,

ABB ENVIRONMENTAL SERVICES, INC.

Rao Angara
Installation Manager

cc: Mr. Eric Nuzie, FDEP
Mr. David Kruzicki, NASCF
Mr. Hermann Bauer, BEI
Mr. Alan Shoultz, SDIV
Mr. Steve Wilson, SDIV
Ms. Lisa Routhier, ABB-ES
Mr. Gerald Young, City of Jacksonville
File

ABB Environmental Services Inc.

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2590 Executive Center Circle East
Tallahassee, Florida 32301

Telephone (904) 656-1293
Fax (904) 877-0742

Directions for Completing the Remedial Investigation Report Operable Unit 4 NAS Cecil Field Jacksonville, Florida November 1996

1. Replace the existing (June 1996) RI text with the enclosed revised text.
2. Replace Appendix C, Lithologic Logs/Construction Diagrams.
3. Insert enclosed 'Hits Tables' to Appendix D.
4. Replace Appendix F.3 (Toxicological Dose-Response Values) and Appendix F.5 (Risk Calculations Spread Sheets).
5. Add Appendix I (Results of Hydraulic Conductivity Testing).

CERTIFICATION OF TECHNICAL
DATA CONFORMITY (MAY 1987)

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

DATE: November 18, 1996

NAME AND TITLE OF CERTIFYING OFFICIAL: Rao Angara
Task Order Manager

NAME AND TITLE OF CERTIFYING OFFICIAL: Jayne McIntosh, P.G.
Project Technical Lead

(DFAR 252.227-7036)

This document that describes the Remedial Investigation of Operable Unit 4, Naval Air Station Cecil Field, Jacksonville, Florida, has been prepared under the direction of a Florida-Registered Professional Geologist. The work and professional opinions rendered in this report were conducted or developed in accordance with commonly accepted procedures consistent with applicable standards of practice.

Jayne McIntosh

Jayne McIntosh

Professional Geologist No.: 1400
Expires July 31, 1998

Date: November 15, 1996

FOREWORD

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

The IR program consists of preliminary assessment and site inspection, remedial investigation and feasibility study (RI/FS), and remedial design and remedial action at sites where chemicals were possibly disposed of. Pollutants are identified during the preliminary assessment and site inspection. The RI/FS analyzes the nature and extent of contamination and determines the optimum remedial solution. The remedial design and remedial action complete the implementation of the solution.

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

This Remedial Investigation report for Operable Unit (OU) 4 summarizes the field program completed at OU 4 and presents the findings and conclusions reached during the investigation.

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

EXECUTIVE SUMMARY

ABB Environmental Services, Inc., has been contracted by the Southern Division, Naval Facilities Engineering Command to complete a remedial investigation (RI) and feasibility study (FS) for Operable Unit (OU) 4, the Rubble Disposal Area, at Naval Air Station (NAS) Cecil Field. The objectives of this RI, initiated in 1995, were to characterize the nature and extent of possible contamination associated with OU 4; gather sufficient data to complete the baseline risk assessment (BRA); and, if warranted by the nature and extent of contamination detected, conduct a FS of remedial alternatives. This document presents the findings of the RI and BRA. Based upon the findings of the RI and BRA, it was determined that remediation of OU 4 will not be necessary; hence, the feasibility study portion of the RI/FS will not be performed.

NAS Cecil Field is located in western Duval County, Florida, approximately 14 miles west of downtown Jacksonville, Florida. The first environmental study for the investigation of waste handling and/or disposal sites at NAS Cecil Field was completed between 1983 and 1985. During subsequent investigations, including an initial assessment study (IAS) conducted in 1985 and a Resource Conservation and Recovery Act facility investigation (RFI) conducted in 1988, OU 4 was evaluated as a discreet site.

According to information obtained during the IAS and the RFI, OU 4 was an active disposal area throughout the 1950s and 1960s. The site was reported to have been used by the base Public Works Department for disposal of building and runway demolition debris as well as other inert waste. The wastes have been reportedly both buried and deposited directly on the land surface. No reports or evidence of hazardous waste at the site have been discovered.

A conceptual model was developed for the site based upon information obtained during previous investigations and served as the basis for determining the scope of this investigation. The model concluded that there was no significant risk to human health or ecological receptors due to past rubble disposal at the site.

Media evaluated to confirm the conceptual model included site soil and groundwater. Potential impacts to surface water and sediment in Rowell Creek to the west of OU 4 were evaluated during the RI conducted for OU 1 and are referenced where appropriate.

Conclusions regarding the physical characteristics of the OU 4 study area and the contaminants detected in surface water, sediment, surface soil, and groundwater include the following:

- Sufficient information was collected in the field or compiled from historical records to confirm that past waste disposal activities at OU 4 have not had a negative impact on the environmental quality of the site or surrounding area.

- There is no risk to human health or the ecological receptors evaluated from exposure to analytes detected in OU 4 surface soil or groundwater.

- A finding of no further action is recommended for OU 4.

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Jacksonville, Florida

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GLOSSARY

ABB-ES	ABB Environmental Services, Inc.
AQUIRE	Aquatic Information Retrieval
ARARs	applicable or relevant and appropriate requirements
ASTM	American Society for Testing and Materials
AWQC	ambient water quality criteria
BAF	bioaccumulation factor
BEAR	basewide ecological assessment report
bls	below land surface
BRA	baseline risk assessment
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CLP	Contract laboratory Program
CPC	contaminant of potential concern
DQO	data quality objective
ECPC	ecological contaminants of potential concern
EE	Envirodyne Engineers
ELCR	excess lifetime cancer risk
EPC	exposure point concentration
ERA	ecological risk assessment
FDA	Florida Department of Agriculture and Consumer Services
FDEP	Florida Department of Environmental Protection
ft/day	feet per day
GIR	General Information Report
G&M	Geraghty & Miller, Inc.
GSE	ground surface elevation
GWE	groundwater elevation
HEAST	Health Effects Assessment Summary Tables
HHCPC	human health chemicals of potential concern
HHRA	human health risk assessment
HI	hazard index
HLA	Harding Lawson Associates
HQ	hazard quotient
IAS	initial assessment study
IR	installation restoration
IRIS	Integrated Risk Information System
K	hydraulic conductivity
LD_{50}	low dose where 50 percent of animals die
LOEC	lowest observed effects concentrations

GLOSSARY (Continued)

mg/kg	milligrams per kilogram
μg/kg	micrograms per kilogram
μg/ℓ	micrograms per liter
NAS	Naval Air Station
NGVD	National Geodetic Vertical Datum
OU	operable unit
PARCC	precision, accuracy, representativeness, completeness, and comparability
PCBs	polychlorinated biphenyls
PDE	potential dietary exposure
RBC	risk-based concentration
RCRA	Resource Conservation and Recovery Act
RFI	RCRA facility investigation
RGO	remedial goal option
RI/FS	remedial investigation and feasibility study
RTVs	reference toxicity values
SCGs	soil cleanup goals
SFF	site foraging frequency
SOUTHNAV-FACENGCOM	Southern Division, Naval Facilities Engineering Command
SVOC	semivolatile organic compound
TAL	target analyte list
TCL	target compound list
TDS	total dissolved solids
TIC	tentatively identified compound
TOC	total organic carbon
TPH	total petroleum hydrocarbons
TRPH	total recoverable petroleum hydrocarbons
UCL	upper confidence limit
USDA	U.S. Department of Agriculture
USEPA	U.S. Environmental Protection Agency
USGS	U.S. Geological Survey
VOC	volatile organic compound

1.0 INTRODUCTION

ABB Environmental Services, Inc. (ABB-ES), has been contracted by the Department of the Navy, Southern Division, Naval Facilities Engineering Command (SOUTHNAV-FACENGCOM), to conduct a remedial investigation/feasibility study (RI/FS) for Operable Unit (OU) 4 (Site 10), Rubble Disposal Area, at Naval Air Station (NAS) Cecil Field in Jacksonville, Florida. The RI/FS has been completed under contract number N62467-89-D-0317-090 as part of the Navy's installation restoration (IR) program. This report presents the findings and conclusions of the RI and the baseline risk assessment (BRA).

1.1 PURPOSE OF REPORT. The purpose of this report is to present the findings of the RI regarding past waste disposal activities at OU 4. Media evaluated include the site soil and groundwater as well as the surface water and sediment in Rowell Creek and a tributary to the north of OU 4. The RI further served as the mechanism for data collection to identify source and migration pathway characteristics and for collection of other information required to complete the BRA. The purpose of the BRA was to assess risks to human health and the environment from exposure to analytes detected in surface soil and groundwater at OU 4.

1.2 REPORT ORGANIZATION. This report consists of eight chapters and has been prepared in accordance with *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA* (U.S. Environmental Protection Agency [USEPA], 1988a). Chapter 1.0 contains general information including the RI and BRA objectives, report organization, site-specific background information, and the conceptual model of site conditions. Chapter 2.0 discusses the activities undertaken to characterize the site conditions as well as the rationale for the sampling program implemented at OU 4.

The physical characteristics of the study area, including the site topography, surface and subsurface soils, geology, hydrology, and ecology, are discussed in Chapter 3.0. The results of the chemical analyses of the groundwater, surface water, sediment, and soil samples collected for site characterization are presented in Chapter 4.0. Contaminant fate and transport are discussed in Chapter 5.0. The human health and ecological risk assessments are discussed in Chapters 6.0 and 7.0, respectively. Chapter 8.0 presents the overall conclusions and recommendations for OU 4. References and appendices are included at the end of the report.

1.3 SITE BACKGROUND. OU 4, the Rubble Disposal Area, is located near the west-central boundary of Cecil Field approximately 1,000 feet northeast of the confluence of Rowell and Sal Taylor Creeks as shown on Figure 1-1. OU 4 encompasses approximately 9 acres, having the approximate dimensions of 2,000 feet from north to south and 200 feet from east to west.

According to information obtained during an initial assessment study (IAS) conducted by Envirodyne Engineers (EE) in 1985 (EE, 1985) and the Resource Conservation and Recovery Act (RCRA) facilities investigation (RFI) conducted by Harding Lawson Associates (HLA) in 1988 (HLA, 1988), OU 4 was used by the base

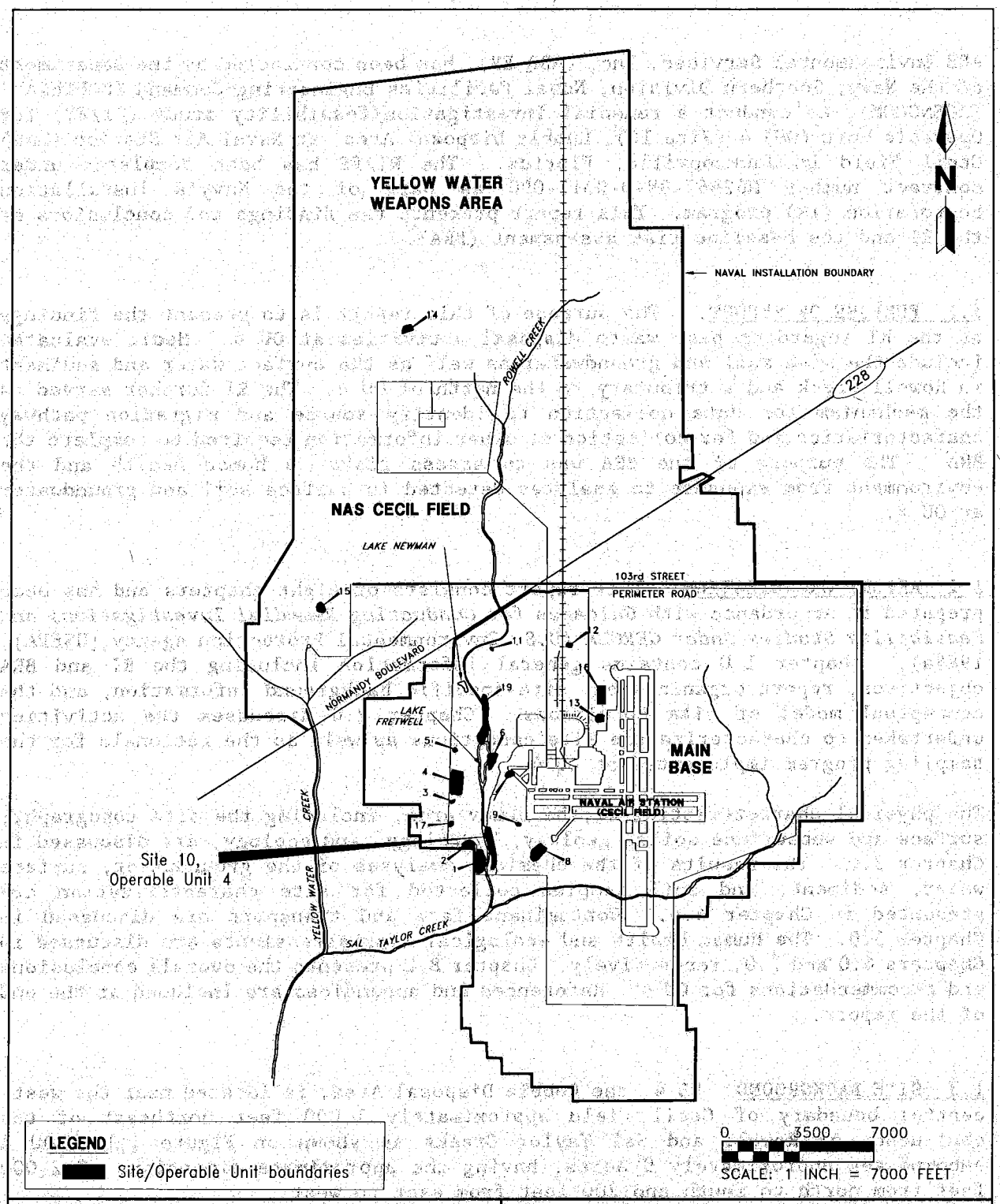

FIGURE 1-1
SITE LOCATION MAP

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Public Works Department as a rubble disposal area for a period of approximately 20 years during the 1950s and 1960s. Wastes disposed of at the site included building demolition debris, concrete, and other inert wastes such as tires, asphalt, and furniture. The wastes have reportedly been both buried, as suggested by the results of a geophysical survey conducted by HLA, and deposited directly on the land surface, as evidenced by the six rubble piles and scattered debris that remains partially visible through thick vegetation. Documentation regarding the quantity of debris dumped on the site is not available. No reports or evidence of hazardous waste disposal at the site have been discovered.

A complete discussion of the findings of the above referenced IAS and RFI as well as other past environmental investigations conducted at Cecil Field is presented in the General Information Report (GIR) (ABB-ES, 1996).

1.4 CONCEPTUAL MODEL. It is anticipated that contaminants released to the environment from past rubble disposal on OU 4 would be detected in site surface soils and groundwater. Impacts may also be evident in the surface water and sediments via overland flow and/or groundwater discharge in Rowell Creek and a tributary located along the northern boundary of OU 4. While, based upon information presented in the IAS and RFI, hazardous constituents are not expected, additional information on site surface soil and groundwater, and surface water and sediment in the tributary is considered necessary to complete a BRA. The BRA will evaluate whether there is a risk to human health or ecological receptors due to past rubble disposal activities.

2.0 STUDY AREA INVESTIGATION

This RI was conducted in accordance with the workplan for OU 4 as outlined in the Remedial Investigation and Feasibility Study Operable Units 3,4,5, and 6 Workplan (ABB-ES, 1994), and a memorandum dated July 14, 1994, presented in Appendix A of this report. The memorandum documents modifications to the scope of the workplan. Based upon the historical use of the site as a rubble disposal area, with no reports of disposal of hazardous materials, it was the consensus among the regulatory agencies, specifically the USEPA and the Florida Department of Environmental Protection (FDEP) as well as the U.S. Navy and the Navy's environmental consultant, ABB-ES, that reduction of the scope of the field sampling program as outlined in the workplan was warranted. The following activities were performed during this RI:

- review of available documentation regarding the findings of previous investigations of OU 4;
- site reconnaissance;
- mapping of all surficial rubble piles;
- installation and sampling of a single, shallow groundwater monitoring well downgradient of the largest rubble pile;
- collection and chemical analysis of six surface soil samples, two surface water and sediment samples, and groundwater samples from each of four existing wells;
- hydraulic conductivity testing in all five OU 4 monitoring wells; and
- groundwater level elevation measurements.

2.1 SURFACE FEATURE INVESTIGATIONS. Investigations completed to characterize existing surface features at the site included a site reconnaissance, a survey of the positions of all sampling locations and the extent of visible rubble piles. Information regarding surface features observed during site reconnaissance is summarized in Section 3.1. The locations of all media sampling points are shown on Figure 2-1.

2.2 CONTAMINANT SOURCE INVESTIGATIONS. Information on the source of materials placed at OU 4 was evaluated during the IAS (EE, 1985) and the RFI (HLA, 1988). A complete discussion of the findings of the above referenced IAS and RFI is presented in the GIR (ABB-ES, 1996).

Contaminant source investigations completed during this RI included a review of the IAS, RFI, and historical aerial photographs, a site reconnaissance, monitoring well installation, and the chemical analysis of surface soil, surface water, sediment, and groundwater samples.

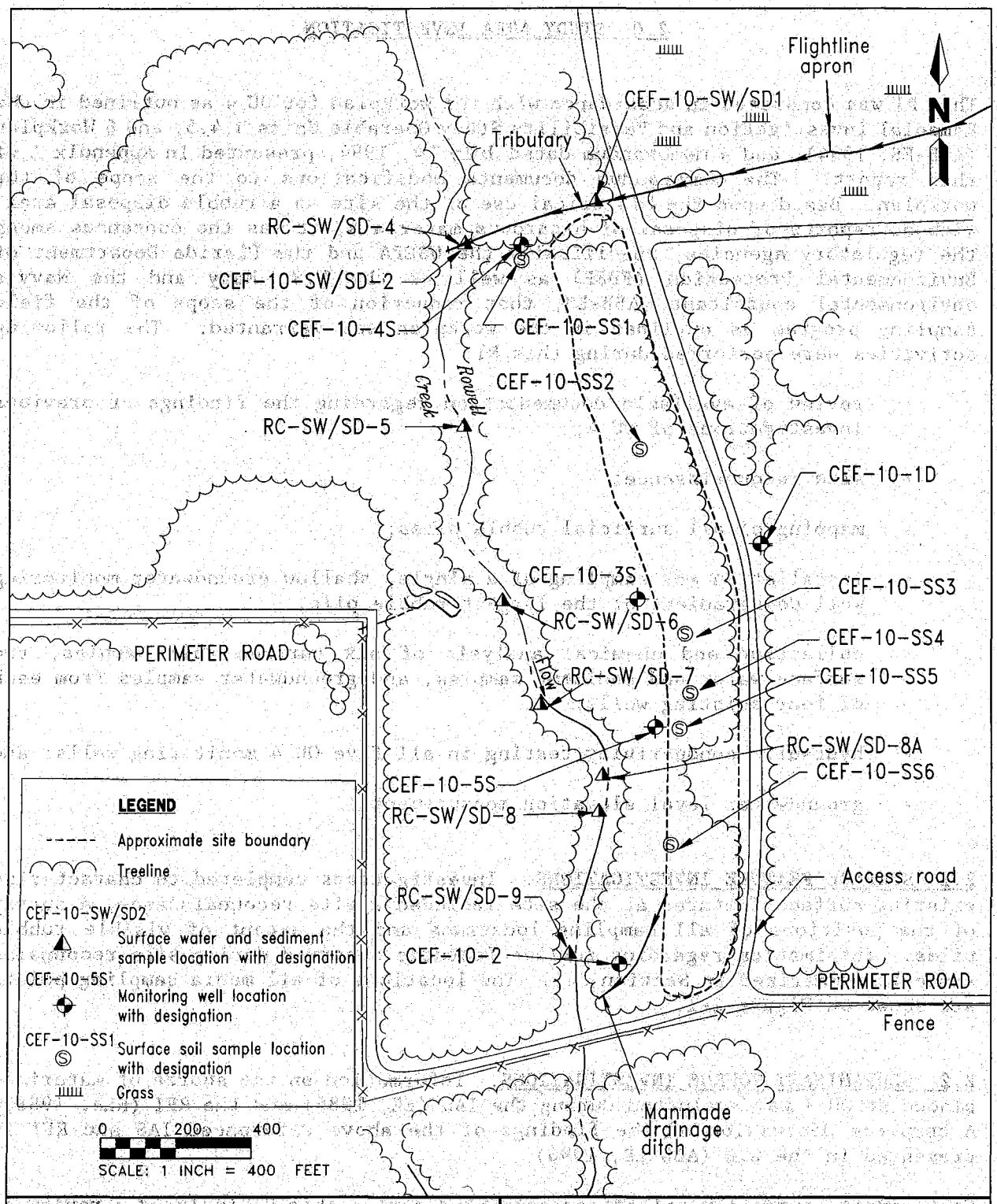

FIGURE 2-1
SAMPLING LOCATION MAP

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2.2.1 Surface Water and Sediment Investigations Two sets plus a duplicate set of surface water and sediment samples (CF10SWSD1, CF10SWSD2, CF10SWSD2D) were collected from the Rowell Creek tributary located along the northern boundary of the site as shown on Figure 2-1. In the sampling location nomenclature, "SD" and "SW" denote sediment and surface water, respectively. The "D" following SD2 denotes a field duplicate taken at SD2.

Field measurements of surface water pH, temperature, turbidity, conductivity, and dissolved oxygen were recorded at each sample location by field personnel. Surface water and sediment samples were submitted for Contract Laboratory Program (CLP) target compound list (TCL) organics, target analyte list (TAL) inorganics and total recoverable petroleum hydrocarbons (TRPH). Total organic carbon (TOC) analyses were completed for all sediment samples. Wet chemistry analyses were performed on the surface water samples including hardness, total dissolved solids, alkalinity, chloride, total phosphorus, sulfate, sulfide, and total kjeldahl nitrogen. Hexavalent chromium analysis was performed on surface water sample CF10SW2 and its duplicate CF10SW2D, to evaluate whether or not this more toxic form of chromium is present. The results of the TCL, TAL, and TRPH analyses of surface water and sediment samples are discussed in Subsection 4.2.3. The results of the wet chemistry analyses are included in Appendix D.

In addition to the samples collected during this RI, the results of a series of surface water and sediment samples collected in Rowell Creek during the evaluation of OU 1 (ABB-ES, 1994b) were also reviewed. The locations of samples RCSWSD4, RCSWSD5, RCSWSD6, RCSWSD7, RCSWSD8, RCSWSD8A, and RCSWSD9 are indicated on Figure 7-4.

2.2.2 Soil Investigation Six surface soil samples plus one duplicate sample (CF10SS1, CF10SS2, CF10SS3, CF10SS4, CF10SS5, CF10SS5D, and CF10SS6) were collected on the downgradient sides of exposed rubble piles and in other selected areas of the site to support the assessment of health and ecological risks from exposure to site soils. The soil samples were collected from the interval of 0 to 12 inches below land surface (bls) and submitted for CLP analysis of TCL parameters, TAL parameters, TRPH, and percent moisture. The results of the soil analyses are discussed in Subsection 4.2.1.

A single geotechnical sample, CF10SS5G, was collected from the vadose zone at a depth of 0 to 2 feet bls and submitted for the analysis of soil moisture content (American Society for Testing and Materials [ASTM] D-2216), Atterberg limits (ASTM D-4318), cation exchange capacity (SW9081), bulk density (ASTM E12-70), and sieve and hydrometer particle size distribution (ASTM D-421 and 422) (ASTM, 1994). The laboratory data sheets are presented in Appendix B of this report.

2.2.3 Groundwater Investigations

Groundwater Sampling Groundwater samples were collected for chemical analysis from four existing wells (CEF-10-1D, CEF-10-2, CEF-10-3S, CEF-10-4S) and one newly installed well (CEF-10-5S).

Shallow monitoring well CEF-10-5S was installed in March 1995 during this RI. The well was constructed in a location downgradient of the largest visible rubble pile on OU 4.

The locations of all of the monitoring wells are shown on Figure 2-1. A summary of the construction details is presented in Table 2-1. Monitoring well lithologic logs and construction diagrams are presented in Appendix C.

Table 2-1
Monitoring Well Construction Detail Summary

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Well Number	Date Installed	Land Surface Elevation[1] (feet, msl)	Total Depth of Well[2] (feet, bls)	Depth of Screened Interval[3] (feet, bls)	Groundwater Elevation[5] (feet, msl)	Lithology Screened	Construction Method
CEF-10-1D	3/84	68.8	115	95 - [4]115	62.87	Upper 5 feet limestone, lower 15 feet clay.	NA
CEF-10-2	6/8/87	48.0	38	9.8 - 29.8	49.65	Upper 9 feet silty to clayey sand, lower 11 feet sand.	HSA
CEF-10-3S	6/11/87	56.1	24	10 - 20	53.76	Sand	HSA
CEF-10-4S	6/11/87	56.0	30	9.9 - 29.9	51.19	Upper 7 feet sand, 5 feet clayey sand, 6 feet sand, lower 2 feet clay.	HSA
CEF-10-5S	3/2/95	52.8	12.2	3.2 - 13.2	51.19	Silty Sand.	HSA

[1] Elevation of northeast corner of concrete pad.
[2] Measured from land surface elevation; includes any sump.
[3] Measured from land surface elevation.
[4] Open hole construction.
[5] Depth to groundwater measured on April 15-16, 1995.

Notes: msl = mean sea level.
bls = below land surface.
D = deep monitoring well.
NA = not available.
HSA = hollow-stem auger.
S = shallow monitoring well.

Groundwater samples were collected from all monitoring wells during April and May 1995. Prior to the collection of groundwater samples, all wells were developed in accordance with procedures outlined in the Workplan for OUs 3, 4, 5, and 6 (ABB-ES, 1994). The groundwater samples were analyzed according to USEPA CLP procedures for TCL organics, TAL inorganics, cyanide, sulfides, TRPH, total dissolved solids, TOC, and major cations and anions. Sample analyses were performed in accordance with USEPA Level IV requirements. Data validation was performed on all analytical results in accordance with USEPA Functional Guidelines (USEPA, 1991). The results of the TCL organics, TAL inorganics, cyanide, and TRPH analyses are discussed in Subsection 4.2.2. The results of all other analyses are presented in Appendix D.

Aquifer Testing *In situ* hydraulic conductivity tests (slug tests) were conducted on all five monitoring wells at OU 4 in accordance with the methods specified

in the workplan. The aquifer slug test data were analyzed using a computer program (G&M, 1989) based on the Bouwer and Rice (1976) method (unconfined aquifer slug test) for wells completed in the surficial aquifer and the Cooper and Others (1973) method for the shallow rock aquifer. The results of the aquifer slug tests are presented in Subsection 3.5.4.

Groundwater Level Measurements. Groundwater level measurements were collected monthly for the period between February 1994 to April 1995 from all monitoring wells in accordance with methods described in the workplan. The results of the groundwater level monitoring are discussed in Subsection 3.5.3.

2.2.4 Background Investigations A sampling program was designed to characterize existing background conditions for NAS Cecil Field and to support the RI and BRA for various operable units including OU 4. The background monitoring network, originally established during the investigation of OU 1, consisted of monitoring well installation and the collection of surface soil, subsurface soil, and groundwater samples. Surface water and sediment sampling were also completed over much of the drainage system for NAS Cecil Field. Refer to Appendix H in the RI/FS Report for OU 1 (ABB-ES, 1994b) for a detailed summary of the background sampling program.

Background sample locations for groundwater selected for comparison with OU 4 data include CFBKMW1S, CFBKMW2S, CFBKMW4S, CFBKMW4SD, CFBKMW5S, CFBKMW7S, and CFBKMW8S. The two soil types present at OU 4, Albany Fine Sand and Wesconnett Fine Sand, are included in a background data set statistically identified as a single population. The data set includes background sample locations CEFBSS05, CEFBSS06, CEFBSS07, CEFBSS08, CEFBSS09, CEFBSS09D, CEFBSS10, CEFBSS11, CEFBSS12, CEFBSS13, CEFBSS14, and CEFBSS15.

3.0 PHYSICAL CHARACTERISTICS OF THE OPERABLE UNIT 4 STUDY AREA

This chapter presents a description of the physical characteristics of the OU 4 study area. Discussion of the physical characteristics is divided into the following sections: surface features, surface water hydrology, soil, geology and hydrogeology, and ecology.

3.1 SURFACE FEATURES. The OU 4 area of investigation covers approximately 9 acres and extends from Perimeter Road north approximately 2,000 feet and is up to 200 feet wide. The site is bounded to the north by a tributary of Rowell Creek, to the east by an unpaved access road, and to the south by Perimeter Road. Undeveloped woodlands bound the site to the west. The adjacent parcels to the north, east, and south are also undeveloped and wooded. The closest developed area is the west end of the east-west oriented flightline, located within 500 feet to the northeast of OU 4.

The general slope of the site is downward toward Rowell Creek from an approximate elevation of 65 feet National Geodetic Vertical Datum (NGVD) along the eastern boundary to a low of approximately 50 feet NGVD near the southwestern corner. According to information presented in the Basewide Ecological Assessment Report ([BEAR] ABB-ES, 1996a), along the easternmost edge of the site adjacent to the unpaved access road, disturbed upland species are encountered. Beyond the disturbed area on the northern two thirds of the site, the vegetation transitions from mixed pine/hardwood forest to mixed upland forest. The southern one third of the site is primarily a floodplain swamp associated with Rowell Creek. A relatively small area of transitional upland mixed forest/floodplain forest species is also present in the south-central region of the site. Several rubble piles are visible in the southern region of the site. Surface features and topography are presented on Figure 3-1. A map of the extent and general description of visible rubble is presented on Figure 3-2.

3.2 SURFACE WATER HYDROLOGY. Review of the U.S. Geologic Survey (USGS) 7.5 Minute Series Topographic Map, Fiftone Quadrangle, dated 1993 suggests that surface water on OU 4 flows west and southwest across the site toward Rowell Creek. Rowell Creek flows southward offbase toward its confluence with Sal Taylor Creek approximately 1,000 feet to the south of OU 4. Surface water may also be channeled locally by a shallow, east-west oriented, drainageway present across the central region of the site. As can be seen from Figure 3-2, the land surface contours in the vicinity of the tributary located along the northern site boundary suggest that the site slopes generally westward toward Rowell Creek. Therefore, in general, surface water from OU 4 is expected to flow westward toward Rowell Creek, rather than northward toward the tributary.

Rowell Creek and Sal Taylor Creek have been classified as Class III waters by the FDEP and, as such, are designated for recreation, propagation, and management of fish and wildlife and are not used for drinking water resources (Jacksonville Area Planning Board, 1980).

3.3 SOIL. The U.S. Department of Agriculture (USDA) Soil Conservation Service Soil Survey of Duval County (USDA, 1978) has classified the majority of the soil

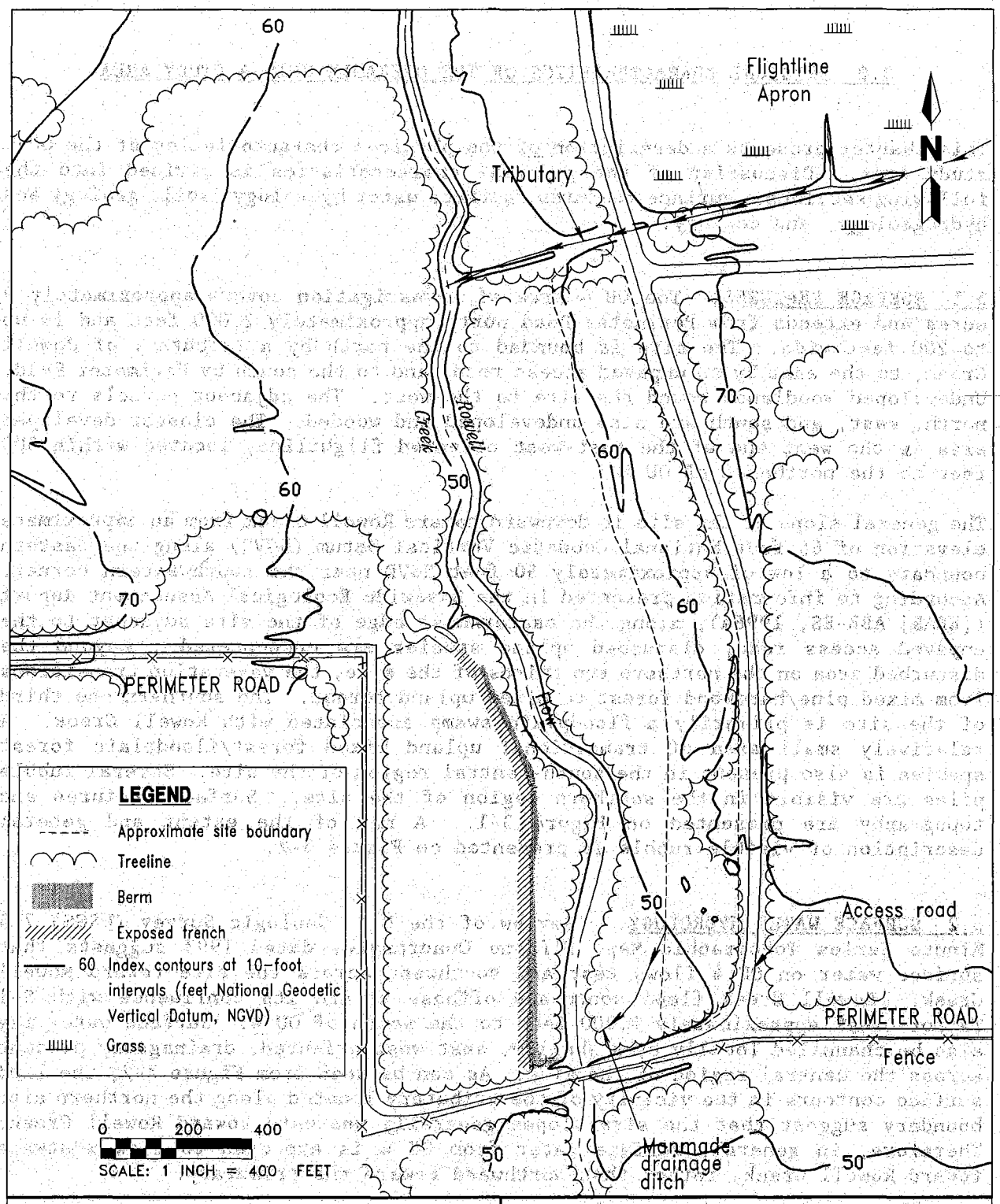

FIGURE 3-1
SURFACE FEATURES AND TOPOGRAPHY

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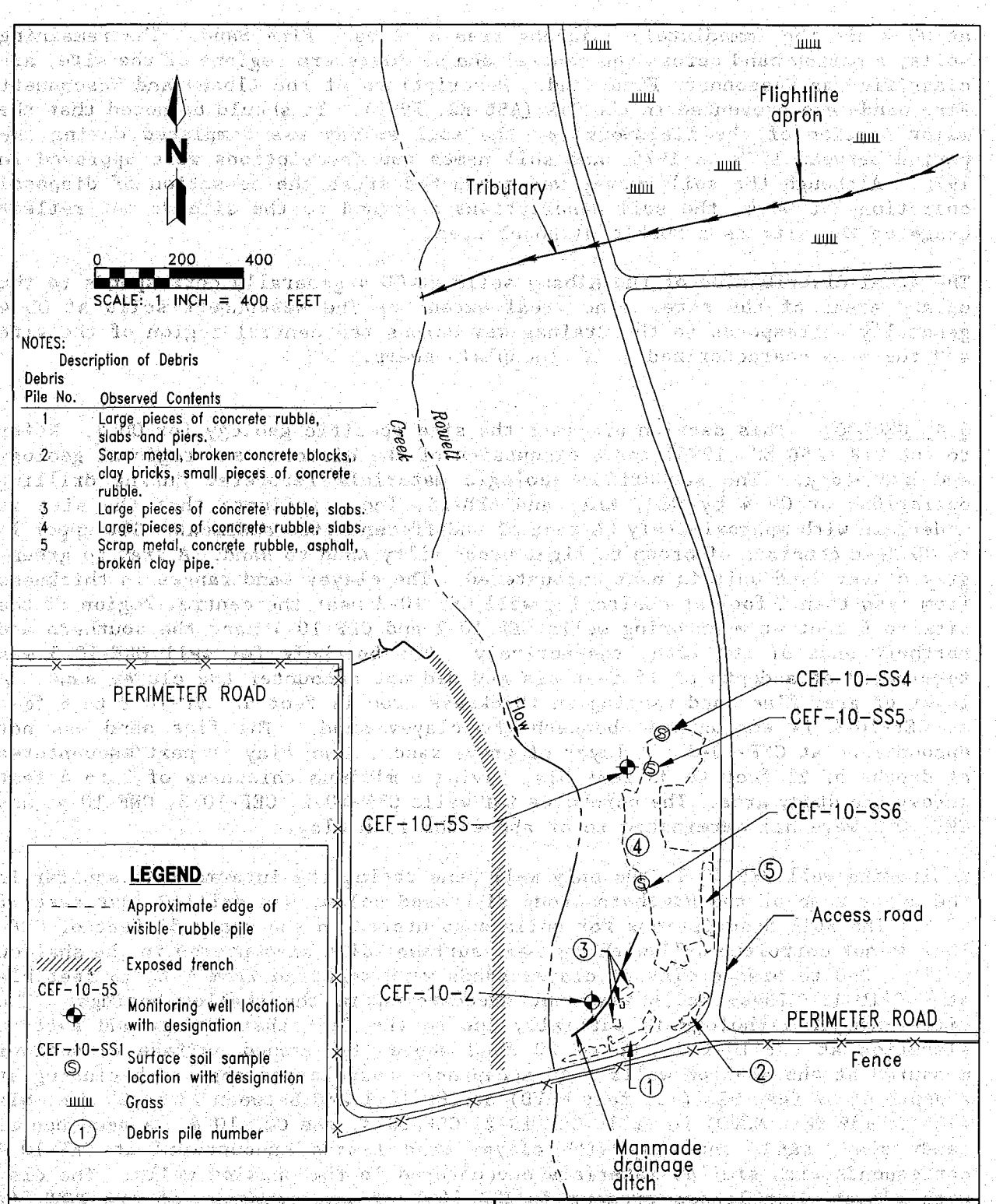

FIGURE 3-2
EXTENT AND GENERAL DESCRIPTION OF RUBBLE PILES

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OPERABLE UNIT 4

NAVAL AIR STATION CECIL FIELD
JACKSONVILLE, FLORIDA

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at OU 4 and the immediately adjacent area as Albany Fine Sand. The remaining soils, a narrow band across the central and southwestern regions of the site, are classified as Wesconnett Fine Sand. Descriptions of the Albany and Wesconnett Fine Sands are presented in the GIR (ABB-ES, 1996). It should be noted that the major portion of the fieldwork for the soil survey was completed during the period between 1973 to 1976, and soil names and descriptions were approved in 1976. Although the soil survey was conducted after the cessation of disposal operations at OU 4, the soil descriptions assigned to the site do not reflect usage of the site as a rubble disposal area.

The areal distribution of the Albany soils at OU 4 generally corresponds to the upland areas of the site. The areal extent of the Wesconnett soils at OU 4 generally corresponds to the drainageway across the central region of the site and the area characterized as a floodplain swamp.

3.4 GEOLOGY. This section presents the site-specific geology for OU 4. Refer to the GIR (ABB-ES, 1996) for a discussion of the historic and regional geology and hydrology. The subsurface geologic materials recovered during drilling operations at OU 4 by G&M, HLA, and ABB-ES, Inc., indicate that the site is underlain with approximately 84 feet of undifferentiated sediment. The upper 13 to 20 feet consists of brown to light brown silty sand to sand. A gray to green-gray clayey sand unit is next encountered. The clayey sand ranges in thickness from less than 1 foot at monitoring well CEF-10-3 near the central region of the site to 6 feet at monitoring wells CEF-10-2 and CEF-10-4 near the southern and northern ends of the site, respectively. The borehole for well CEF-10-5 was terminated at a depth of 15 feet bls and did not encounter the clayey sand. A layer of gray fine sand ranging in thickness from 14 feet at CEF-10-2 to 6 feet at CEF-10-4 is encountered beneath the clayey sand. The fine sand was not encountered at CEF-10-3. A layer of gray, sandy, lean clay is next encountered at depths of 21 feet to 35 feet bls, having a minimum thickness of 2 to 4 feet across the study area. The boreholes for wells CEF-10-2, CEF-10-3, CEF-10-4, and CEF-10-5 were all terminated in or above the lean clay.

Monitoring well CEF-10-1, the only well penetrating the intermediate aquifer in the upper zone of the Hawthorn Group discussed below, was drilled just east of OU 4. The soil descriptions for soils encountered in the upper 37 feet of CEF-10-1 do not correlate well with the near surface soils encountered in the shallow wells. Red to orange clay to clayey sands were reported from 4 to 18 feet bls at CEF-10-1. These soils were not encountered in the shallow borings. The difference in lithology is partially due to the fact that the ground surface elevation at CEF-10-1 is 12 to 20 feet above the ground surface elevations measured at the shallow wells. An acceptable correlation appears beginning at a depth of 37 feet bls (+31 feet NGVD) at CEF-10-1 and between 13 to 20 feet bls (+35 to +39 feet NGVD) in wells CEF-10-2, CEF-10-3, and CEF-10-4. A sequence of sandy clay, sand, and clay with clayey sand lenses encountered at CEF-10-1 corresponds with similar materials encountered in the shallow wells. The clay with clayey sand lenses present in CEF-10-1 at an elevation of +26 NGVD is probably the lean clay layer encountered in CEF-10-2, CEF-10-3, and CEF-10-4 at elevations of +13 feet NGVD, +35 feet NGVD, and +28 feet NGVD, respectively. As stated above, the boreholes for wells CEF-10-2, CEF-10-3 and CEF-10-4 did not completely pass through the lean clay. The lean clay layer is 9 feet thick at CEF-10-1.

The soils beneath the lean clay at CEF-10-1 consist of a 14-foot-thick bed of fine sand with clay lenses followed by a bed of soft clay 18 feet thick. A hard limestone unit approximately 16 feet thick is encountered from 84 to 100 feet bls. The top 9 feet of the limestone unit contains soft clay. A soft white clay is present below the limestone from 100 to 115 feet bls, which is the total depth of monitoring well CEF-10-1D. Lithologic logs are presented in Appendix C. A geologic cross section through boring locations CEF-10-2, CEF-10-5S, CEF-10-35, and CEF-10-45 is presented on Figure 3-3.

3.5 HYDROGEOLOGY. There are three water-bearing systems at OU 4. According to the Florida hydrostratagraphic nomenclature (Scott, 1988), these units, from most shallow to deepest are the surficial aquifer system, the carbonate-rich Upper Zone of the Hawthorn Group, referred to as the intermediate aquifer, and the Floridan aquifer system.

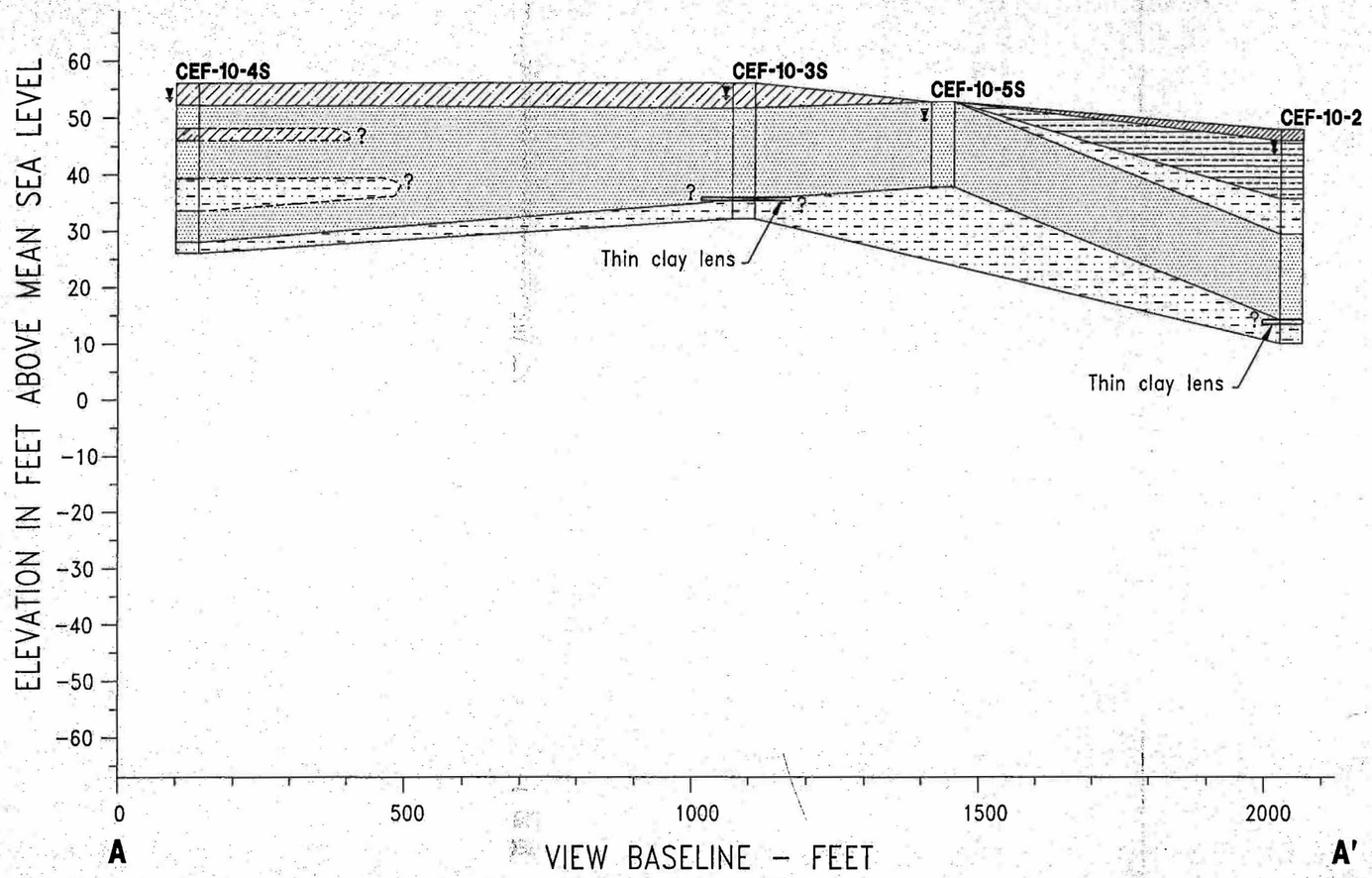
At OU 4, the surficial aquifer system is present in the upper 84 feet of undifferentiated sediments described above. The intermediate aquifer consists of the limestone encountered at a depth of 84 feet bls in CEF-10-1. Groundwater samples were collected from wells completed in the surficial and intermediate aquifers. The Floridan aquifer system was not penetrated during this investigation because the overlying Hawthorn Formation, in excess of 300 feet thick in the study area, acts as a confining layer. A brief discussion of the hydraulic characteristics of each unit sampled is presented in subsequent sections below.

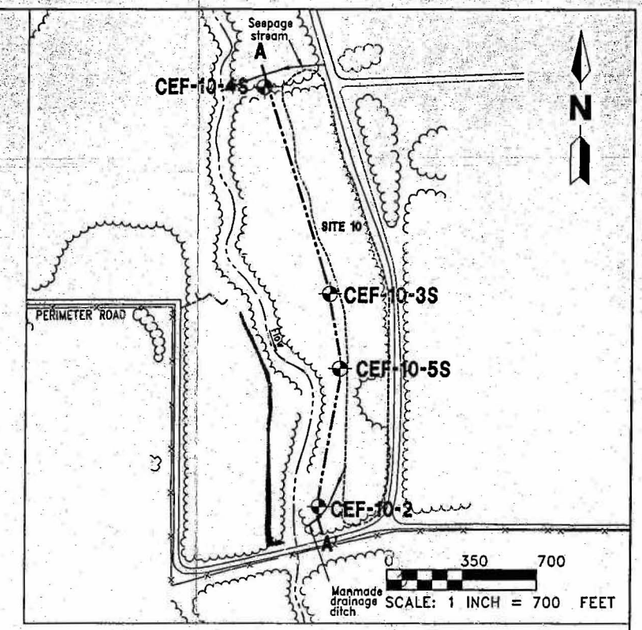
3.5.1 Surficial Aquifer System The surficial aquifer system in the area of OU 4 is composed of undifferentiated sediments and is not separated into an upper and lower zone based on geology, but rather is considered as one unit. The undifferentiated sediments consist of mostly quartz sand with some clayey sand and clay. The surficial aquifer system is unconfined.

3.5.2 Intermediate Aquifer System In addition to its clay rich sediment, the Hawthorn includes near its top a locally continuous carbonate unit composed of dolomite with significant secondary porosity (e.g., fractures). This carbonate-rich unit forms the historical "rock aquifer" or "secondary artesian aquifer," a water-bearing unit widely used in this region as a private drinking water source. In the NAS Cecil Field area, the unit is approximately 20 to 25 feet thick and occurs at a depth of 100 to 125 feet bls. The limestone was encountered at OU 4 at a depth of 84 to 100 feet bls in monitoring well CEF-10-1D. The total depth of well CEF-10-1D is 115 feet bls. The total thickness of the entire Hawthorn Group (including the underlying clayey confining beds) exceeds 300 feet in this area (Scott and others, 1991).

3.5.3 Groundwater Flow Directions

Surficial Aquifer System. The groundwater flow direction in the surficial aquifer is expected to follow topographic contours and is, therefore, estimated to the west-southwest toward Rowell Creek (Figure 3-3). Groundwater flow directions presented in the recently published USGS document, *Groundwater Flow in the Surficial Aquifer System and Potential Movement of Contaminants from Selected Waste Disposal Sites at Cecil Field Naval Air Station*, Jacksonville, Florida (USGS, 1996), support the estimated flow direction.





LEGEND

CEF-10-5S	Monitoring well location and designation
	Water table
	Sand
	Sandy silt
	Silty sand
	Clayey sand
?	Undefined boundary

FIGURE 3-3
GEOLOGIC CROSS SECTION A-A'

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Intermediate Aquifer System. The groundwater flow direction in the intermediate aquifer in the vicinity of the site could not be directly determined since only one well, CEF-10-1, completed in the intermediate aquifer was used during this investigation. A review of literature indicates the groundwater flow in the intermediate aquifer is to the northeast in the vicinity of OU 4 (G&M, 1983).

There were no well clusters constructed to provide groundwater-level data from the surficial and intermediate aquifers at a single location. A comparison between groundwater levels measured in CEF-10-1 (average groundwater elevation [GWE] 62.81 feet NGVD, ground surface elevation [GSE] 68.8 feet NGVD,) and CEF-10-3 located 350 feet to the southwest (GWE 54.20 feet NGVD, GSE 56.1 feet NGVD) reveals that the potentiometric surface in the intermediate aquifer is higher than the piezometric surface in the surficial aquifer, assuming that the potentiometric surface of the intermediate aquifer is constant over the 350 feet to CEF-10-3. These measurements suggest the potential exists for movement of groundwater upward from the intermediate to the surficial aquifer in the vicinity of OU 4. This phenomenon is also described by G&M (1983).

3.5.4 Hydraulic Conductivity Slug tests were conducted in all four shallow wells and the single deep well used during this investigation to estimate hydraulic conductivity (K). The calculated hydraulic conductivities for the surficial aquifer are summarized in Table 3-1. The mean K value for the shallow wells is 2.2 feet per day (ft/day). The calculated hydraulic conductivity for the intermediate aquifer is 0.1 ft/day. Pumping tests of the surficial and intermediate aquifers were conducted by the USGS during a 6-week period in September and October 1994. The results are summarized in a memorandum dated March 9, 1995 (USGS, 1995). The site of the pumping test was located near the northwest corner of NAS Cecil Field approximately 1.8 miles north of OU 4. The results of the tests yield lateral hydraulic conductivity estimates of 5 ft/day for the surficial aquifer and 36 ft/day for the intermediate aquifer.

Table 3-1
Hydraulic Conductivity Estimates for the Surficial Aquifer System

Remedial Investigation, Operable Unit 4
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Well	K in ft/day
CEF-10-2	4.9
CEF-10-3S	1.9
CEF-10-4S	1.4
CEF-10-5S	0.6

Surficial Aquifer System:
mean = 2.2 ft/day.
median = 1.6 ft/day.

Notes: K in ft/day = hydraulic conductivity from slug test data in feet per day.
S = shallow monitoring well.

3.5.5 Aquifer Flow Rate Typically, a seepage velocity could be calculated using an estimated effective porosity and calculated horizontal gradient and K values. The horizontal gradient is determined using groundwater elevations at two points (wells) on a line generally parallel to the direction of groundwater flow. OU 4 is relatively long and narrow with the long axis of the site perpendicular to the groundwater flow direction, hence placement of wells on the site was also on a line generally perpendicular to groundwater flow. Since no two wells are on a line that is parallel to the groundwater flow direction, a meaningful seepage velocity could not be calculated.

It should be noted that this evaluation of OU 4 is not dependent upon determination of a seepage velocity, thus the lack of a seepage velocity in this case does not represent a data gap.

4.0 NATURE AND EXTENT OF CONTAMINATION

The investigation of OU 4 has been conducted in three phases, including the IAS in 1985, the RFI in 1988, and this RI conducted during 1995. Both the RFI and RI included field programs during which physical and chemical data were obtained. The RI, however, represents the most comprehensive set of physical and chemical data developed to date. For this reason, discussion of the nature and extent of contamination at OU 4 focuses on the data obtained during the RI. A complete discussion of the findings of the IAS and RFI is presented in the GIR (ABB-ES, 1996).

Descriptions of the sample collection methodology and decontamination procedures for field sampling equipment are presented in the Remedial Investigation and Feasibility Study Operable Units 3, 4, 5, and 6 Sampling and Analysis Plan (ABB-ES, 1994). Investigation-derived waste was managed in accordance with the Investigation-Derived Waste Management Plan (ABB-ES, 1994c).

The complete TCL and TAL data set for all media during this RI is presented in Appendix D. Chemical analytical data from previous investigations are presented in Appendix E.

Discussion of the nature and extent of contamination at OU 4 is structured according to the RI/FS guidance (USEPA, 1988a). The source of contamination is described first in Section 4.1. In Section 4.2, the analytical results for environmental media sampled during the investigation are discussed in the following order: surface soil, groundwater, surface water, and sediment. Within each medium, analytical fractions are discussed in the following order: volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), pesticides and polychlorinated biphenyls (PCBs), TRPH, and inorganics. Tables included in the text present a summary of all analytes detected. However, only those analytes that were detected at concentrations exceeding guidance concentrations or were identified as contaminants of potential concern (CPCs) in the BRA are discussed in the text.

In the case of duplicate samples, the average of the sample and its duplicate is used for consistency with the procedure employed in the BRA. In accordance with that procedure, if either the sample or duplicate is reported as not detected, half of the reported detection limit value is used as the concentration for that sample or duplicate.

The chemical analytical data collected during this investigation of OU 4 have been subjected to data validation and evaluation. Data quality indicators include the precision, accuracy, representativeness, completeness, and comparability (PARCC) of the analytical data on a per medium basis. PARCC reports summarize the quality control measures taken during the investigation and discuss the suitability of the data for use in this investigation. In general, the data set was found to comply with PARCC criteria and is considered acceptable for use in this RI and the associated BRA. The PARCC summary reports are available upon request.

An evaluation was made of the chemical analytical results for each medium investigated by comparing the results to background criteria and applicable or relevant and appropriate requirements (ARARs). The background criteria are twice

the mean of the concentrations detected in background samples for each respective medium. The background screening program is briefly discussed in Subsection 2.2.4. For a more detailed discussion, refer to Section 2.9 and Appendix H in the RI Report for OU 1 (ABB-ES, 1994b).

The ARARs selected for the evaluation were as follows:

Surface Soil:	Soil Cleanup Goals (SCGs) for Florida, as listed in a memorandum dated September 29, 1995, J.M. Ruddell, Director, Division of Waste Management to District Directors and Waste Program Administrators, FDEP (FDEP, 1995).
Groundwater:	FDEP Groundwater Guidance Concentrations, dated June 1994 (FDEP, 1994), which include the Florida Primary and Secondary Drinking Water Standards and guidance concentrations promulgated under Chapter 62-550, Rules and Regulations of the State of Florida.

4.1 SOURCES. The possible source of contamination at OU 4 consists of concrete rubble, building demolition debris, and other inert wastes such as tires, asphalt, and furniture placed at the site by the base Public Works Department during the 1950s and 1960s. Documentation regarding the quantity of debris dumped on the site is not available. No reports or evidence of hazardous waste at the site have been discovered. No samples of the rubble were collected for chemical or physical characterization.

4.2 ANALYTICAL RESULTS

4.2.1 Surface Soil Soil samples were collected from a total of six locations across OU 4 during the 1995 investigation. All of the detected analytes are summarized in Table 4-1. Analytes identified as human health or ecological CPCs are highlighted in the table. The distribution of the analytes identified as human health CPCs is presented on Figure 4-1.

VOCs in Surface Soil. Methylene chloride was detected in one of six soil samples (CF10SS6) at a concentration of 3J micrograms per kilogram (μg/kg). The detected concentration does not exceed the FDEP SCG of 16 milligrams per kilogram (mg/kg) in a residential setting. Methylene chloride was identified as a contaminant of ecological concern in the BRA and is discussed further in Chapter 7.0. The detection of methylene chloride in the sample may be due to laboratory contamination rather than its actual presence in the environment. No other VOCs were detected in the six soil samples collected at OU 4.

SVOCs in Surface Soil. Di-n-butylphthalate was detected in five of six surface soil samples at concentrations ranging from 21J to 220J μg/kg. The concentrations reported for di-n-butylphthalate do not exceed the FDEP SCG of 7,300 mg/kg in a residential setting.

Di-n-butylphthalate was identified as a contaminant of ecological concern in the BRA and is discussed further in Chapter 7.0. Di-n-butylphthalate was not identified as a human health contaminant of potential concern (HHCPC). No other SVOCs were detected in the surface soil samples analyzed.

Table 4-1
Summary of Organic and Inorganic Detections in Surface Soil

Remedial Investigation, Operable Unit 4
Naval Air Station Cecil Field
Jacksonville, Florida

Analyte	Frequency of Detection[1]	Range of Reporting Limits	Range of Detected Concentrations	Mean of Detected Concentrations[2]	Screening Background Concentration[3]	Maximum Background Concentration	Florida Soil Cleanup Goals (Residential)[4]
Volatile Organic Compounds (µg/kg)							
Methylene chloride #	1/6	6 - 14	3 J	3 J	NA	NA	16,000
Semivolatile Organic Compounds (µg/kg)							
Di-n-butylphthalate #	5/6	380 - 480	21 J - [5]140	55.3	NA	NA	7,300,000
Total Petroleum Hydrocarbons (mg/kg)							
TRPH #	6/6	12 - 15	26 J - 270 J	100	NA	NA	50
Inorganic Analytes (mg/kg)							
Aluminum #	6/6	40	144 - 7,830	1,980	2,370	2,770	75,000
Arsenic #	1/6	20	2.7	2.7	ND	ND	0.8
Barium #	1/6	40	10.3	10.3	9	[5]11.2	5,200
Calcium	4/6	1,000	179 - 6,350	4,062	458	269	NSC
Chromium #	1/6	2	17	17	4.6	2.3	290
Cobalt #	1/6	10	0.67	0.67	ND	ND	4,700
Iron	6/6	20	140 J - 9,150 J	2,180	648	734	NSC
Lead #	6/6	0.6	1.3 J - 7.2	4.8	6.4	5.1	500
Magnesium	6/6	1,000	15 - 115	78.7	108	75.9	NSC
Manganese #	6/6	3	1.8 - 11.7	5.4	8.6	5.9	370
Potassium	1/6	1,000	59.4	59.4	ND	ND	NSC
Sodium	2/6	1,000	200 - 253 J	227	ND	ND	NSC
Vanadium #	6/6	10	0.74 - 28.5	7	4.6	2.3	490

See notes at end of table.

Table 4-1 (Continued)
Summary of Organic and Inorganic Detections in Surface Soil

Remedial Investigation, Operable Unit 4
Naval Air Station Cecil Field
Jacksonville, 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 mean of detected concentrations is the arithmetic mean of all samples in which the analyte was detected; it does not include those samples with a "U" or "UJ" validation qualifier for that analyte.
[3] The background screening value is twice the average of detected concentrations for inorganic analytes in background samples.
[4] Florida Department of Environmental Protection memorandum titled "Soil Cleanup Goals for Florida" dated September 29, 1995. The value cited for arsenic is an updated value cited in a memorandum titled "Applicability of Soil Clean-up Goals for Florida," dated January 9, 1996.
[5] Value is the average of a sample and its duplicate.

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

Sample locations include CEF10SS1, CEF10SS2, CEF10SS3, CEF10SS4, CEF10SS5, CEF10SS6.
Duplicate samples include CEF10SS5D.

µg/kg = micrograms per kilogram.
# = these chemicals represent ecological contaminants of potential concern.
J = indicates chemical identified by chemist but quantity was estimated.
NA = not appropriate.
mg/kg = milligrams per kilogram.
▒▒▒ = these chemicals represent human health chemicals of potential concern.
ND = not detected.
NSC = no screening concentration available.

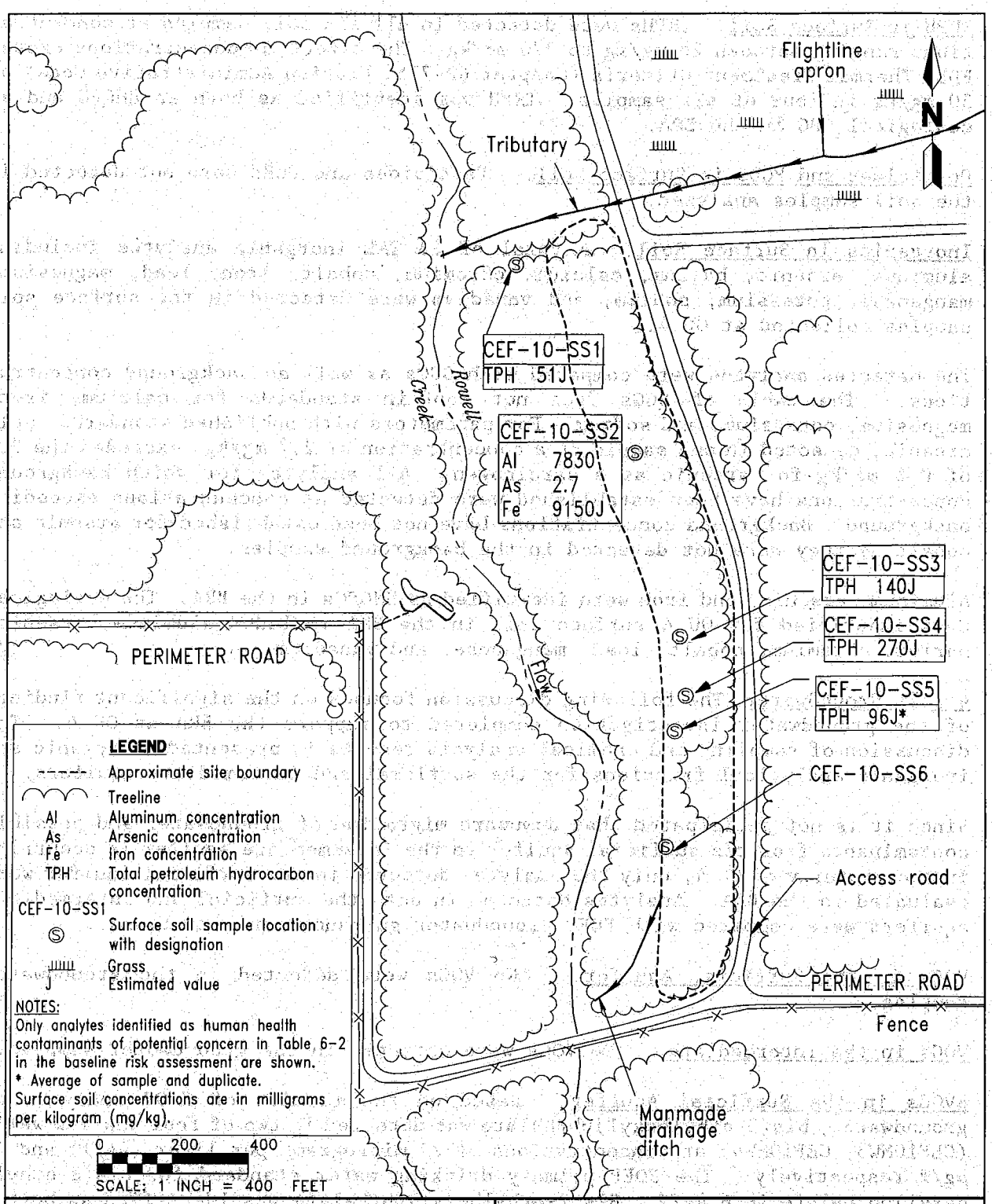

FIGURE 4-1
HUMAN HEALTH CONTAMINANTS OF POTENTIAL CONCERN IN SURFACE SOIL

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TRPH in Surface Soil. TRPHs were detected in all six soil samples at concentrations ranging between 26 mg/kg to 270 mg/kg. The detected concentrations exceed FDEP Thermal Treatment Criteria (Chapter 62-775, Florida Administrative Code) of 50 mg/kg in four of six samples. TRPH was identified as both an HHCPC and an ecological CPC in the BRA.

Pesticides and PCBs in Surface Soil. Pesticides and PCBs were not detected in the soil samples analyzed.

Inorganics in Surface Soil. A total of 13 TAL inorganic analytes including aluminum, arsenic, barium, calcium, chromium, cobalt, iron, lead, magnesium, manganese, potassium, sodium, and vanadium were detected in the surface soil samples collected at OU 4.

The detected analytes were compared with SCGs as well as background concentrations. The table of SCGs does not contain standards for calcium, iron, magnesium, potassium, and sodium. For parameters with published standards, only arsenic, detected in one sample at a concentration of 2.7 mg/kg, exceeded the SCG of 0.8 mg/kg for arsenic as a carcinogen. All analytes for which background concentrations have been established were detected at concentrations exceeding background. Background concentrations have not been established for arsenic and cobalt as they were not detected in the background samples.

Aluminum, arsenic, and iron were identified as HHCPCs in the BRA. The ecological CPCs identified for OU 4 surface soil in the BRA included aluminum, arsenic, barium. chromium, cobalt, lead, manganese, and vanadium.

4.2.2 Groundwater The following discussion focuses on the significant findings of the groundwater investigation completed to support the BRA at OU 4. The discussion of sampling and chemical analysis results is presented by organic and inorganic analytical fractions for the surficial and intermediate aquifers.

Since it is not anticipated that downward migration of groundwater and possible contaminants from the surficial aquifer to the intermediate aquifer is occurring in the vicinity of OU 4, only the analytes detected in the surficial aquifer were evaluated in the BRA. Analytes detected in both the surficial and intermediate aquifers were compared with FDEP groundwater guidance concentrations.

VOCs in the Surficial Aquifer. No VOCs were detected in the groundwater samples.

VOCs in the Intermediate. No VOCs were detected in the groundwater samples.

SVOCs in the Surficial Aquifer. Based on the results of SVOC analyses of groundwater, bis(2-ethylhexyl)phthalate was detected in two of four shallow wells (CEF10MW3, CEF10MW4) at concentrations of 2J micrograms per liter ($\mu g/\ell$) and 6J $\mu g/\ell$ respectively. The FDEP primary drinking water standard for bis(2-ethylhexyl)phthalate is 6 $\mu g/\ell$. Bis(2-ethylhexyl)phthalate was identified as both a HHCPC and an ecological CPC in the surficial aquifer by the BRA. No other SVOCs were detected in the surficial aquifer.

SVOCs in the Intermediate Aquifer. Bis(2-ethylhexyl)phthalate was also detected in the single deep well (CEF10MW1) at a concentration of 5J $\mu g/\ell$. As indicated

above, the FDEP primary drinking water standard for bis(2-ethylhexyl)phthalate is 6 $\mu g/\ell$. No other SVOCs were detected in the surficial aquifer.

Pesticides and PCBs in the Surficial Aquifer. No pesticides or PCBs were detected in the groundwater samples collected from the surficial aquifer.

Pesticides and PCBs in the Intermediate Aquifer. No pesticides or PCBs were detected in the groundwater sample collected from the intermediate aquifer.

Inorganic Analytes in the Surficial Aquifer. A total of 11 TAL inorganic analytes were detected in the groundwater samples collected from the surficial aquifer. Table 4-2 summarizes the results of all organic and inorganic analytes detected in surficial aquifer and denotes human health and ecological CPCs identified in the BRA. The distribution of the analytes identified as human health CPCs is presented on Figure 4-2.

Aluminum and iron were detected at concentrations exceeding FDEP secondary drinking water standards of 200 $\mu g/\ell$ and 300 $\mu g/\ell$, respectively. Aluminum was detected at concentrations of 669 $\mu g/\ell$ and 1,170 $\mu g/\ell$ in wells CEF10MW4 and CEF10MW5, respectively. Iron was detected at concentrations ranging from 529 $\mu g/\ell$ to 2,690 $\mu g/\ell$ in wells CEF10MW2, CEF10MW3, CEF10MW4 and CEF10MW5S.

Aluminum and iron were identified as both human health and ecological CPCs. Manganese was identified as an ecological CPC. Manganese was detected in one of four wells (CEF10MW5S) in both samples of the duplicate pair at an average concentration of 49.4 $\mu g/\ell$. The FDEP secondary drinking water standard for manganese (50 $\mu g/\ell$) was not exceeded.

Inorganic Analytes in the Intermediate Aquifer. A total of five TAL inorganic analytes were detected in the groundwater samples collected from the intermediate aquifer including calcium, magnesium, potassium, sodium, and cyanide. A summary of the detected concentrations is presented in Table 4-3. The detected concentrations were compared with published FDEP standards. The primary drinking water standards for cyanide (200 $\mu g/\ell$) and sodium (160,000 $\mu g/\ell$) have not been exceeded. The FDEP does not have a published standard for calcium, magnesium, or potassium.

4.2.3 Surface Water and Sediment Two surface water and sediment samples (CF10SW/SD1, CF10SW/SD2, CF10SW/SD2D) were collected in the Rowell Creek tributary located along the northern boundary of OU 4. As discussed in Section 3.2, land surface in the vicinity of the tributary located along the northern site boundary slopes generally westward rather than northward toward the tributary. Therefore, it is unlikely that a complete pathway via overland flow or groundwater migration from OU 4 to the tributary exists. East of OU 4, the tributary lies parallel to and within 200 feet south of the flightline. It is anticipated that source water for the tributary is partially derived from surface water runoff from the flightline area. Hence, analytes detected in the surface water or sediments are likely due to flightline activities. Due to the lack of a complete pathway and the likelihood that detected analytes are the result of flightline activities, the analytical results of the surface water and sediment samples collected in the Rowell Creek tributary were not included for evaluation in the BRA. A summary of the TAL and TCL analytes detected in the surface water and sediment samples is presented in Tables 4-4 and 4-5 for reference only. Regulatory screening concentrations have not been provided since the surface water and sediment samples were not evaluated.

Table 4-2
Summary of Organic and Inorganic Detections in Surficial Aquifer Groundwater

Remedial Investigation, Operable Unit 4
Naval Air Station Cecil Field
Jacksonville, Florida

Analyte	Frequency of Detection[1]	Range of Reporting Limits	Range of Detected Concentrations	Mean of Detected Concentrations[2]	Background Screening Concentration[3]	Florida Standards and Guidance Concentrations
Semivolatiles (µg/ℓ)						
bis(2-Ethylhexyl)phthalate #	2/4	10	2 J - 6 J	4 J	NA	6
Inorganic Analytes (µg/ℓ)						
Aluminum #	2/4	200	669 - [4]1,060	864	776	200
Barium	2/4	200	[4]16.5 - 18.5	17.5	41.2	2,000
Calcium	3/4	5,000	2,380 - [4]14,100	9,310	380	NSC
Chromium	1/4	10	[4]3.8	3.8	70	100
Iron #	4/4	100	529 J - [4]2,180 J	1,140	450	300
Magnesium	4/4	5,000	544 - 2,670	1,290	1,290	NSC
Manganese #	1/4	15	[4]49.4	49.4	9.8	50
Nickel	1/4	40	[4]13.5	13.5	32	100
Potassium	4/4	5,000	215 - 704	464	1,580	NSC
Sodium	4/4	5,000	2,710 - [4]5,570	4,360	1,150	160,000
Vanadium	2/4	50	2.7 - [4]4.4 J	3.5	96	49

[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 mean of detected concentrations is the arithmetic mean of all samples in which the analyte was detected; it does not include those samples with a "U" or "UJ" validation qualifier for that analyte.
[3] The background screening value is twice the average of detected concentrations for inorganic analytes in background samples.
[4] Value is the average of a sample and its duplicate.

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

Sample locations include CEF10MW2, CEF10MW3, CEF10MW4, CEF10MW5S.
Duplicate samples include CEF10MW5S and CEF10MW5SD.

µg/ℓ = micrograms per liter.
▒ = these chemicals represent human health chemicals of potential concern.
J = indicates chemical identified by chemist but quantity was estimated.
NA = not appropriate.
# = these chemicals represent ecological contaminants of potential concern.
NSC = no screening concentration available.

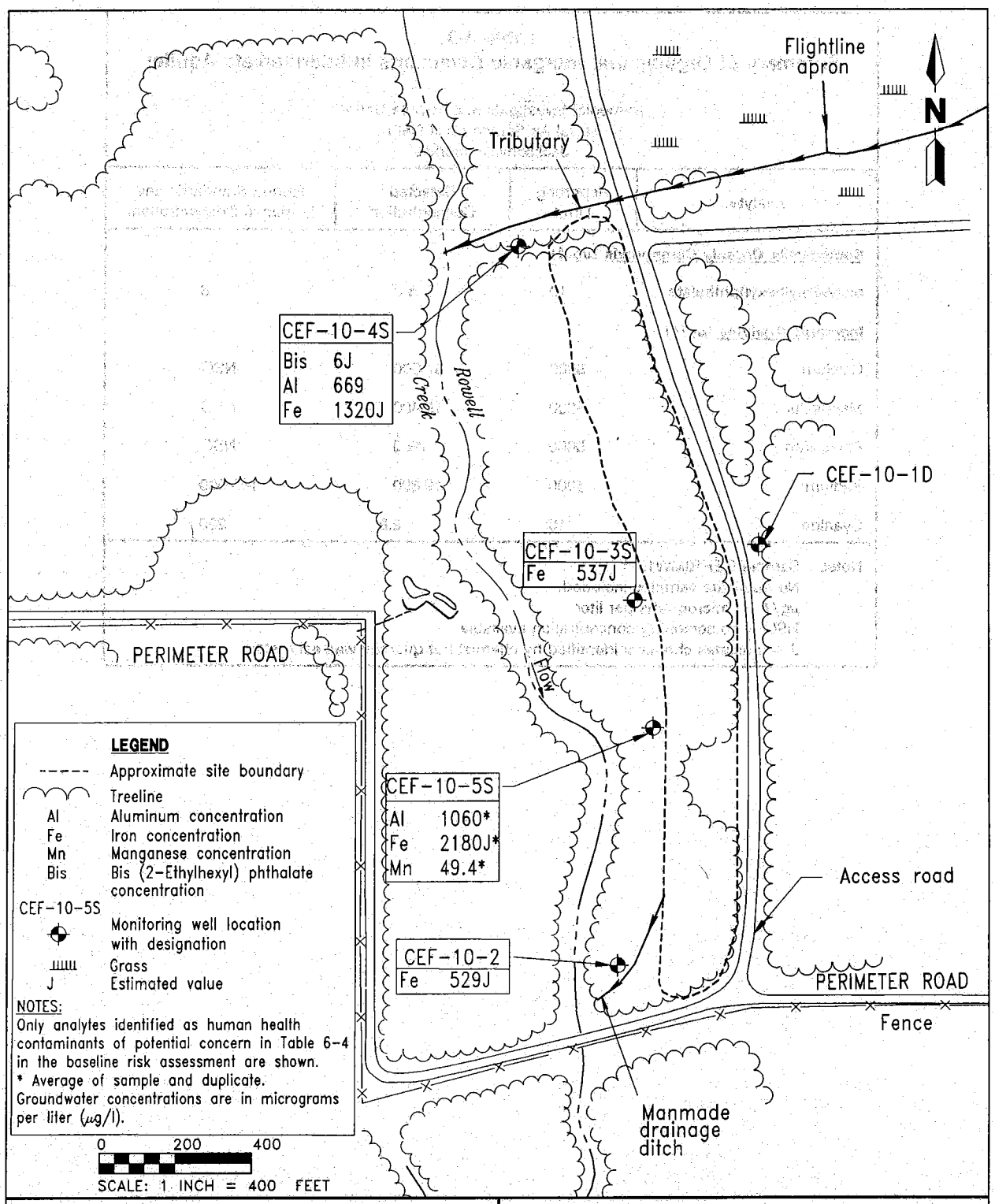

FIGURE 4-2
HUMAN HEALTH CONTAMINANTS OF POTENTIAL CONCERN IN GROUNDWATER

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Table 4-3
Summary of Organic and Inorganic Detections in Intermediate Aquifer

Remedial Investigation, Operable Unit 4
Naval Air Station Cecil Field
Jacksonville, Florida

Analyte	Reporting Limit	Detected Concentration	Florida Standards and Guidance Concentrations
Semivolatile Organic Compounds (μg/ℓ)			
bis(2-Ethylhexyl)phthalate	10	5 J	6
Inorganic Analytes (μg/ℓ)			
Calcium	5000	37,500	NSC
Magnesium	5000	19,400	NSC
Potassium	5000	1950	NSC
Sodium	5000	19,600	160,000
Cyanide	10	2.8	200

Notes: Sample CEF10MW1.
No duplicate samples included.
μg/ℓ = micrograms per liter.
NSC = no screening concentration available.
J = indicates chemical identified by chemist but quantity was estimated.

Table 4-4
Summary of Organic Detections in Surface Water[1] and Sediment

Remedial Investigation, Operable Unit 4
Naval Air Station Cecil Field
Jacksonville, Florida

Analyte	Frequency of Detection[2]	Range of Reporting Limits	Range of Detected Concentrations	Mean of Detected Concentrations[3]
SEDIMENT				
Volatile Organic Compounds (µg/kg)				
2-Butanone	2/2	13 - 19	[4]4 J - [4]6 J	5.2
Toluene	2/2	8 - 19	6 J - [4]8	7.3
Semivolatile Organic Compounds (µg/kg)				
Di-n-butylphthalate	2/2	440 - 620	[4]78 J - 92 J	85
Benzo(b)fluoranthene	1/2	440	46 J	46
Benzo(a)pyrene	1/2	440	46 J	46
Indeno(1,2,3-cd)pyrene	1/2	440	40 J	40
Benzo(g,h,i,)perylene	1/2	440	43 J	43
Pesticides/PCBs (µg/kg)				
4,4-DDE	1/2	6	[4]0.37 J	0.37
4,4-DDD	1/2	5 - 6	[4]1.5 J	1.5
4,4-DDT	1/2	5	3.4 J	3.7
Total Recoverable Petroleum Hydrocarbons (µg/kg)				
TRPH	2/2	16 - 67	[4]250 - 710	480

[1] No organic analytes were detected in the surface water samples.
[2] 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).
[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 a "U" or "UJ" validation qualifier for that analyte.
[4] Value is the average of a sample and its duplicate.

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

Samples include CF10SD1 and CF10SD2.
Duplicate sample CF10SD2D.

µg/kg = micrograms per kilogram.
J = indicates chemical identified by chemist but quantity was estimated.
PCBs = polychlorinated biphenyls.
DDE = dichlorodiphenyldichloroethene.
DDD = dichlorodiphenyldichloroethane.
DDT = dichlorodiphenyltrichloroethane.
TRPH = total recoverable petroleum hydrocarbons.

Table 4-5
Summary of Inorganic Detections in Surface Water and Sediment

Remedial Investigation, Operable Unit 4
Naval Air Station Cecil Field
Jacksonville, Florida

Analyte	Frequency of Detection[1]	Range of Reporting Limits	Range of Detected Concentrations
Surface Water Inorganics (µg/ℓ)			
Aluminum	2/2	200	340 - 1030
Calcium	2/2	5,000	[2]10,200 - 14,000
Iron	1/2	100	330
Magnesium	2/2	5,000	[2]901 - 1000
Manganese	2/2	15	[2]10.7 - 12
Sodium	2/2	5,000	1,770 - [2]1,990
Vanadium	2/2	50	[2]1.8 - 3.9
Sediment Inorganics (mg/kg)			
Aluminum	2/2	40	[2]1,690 - 1,700
Barium	2/2	40	3.1 - [2]7.4
Calcium	2/2	1,000	186 - [2]1,680
Chromium	2/2	2	[2]2.8 J - 3.3
Iron	2/2	20	[2]518 J - 519
Lead	1/2	0.6	[2]5.0
Magnesium	1/2	1,000	[2]288
Manganese	2/2	3	4.3 - [2]9.8
Selenium	1/2	1	2.8 J
Sodium	2/2	1,000	293 J - [2]352
Vanadium	2/2	10	[2]4.7 - 5.1

[1] Frequency of detection is the number of samples in which the analyte was detected divided by the total number of samples analyzed (excluding rejected values).
[2] Value is the average of a sample and its duplicate.

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

Samples include CF10SW1/SD1 and CF10SW1/SD1.
Duplicate sample CF10SW2D/SD2D.

µg/ℓ - micrograms per liter.
mg/kg = milligrams per kilogram.
J = indicates chemical identified by chemist but quantity was estimated.

Seven surface water and sediment samples (RCSW4, RCSW5, RCSW6, RCSW7, RCSW8, RCSW8A, and RCSW9) were collected in the segment of Rowell Creek that parallels OU 4 during the investigation of OU 1. The interpretation of the detected analytes, presented in the Remedial Investigation and Baseline Risk Assessment documents for Operable Unit 1 (ABB-ES, 1994b, 1994a), was reviewed for this RI. The Baseline Risk Assessment concludes that the calculated risks for humans associated with exposures to contaminants in surface water and sediment in Rowell Creek adjacent to OU 1 are within the USEPA acceptable cancer risk range and the USEPA guidance values for noncarcinogenic effects.

Impairment of the benthic macroinvertebrate community and sediment toxicity were observed at two of seven sampling locations in Rowell Creek adjacent to Site 1 (RC-SW/SD-6, RC-SW/SD-7). The chemical analytical data for the surface water and sediment samples collected at the locations exhibiting the adverse biological response were compared with chemical analytical data for the surface water and sediment samples collected at unaffected locations. The results of the comparison suggest that the analytes present in surface water and sediment, at the concentrations detected, are not the likely cause of the observed adverse biological response. Rather, an association between the observed effects and the discharge of surface water from the tributary originating on Site 2 is suggested.

According to the Remedial Investigation Report, OU 4 was not identified as a possible source of analytes detected in the surface water and sediments in Rowell Creek. Refer to the Remedial Investigation and Baseline Risk Assessment documents for Operable Unit 1 (ABB-ES, 1994b, 1994a) for a complete discussion of the evaluation of surface water and sediment in Rowell Creek.

5.0 CONTAMINANT FATE AND TRANSPORT

According to the findings of the BRA presented in Chapters 6.0 and 7.0 of this report, no significant risk to human health or the environment from exposure to analytes detected in the soil or groundwater at OU 4 or in the surface water or sediment in nearby Rowell Creek were identified. Therefore, fate and transport mechanisms for the detected parameters were not evaluated.

6.0 HUMAN HEALTH RISK ASSESSMENT

6.1 HUMAN HEALTH RISK ASSESSMENT (HHRA). An HHRA was conducted as part of the BRA for OU 4. The purpose of the HHRA is to characterize the risks associated with the potential exposures to site-related chemicals. The methodology for the HHRA is described in the GIR (ABB-ES, 1996) and consists of the following steps:

- evaluating the appropriateness of the data,
- selecting CPCs and conducting exposure assessment,
- toxicity assessment, and
- risk characterization.

6.1.1 Data Evaluation The data quality objectives (DQOs) for collecting environmental samples and conducting laboratory analyses are described in the RI/FS Workplan (ABB-ES, 1994). Chemical analyses were performed in accordance with CLP Statement of Work. The analytical results were evaluated, using the national functional guidelines (USEPA, 1988b; 1991) to assess the laboratories' compliance with the analytical methodology. Based on a third party's evaluation of the analytical data's conformance with the DQOs, the data presented are acceptable for use in the HHRA.

6.1.2 Selection of Human Health Chemicals of Potential Concern (HHCPC) HHCPCs are potentially site-related chemicals or analytes that have been detected at concentrations that are above standards or guidelines; above risk-based screening concentrations; and for inorganic analytes, above background screening concentrations. HHCPC selection methodology is described in the GIR. The locations from which background samples were collected are presented in Section 2.9 and Appendix H of the OU 1 RI report (ABB-ES, 1994b).

An exposure point concentration (EPC) for each HHCPC was used to estimate a reasonable maximum exposure for each site medium. Since less than 10 samples per environmental medium were collected at OU 4, the maximum detected concentration of each HHCPC was used as the EPC (USEPA, 1992). The process for establishing an EPC is described in the GIR.

6.1.2.1 Surface Soil Six surface soil samples and one duplicate were collected (Figure 2-1). Surface soil samples evaluated in the HHRA include CF10SS1, CF10SS2, CF10SS3, CF10SS4, CF10SS5, CF10SS5D (duplicate), and CF10SS6. The maximum detected concentration for each analyte detected in the surface soil samples was compared to USEPA Region III risk-based concentration (RBC) (USEPA, 1995a), Florida SCG (FDEP, 1995), and, in the case of inorganic analytes, background screening concentrations.

Table 6-1 presents all of the detected analytes and the RBCs, SCGs, and background screening concentrations used for comparison. The soil samples comprising the background data set are also identified.

HHCPCs selected for surface soil samples collected at OU 4 include three inorganic compounds (aluminum, arsenic, and iron) and TRPH (Table 6-1). The exposure point concentrations used for calculating risk are identified in Table 6-2.

Table 6-1
Selection of Human Health Contaminants of Potential Concern in Surface Soil

Remedial Investigation, Operable Unit 4
Naval Air Station Cecil Field
Jacksonville, Florida

Analyte	Frequency of Detection[1]	Reporting Limit Range	Detected Concentration Range	Mean[2]	Background Screening Concentration[3]	Risk-based Concentration[4]	Florida Soil Cleanup Goals[5]	Analyte HHCPC? (Yes/No)	Reason[6]
Volatile Organic Compounds (µg/kg)									
Methylene chloride	1/6	6 - 14	3 J	3 J	NA	85,000	16,000	No	S, G
Semivolatile Organic Compounds (µg/kg)									
Di-n-butylphthalate	5/6	380 - 480	21 J - [7]140	55.3	NA	780,000	7,300,000	No	S, G
Inorganic Analytes (mg/kg)									
Aluminum	6/6	40	144 - 7,830	1,980	2,370	7,800	75,000	Yes	
Arsenic	1/6	20	2.7	2.7	ND	[8] 0.43	[8] 0.8	Yes	
Barium	1/6	40	10.3	10.3	9	550	5,200	No	S, G
Calcium	4/6	1,000	179 - 6,350	4,062	458	1,000,000	NSC	No	S
Chromium	1/6	2	17	17	4.6	[9] 39	[9] 290	No	S, G
Cobalt	1/6	10	0.67	0.67	ND	470	4,700	No	S, G
Iron	6/6	20	140 J - 9,150 J	2,180	648	2,300	NSC	Yes	
Lead	6/6	0.6	1.3 J - 7.2	4.8	6.4	[10] 400	500	No	S, G
Magnesium	6/6	1,000	15 - 115	78.7	108	460,468	NSC	No	S
Manganese	6/6	3	1.8 - 11.7	5.4	8.6	39	370	No	S, G
Potassium	1/6	1,000	59.4	59.4	ND	1,000,000	NSC	No	S
Sodium	2/6	1,000	200 - 253 J	227	ND	1,000,000	NSC	No	S
Vanadium	6/6	10	0.74 - 28.5	7	4.6	55	490	No	S, G
Total Petroleum Hydrocarbons (mg/kg)									
TRPH	6/6	12 - 15	26 J - 270 J	100	NA	NSC	[11] 50	Yes	

See notes on next page.

Table 6-1 (Continued)
Selection of Human Health Contaminants of Potential Concern in Surface Soil

Remedial Investigation, Operable Unit 4
Naval Air Station Cecil Field
Jacksonville, Florida

[1] Frequency of detection is the number of samples in which the analyte was detected in relation to the total number of samples analyzed (excluding rejected values).
[2] The mean of detected concentrations is the arithmetic mean of all samples in which the analyte was detected. It does not include those samples with "R", "U", or "UJ" validation qualifiers.
[3] The background screening value is twice the average of detected concentrations for inorganic analytes in background samples.
[4] For all chemicals except the essential nutrients (calcium, magnesium, potassium, and sodium). U.S. Environmental Protection Agency (USEPA) Region III Risk-Based Concentration (RBC) table for residential surface soil exposure per January 1993 guidance (Selecting Exposure Routes and Contaminants of Concern by Risk-based Screening, EPA/903/R-93-001) was used for screening. Actual values are taken from the USEPA Region III RBC tables dated October 4, 1995, which are based on an excess lifetime cancer risk of 10^{-6} and an adjusted hazard quotient of 0.1. For the essential nutrient, screening values were derived based on recommended daily allowances.
[5] Florida Department of Environmental Protection memoranda titled "Soil Cleanup Goals for Florida" dated September 29, 1995 and "Applicability of Soil Clean-up Goals for Florida," dated January 19, 1996.
[6] Analyte was included or excluded from the risk assessment for the following reasons:
B = the maximum detected concentration did not exceed twice the arithmetic mean of detected concentrations at background locations and will not be considered further.
S = the maximum detected concentration did not exceed the risk-based screening concentration and will not be considered further.
G = the maximum detected concentration did not exceed Florida soil cleanup goal concentration and will not be considered further.
[7] The value is the average of a sample and its duplicate. For duplicate samples having one nondetect value, 1/2 the contract-required quantitation limit/contract-required detection limit is used as a surrogate.
[8] The value is based on arsenic as a carcinogen.
[9] The value is based on hexavalent chromium form.
[10] The value for lead is based on the USEPA Office of Solid Waste and Emergency Response Directive No. 9355.4-12 "Revised Interim Recommended Soil Cleanup for Comprehensive Environmental Response, Compensation, and Liability Act and Resource Conservation and Recovery Act Sites." (USEPA, 1994)
[11] The screening value is from FDEP Soil Thermal Treatment Facilities (Florida Administrative Code 62-775) dated November 1992.

Notes: The average of a sample and its duplicate is used for all table calculations.
Samples include CEF10SS1, CEF10SS2, CEF10SS3, CEF10SS4, CEF10SS5, and CEF10SS6.
Duplicate samples include CEF10SS5D.
Background samples include CEFBSS05, CEFBSS06, CEFBSS07, CEFBSS08, CEFBSS09, CEFBSS09D (Duplicate), CEFBSS010, CEFBSS011, CEFBSS012, CEFBSS013, CEFBSS014, and CEFBSS015.

HHCPC = human health contaminants of potential concern.
μg/kg = micrograms per kilogram.
J = indicates chemical identified by chemist, but quantity was estimated.
NA = not appropriate.
mg/kg = milligrams per kilogram.
ND = not detected.
NSC = no screening concentration available.

Table 6-2
Surface Soil Exposure Point Concentrations for Human Health Contaminants of Potential Concern

Remedial Investigation, Operable Unit 4
Naval Air Station Cecil Field
Jacksonville, Florida

Chemical	Frequency of Detection[1]	Maximum Detected Concentration	95% UCL[2]	Exposure Point Concentration[3]
Inorganic Analytes (mg/kg)				
Aluminum	6/6	7,830	NC	7,830
Arsenic	1/6	2.7	NC	2.7
Iron	6/6	9,150 J	NC	9,150
TRPH	6/6	270 J	NC	270

[1] Frequency of detection is the number of samples in which the analyte was detected divided by the number of samples analyzed (excluding rejected values).
[2] The 95 percent UCL is calculated on the arithmetic mean of all samples using one-half the contract-required quantitation limit or contract-required detection limit (CRQL/CRDL) for samples reported as nondetected concentrations.
[3] The exposure point concentration equals the 95 percent UCL unless the maximum detected concentration is less than the 95 percent UCL. If there are nine or less total samples, the maximum detected concentration is the exposure point concentration.

Notes: % = percent.
UCL = upper confidence limit.
mg/kg = milligram per kilogram.
NC = not calculated.
J = indicates chemical identified by chemist, but quantity was estimated.
TRPH = total recoverable petroleum hydrocarbons.

6.1.2.2 Groundwater Four unfiltered groundwater samples and one duplicate sample were collected at Site 10.

Section 3.5 of this report discusses the different hydrogeological zones located at OU 4. All wells except CEF-10-1D were installed in the upper portions of the surficial aquifer. Monitoring well CEF-10-1D was installed in the intermediate aquifer. Migration of contaminants from the surficial aquifer to the intermediate aquifer is unlikely; therefore, CEF-10-1D was not included in this HHRA. Groundwater samples evaluated in the HHRA included CEF10MW2, CEF10MW3, CEF10MW4, and CEF10MW5S and its duplicate sample CEF10MW5SD. Monitoring well locations are indicated on Figure 2-1.

Table 6-3 presents all of the detected analytes and the RBCs, Florida guidance concentrations, and background screening concentrations used for comparison. The groundwater samples comprising the background data set are also identified.

HHCPCs selected for groundwater associated with OU 4 include one SVOC (bis(2-ethylhexyl)phthalate) and three inorganics (aluminum, iron, and manganese) (Table 6-3). The EPCs used for calculating risk are identified in Table 6-4.

6.1.2.3 Surface Water and Sediment Surface water and sediment samples were collected in a tributary north of the site. There is no apparent overland or groundwater migration pathway from OU 4 to the tributary north of the site. Therefore, these media are not evaluated in this HHRA.

6.1.3 Exposure Assessment The exposure assessment is conducted to assess hypothetical pathways whereby humans are potentially exposed to analytes detected at the site. The exposure assessment used the EPCs and hypothetical pathways to estimate the magnitude of actual and/or potential human exposure, and the frequency and duration of exposure. This process was performed for both current and potential future site usage. Figure 6-1 describes the hypothetical exposure pathways in which humans could potentially be exposed to chemicals detected at the site. A summary of potential exposure pathways including medium and route of exposure, the potential exposed population, and the rationale for selection or exclusion is provided in Table 6-5 and described in Paragraphs 6.1.3.1 and 6.1.3.2 for surface soil and groundwater, respectively. Receptor-specific exposure parameters for each exposure scenario are presented in Appendix F.1. Risk calculation spreadsheets in Appendix F.5 contain the assumed exposure parameters and calculations of site-specific cancer and noncancer risk.

6.1.3.1 Surface Soil Residential development is unlikely due to the site's proximity to the runway; however, this RI evaluated the residential exposure scenario as a worst case scenario. Excavation activities, such as installation of utility lines, are unlikely because of the additional expense incurred due to working around the building rubble found at the site. Therefore, the excavation worker was not evaluated in this HHRA.

Although the area is in a restricted portion of the installation, adult and adolescent trespassers could obtain access to the site. Site maintenance workers could be exposed to contaminants in surface soil while performing routine maintenance, such as weed control. Hence, exposure of adult and child residents, trespassers, and site maintenance workers to surface soil contaminants through ingestion, dermal contact, and inhalation of particulates was evaluated in the HHRA.

Table 6-3
Selection of Human Health Contaminants of Potential Concern in Groundwater

Remedial investigation, Operable Unit 4
Naval Air Station Cecil Field
Jacksonville, Florida

Analyte	Frequency of Detection[1]	Reporting Limit Range	Detected Concentration Range	Mean[2]	Background Screening Concentration[3]	Risk-based Concentration[4]	Florida Guidance Concentration[5]	Analyte HHCPC? (Yes/No)	Reason[6]
Semivolatile Organic Compounds (µg/ℓ)									
bis(2-Ethylhexyl)phthalate	2/4	10	2 J - 6 J	4 J	NA	4.8	6	Yes	
Inorganic Analytes (µg/ℓ)									
Aluminum	2/4	200	669 - [7]1,059.5	864	776	3,700	200	Yes	
Barium	2/4	200	[7]16.45 - 18.5	17.5	41.2	260	2,000	No	B
Calcium	3/4	5,000	2,380 - [7]14,100	9,310	380	1,055,398	NSC	No	S
Chromium	1/4	10	[7]3.75	3.8	70	[8] 18	[8] 100	No	B
Iron	4/4	100	529 J - [7]2,180 J	1,140	450	1,100	300	Yes	
Magnesium	4/4	5,000	544 - 2,670	1,290	1,290	118,807	NSC	No	S
Manganese	1/4	15	[7]49.35	49.4	9.8	18	50	Yes	
Nickel	1/4	40	[7]13.45	13.5	32	73	100	No	B
Potassium	4/4	5,000	215 - 704	464	1,580	297,016	NSC	No	B
Sodium	4/4	5,000	2,710 - [7]5,570	4,360	1,150	396,022	160,000	No	S, G
Vanadium	2/4	50	2.7 - [7]4.4 J	3.5	96	26	49	No	B

See notes on next page.

Table 6-3 (Continued)
Selection of Human Health Contaminants of Potential Concern in Groundwater

Remedial investigation, Operable Unit 4
Naval Air Station Cecil Field
Jacksonville, Florida

[1] Frequency of detection is the number of samples in which the analyte was detected in relation to the total number of samples analyzed (excluding rejected values).
[2] The mean of detected concentrations is the arithmetic mean of all samples in which the analyte was detected. It does not include those samples with "R", "U", or "UJ" validation qualifiers.
[3] The background screening value is twice the average of detected concentrations for inorganic analytes in background samples.
[4] For all chemicals except the essential nutrients (calcium, magnesium, potassium, and sodium). U.S. Environmental Protection Agency (USEPA) Region III Risk-Based Concentration (RBC) table for tap water exposure per January 1993 guidance (Selecting Exposure Routes and Contaminants of Concern by Risk-based Screening, EPA/903/R-93-001) was used for screening. Actual values are taken from the USEPA Region III RBC tables dated October 4, 1995, which are based on an excess lifetime cancer risk of 10^{-6} and an adjusted hazard quotient of 0.1. For the essential nutrient, screening values were derived based on recommended daily allowances.
[5] The values are from Florida Department of Environmental Protection "Ground Water Guidance Concentrations," June 1994.
[6] Analyte was included or excluded from the risk assessment for the following reasons:
B = the maximum detected concentration did not exceed twice the arithmetic mean of detected concentrations at background locations and will not be considered further.
S = the maximum detected concentration did not exceed the risk-based screening concentration and will not be considered further.
G = the maximum detected concentration did not exceed Florida's guidance concentration and will not be considered further.
[7] The value is the average of a sample and its duplicate. For duplicate samples having one nondetect value, 1/2 the contract-required quantitation limit/contract-required detection limit is used as a surrogate.
[8] The value is based on hexavalent chromium form.

Notes: The average of a sample and its duplicate is used for all table calculations.
Samples include CF10MW2, CF10MW3, CF10MW4, and CF10MW5S.
Duplicate samples include CF10MW5S.
Background samples include CFBKMW1S, CFBKMW2S, CFBKMW4S, CFBKMW4SD (Duplicate), CFBKMW5S, CFBKMW7S, and CFBKMW8S.

HHCPC = human health contaminants of potential concern.
$\mu g/\ell$ = micrograms per liter.
J = indicates chemical identified by chemist, but quantity was estimated.
NA = not appropriate.
NSC = no screening concentration available.

Table 6-4
Groundwater Exposure Point Concentrations for Human Health Contaminants of Potential Concern

Remedial Investigation, Operable Unit 4
Naval Air Station Cecil Field
Jacksonville, Florida

Chemical	Frequency of Detection[1]	Maximum Detected Concentration	95% UCL[2]	Exposure Point Concentration[3]
Semivolatile Organic Compounds (μg/ℓ)				
bis(2-Ethylhexyl)phthalate	2/4	6 J	NC	6
Inorganic Analytes (μg/ℓ)				
Aluminum	2/4	[4]1,060	NC	1,060
Iron	4/4	2,180 J	NC	2,180
Manganese	1/4	[4]49.4	NC	49.4

[1] Frequency of detection is the number of samples in which the analyte was detected divided by the number of samples analyzed (excluding rejected values).
[2] The 95 percent UCL is calculated on the arithmetic mean of all samples using one-half the contract-required quantitation limit or contract-required detection limit for samples reported as nondetected concentrations.
[3] The exposure point concentration equals the 95 percent UCL unless the maximum detected concentration is less than the 95 percent UCL. If there are nine or less total samples, the maximum detected concentration is the exposure point concentration.
[4] Value is the average of a sample and its duplicate.

Notes: % = percent.
UCL = upper confidence limit.
μg/ℓ = micrograms per liter.
J = indicates chemical identified by chemist, but quantity was estimated.
NC = not calculated.

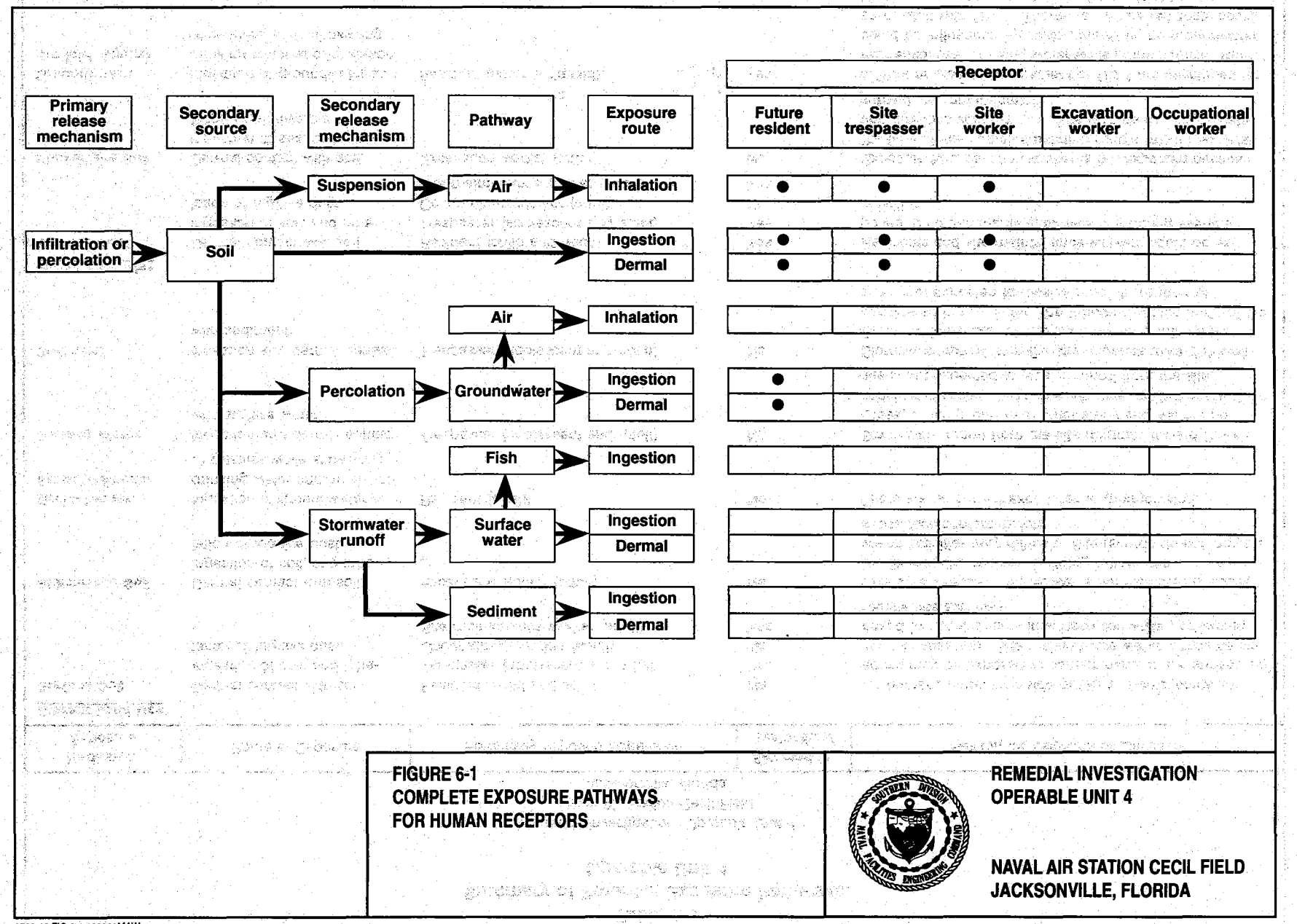


FIGURE 6-1
COMPLETE EXPOSURE PATHWAYS
FOR HUMAN RECEPTORS

REMEDIAL INVESTIGATION
OPERABLE UNIT 4

NAVAL AIR STATION CECIL FIELD
JACKSONVILLE, FLORIDA

8500-13 FIG.6-1.103096MAW

Table 6-5
Summary of Potential Exposure Pathways, Operable Unit 4

Remedial Investigation, Operable Unit 4
Naval Air Station Cecil Field
Jacksonville, Florida

Medium of Exposure	Route of Exposure	Potentially Exposed Population	Selected for Evaluation?	Reason for Selection or Exclusion
Current 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)	No Yes No Yes	No humans currently reside at OU 4. Adolescents and adults may be exposed to contaminants in the surface soil while trespassing. 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	Exposure to excavation worker is not expected because the fill material contains building rubble, making excavation activities very difficult. Site records do not indicate subsurface contamination.
Groundwater: Surficial Aquifer	Ingestion of groundwater as drinking water and inhalation of volatiles while showering.	Resident (adult)	No	There are no current exposures to groundwater.
Surface Water	Ingestion and dermal contact with surface water.	Trespasser (adolescent and adult)	No	Stormwater runoff from the site migrates toward Rowell Creek, which is part of another study and will not be considered in this study. The tributary located north of the site is not expected to receive runoff from the site.
Sediment	Ingestion and dermal contact with sediment.	Trespasser (adolescent and adult)	No	Stormwater runoff from the site migrates toward Rowell Creek, which is part of another study and will not be considered in this study. The tributary located north of the site is not expected to receive runoff from the site.
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)	Yes Yes No Yes	Residents and site maintenance workers could be exposed to contaminants in surface soil during everyday activities.
Subsurface Soil	Dermal contact with soil, ingestion of soil, and inhalation of fugitive dust.	Excavation worker (adult)	No	Exposure to excavation worker is not expected because the fill material contains building rubble making excavation activities very difficult. Site records do not indicate subsurface contamination.
Groundwater: Surficial Aquifer	Ingestion of groundwater as drinking water and inhalation of volatiles while showering.	Resident (adult and child)	Yes	If OU 4 or areas downgradient of OU 4 are developed for residential use, drinking water wells in the surficial aquifer could be influenced by contaminants in the groundwater associated with OU 4. Therefore, future residents could be exposed to contaminants in the surficial aquifer.

6.1.3.2 **Groundwater** Currently, groundwater at OU 4 is not used for any potable or nonpotable purpose. However, if areas hydraulically downgradient of OU 4 were developed for residential use, then exposure to contaminants in groundwater could be an exposure pathway. Therefore, hypothetical future domestic use of the surficial aquifer (adult ingestion and inhalation of volatiles while showering and child ingestion) was evaluated in the HHRA.

6.1.4 **Toxicity Assessment** The purpose of the toxicity assessment is to identify adverse effects associated with exposure to each HHCPC and to identify the relationship between level of exposure and severity or likelihood of adverse effects. The toxicity assessment methodology is discussed in the GIR. The GIR and Appendix F.2 to this report contain brief toxicity summaries for HHCPCs identified in surface soil and groundwater at OU 4. Appendix F.3 contains dose-response information for the HHCPCs. Dose-response values used in this HHRA were current as of September 1996 for the Integrated Risk Management System (IRIS) and November 1995 for the Health Effects Assessment Summary Tables (HEAST). This information is used in the risk characterization (Subsection 6.1.5) to estimate the excess lifetime cancer risk (ELCR) for carcinogens and the noncancer or hazard index (HI) for all HHCPCs. Uncertainties associated with chemical-specific toxicity values are discussed in Subsection 6.1.6.

6.1.5 **Risk Characterization** Risk characterization involves integration of the exposure and toxicity assessments into a qualitative or quantitative expression of potential human health risks associated with contaminant exposure. Both carcinogenic and noncarcinogenic risks were estimated for each HHCPC and each complete exposure pathway selected for evaluation in the exposure assessment. Risk estimates for potential exposures to surface soil and groundwater under current and assumed future land-use scenarios are discussed in Paragraphs 6.1.5.1 and 6.1.5.2, respectively. Table 6-6 summarizes the cancer and noncancer risk under a current land-use scenario. Figure 6-2 summarizes the ELCR associated with current land use, and Figure 6-3 summarizes the HI for current land use. Table 6-7 summarizes the cancer and noncancer risk for assumed future land use. Figure 6-4 summarizes the ELCR, and Figure 6-5 summarizes the HI for future land use.

6.1.5.1 **Surface Soil** The risk calculations for surface soil exposure scenarios are shown in Tables F.5-1 through F.5-10 in Appendix F.5. The current surface soil exposure scenarios are the aggregate (combined adult and adolescent) trespasser and site maintenance worker. The ELCR associated the aggregate trespasser and site maintenance worker exposed to surface soil ingestion, dermal contact, and fugitive dust inhalation are $4x10^{-7}$ and $8x10^{-8}$, respectively. For future land-use exposure scenario, the aggregate (combined adult and child) resident ELCR is $6x10^{-6}$. Arsenic is the only carcinogen detected in the surface soil samples that exceeded screening criteria. The ELCR associated with arsenic exposure is within the USEPA's allowable ELCR range ($1x10^{-4}$ to $1x10^{-6}$) but is above Florida's risk guidance value ($1x10^{-6}$).

The residential exposure scenario may not be representative of conditions likely to occur at the site. The site is located next to a runway, which is an economically important area that would preclude residential development. A realistic land-use scenario would consist of the aggregate trespasser or site maintenance worker. The aggregate trespasser or site maintenance worker have an ELCR of $4x10^{-7}$ and $8x10^{-8}$, respectively. The ELCR for the trespasser and site

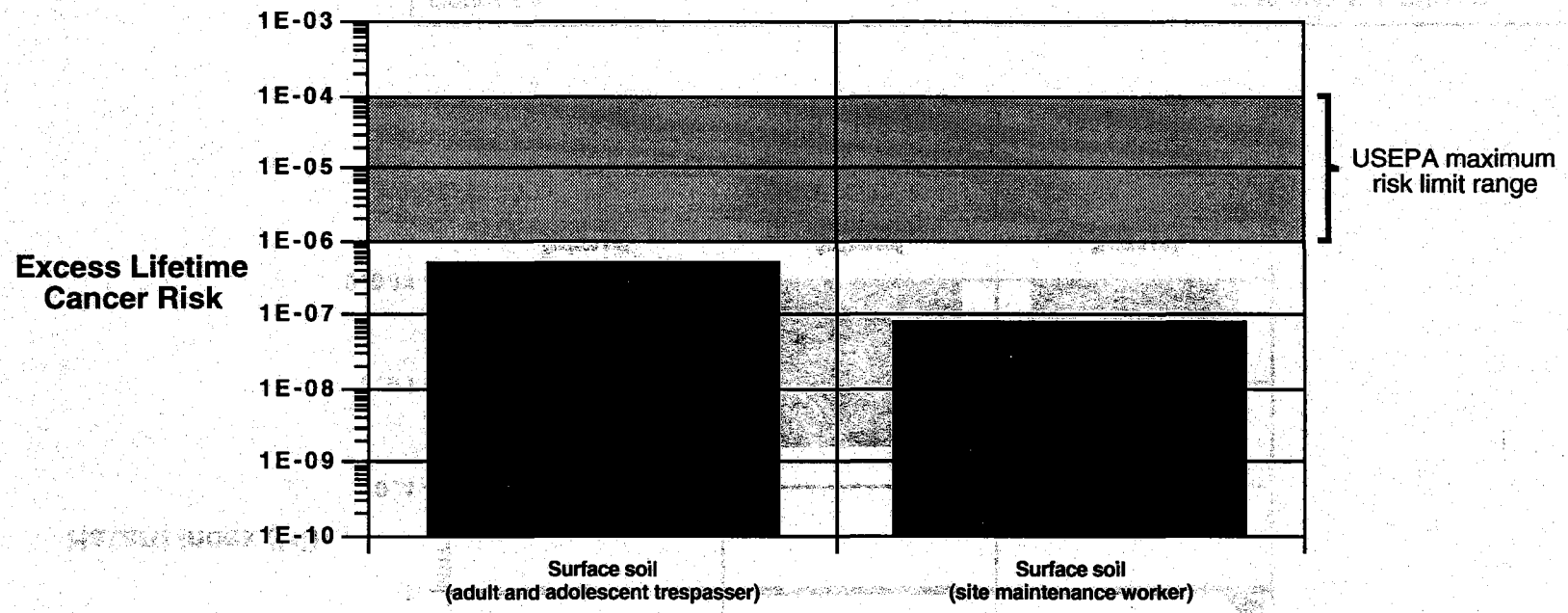
Table 6-6
Current Land-Use Risk Summary

Remedial Investigation, Operable Unit 4
Naval Air Station Cecil Field
Jacksonville, Florida

Medium and Receptor	Exposure Route	HI	ELCR
Current Land Use			
Surface Soil			
Adult trespasser	Incidental ingestion	0.01	$2x10^{-7}$
	Dermal contact	0.02	$1x10^{-8}$
	Inhalation of particulates	ND	$5x10^{-12}$
	Total adult trespasser risks	0.03	$2x10^{-7}$
Adolescent trespasser	Incidental ingestion	0.02	$2x10^{-7}$
	Dermal contact	0.02	$7x10^{-9}$
	Inhalation of particulates	ND	$3x10^{-12}$
	Total adolescent trespasser risks	0.04	$2x10^{-7}$
	Total trespasser risks	NA	$4x10^{-7}$
Site maintenance worker	Incidental ingestion	0.003	$7x10^{-8}$
	Dermal contact	0.009	$8x10^{-9}$
	Inhalation of particulates	ND	$2x10^{-11}$
	Total site maintenance worker risks	0.01	$8x10^{-8}$

Notes: The values used in this table are calculated in Appendix F.5.

HI = hazard index.
ELCR = excess lifetime cancer risk.
ND = no toxicity values available for calculation.
NA = not applicable.



NOTES:
USEPA = U.S. Environmental Protection Agency
a = Excess lifetime cancer risk

FIGURE 6-2
CANCER RISK[a] SUMMARY, CURRENT LAND USE

REMEDIAL INVESTIGATION
OPERABLE UNIT 4

NAVAL AIR STATION CECIL FIELD
JACKSONVILLE, FLORIDA

8500-13 FIG 6-2 101796MAW

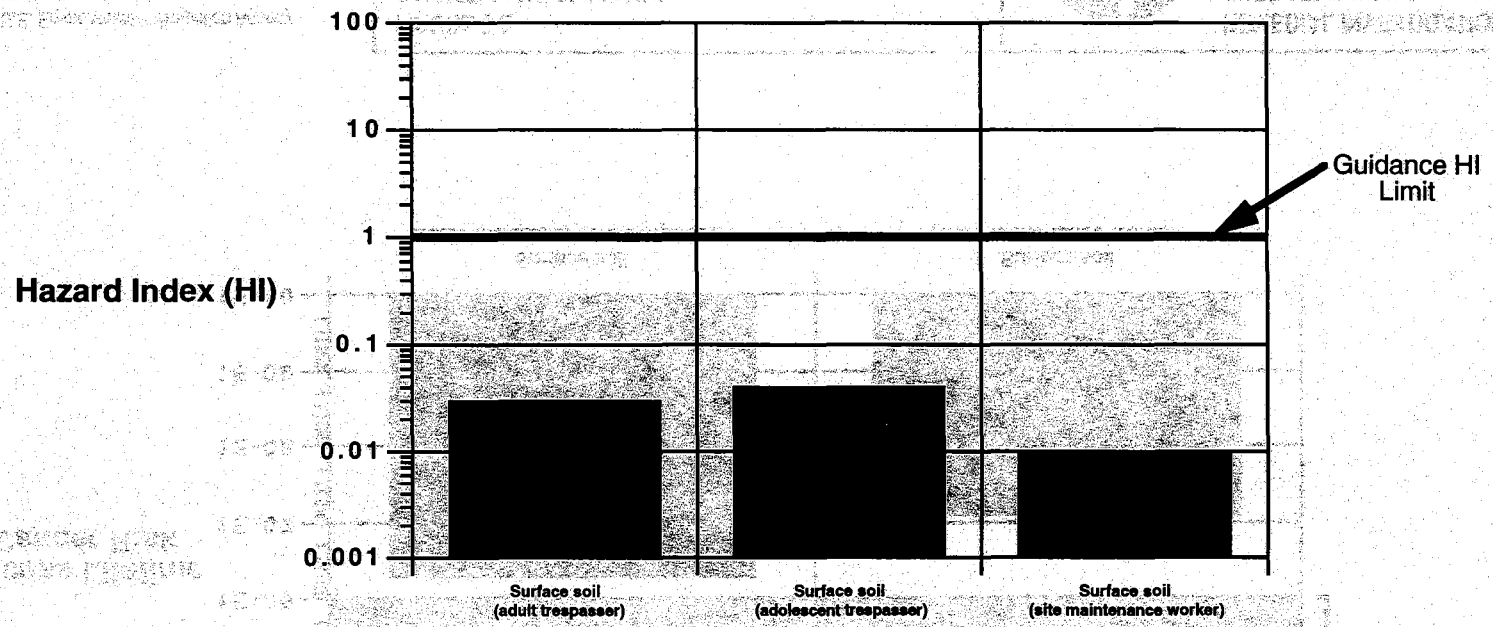


FIGURE 6-3
HAZARD INDEX SUMMARY, CURRENT LAND USE

REMEDIAL INVESTIGATION
OPERABLE UNIT 4

NAVAL AIR STATION CECIL FIELD
JACKSONVILLE, FLORIDA

8500-13 FIG 6-3 101796MAW

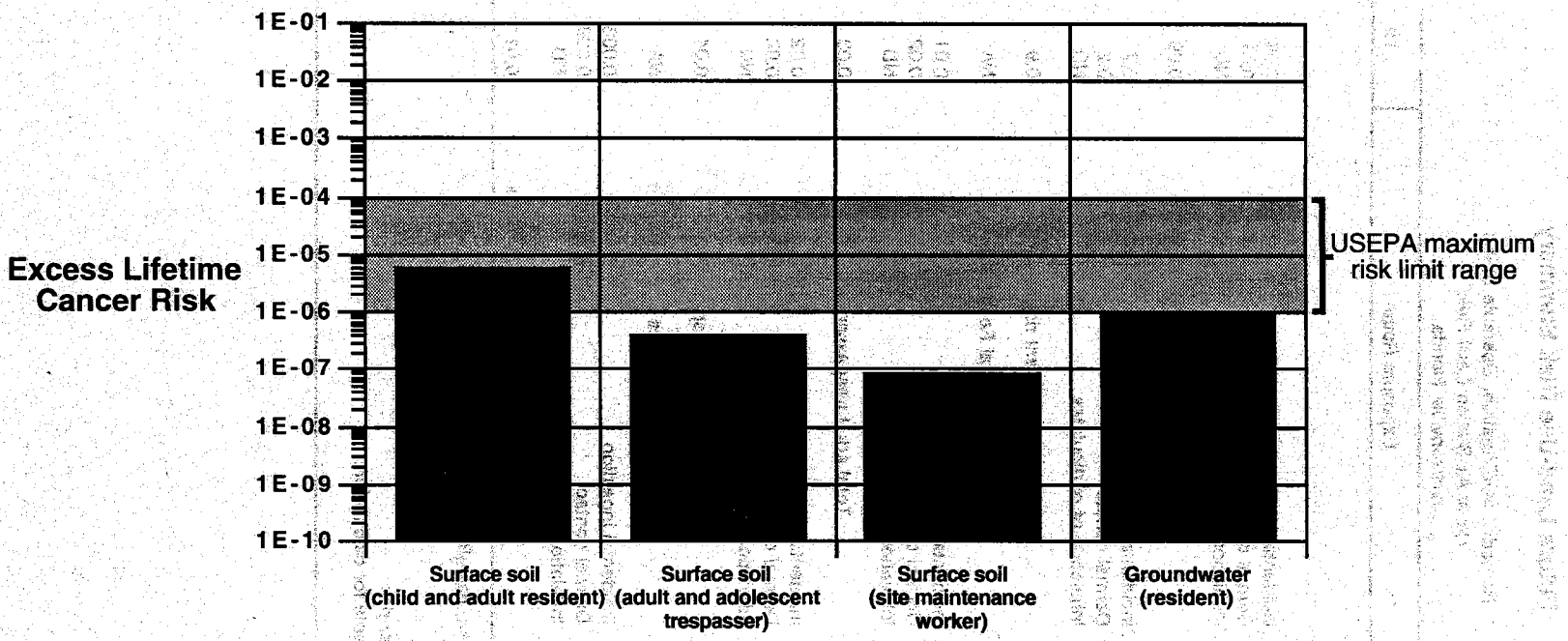
Table 6-7
Future Land-Use Risk Summary

Remedial Investigation, Operable Unit 4
Naval Air Station Cecil Field
Jacksonville, Florida

Medium and Receptor	Exposure Route	HI	ELCR
Future Land Use			
Surface Soil			
Adult Resident	Incidental ingestion	0.08	$2x10^{-6}$
	Dermal contact	0.01	$1x10^{-7}$
	Inhalation of particulates	ND	$3x10^{-10}$
	Total adult resident risks	0.09	$2x10^{-6}$
Child Resident	Incidental ingestion	0.7	$4x10^{-6}$
	Dermal contact	0.2	$4x10^{-8}$
	Inhalation of particulates	ND	$3x10^{-10}$
	Total child resident risks	0.9	$4x10^{-6}$
	Total Resident risks	NA	$6x10^{-6}$
Adult trespasser	Incidental ingestion	0.01	$2x10^{-7}$
	Dermal contact	0.02	$1x10^{-8}$
	Inhalation of particulates	ND	$5x10^{-12}$
	Total adult trespasser risks	0.03	$2x10^{-7}$
Adolescent trespasser	Incidental ingestion	0.02	$2x10^{-7}$
	Dermal contact	0.02	$7x10^{-9}$
	Inhalation of particulates	ND	$3x10^{-12}$
	Total adolescent trespasser risks	0.04	$2x10^{-7}$
	Total trespasser risks	NA	$4x10^{-7}$
Site maintenance worker	Incidental ingestion	0.003	$7x10^{-8}$
	Dermal contact	0.009	$8x10^{-9}$
	Inhalation of particulates	ND	$2x10^{-11}$
	Total site maintenance worker risks	0.01	$8x10^{-8}$

Notes: The values used in this table are calculated in Appendix F.5.

HI = hazard index.
ELCR = excess lifetime cancer risk.
ND = no toxicity values available for calculation.
NA = not applicable.



NOTE:
USEPA = U.S. Environmental Protection Agency
a = Excess lifetime cancer risk

FIGURE 6-4
CANCER RISK[a] SUMMARY, FUTURE LAND USE

REMEDIAL INVESTIGATION
OPERABLE UNIT 4

NAVAL AIR STATION CECIL FIELD
JACKSONVILLE, FLORIDA

8500-13 FIG 6-4 101796MAW

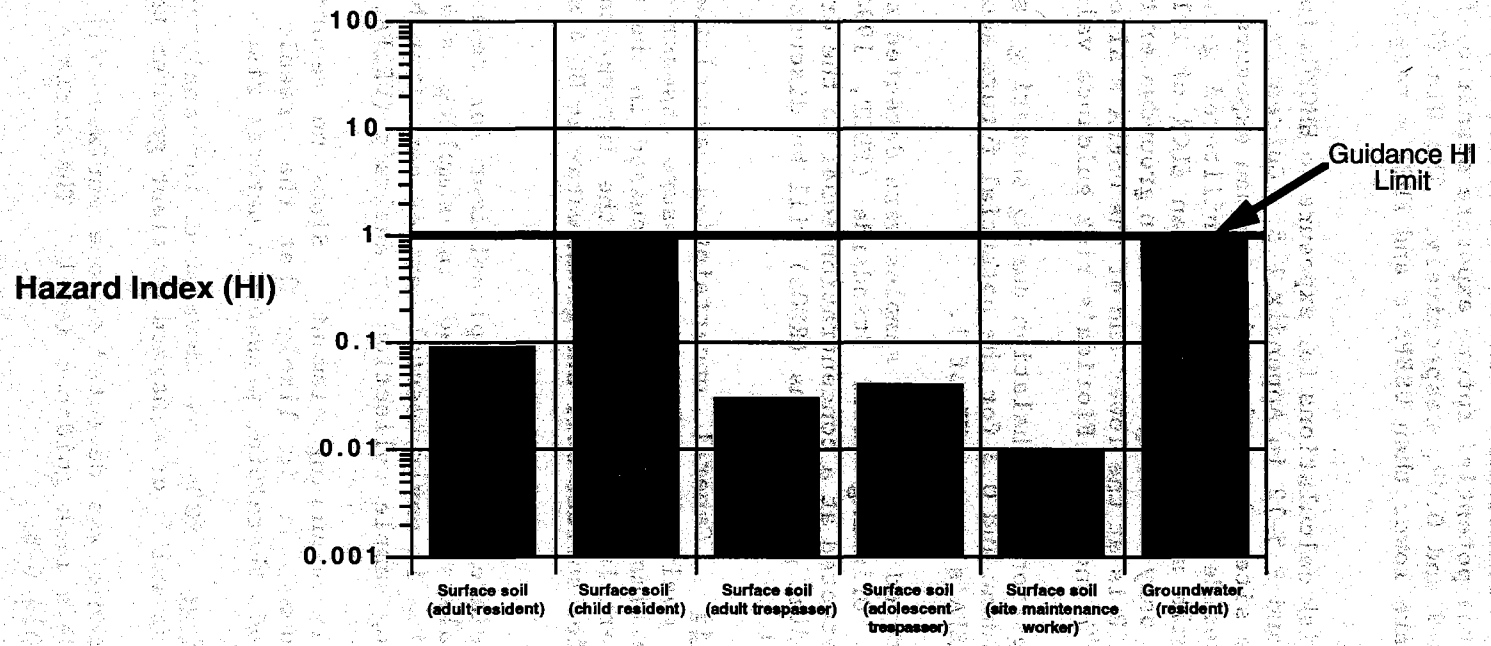


FIGURE 6-5
HAZARD INDEX SUMMARY, FUTURE LAND USE

REMEDIAL INVESTIGATION
OPERABLE UNIT 4

NAVAL AIR STATION CECIL FIELD
JACKSONVILLE, FLORIDA

8500-13 FIG 6-5 101796MAW

maintenance worker is within the USEPA's allowable cancer risk range ($1x10^{-4}$ to $1x10^{-6}$) and below Florida's risk guidance value ($1x10^{-6}$).

For current land-use surface soil exposure scenario, the HIs for the child and adult trespasser and site maintenance worker are 0.03, 0.04, and 0.01, respectively. The HIs for the potential future exposure scenarios for child and adolescent residents are 0.9 and 0.09, respectively. The HIs for current and future land-use scenarios are lower than USEPA's and FDEP's target HI criteria of 1.

6.1.5.2 Groundwater The risk calculations for exposure to HHCPCs in groundwater are shown in Table F.5-11 and F.5-12 in Appendix F.5. Currently, there are no potable supply wells at the site; thus, there is no human exposure to groundwater. Future aggregate resident's ingestion of unfiltered groundwater and inhalation of volatiles while showering represents an ELCR of $1x10^{-6}$. Bis(2-ethylhexyl)phthalate is the only carcinogen detected in groundwater that exceeded screening criteria. The ELCR is at the lower end of the USEPA's allowable cancer risk range ($1x10^{-4}$ to $1x10^{-6}$) and is at Florida's risk guidance value ($1x10^{-6}$).

The HI for groundwater ingestion and inhalation during showering is 0.6 for the potential future child resident and 0.3 for the potential future adult resident. These HIs do not exceed USEPA's target HI of 1.

Aluminum and iron in unfiltered groundwater samples were detected at concentrations exceeding Florida's Drinking Water Standards (FDEP, 1994). Bis(2-ethylhexyl)phthalate was detected at a concentration equal to the drinking water standard. Therefore, remedial goal options (RGOs) will be discussed for these chemicals in Subsection 6.1.7.

6.1.6 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 the GIR (ABB-ES, 1996). Site-specific uncertainties important for the interpretation of the calculated risk estimates for surface soil and groundwater at OU 4 are discussed below.

- Bis(2-ethylhexyl)phthalate is a common plasticizer for resins. Because bis(2-ethylhexyl)phthalate may be used in sampling and laboratory equipment, its detection in environmental samples can often be attributed to contamination during sample collection or analysis (USEPA, 1991).

- Arsenic is a naturally occurring element. Since no record of arsenic disposal has been found, it is likely that the arsenic detected is naturally occurring and, therefore, presents a natural risk.

6.1.7 Remedial Goal Options RGOs are developed for analytes having an associated ELCR greater than $1x10^{-6}$ or a hazard quotient greater than 0.1.

6.1.7.1 Surface Soil Arsenic was detected in one surface soil sample at a concentration above Florida's risk guidance level. The surface soil RGO for arsenic is presented in Table 6-8.

Table 6-8
Remedial Goal Options for Surface Soil

Remedial Investigation, Operable Unit 4
Naval Air Station Cecil Field
Jacksonville, Florida

Analyte	Detected Concentration Range (mg/kg)	Exposure Point Concentration (mg/kg)	Excess Lifetime Cancer Risk and Corresponding Soil Concentration			Hazard Index and Corresponding Soil Concentration[1]			Florida Soil Cleanup Goal[2]
			10^{-4}	10^{-5}	10^{-6}	3	1	0.1	
Arsenic	2.7	2.7	140	14	1.4	NR	NR	NR	0.8

[1] NR in these columns indicates that the chemical is not associated with a hazard index greater than 1.
[2] The value is from the Florida Department of Environmental Protection memorandum titled "Applicability of Soil Cleanup Goals for Florida" dated January 19, 1996.

Notes: mg/kg = milligrams per kilogram.
NR = the remedial goal option exceeds the maximum detected concentration: no action is necessary to achieve this goal.

6.1.7.2 Groundwater No analytes detected in groundwater samples exceeded either the State or Federal risk guidelines. However, three analytes were detected at concentrations equal to or exceeding the Florida Primary or Secondary Drinking Water Standards (FDEP, 1994) and are presented in a groundwater RGO table (Table 6-9). Bis(2-ethylhexyl)phthalate was detected at a concentration equal to the Florida Primary Drinking Water Standards; aluminum and iron exceeded Florida Secondary Standards (FDEP, 1994). Secondary standards are not based on risk to human health, but on aesthetic considerations such as taste and odor.

OU 4 is not suitable for residential or industrial development without significant alteration to the existing land surface. Also, the site is bordered on the hydraulically downgradient side by transitional upland and floodplain swamp habitat associated with Rowell Creek, which will likely prevent future development downgradient of the site. Based on these site-specific considerations, future human exposure to unfiltered groundwater is not expected.

Table 6-9
Remedial Goal Options for Unfiltered Groundwater

Remedial Investigation, Operable Unit 4
Naval Air Station Cecil Field
Jacksonville, Florida

Analyte	Detected Concentration Range (µg/ℓ)	Exposure Point Concentration (µg/ℓ)	Excess Lifetime Cancer Risk and Corresponding Soil Concentration[1]			Total Hazard Index and Corresponding Soil Concentration[2]			Florida Primary and Secondary Standard[3]	Federal MCL[4]
			10^{-4}	10^{-5}	10^{-6}	3	1	0.1		
bis(2-Ethylhexyl)phthalate	2 - 6	6	600	60	6	NR	NR	NR	6	NS
Aluminum	669 - 1059.5	1,060	NA	NA	NA	NR	NR	NR	200	NS
Iron	529 - 2,180	2,180	NA	NA	NA	NR	NR	NR	300	NS
Manganese	49.35	49.4	NA	NA	NA	NR	NR	NR	50	NS

[1] NA in these columns indicates that the chemical is not associated with a cancer risk greater than 1×10^{-6}.
[2] NR in these columns indicates that the chemical is not associated with a hazard index greater than 1.
[3] The value is from the Florida Department of Environmental Protection memorandum titled "Florida Ground Water Guidance Concentrations" dated June 1994.
[4] The Federal MCLs are identified in the U.S. Environmental Protection Agency "Drinking Water Regulations and Health Advisories" dated May 1995.

Notes: µg/ℓ = micrograms per liter.
MCL = maximum contaminant level.
NR = the remedial goal option exceeds the maximum detected concentration: no action is necessary to achieve this goal.
NS = no standard available.
NA = not applicable.

7.0 ECOLOGICAL RISK ASSESSMENT

This Ecological Risk Assessment (ERA) evaluates actual and potential adverse effects to ecological receptors associated with exposure to contamination from OU 4. The ERA for OU 4 was completed in accordance with the methodologies described in the GIR (ABB-ES, 1996) and current guidance materials for ERAs at Superfund sites including the following:

- Risk Assessment Guidance for Superfund, Environmental Evaluation Manual (USEPA, 1989a)
- Ecological Assessment of Hazardous Waste Sites, A Field and Laboratory Reference (USEPA, 1989b)
- Ecological Assessment of Superfund Sites, An Overview (USEPA, 1991a)
- Framework for Ecological Risk Assessment (USEPA, 1992a)

Recent risk assessment guidance including the USEPA "Eco Update" bulletins (USEPA, 1991b; 1992b; 1992c) and recent publications (e.g., Maughan, 1993; Suter, 1993) were also consulted.

The introduction for the OU 4 ERA includes the problem formulation. Problem formulation is the initial step of the ERA process whereby receptors, exposure pathways, and the assessment and measurement endpoints are selected for evaluation.

Identification of Receptors. Terrestrial and aquatic flora and fauna potentially occurring at Cecil Field are presented in the GIR (ABB-ES, 1996). A discussion of flora and fauna observed at OU 4 by ABB-ES ecologists is provided in Subsections 7.1.1 and 7.1.2, respectively. The possible occurrence of rare, threatened, endangered, and commercially exploited species is discussed in Subsection 7.1.3.

Wildlife receptors, terrestrial plants, and terrestrial invertebrates are expected to be found in the upland areas of OU 4, and aquatic receptors are likely to occur in the wetland portions of OU 4. Aquatic receptors potentially inhabiting Rowell Creek, the small tributary in the northern portion of the site, and the drainage ditch and floodplain swamp in the southern portion of the site (shown on Figure 7-1) include a variety of invertebrates, plants, algae, reptiles/amphibians, and possibly small fish.

Identification of Exposure Pathways. Exposure pathways are identified for four groups of ecological receptors (terrestrial wildlife, terrestrial plants, terrestrial invertebrates, and aquatic receptors). The exposure pathway includes a source of contamination, potentially contaminated media, and an exposure route. The exposure pathways from the OU 4 waste source to ecological receptors are depicted in the contaminant pathway model on Figure 7-2.

The model depicts all potential exposure pathways, however, shading indicates only those pathways that are evaluated in the ERA for OU 4. This limitation is necessary to focus the risk evaluation on the pathways for which (1) contaminant exposures are the highest and most likely to occur and (2) there are adequate

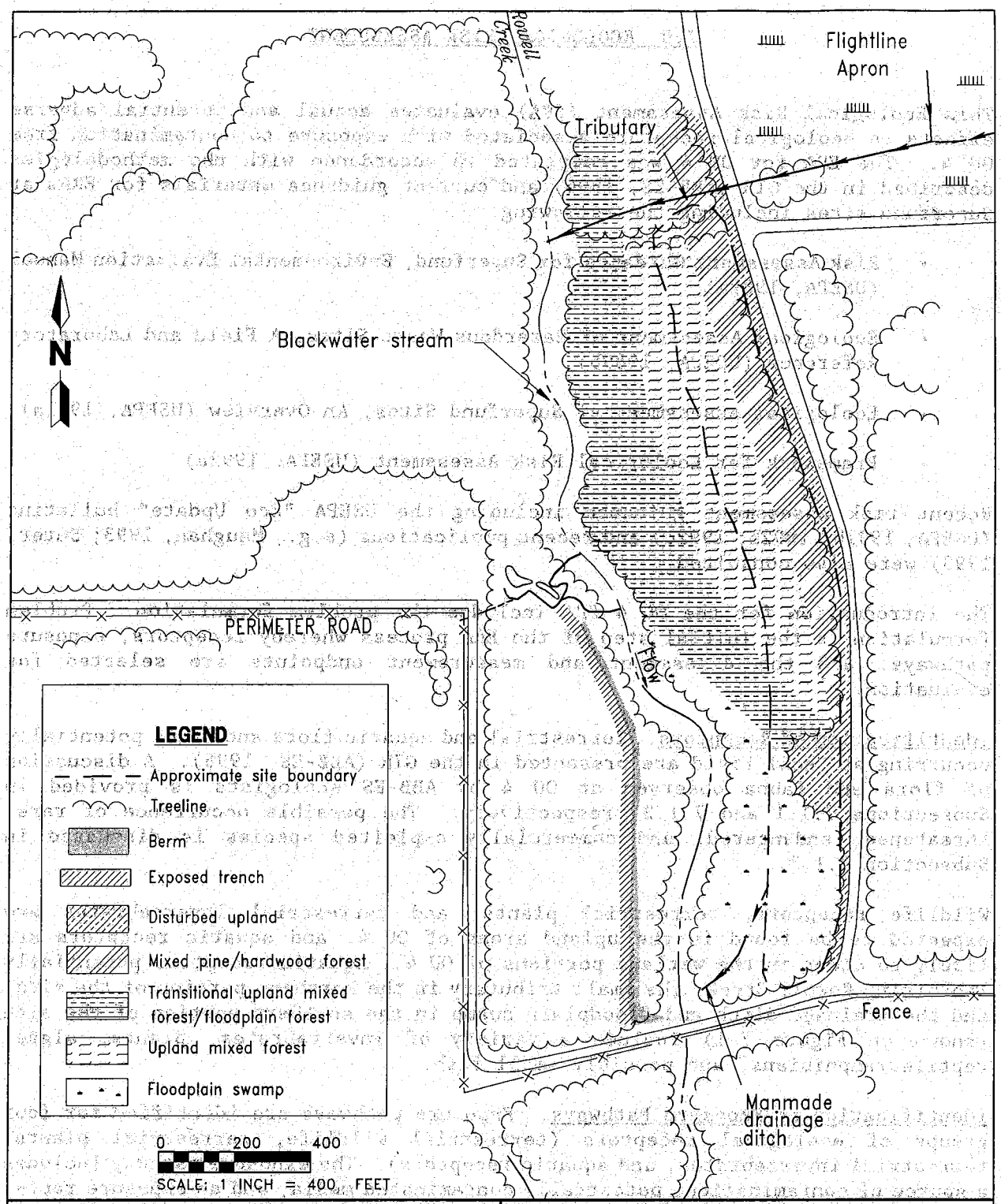


FIGURE 7-1
ECOLOGICAL COMMUNITIES

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REMEDIAL INVESTIGATION
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NAVAL AIR STATION CECIL FIELD
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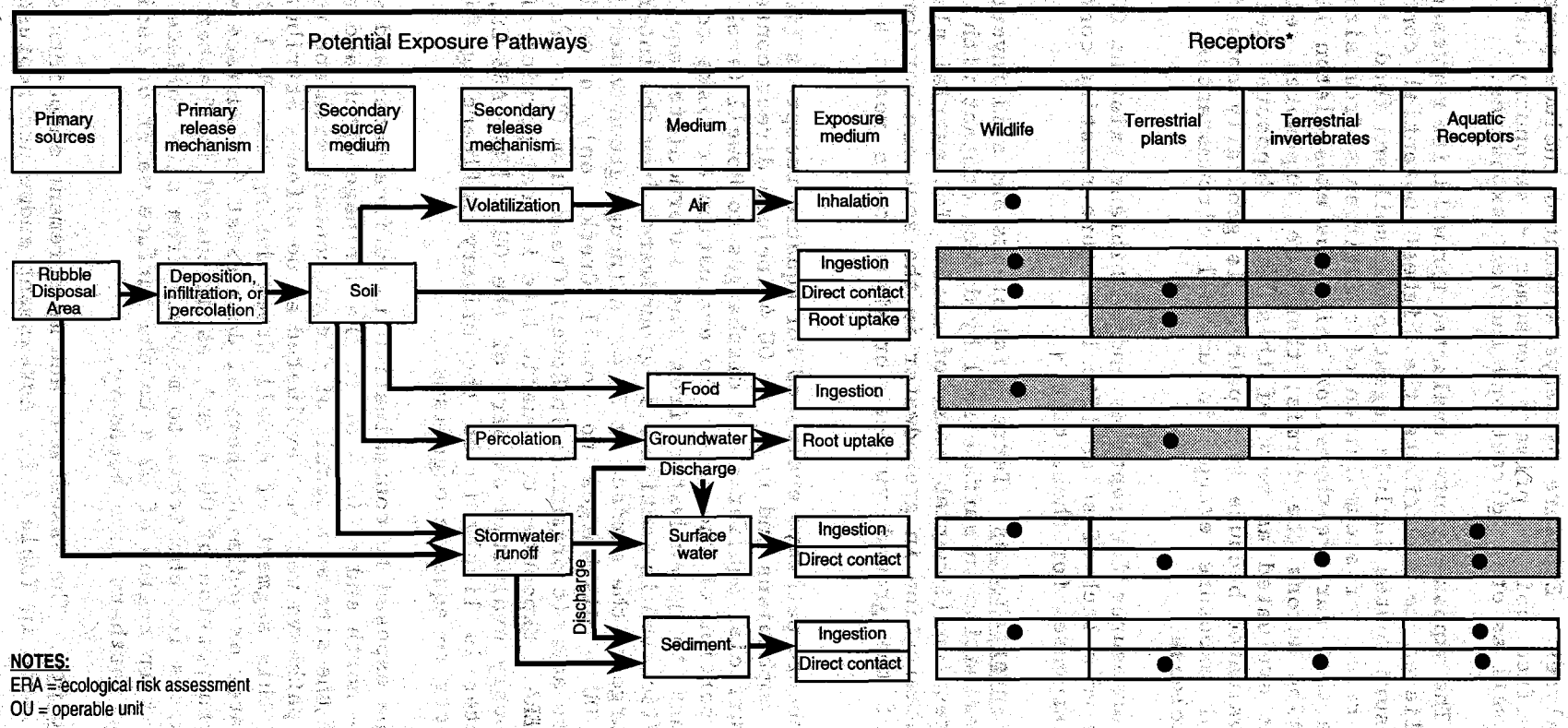


NOTES:
ERA = ecological risk assessment
OU = operable unit

* Shading indicates the exposure pathways that are quantitatively evaluated for receptors in the OU 4 ERA. Nonshaded pathways are evaluated qualitatively, not evaluated due to the lack of toxicity information, not evaluated because it is not considered a significant pathway, or evaluated under a different operable unit.

FIGURE 7-2
CONTAMINANT PATHWAY MODEL FOR ECOLOGICAL RECEPTORS

REMEDIAL INVESTIGATION
OPERABLE UNIT 4

NAVAL AIR STATION CECIL FIELD
JACKSONVILLE, FLORIDA

8500-52-TKD.FIG 7-2 053196MAW

data pertaining to the receptors, contaminant exposures, and toxicity for completion of risk analyses. Exposure pathways evaluated include portions of food chains (e.g., surface soil → primary consumer → secondary consumer → tertiary consumer) as well as other direct and indirect exposures.

Terrestrial Wildlife. The exposure routes evaluated for wildlife represent those pathways that are believed to contribute the highest potential contaminant exposures. These exposure routes include ingestion of soil and food items that are contaminated as a result of accumulation of constituents from site media. An assumption was made that fur, feathers, or chitinous exoskeleton limit the transfer of contamination across the dermis; therefore, exposures related to dermal contact are not evaluated as part of this ERA. Exposures related to inhalation were not evaluated because this pathway is generally considered an insignificant route of exposure except in unusual circumstances, such as following a spill or release.

Potential contaminant exposures for reptiles and amphibians exist at OU 4, but were not evaluated due to a lack of scientific literature relating contaminant exposures to adverse responses for these taxa.

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. Terrestrial plants may also be exposed to contamination in groundwater in the southern portion of the site where water is at the ground surface, or where roots reach a zone of saturation.

Aquatic Receptors. Exposure pathways evaluated for aquatic receptors (including invertebrates, plants, amphibians and fish) at OU 4 include direct contact with groundwater from the surficial aquifer as it discharges to Rowell Creek and the swamp in the southern portion of the site. No evaluation of risks to aquatic organisms from exposure to groundwater from the intermediate aquifer was performed because, as discussed in Section 3.5, groundwater from the intermediate aquifer does not discharge to the surface at OU 4. Although groundwater from the surficial aquifer at OU 4 discharges to Rowell Creek, only a qualitative evaluation of impacts to aquatic organisms in Rowell Creek from OU 4 groundwater was performed in this ERA. Exposures to aquatic life in that portion of Rowell Creek have been previously evaluated as part of the OU 1 ERA (ABB-ES, 1994a) because OU 1 groundwater is likely to be the primary influencing factor on potential adverse effects to aquatic organisms.

Aquatic life may also be exposed to contamination in surface water and sediment in the tributary at the north end of OU 4 or in the drainage ditch and swamp in the southern portion of the site as a result of direct contact with and ingestion of these media. These pathways were not evaluated as no effects attributable to OU 4 were observed in this segment of Rowell Creek during the OU 1 BRA. In addition, no surface water or sediment chemical data exist for surface water or sediment in the southern portion of OU 4 and, as discussed in Chapter 3.0, no transport mechanism exists for chemicals to migrate from site surface soil or groundwater in the northern region of OU 4 to the surface water or sediment in the tributary along the northern site boundary.

Identification of Endpoints. The assessment and measurement endpoints selected for the OU 4 ERA are listed in Table 7-1. Assessment endpoints represent the

Table 7-1
Endpoints for Ecological Assessment

Remedial Investigation, Operable Unit 4
Naval Air Station Cecil Field
Jacksonville, Florida

Medium	Receptor	Assessment Endpoint	Measurement Endpoint
Surface Soil	Wildlife	Maintenance and productivity of wildlife populations and communities.	Oral contaminant doses (mg/kg BW-day) based on measured adverse effects on growth, reproduction, or survival (i.e., LC_{50} studies) of mammalian or avian laboratory test populations.
Surface Soil	Terrestrial invertebrates	Maintenance and productivity of terrestrial invertebrate communities	Contaminant concentrations (mg/kg) in surface soil based on measured adverse effects on survival (i.e., LC_{50} studies) of terrestrial invertebrates. When no survival studies were available, measured adverse effects on reproduction and growth are used.
Surface Soil	Terrestrial plants	Maintenance and productivity of plant communities.	Contaminant concentrations (mg/kg) in surface soil at which adverse effects on growth, reproduction, or survival of terrestrial plants are observed.
Groundwater	Aquatic Organisms	Maintenance and productivity of aquatic populations	Contaminant concentrations ($\mu g/\ell$) in surface water at which adverse effects on growth, reproduction, survival, or biodiversity of aquatic plants, aquatic invertebrates, amphibians, and fish are observed.

Notes: mg/kg = milligrams per kilogram.
BW = body weight.
LC_{50} = contaminant concentration estimated to result in the death of 50 percent of an exposed population.
$\mu g/\ell$ = micrograms per liter.

ecological component to be protected, whereas the measurement endpoints approximate or provide a measure of the achievement of the assessment endpoint. The assessment endpoint selected for the OU 4 ERA is the maintenance and productivity of receptor populations and communities at OU 4. The specific objectives of the OU 4 assessment are to determine whether or not the chemical concentrations in surface soil and groundwater at OU 4 are likely to result in population and subsequent community decline of ecological species. The measurement endpoints used to gauge the likelihood of population- and community-level effects are toxicological benchmark values based on laboratory-measured survival, growth, and reproductive effects.

7.1 SITE CHARACTERIZATION. In September 1995, ABB-ES ecologists visited the site to characterize the habitats that exist at OU 4. Teams of ecologists walked along transects through the site, identifying characteristic flora and fauna for each habitat that was encountered. Figure 7-1 provides an overview of the habitats present at OU 4.

7.1.1 Vegetative Cover The following vegetative communities were identified at OU 4 (roughly from east to west): disturbed upland (along the road), mixed hardwood/pine community, upland mixed forest (with a transitional hardwood/floodplain forest grading down into Rowell Creek, a blackwater stream), and floodplain swamp. More details regarding the characteristics of these communities are provided in the NAS Cecil Field BEAR (ABB-ES, 1996a).

The disturbed uplands, mixed pine/hardwoods, and upland mixed forest communities are representative of those habitats that contain upland species of plants. Upland tree and shrub species observed within these communities at OU 4 include sweetgum (*Liquidambar styraciflua* L.), saw palmetto (*Serenoa repens*), cherry (*Prunus* sp.), various pines (*Pinus* sp.), water oak (*Quercus nigra*), live oak (*Q. virginiana*), southern bayberry (*Myrica cerifera*), and hollies (*Ilex* sp.).

Herbaceous plants and graminoids common to upland communities and observed at OU 4 include bracken fern (*Pteridium aquilinum*), wild poinsettia (*Poinsettia heterophylla*), dog fennel (*Eupatorium capitatum*), yellow aster (*Aster* sp.), fleabane (*Erigeron* sp.), morning glory (*Ipomoea* sp.), evening primrose (*Oenothera* sp.), black-eyed Susan (*Rudbeckia* sp.), goldenrod (*Solidago* sp.), thistle (*Cirsium* sp.), beauty berry (*Callicarpa americana*), meadow beauty (*Rhexhia virginica*), violet (*Viola* sp.), poison ivy (*Toxicodendron radicans*), pea (*Cassia* sp.), water pennywort (*Hydrocotyle americana*), vervain (*Verbena* sp.), and crabgrass (*Digitaria* sp.). Vines commonly found growing in masses on shrubs and on trees in upland areas of OU 4 include bullbriar greenbriar (*Smilax bona-nox*), muscadine grape (*Vitis rotundifolia*), Virginia creeper (*Parthenocissus quinquefolia*), and peppervine (*Ampelopsis arborea*).

The hardwood/floodplain forest, floodplain swamp, and black water stream habitats are representative of those habitats that contain transitional and wetland species of plants. Tree and shrub species observed within these communities at OU 4 include cypress (*Taxodium* sp.), sweetbay magnolia (*Magnolia virginiana*), red maple (*Acer rubrum*), groundsel tree (*Baccharis halmifolia*), and blueberry (*Vaccinium* sp.).

Herbaceous plant species and graminoids common to transitional/wetland communities and observed at OU 4 include sundew (*Drosera intermedia*), cardinal

flower (*Lobelia cardinalis*), cinnamon fern (*Osmunda cinnamomea*), royal fern (*Osmunda regalis*), pickerelweed (*Pontederia cordata*), panic grass (*Panicum vergatum*), rushes (*Juncus* sp.), and cattails (*Typha* sp.).

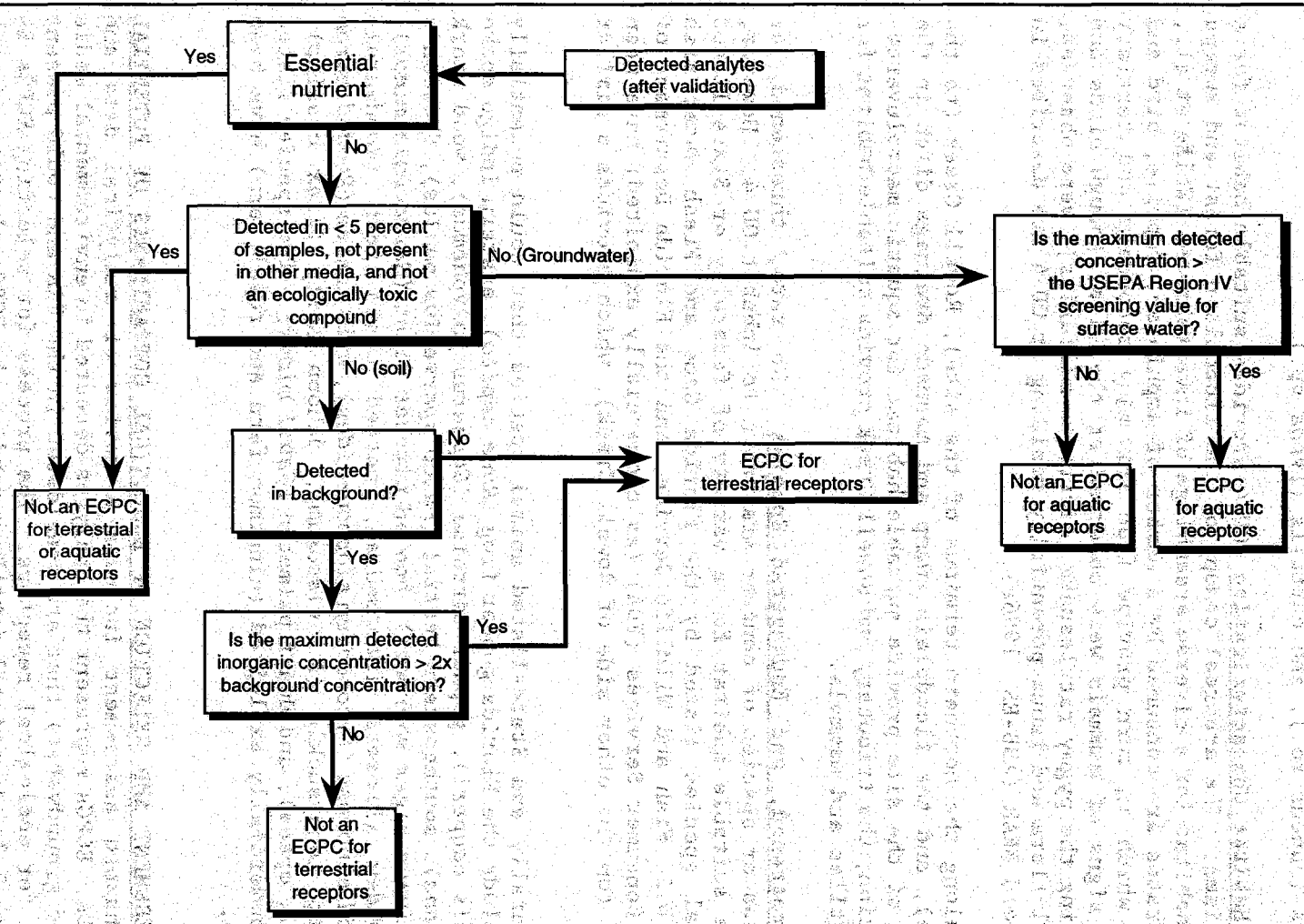
7.1.2 Wildlife Habitat Characterization OU 4 provides suitable habitat for a variety of organisms. The arboreal canopy of the floodplain forest and swamps provides proper habitat for a diverse assemblage of invertebrates (Wolfe et al., 1988). Invertebrates are consumed by a number of amphibian, reptile, bird and mammal species, which in turn provide food for many secondary and tertiary consumers. Few signs of mammals were observed at the site, though birds and reptiles (including the pygmy rattlesnake [*Sistrurus miliarius*]) were observed. Other terrestrial flora and fauna potentially residing at OU 4 are described in the NAS Cecil Field BEAR (ABB-ES, 1996a).

The tributary (along the northern terminus of the site), Rowell Creek (to the west of the site), and the floodplain swamp and manmade drainage ditch in the southern portion of the site provide suitable habitat for aquatic macroinvertebrates. In addition, the tributary and Rowell Creek provide suitable habitat for semi-aquatic reptiles and mammals.

7.1.3 Rare, Threatened, and Endangered Species No rare, threatened, or endangered species or species of concern are known to inhabit OU 4. However, OU 4 may provide suitable habitat for a variety of federally or State-listed species. Several species listed by the Florida Game and Fresh Water Fish Commission, the U.S. Fish and Wildlife Service, and the Florida Department of Agriculture and Consumer Services (FDA) (as commercially exploited) have been observed at OU 1 (on the other side of Rowell Creek), which provides a similar habitat as OU 4.

Some of the federally and State-listed animal species that could potentially occur at OU 4 include the Florida gopher frog (*Rana capito*), eastern indigo snake (*Drymarchon corais couperi*), gopher tortoise (*Gopherus polyphemus*), wood stork (*Mycteria americana*), southeastern kestrel (*Falco sparverius paulus*), Sherman's fox squirrel (*Sciurus niger shermani*), hooded pitcher plant (*Sarracenia minor*), spoon-leaved sundew (*Drosera intermedia*), netted chain fern (*Woodwardia areolata*), foxtail clubmoss (*Lycopodium alopecuroides*), wild azalea (*Rhododendron canescens*), swamp honeysuckle (*R. viscosum*), dahoon holly (*Ilex cassine*), American holly (*I. opaca*), and dwarf palmetto (*Sabal minor*). Two species listed by the FDA as commercially exploited (cinnamon fern and royal fern) have been observed at OU 4.

7.2 HAZARD ASSESSMENT AND SELECTION OF ECOLOGICAL CONTAMINANTS OF POTENTIAL CONCERN. The hazard assessment includes a review of analytical data and selection of ECPCs. ECPCs represent the analytes detected in environmental media (surface soil and groundwater) that are considered in the ERA and could present a potential risk for ecological receptors. The process for selecting ECPCs is depicted on Figure 7-3. Additional details regarding the ECPC selection process are provided in the GIR (ABB-ES, 1996).



NOTES:
ECPC = ecological contaminant of potential concern
USEPA = U.S. Environmental Protection Agency
> = greater than
< = less than
x = times

FIGURE 7-3
ECOLOGICAL CONTAMINANT OF POTENTIAL CONCERN SELECTION PROCESS

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JACKSONVILLE, FLORIDA

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The background investigation is discussed in Subsection 2.2.4. Two times the arithmetic mean of detected inorganic analytes from the basewide Cecil Field background surface soil (excluding Arents soil) and groundwater (including only data collected from the surficial aquifer) databases were used for screening ECPCs. In addition, USEPA Region IV surface water screening criteria (USEPA, 1995), which are derived to be protective of aquatic life, were used for screening groundwater ECPCs for aquatic organisms. Analytical results from 11 surface soil locations (CEF-BK-SS-5 through CEF-BK-SS-15, with one duplicate collected at CEF-BK-SS-9) were included in the background surface soil summary. Analytical results from 6 monitoring well locations screened in the surficial aquifer (CEF-BK-MW-1S, CEF-BK-MW-2S, CEF-BK-MW-4S [including a duplicate], CEF-BK-MW-5S, CEF-BK-MW-7S, and CEF-BK-MW-8S) were included in the background groundwater summary.

Analytical data for OU 4 were evaluated to determine their validity for use in risk assessment pursuant to national guidance, *Guidance for Data Useability in Risk Assessment (Parts A and B)* (USEPA, 1992d). More detail regarding data useability is provided in the GIR (ABB-ES, 1996). In accordance with USEPA Region IV guidance (USEPA, 1991c), if the maximum detected concentration of an inorganic analyte detected in surface soil was less than two times the average inorganic concentration detected in the respective background samples, then the analyte was not selected as an ECPC for wildlife. If the maximum detected concentration of an analyte detected in groundwater was less than the USEPA Region IV surface water screening value or two times the average inorganic background concentration, then the analyte was not selected as an ECPC for aquatic receptors.

As discussed in the GIR (ABB-ES, 1996), the essential nutrients (e.g., calcium, magnesium, potassium, and sodium) were excluded as ECPCs for all media, and iron was excluded as an ECPC for surface soil; these analytes are considered to be toxic at only extremely elevated concentrations.

All analytes detected in site media are summarized in tables that include the following: frequency of detection, range of detection limits, range of detected concentrations, average of detected concentrations, and screening values (i.e., twice the average background concentration for inorganic analytes or USEPA Region IV screening criteria). For those analytes that are retained as ECPCs for the ERA, the following information is also provided: average of all concentrations, 95th percentile upper confidence limit (UCL), and maximum and average exposure point concentrations. A discussion of how exposure point concentrations are determined is provided in Section 7.3.

<u>7.2.1 Surface Soil</u> Six surface soil samples were collected in April 1995 at OU 4 (CF-10-SS1 through CF-10-SS6) (Figure 2-1); all six samples were evaluated in the OU 4 ERA. The selection of surface soil ECPCs is presented in Table 7-2.

One VOC (methylene chloride), 1 SVOC (di-n-butylphthalate), 13 inorganic analytes, and total petroleum hydrocarbons (TPH) were detected in surface soil samples collected in the OU 4 disposal area. Both detected organic analytes and TPH were retained as wildlife ECPCs. In addition, eight inorganic analytes (including aluminum, arsenic, barium, chromium, cobalt, lead, manganese, and vanadium) were retained as wildlife ECPCs for the OU 4 ERA because their maximum detected concentrations were greater than two times the average background soil

Table 7-2
Selection of Ecological Contaminants of Potential Concern in Surface Soil [1]

Remedial Investigation, Operable Unit 4
Naval Air Station Cecil Field
Jacksonville, Florida

Analyte	Frequency of Detection[2]	Range of Detection Limits	Range of Detected Concentrations	Average of Detected Concentrations[3]	2X Average Background Concentration[4]	Contaminant of Ecological Concern?	Average of all Concentrations[5]	Exposure Point Concentrations	
								Maximum[6]	Average[7]
Volatile Organic Compounds (µg/kg)									
Methylene chloride	1/6	6 - 14	3 J	3 J	NA	Yes	3.2	3	3
Semivolatile Organic Compounds (µg/kg)									
Di-n-butylphthalate	5/6	380 - 480	21 J - [8]140	55	NA	Yes	79	140	79
Inorganic Analytes (mg/kg)									
Aluminum	6/6	40	144 - 7,830	1,980	2,370	Yes	1,980	7,830	1,980
Arsenic	1/6	20	2.7	2.7	NA	Yes	8.8	2.7	2.7
Barium	1/6	40	10.3	10.3	9.0	Yes	18.4	10.3	10.3
Calcium	4/6	1,000	179 - 6,350	4,060	458	No[9]			
Chromium	1/6	2	17	17	4.6	Yes	3.7	17	3.7
Cobalt	1/6	10	0.67	0.67	NA	Yes	4.3	0.67	0.67
Iron	6/6	20	140 J - 9,150	2,190	648	No[9]			
Lead	6/6	0.6	1.3 J - 7.2 J	4.8	6.4	Yes	4.8	7.2	4.8
Magnesium	6/6	1,000	15 - 115	78.7	108	No[9]			
Manganese	6/6	3	1.8 - 11.7	5.4	8.6	Yes	5.4	11.7	5.4
Potassium	1/6	1,000	59.4	59.4	NA	No[9]			

See notes at end of table

Table 7-2 (Continued)
Selection of Ecological Contaminants of Potential Concern in Surface Soil [1]

Remedial Investigation, Operable Unit 4
Naval Air Station Cecil Field
Jacksonville, Florida

Analyte	Frequency of Detection[2]	Range of Detection Limits	Range of Detected Concentrations	Average of Detected Concentrations[3]	2X Average Background Concentration[4]	Contaminant of Ecological Concern?	Average of all Concentrations[5]	Exposure Point Concentrations	
								Maximum[6]	Average[7]
Inorganic Analytes (mg/kg)									
Sodium	2/6	1,000	200 - 253 J	227	NA	No[9]			
Vanadium	6/6	10	0.74 - 28.5	7	4.6	Yes	7	28.5	7
General Chemistry (mg/kg)									
TPH	6/6	12 - 15	26 J - 270 J	100	NA	Yes	100	270	100

[1] Sample locations include CEF-10-SS1 through CEF-10-SS6 (duplicate at sample location CEF-10-SS5).
[2] Frequency of detection is equal to the number of samples in which the analyte is detected in relation to the total number of samples analyzed.
[3] Arithmetic mean of all samples in which analyte was detected.
[4] Background sample locations include CEF-BK-SS-5 through CEF-BK-SS-15 (duplicate collected at CEF-BK-SS-9). Two times the arithmetic mean of detected background concentrations for inorganic analytes are used to screen ecological contaminants of potential concern.
[5] The average of all concentrations was derived by assigning a value of 1/2 the detection limit to all nondetects.
[6] Maximum exposure point concentrations (EPCs) are equal to the maximum detected concentration.
[7] Average EPCs are equal to the arithmetic mean of all concentrations. When the arithmetic mean is greater than the maximum exposure point concentration, the maximum EPC is used.
[8] Value is the average of a sample and its duplicate.
[9] Analyte is an essential nutrient and not considered toxic except at high concentrations.

Notes: µg/kg = micrograms per kilogram.
J = indicates chemical identified by chemist, but quantity was estimated.
NA = not available.
mg/kg = milligrams per kilogram.
TPH = total petroleum hydrocarbons.

concentration. TPH was detected in all six soil samples at concentrations ranging from 26 mg/kg to 270 mg/kg (Table 7-2).

7.2.2 Groundwater Analytes detected in unfiltered groundwater from the surficial aquifer for OU 4 are summarized in Table 7-3. An evaluation of unfiltered groundwater data is conservative because contaminant concentrations tend to be higher than those for filtered groundwater due to sorption to particulate matter. Since the turbidity of unfiltered groundwater at CEF-MW-5S exceeds 5 nephelometric turbuidity units, dissolved (i.e., filtered) groundwater samples from the surficial aquifer were collected and the data are also provided in Table 7-3. Data collected in April and May 1995 from four monitoring wells screened in the surficial aquifer were used to evaluate groundwater conditions potentially contributing to surface water contamination in Rowell Creek to the west of OU 4 and in the swamp in the southern portion of OU 4.

One SVOC, bis(2-ethylhexyl)phthalate, and 11 inorganic analytes were detected in unfiltered groundwater samples collected at OU 4. Five inorganic analytes were eliminated as aquatic ECPCs because either their maximum detected concentrations were less than the Region IV Chronic Water Quality Screening Value (USEPA, 1995) or two times the average background screening concentration. Three analytes were eliminated as ECPCs because they are essential nutrients. The remaining analytes, bis(2-ethylhexyl)phthalate, aluminum, iron, and manganese, were retained as aquatic ECPCs for evaluation.

Filtered groundwater samples were collected for inorganic analysis from only one monitoring well (CEF-10-5S), as shown in Table 7-3. Six inorganic analytes were selected as filtered inorganic ECPCs. All of the unfiltered inorganic ECPCs were detected in filtered groundwater from OU 4, indicating that all detected inorganic analytes are potentially available to biota. One analyte (copper) was detected in the filtered sample, but not in the unfiltered sample, and several analytes (e.g., barium and vanadium) were detected at higher concentrations in the filtered sample than in the unfiltered sample. Uncertainties regarding the bioavailable fraction of inorganic analytes in groundwater at OU 4 remain, due to the small population of filtered samples that were collected.

7.3 EXPOSURE ASSESSMENT. Exposure assessment is the process of estimating or measuring the amount of an ECPC to which an ecological receptor may be exposed.

The following subsections describe how contaminant exposures were estimated or measured for wildlife, terrestrial plants, terrestrial soil invertebrates, and aquatic receptors at OU 4. The contaminant pathway model (Figure 7-2) provides a summary of the potential exposure pathways that exist at OU 4 for each group of receptors. Additional detail regarding exposure assessment is provided in the GIR (ABB-ES, 1996).

7.3.1 Calculation of Exposure Point Concentrations Maximum and average EPCs were chosen for all ECPCs in surface soil and groundwater to assess exposure to terrestrial and aquatic receptors. Maximum EPCs represent the highest concentration of any analyte that ecological receptors could encounter at the site, whereas average EPCs are representative of typical site concentrations. Because there were less than 10 samples in both the surface soil and groundwater data sets, the maximum detected concentration was selected as the maximum EPC (rather than the 95th percent UCL calculated on the log-transformed arithmetic

Table 7-3
Selection of Ecological Contaminants of Potential Concern in Groundwater [1]

Remedial Investigation, Operable Unit 4
Naval Air Station Cecil Field
Jacksonville, Florida

Analyte	Frequency of Detection[2]	Range of Detection Limits	Range of Detected Concentrations	Average of Detected Concentrations[3]	Region IV Chronic Water Quality Screening Value[4]	2X Average Background Groundwater Concentration[5]	Contaminant of Ecological Concern?[6]	Average of all Concentrations[7]	Exposure Point Concentrations	
									Maximum[8]	Average[9]
Semivolatile Organic Compounds (µg/ℓ)										
bis(2-Ethylhexyl)-phthalate	2/4	10	2 J - 6 J	4 J	0.3	NA	Yes	4.5	6	4.5
Unfiltered Inorganic Analytes (µg/ℓ)										
Aluminum	2/4	200	669 - [10]1,060	864	[11]87	776	Yes	482	1,060	482
Barium	2/4	200	[10]16.5 - 18.5	17.5	NA	41	No[12]			
Calcium	3/4	5,000	2,380 - [10]14,200	9,310	NA	380	No[13]			
Chromium	1/4	10	[10]3.8	3.8	[14]11	70	No[12,15]			
Iron	4/4	100	529 J - [10]2,190 J	1,140	1,000	450	Yes	1,140	2,190	1,140
Magnesium	4/4	5,000	544 - 2,670	1,290	NA	1,290	No[13]			
Manganese	1/4	15	[10]49.4	49.4	NA	10	Yes	18	49.4	18
Nickel	1/4	40	[10]13	14	[16]82	32	No[12,15]			
Potassium	4/4	5,000	215 - 704	464	NA	1,580	No[12,13]			

See notes at end of table.

Table 7-3 (Continued)
Selection of Ecological Contaminants of Potential Concern in Groundwater [1]

Remedial Investigation, Operable Unit 4
Naval Air Station Cecil Field
Jacksonville, Florida

Analyte	Frequency of Detection[2]	Range of Detection Limits	Range of Detected Concentrations	Average of Detected Concentrations[3]	Region IV Chronic Water Quality Screening Value[4]	2X Average Background Groundwater Concentration[5]	Contaminant of Ecological Concern?[6]	Average of all Concentrations[7]	Exposure Point Concentrations	
									Maximum[8]	Average[9]
Unfiltered Inorganic Analytes (µg/ℓ)										
Sodium	4/4	5,000	2,710 - [10]5,580	4,360	NA	1,150	No[13]			
Vanadium	2/4	50	2.7 - [10]4.4 J	3.5	NA	96	No[12]			
Filtered Inorganic Analytes (µg/ℓ)										
Aluminum	1/1	200	[10]720	[10]720	[11]87	NA	Yes	720	720	720
Barium	1/1	200	[10]69.4	[10]69.4	NA	NA	Yes	69.4	69.4	69.4
Calcium	1/1	5,000	[10]11,500 J	[10]11,500 J	NA	NA	No[13]			
Chromium	1/1	10	[10]3.6	[10]3.6	[14]11	NA	No[15]			
Copper	1/1	25	[10]11	[10]11	[16]6	NA	Yes	11	11	11
Iron	1/1	100	[10]1,310 J	[10]1,310 J	1,000	NA	Yes	1,310	1,310	1,310
Magnesium	1/1	5,000	[10]1,090	[10]1,090	NA	NA	No[13]			
Manganese	1/1	15	[10]22.0	[10]22.0	NA	NA	Yes	22.0	22.0	22.0
Nickel	1/1	40	[10]13	[10]13	[16]82	NA	No[15]			
Potassium	1/1	5,000	[10]979	[10]979	NA	NA	No[13]			

See notes at end of table.

Table 7-3 (Continued)
Selection of Ecological Contaminants of Potential Concern in Groundwater [1]

Remedial Investigation, Operable Unit 4
NAS Cecil Field
Jacksonville, Florida

Analyte	Frequency of Detection[2]	Range of Detection Limits	Range of Detected Concentrations	Average of Detected Concentrations[3]	Region IV Chronic Water Quality Screening Value[4]	2X Average Background Groundwater Concentration[5]	Contaminant of Ecological Concern?[6]	Average of all Concentrations[7]	Exposure Point Concentrations	
									Maximum[8]	Average[9]
Filtered Inorganic Analytes (μg/ℓ)										
Sodium	1/1	5,000	[10]7,510	[10]7,510	NA	NA	No[13]			
Vanadium	1/1	50	[10]15	[10]15	NA	NA	Yes	15	15	15

[1] Sample locations include CEF-10-2S through CEF-10-5S (duplicate at sample location CEF-10-5S). Filtered inorganics data are from CEF-10-5S and CEF-10-5SD.
[2] Frequency of detection is equal to the number of samples in which the analyte is detected in relation to the total number of samples analyzed.
[3] Arithmetic mean of all samples in which analyte was detected.
[4] U.S. Environmental Protection Agency (USEPA) Region IV Waste Management Division Chronic Freshwater Quality Screening Values based on the Water Quality Standards Units Screening List (USEPA, 1995).
[5] Background sample locations (for unfiltered data only) include: CEF-BK-MW-1S, CEF-BK-MW-2S, CEF-BK-MW-4S, CEF-BK-MW-4SD, CEF-BK-MW-5S, CEF-BK-MW-7S, and CEF-BK-MW-8S. Two times the arithmetic mean of detected background concentrations for inorganic analytes are presented.
[6] Contaminant of potential concern for aquatic receptors.
[7] The average of all concentrations is derived by assigning a value of 1/2 the sample quantitation limit to all nondetects.
[8] Maximum exposure point concentrations (EPCs) are equal to the maximum detected concentration.
[9] Average EPCs are equal to the arithmetic mean of all concentrations. If the arithmetic mean of all concentrations is greater than the maximum EPC, then the maximum EPC is used.
[10] Value is the average of a sample and its duplicate.
[11] Criterion is based on a pH of 6.5-9 (USEPA, 1988).
[12] Maximum analyte concentration is less than two times the average background concentration.
[13] Analyte is an essential nutrient and is not considered toxic except at high concentrations.
[14] Screening value for hexavalent species of chromium.
[15] Maximum analyte concentration is less than the Region IV chronic surface water screening value.
[16] Hardness-dependent criterion based on a calculated hardness concentration of 46 milligrams calcium carbonate using mean calcium and magnesium concentrations (Greenberg et al., 1992).

Notes: μg/ℓ = micrograms per liter.
NA = not available.
J = indicates chemical identified by chemist, but quantity was estimated.

mean) for each analyte (USEPA, 1992e). The average of all samples, which assigns a value of one-half the sample quantitation limit to all samples in which the analyte was not detected, was used to represent the average EPC unless it exceeded the maximum EPC, in which case the maximum EPC was used for both scenarios.

Maximum and average EPCs are presented in each ECPC table (Table 7-2 for surface soil and Table 7-3 for groundwater). To efficiently evaluate exposure and risk at OU 4, a tiered approach was used. If no risk was calculated from exposure to the maximum EPC, then no average exposure scenarios were evaluated.

7.3.2 Terrestrial Wildlife Exposure routes for wildlife receptors for which EPCs were selected include direct or indirect ingestion of OU 4 soil and ingestion of contaminated food. The actual amount of an ECPC taken in by wildlife species depends on a number of factors. To evaluate exposures at OU 4, representative wildlife species were selected for evaluation in food-chain models which estimate contaminant exposures to wildlife species respective to their position in the food chain. Contaminant exposures for terrestrial wildlife are related to the foraging characteristics of the species; therefore, terrestrial receptors were chosen to represent the trophic levels typical of a southeastern disturbed upland and forested community. The following representative wildlife species (summarized in Table 7-4) were selected for the OU 4 ERA:

- **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). Relative to other small mammals, insectivorous species may receive high doses of contamination as a result of their voracious appetite relative to their small body size and the ability of their prey items to accumulate constituents. The shrew represents small mammal omnivores found in wooded portions of OU 4.

- **Rufous-sided towhee** (*Pipilo erythrophthalmus*). The towhee inhabits dense brushy cover in woodland edges and is an omnivore that forages in the leaf litter of the forest floor for insects, seeds, and fruits (DeGraaf and Rudis, 1986). The home range of the towhee is 1.5 acres. The towhee represents avian omnivores found in forested areas at OU 4.

- **American woodcock** (*Scolopax minor*). The woodcock is a vermivorous (feeding primarily on earthworms) bird that inhabits areas of fertile, moist soil. These areas include open pastures, cultivated fields, and stream banks (DeGraaf and Rudis, 1986). The woodcock represents avian receptors found in forested areas at OU 4.

- **Red fox** (*Vulpes vulpes*). This omnivorous mammal prefers open woodlands and grassy fields, and is most active at dawn, dusk, and night. It is an opportunistic forager, feeding on small mammals, birds, amphibians, reptiles, and invertebrates, as well as berries and other fruits (Burt and Grossenheider, 1976). The home range for the red fox is approximately 250 acres. The red fox represents predatory mammals at OU 4.

Table 7-4
Ecological Receptors Evaluated

Remedial Investigation, Operable Unit 4
Naval Air Station Cecil Field
Jacksonville, Florida

Receptor Evaluated		Media	
Common Name	Scientific Name	Surface Soil	Groundwater
Short-tailed shrew	Blarina brevicauda	✓	
Rufous-sided towhee	Pipilo erythrophthalmus	✓	
American woodcock	Scolopax minor	✓	
Red fox	Vulpes vulpes	✓	
Great-horned owl	Bubo virginianus	✓	
Terrestrial Plants		✓	✓
Terrestrial Invertebrates		✓	
Aquatic receptors			✓

- **Great horned owl** (*Bubo virginianus*). The great horned owl is primarily a nocturnal hunter of small mammals. Its habitat includes low, wet, deep woods and heavily wooded swamps often near open country where it may hunt for its primary prey items consisting of small mammals and birds (DeGraaf and Rudis, 1986). The home range of the owl is 15 acres. The owl represents predatory avian carnivores at OU 4 that may be exposed to contamination via accumulation in mammalian and avian tissue.

Exposure assumptions (body weights, food ingestion rates, relative consumption of food items, etc.) for each of the representative wildlife species for OU 4 are provided in Table 7-5.

The site foraging frequency (SFF) considers the frequency a receptor feeds within the site area by estimating the acreage of the site relative to the receptor's home range and by considering the fraction of the year the receptor would be exposed to site-related chemicals. By definition, the SFF cannot exceed 1. The area of OU 4 is larger than the home range for the short-tailed shrew, the rufous-sided towhee, and the great horned owl. Since all representative wildlife species are expected to actively forage at the site year-round, it is assumed that the SFFs for these organisms are 1.

Wildlife species may be exposed to ECPCs in surface soil by incidental ingestion of these media or by ingesting prey items that have bioaccumulated these ECPCs. To estimate this exposure, a potential dietary exposure (PDE) (or body dose) is estimated for all representative wildlife species for each ECPC in all media according to the equations in Table 7-6 and the methodologies described in the GIR (ABB-ES, 1996).

Tissue concentrations of ECPCs in prey items were estimated using bioaccumulation factors (BAFs). BAFs were extrapolated from literature values or regression equations from scientific literature. Based on the lack of scientific data for VOC bioaccumulation and evidence provided in several reference materials (Suter, 1993; Maughan, 1993), an assumption was made that VOCs do not bioaccumulate in prey tissue. The general approach used to select BAFs for OU 4 is summarized in Table 7-7. BAFs for each of the ECPCs evaluated at OU 4 are included in Appendix G, Table G-1. Terrestrial BAFs for invertebrates and plant prey items are defined as the ratio of the ECPC concentration in plant or invertebrate tissue (mg contaminant/kg tissue wet weight) to the ECPC concentration in surface soil (mg contaminant/kg soil dry weight). Terrestrial BAFs reported for avian and mammalian receptors are defined as the reported ratios of ECPC concentrations in the tissues of these receptors (mg contaminant/kg tissue wet weight) to the concentrations of ECPCs in their food items (mg contaminant/kg tissue wet weight).

Although indirect exposures to wildlife from groundwater ECPCs exist, this exposure pathway is not a significant route of exposure and is unlikely to result in risk. Consequently, risks to wildlife from exposure to groundwater ECPCs were not evaluated.

The PDEs calculated from exposure to surface soil ECPCs for each receptor and the exposure assumptions used in calculating the PDEs are presented in Appendix H, Tables H-1 and H-2.

Table 7-5
Exposure Parameters for Representative Wildlife Species

Remedial Investigation, Operable Unit 4
Naval Air Station Cecil Field
Jacksonville, Florida

Representative Wildlife Species	Body Weight (kg)	Reported Diet	Assumed Diet for Exposure Assessment (% of diet)	Food Ingestion Rate (kg/day)	Home Range (acres)
Short-tailed Shrew (*Blarina brevicauda*)	0.017 [a]	Earthworms, slugs & snails, fungi, insects, and vegetation [b]	78% Invertebrates 12% Plants 10% Soil [c]	0.0024 [d]	0.96 ± 0.09 [b]
Rufous-sided Towhee (*Pipilo erythrophthalmus*)	0.039 [e]	30 percent animals (moths, ants, caterpillars, beetles, bugs, spiders, snails) 70 percent vegetation (seeds of weeds, grasses, and berries) [e,f]	65% Plants 30% Invertebrates 5% Soil [c]	0.0071 [g]	1.5 [f]
American Woodcock (*Scolopax minor*)	0.197 [h]	Primarily earthworms and insects with some plants [b]	80% Invertebrates 10% Plants 10% Soil [b]	0.02 [g]	80.1 ± 68.2 [b]
Red fox (*Vulpes vulpes*)	4.69 [i]	Small mammals, birds, and invertebrates, as well as berries and other fruits. [b]	57% Small mammals 20% Invertebrates 10% Small birds 10% Plants 3% Soil [b]	0.24 [d]	1,727 ± 339 [b]

See notes at end of table

Table 7-5 (Continued)
Exposure Parameters for Representative Wildlife Species

Remedial Investigation, Operable Unit 4
Naval Air Station Cecil Field
Jacksonville, Florida

Representative Wildlife Species	Body Weight (kg)	Reported Diet	Assumed Diet for Exposure Assessment (% of diet)	Food Ingestion Rate (kg/day)	Home Range (acres)
Great horned owl (*Bubo virginianus*)	1.59 [j]	Mostly rabbits; also mice, rats, chipmunks, weasels, squirrels, skunks, birds, bats, snakes, frogs, crayfish, perch, grasshoppers [j]	80% Small mammals 19% Small birds 1% Soil [c]	0.079 [g]	15 [k]

References:

[a] Mean of means reported for male and female shrews in summer and fall (U.S. Environmental Protection Agency [USEPA], 1993).
[b] Wildlife Exposure Factors Handbook (USEPA, 1993).
[c] Values are based on diet composition. When necessary, surrogate values for soil ingestion were chosen for another species based on similarities in diet. Other values were based on diet composition (USEPA, 1993). Rufous-sided towhee value from Beyer et al. (1991).
[d] Calculated using a regression equation for mammals based on body weight (kg). Food ingestion (kg/day) = $0.0687 \times Wt^{0.822}$ (kg) (USEPA, 1993).
[e] Terres (1980).
[f] DeGraaf & Rudis (1986). Rufous-sided towhee home range taken from savanna sparrow average (similar species).
[g] Calculated using a regression equation for birds based on body weight (kg). Food ingestion (kg/day) = $0.0582 \times Wt^{0.651}$ (kg) (USEPA, 1993).
[h] Median of mean weights reported for adult male and female American woodcocks (USEPA, 1993).
[i] Average of adult male and female foxes in spring (USEPA, 1993).
[j] Terres (1991).
[k] Great horned owl home range taken from low end of range in southeast Madison County, New York (Hager, 1957).

Notes: kg/day = kilograms per day.
kg = kilograms.
% = percent.
Wt = weight.

Table 7-6
Model for Estimation of Contaminant Exposures for Representative Wildlife Species

Remedial Investigation, Operable Unit 4
Naval Air Station Cecil Field
Jacksonville, Florida

Estimation of Contaminant Exposures Related to Surface Soil

Description: Estimates the amount (dose) of a contaminant ingested and accumulated by a species via incidental ingestion of contaminated surface soil and ingestion of contaminated food items.

Soil Contaminant Concentration:

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

Average: Average of all concentrations. If the average is greater than the maximum exposure point concentration (EPC), the maximum EPC was selected.

Soil Exposure:

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

Concentration of a Contaminant in Primary Prey Items (T_N):

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

Concentration of a Contaminant in Secondary Prey Items (T_N):

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

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

* For a discussion of the weighted contaminated concentration in prey items, see explanation of the PDE term below, and Section 24 of the GIR (ABB-ES, 1996)

Total Exposure Related to Surface Soil:

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

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

Notes:
% = percent.
mg/kg = milligrams per kilogram.
GIR = general information report.
ABB-ES = ABB Environmental Services, Inc.
mg/kgbw-day = milligrams per kilograms of body weight per day.
kg = kilograms.

Table 7-7
Estimation of Bioaccumulation Factors

Remedial Investigation, Operable Unit 4
Naval Air Station Cecil Field
Jacksonville, Florida

Receptor Group	Nature of Approach	General Approach
Terrestrial Surface Soil/Sediment		
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). Evidence from the literature (Levine et al., 1989) suggests that lead does not bioaccumulate in plant tissue, therefore, a BAF of zero was assigned (i.e., a zero does not imply that literature information is lacking).
	SAR	When literature values were unavailable, plant BAFs for semivolatile organic compounds (SVOCs) were calculated using a regression equation based on the uptake of organic chemicals into plant tissue from Travis and Arms (1988).[1]
	Extrapolation and Empirical Data	When literature values were unavailable, 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 are generally lacking in 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 available, literature values were used to estimate BAFs for invertebrates.
	Assumption	Earthworm data were used to represent all invertebrates.
	Empirical Data and Assumption	A single BAF for polynuclear aromatic hydrocarbons was calculated using data presented in Beyer (1990); dry weight was converted to wet weight assuming earthworms are 80 percent water.
	Assumption	Bioaccumulation data for VOCs are generally lacking in 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.

See notes at end of table

Table 7-7 (Continued)
Estimation of Bioaccumulation Factors

Remedial Investigation, Operable Unit 4
Naval Air Station Cecil Field
Jacksonville, Florida

Receptor Group	Nature of Approach	General Approach
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 unavailable 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) [3].
Unit: mg/kg wet tissue per mg/kg wet food	Extrapolation/ Empirical Data	When literature values were unavailable, BAFs for small mammals for inorganics were derived from ingestion-to-beef biotransfer factor presented in Baes et al. (1984) [4].
	Assumption	Bioaccumulation data for VOCs are generally lacking in 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.
Small Birds Unit: mg/kg wet tissue per mg/kg wet food	Literature Values	When available, literature values were used to estimate BAFs for small birds.
	No information	BAFs were not obtained for 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] Plant bioaccumulation factors (BAFs) calculated using the following Travis and Arms (1988) regression:
log BAF = 1.588 to 0.578 log K_{ow}.

[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.

[3] Small mammal BAFs calculated using the following Travis and Arms (1988) regression:
log biotransfer factor (BRF) = log K_{ow} - 7.6
where BTF = biotransfer factor (mg/kg tissue divided by mg chemical ingested per day).

[4] BTFs were converted to a BAF (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 non-lactating cattle reported in Travis and Arms, 1988).

Notes: mg/kg = milligrams per kilogram.
SAR = Structural Activity Relationship.

7.3.3 Terrestrial Plants and Invertebrates Terrestrial plants and soil invertebrates may be exposed to ECPCs via direct contact with and root uptake (plants) or ingestion (invertebrates) of ECPCs measured in OU 4 surface soil. For the purposes of the OU 4 ERA, exposures to terrestrial plants and invertebrates are assumed to occur within the top one foot interval of surface soil. Terrestrial plants may also be exposed to groundwater in the floodplain swamp in the southern portion of OU 4 where groundwater is at or near the ground surface.

7.3.4 Aquatic Receptors Aquatic organisms may be exposed to ECPCs via direct contact with groundwater from the surficial aquifer. The aquatic organisms most likely to experience adverse effects from concentrations of ECPCs in groundwater include benthic species (i.e., those species in close contact with the undiluted concentration of ECPCs detected in groundwater before mixing with surface water).

7.4 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 the GIR (ABB-ES, 1996).

7.4.1 Surface Soil Wildlife receptors, terrestrial plants, and terrestrial invertebrates are potentially exposed to ECPCs detected in surface soil at OU 4. The measures of adverse ecological effects for these receptors are discussed separately.

Terrestrial Wildlife. As identified in the problem formulation, the assessment endpoint selected for terrestrial wildlife is the maintenance of wildlife populations and communities within the habitats present at OU 4. Because no long-term wildlife population data are available at NAS Cecil 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 contaminant in an oral exposure with an adverse response to growth, reproduction, or survival of a test population (avian or mammalian species) were used in food-web models as a measure of the assessment endpoint. Wildlife ingestion toxicity data are presented in Appendix G, Table G-2.

For each ECPC identified and each representative wildlife species selected, two reference toxicity values (RTVs) are identified. A lethal RTV represents the threshold for lethal effects and is based on oral LD_{50} data (oral dose [in mg/kg body weight-day] lethal to 50 percent of a test population). The lethal RTV is equal to one-fifth of the lowest reported LD_{50} for the most closely related test species; this is considered to be protective against lethal effects for 99.9 percent of individuals in a test population (USEPA, 1986). A sublethal RTV is selected to represent a threshold body weight-normalized dose for adverse effects related to reproduction or growth. A summary of RTVs selected from the ingestion toxicity data are provided in Appendix G, Table G-3.

If neither lethal nor sublethal toxicity information were available for an ECPC for a taxonomic group, no RTVs were identified and risks associated with the predicted exposure for the respective ECPC were not quantitatively evaluated. However, the absence of specific data for a taxonomic group does not imply that there is no anticipated toxicological effect associated with contaminant exposure

by these receptors; therefore, potential risks to these taxonomic groups are qualitatively discussed in the uncertainties section.

Terrestrial Plants and Invertebrates. The assessment endpoints selected for terrestrial plants and soil invertebrates is the survival, growth, and reproduction of terrestrial invertebrate and plant communities. Site-specific toxicity data for plants and invertebrates are not available for OU 4; therefore, the results of toxicity studies from the literature that relate the soil concentrations of a contaminant with an adverse growth, reproduction, or survival effects of a test population are used as a measure of the assessment endpoint. These study results are summarized in Appendix G, Tables G-4 (plants) and G-5 (invertebrates).

7.4.2 Groundwater Aquatic organisms and terrestrial plants are potentially exposed to groundwater from the surficial aquifer as it discharges to Rowell Creek and the swamp in the southern portion of the site. The measures of adverse ecological effects for aquatic organisms and terrestrial plants are discussed separately.

Terrestrial Plants. The assessment endpoint selected for terrestrial plants is the survival, growth, and reproduction of plant communities. The results of toxicity studies from the literature that relate the concentrations of a contaminant in solution with adverse growth, reproduction, or survival effects of a test population were used as a measure of the assessment endpoint. These study results are summarized in Appendix G, Table G-4.

Aquatic Receptors. The selected assessment endpoint for aquatic receptors at OU 4 is the survival and maintenance of fish, amphibian, invertebrate, and aquatic plant populations. Adverse effects to aquatic populations from exposure to groundwater ECPCs were estimated by comparing exposure concentrations with available standards, criteria, and toxicity data.

Surface water RTVs selected for comparison to groundwater exposure concentrations include State of Florida Freshwater Class III Surface Water Quality Standards (Florida Legislature, 1995), Federal Ambient Water Quality Criteria (AWQC) (USEPA, 1991d; USEPA, 1988), and USEPA Region IV water quality criteria (USEPA, 1995). Additional aquatic toxicity information for the ECPCs was obtained from searches of the USEPA Aquatic Information Retrieval (AQUIRE) database (AQUIRE, 1994). Data from the AQUIRE database for each ECPC in groundwater are summarized in Appendix G, Table G-6.

7.5 RISK CHARACTERIZATION. This section presents the risk characterization for ecological receptors exposed to contaminated surface soil and groundwater at OU 4.

7.5.1 Surface Soil Potential risks associated with exposures to ECPCs in surface soil at OU 4 are discussed separately for wildlife and terrestrial plants and soil invertebrates. Risks to wildlife are characterized by comparing PDE concentrations for each surface soil ECPC with a respective RTV (estimated threshold dose for toxicity). Risks for terrestrial plants and soil invertebrates are evaluated by comparing toxicity benchmarks to exposure concentrations.

Terrestrial Wildlife. Risks for the representative wildlife species associated with ingestion and bioaccumulation of ECPCs in surface soil and prey items are quantitatively evaluated using hazard quotients (HQs), which are calculated for each ECPC by dividing the PDE concentration by the selected lethal and sublethal RTV. HIs are 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 no risks to wildlife populations exist. For instance, if the maximum PDE 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 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 average 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 lethal and sublethal HQs and HIs calculated based on maximum exposure point concentrations for each representative wildlife species are provided in Appendix H, Tables H-3 and H-4; a summary of risks to representative wildlife receptors is provided in Table 7-8. Summary HIs for all wildlife receptors exposed to maximum ECPCs for both lethal and sublethal effects were less than 1. Lethal endpoint HIs ranged from 0.00049 for the red fox to 0.24 for the short-tailed shrew. Sublethal endpoints ranged from 0.00099 for the red fox to 0.47 for the short-tailed shrew. As a result, no evaluation of risk from average EPCs was completed.

The results of the food-web modeling suggest that wildlife receptors are not likely to be at risk from exposure to OU 4 surface soil.

Terrestrial Plants. Risks for terrestrial plants were evaluated by comparing the selected phytotoxicity benchmarks to maximum and average exposure concentrations. The results of this evaluation are presented in Table 7-9 and are discussed in the following paragraphs. No phytotoxicity benchmarks are available for TPH.

Maximum and average concentrations of aluminum, chromium, and vanadium exceed plant RTVs. Average concentrations of chromium and vanadium slightly exceed their respective plant RTVs, indicating that these analytes are not likely to cause risk to these receptors (i.e., only isolated locations may contain higher concentrations). In fact, the only detected chromium concentration (17 mg/kg) and the maximum detected concentration of vanadium (28.5 mg/kg) are collocated at CEF-10-SS2. Vanadium concentrations detected at the other five surface soil locations (ranging from 0.74 to 5.6 mg/kg) only slightly exceed the vanadium

Table 7-8
Summary of Ecological Risk Assessment for Surface Soil[1]

Remedial Investigation, Operable Unit 4
Naval Air Station Cecil Field
Jacksonville, Florida

Medium Evaluated	Ecological Receptor	Lethal Effects from Exposure to Maximum EPCs	Sublethal Effects from Exposure to Maximum EPCs
Surface Soil	Short-tailed shrew	0.24	0.47
	Rufous-sided towhee	0.061	0.15
	American woodcock	0.014	0.022
	Red fox	0.00049	0.00099
	Great horned owl	0.0044	0.0057

[1] The information listed below is a summary of Tables H-3 and H-4 in Appendix H. No hazard indices exceeded 1; therefore, risks from average exposure concentrations were not estimated.

Notes: EPC = exposure point concentration.

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

Remedial Investigation, Operable Unit 4
Naval Air Station Cecil Field
Jacksonville, Florida

Analyte	Exposure Point Concentrations [1]		RTV		RTV Exceeded? [3] (by Maximum/by Average)	
	Maximum	Average	Plant [2]	Invertebrate [2]	Plant	Invertebrate
Volatile Organic Compounds (mg/kg)						
Methylene chloride	0.003	0.003	1,000	150	No/No	No/No
Semivolatile Organic Compounds (mg/kg)						
Di-n-butylphthalate	0.14	0.079	200	478	No/No	No/No
Inorganic Analytes (mg/kg)						
Aluminum	7,830	1,980	50	NA	Yes/Yes	NA
Arsenic	2.7	2.7	10	100	No/No	No/No
Barium	10.3	10.3	500	NA	No/No	NA
Chromium	17	3.7	1	50	Yes/Yes	No/No
Cobalt	0.67	0.67	20	NA	No/No	NA
Lead	7.2	4.8	50	1,190	No/No	No/No
Manganese	11.7	5.4	500	NA	No/No	NA
Vanadium	28.5	7	2	NA	Yes/Yes	NA
Total Petroleum Hydrocarbons (mg/kg)						
Total Petroleum Hydrocarbons	270	100	NA	NA	NA	NA

[1] Exposure Point Concentrations (EPCs) are presented in Table 7-2. The maximum EPCs are equal to the lesser of the maximum detected concentration or the 95th percent upper confidence limit. Average EPCs are equal to the mean of all concentrations. When the mean is greater than the maximum exposure point concentration, the maximum exposure point concentration was used.

[2] Plant and invertebrate reference toxicity values (RTVs) are presented in Appendix H, Tables H-4 and H-5 (respectively). Generally, the plant RTVs are the lowest observed effects concentrations from among plant growth studies on plants in solid media, and invertebrate RTVs are the lowest LC_{50} (14-day soil test on *Eisenia foetida*) from among chemicals in the same chemical class (applies to organic compounds). A conservative factor of 0.2 was applied to invertebrate RTVs; the resultant value should be protective of 99.9 percent of the population from acute effects (U.S. Environmental Protection Agency [USEPA], 1986).

[3] Comparison shown is maximum EPC to RTV/average EPC to RTV.

Notes: RTV = reference toxicity value.
mg/kg = milligrams per kilogram.
= indicates exceedances.
NA = not available.
LC_{50} = concentration lethal to 50% of the test population.

phytotoxicity value. No observations of stressed vegetation were evident at OU 4 during the September 1995 habitat characterization.

Aluminum was detected at all six surface soil sample locations at concentrations ranging from 144 to 7,830 mg/kg. Background concentrations of aluminum (2,370 mg/kg) at NAS Cecil Field constitute one-third of the levels detected at OU 4 and are two orders of magnitude greater than the phytotoxicity benchmark for aluminum. Likewise, background concentrations of vanadium and chromium (both 4.6 mg/kg) at NAS Cecil Field are two to four times greater than their phytotoxicity benchmarks. It is likely that the phytotoxicity benchmarks for these analytes over-estimate adverse effects to plants.

The phytotoxicity benchmarks used for aluminum, chromium, and vanadium were obtained from Will and Suter (1994) and were derived to represent the 10th percentile of the lowest observed effects concentrations (LOECs) for growth and yield endpoints. Since the number of aluminum, chromium, and vanadium studies included in the Will and Suter review was less than 10 (n=1, n=7, and n=2, respectively), the phytotoxicity benchmarks are equal to the lowest LOEC, and a confidence level of "low" was assigned by the authors to these benchmarks. Furthermore, some of the plants used in the laboratory studies for chromium are particularly sensitive species (e.g., lettuce, tomato, oats, soybean); therefore, risks to wild plants may be over-estimated. Will and Suter (1994) emphasize that the derived benchmarks are conservative means for estimating population- or community-level impacts.

These results suggest that growth of plants could potentially be impaired in soil at concentrations in excess of the aluminum, chromium, and vanadium phytotoxicity values; therefore, plants at OU 4 may potentially be adversely affected. However, the conservative nature employed in selecting phytotoxicity benchmarks combined with the sporadic detection of some of the analytes (i.e., chromium and vanadium) and the relative amounts of these analytes at background levels suggest that plant populations at OU 4 are not likely to be adversely impacted from exposure to these inorganic analytes in surface soil.

Terrestrial Invertebrates. Risks for terrestrial invertebrates were evaluated by comparing invertebrate toxicity benchmarks to maximum and average exposure concentrations. The results of this evaluation are presented in Table 7-9. No maximum or average concentrations of any analyte exceeds available invertebrate benchmarks, suggesting that terrestrial invertebrates are not at risk from exposure to ECPCs detected in OU 4 surface soil. Invertebrate benchmark values are not available for aluminum, barium, cobalt, manganese, vanadium, and TPH.

7.5.2 Groundwater Potential risks associated with exposures to ECPCs in groundwater from the surficial aquifer as it discharges to Rowell Creek and the floodplain swamp in the southern portion of OU 4 are discussed separately for terrestrial plants and aquatic receptors. Risks to terrestrial plants are evaluated by comparing toxicity benchmarks from studies evaluating plant exposures to chemicals in solution to exposure concentrations. Risks to aquatic organisms are evaluated by comparing exposure concentrations to toxicity benchmarks from laboratory tests (e.g., AQUIRE information, AQUIRE, 1994), Federal AWQC (USEPA, 1991d; USEPA, 1988), USEPA Region IV Chronic Water Quality Criteria (USEPA, 1995), and State of Florida Surface Water Quality Standards for Class III waters (Florida Legislature, 1995).

Terrestrial Plants. Risks for terrestrial plants were evaluated by comparing the selected phytotoxicity benchmarks to maximum and average exposure concentrations. The results of this evaluation, presented in Table 7-10, indicate that maximum and average concentrations of both dissolved and total aluminum in groundwater exceed plant RTVs. The maximum and average EPCs of all other analytes were less than plant RTVs, indicating that adverse effects to plants from exposure to these analytes are not likely to occur. Phytotoxicity benchmarks for groundwater were not available for bis(2-ethylhexyl)phthalate or barium.

Aluminum was detected in two of the four monitoring well samples included in the ERA. Total aluminum concentrations of 1,060 $\mu g/\ell$ and 669 $\mu g/\ell$ were detected at CEF-10-MW5S (in the central portion of the site) and CEF-10-MW4S (in the northern portion of the site), respectively; dissolved aluminum was detected at a concentration of 720 $\mu g/\ell$ at CEF-10-MW5S. Aluminum was not detected at CEF-10-MW3S (located between CEF-10-MW5S and CEF-10-MW4S). Furthermore, aluminum is ubiquitous in groundwater at NAS Cecil Field; background concentrations of aluminum (776 $\mu g/\ell$), which account for nearly 75 percent of the levels detected in OU 4 groundwater, also exceed the aluminum benchmark.

An evaluation of total aluminum in groundwater at OU 4 represents an overestimate of the amount of aluminum that plants could be exposed to. The dissolved concentration of aluminum at CEF-10-MW5S (720 $\mu g/\ell$) is less than 4 times the aluminum benchmark. It should also be noted that no observable signs of stress to vegetation in the floodplain swamp or Rowell Creek were observed by ABB-ES ecologists during the September 1995 OU 4 habitat characterization.

These results suggest that plants exposed to aluminum in OU 4 groundwater could be adversely affected. However, the conservative nature employed by evaluating total concentrations in groundwater coupled with the sporadic detections of aluminum at the site and the relative amount that background aluminum concentrations contribute to OU 4 minimizes the chance that plant populations would exhibit adverse effects.

Aquatic Receptors. Risks to aquatic organisms are evaluated by comparing maximum and average exposure concentrations with several aquatic toxicity benchmarks. The results of this evaluation, which are presented in Table 7-11, indicate that maximum and average concentrations of bis(2-ethylhexyl)phthalate, dissolved and total aluminum, dissolved copper, and dissolved and total iron exceed available aquatic benchmarks.

As mentioned previously, background concentrations of aluminum at NAS Cecil Field constitute 75 percent of the concentrations detected in OU 4 groundwater. In addition, background concentrations of iron at NAS Cecil Field account for 20 percent of the concentrations detected in OU 4 groundwater.

Bis(2-ethylhexyl)phthalate was detected in two monitoring wells at concentrations ranging from 2 to 6 $\mu g/\ell$; both detected concentrations and the average site concentration (4.5 $\mu g/\ell$) exceed the lowest adverse effect concentration in the AQUIRE database (0.89 $\mu g/\ell$ for moorfrog hatchability). Both the maximum and average concentrations slightly exceed the FDEP Class III fresh water standard (3.0 $\mu g/\ell$ for phthalate esters), and none of the concentrations exceed the Federal AWQC of 160 $\mu g/\ell$. A review of the AQUIRE database for bis(2-ethylhexyl)-phthalate indicates that all of the other adverse effects concentrations are at least an order of magnitude greater than the selected endpoint (i.e., the next

Table 7-10
Summary of Ecological Risk for Plants in Groundwater

Remedial Investigation, Operable Unit 4
Naval Air Station Cecil Field
Jacksonville, Florida

Analyte	Exposure Point Concentrations [1]		Plant RTV	Plant RTV Exceeded? [3] (by Maximum/by Average)
	Maximum	Average		
Semivolatile Organic Compounds (mg/ℓ)				
bis(2-Ethylhexyl)phthalate	0.006	0.0045	NA	NA
Unfiltered Inorganic Analytes (mg/ℓ)				
Aluminum	1.06	0.482	0.2	Yes/Yes
Iron	2.19	1.14	10	No/No
Manganese	0.0494	0.018	4	No/No
Filtered Inorganic Analytes (mg/ℓ)				
Aluminum	0.72	0.72	0.2	Yes/Yes
Barium	0.0694	0.0694	NA	NA
Copper	0.011	0.011	0.03	No/No
Iron	1.31	1.31	10	No/No
Manganese	0.0220	0.0220	4	No/No
Vanadium	0.015	0.015	0.5	No/No

[1] Exposure Point Concentrations (EPCs) are presented in Table 7-3. The maximum EPCs are equal to the maximum detected concentration. Average EPCs are equal to the arithmetic mean of all concentrations. When the arithmetic mean is greater than the maximum exposure point concentration, the maximum exposure point concentration was used.
[2] Plant RTVs are presented in Appendix H, Table H-4. Generally, plant RTVs are the lowest LOEC from plant growth studies conducted in solution.
[3] Comparison shown is maximum EPC to RTV/average EPC to RTV.

Notes: RTV = reference toxicity value.
mg/ℓ = milligrams per liter.
NA = not available.
▒ = indicates exceedances.

Table 7-11
Comparison of Groundwater ECPC Exposure Concentrations with Surface Water Toxicity Benchmarks

Remedial Investigation, Operable Unit 4
Naval Air Station Cecil Field
Jacksonville, Florida

Analyte[1]	Maximum Exposure Point Concentration	Average Exposure Point Concentration	FDEP Class III Fresh Water Standards[2] (µg/ℓ)	Chronic AWQC[3] (µg/ℓ)	Chronic Region IV Water Quality Criteria[4]	AQUIRE Lowest Reported Adverse Effect Concentration[5] (µg/ℓ) / Test Species	Result
Semivolatile Organic Compounds (µg/ℓ)							
bis(2-Ethylhexyl)phthalate	6	4.5	3.0	[6]160	NA	0.89 / moorfrog hatchability	Exceeds benchmark
Unfiltered Inorganic Analytes (µg/ℓ)							
Aluminum	1,060	482	NA	[7]87	[7]87	15 / trout LC_{50}	Exceeds benchmark
Iron	2,190	1,140	1,000	1,000	1,000	460 / trout hatchability	Exceeds benchmark
Manganese	49.4	18	NA	NA	NA	280 / phytoplankton population endpoints	Does not exceed benchmark
Filtered Inorganic Analytes (µg/ℓ)							
Aluminum	720	720	NA	[7]87	[7]87	15 / trout LC_{50}	Exceeds benchmark
Barium	69.4	69.4	NA	NA	NA	8,900 / water flea reproduction	Does not exceed benchmark
Copper	11	11	6	6	6	1.5 / water flea reproduction	Exceeds benchmark
Iron	1,310	1,310	1,000	1,000	1,000	460 / trout hatchability	Exceeds benchmark

See notes at end of table

Table 7-11 (Continued)
Comparison of Groundwater ECPC Exposure Concentrations with Surface Water Toxicity Benchmarks

Remedial Investigation, Operable Unit 4
Naval Air Station Cecil Field
Jacksonville, Florida

Analyte[1]	Maximum Exposure Point Concentration	Average Exposure Point Concentration	FDEP Class III Fresh Water Standards[2] (µg/ℓ)	Chronic AWQC[3] (µg/ℓ)	Chronic Region IV Water Quality Criteria[4]	AQUIRE Lowest Reported Adverse Effect Concentration[5] (µg/ℓ) / Test Species	Result
Manganese	22	22	NA	NA	NA	280 / phyto-plankton population endpoints	Does not exceed benchmark
Vanadium	15	15	NA	NA	NA	128 / guppie LC_{50}	Does not exceed benchmark

[1] Results of analyses of surface water samples included in Appendix A. Only those analytes selected as aquatic contaminants of potential concern in Table 7-3 are presented.
[2] Chapter 17-302, Class III Fresh Water Quality Standards (Florida Legislature, 1995).
[3] Chronic Federal AWQC (U.S. Environmental Protection Agency [USEPA], 1991d and 1988).
[4] U.S. Environmental Protection Agency Region IV chronic water quality criteria and related information for toxic pollutants (USEPA, 1995).
[5] From Appendix H, Table H-6. Only growth, mortality, population, biomass, and reproductive effects to plants, invertebrates, reptiles/amphibians and fish were considered.
[6] Insufficient data to develop criteria. Value represented in lowest observed effects concentrations.
[7] Criterion is based on a pH of 6.5 to 9 (USEPA, 1988).
[8] Hardness-dependent criterion based on a calculated hardness concentration of 46 milligrams calcium carbonate using average calcium and magnesium concentrations (Greenberg et al., 1992).

Notes: ECPC = ecological chemical of potential concern.
FDEP = Florida Department of Environmental Protection.
µg/ℓ = micrograms per liter.
AWQC = Ambient Water Quality Criteria (guidance criteria established under the Clean Water Act).
AQUIRE = Aquatic Information Retrieval.
▒ = concentration exceeds the most conservative toxicity benchmark.
NA = not available.
LC_{50} = low dose where 50 percent of animals die.

lowest adverse effects concentration is 2.5 μg/ℓ for reproductive effects to water fleas). This evidence suggests that it is unlikely that levels of bis(2-ethylhexyl)phthalate detected in groundwater pose a risk to the majority of the aquatic receptors at OU 4.

As mentioned previously, total aluminum was detected in two monitoring wells at concentrations of 669 and 1,060 μg/ℓ; both detected concentrations and the average site concentration (482 μg/ℓ) exceed the USEPA chronic water quality criterion (87 μg/ℓ) for aluminum and the lowest adverse effect concentration in the AQUIRE database (15 μg/ℓ, an LC_{50} for trout). The dissolved concentration of aluminum (720 μg/ℓ) and the background concentration of aluminum (776 μg/ℓ) also exceed these benchmarks. A review of the aluminum AWQC document (USEPA, 1988) indicates that the 87 μg/ℓ criterion is based on an endpoint for larval trout, which are among the most sensitive ecological receptors with regard to aluminum exposure. No salmonids occur in Rowell Creek (a warmwater system) or in the floodplain swamp in the southern portion of the site. AQUIRE data (Appendix G, Table G-6) indicate that several species of frogs, minnows, snails, and bass are also sensitive to aluminum concentrations below the EPCs. However, the majority of species (for which there are data in AQUIRE) are tolerant of the concentrations of aluminum detected in unfiltered groundwater at OU 4.

Iron was detected in all four monitoring wells at concentrations ranging from 529 to 2,190 μg/ℓ. The maximum concentration exceeds several guidelines and criteria (1,000 μg/ℓ) by a factor of two; the average total concentration (1,143 μg/ℓ) and the dissolved concentration at CEF-10-MW5S (1,310 μg/ℓ) only slightly exceed these guidelines and criteria. The detected concentrations also exceed the lowest adverse effect concentration in the AQUIRE database (460 μg/ℓ for trout hatchability). As previously mentioned, no salmonids occur in Rowell Creek or in the floodplain swamp in the southern portion of the site. A review of the AQUIRE database (Appendix G, Table G-6) for iron reveals that the next lowest adverse effect concentration for an aquatic species likely to occur in Rowell Creek and in the floodplain swamp is 3,700 μg/ℓ (based on an endpoint for duckweed growth). This evidence suggests that it is unlikely that levels of iron detected in both total and dissolved groundwater samples pose a risk to aquatic receptors at OU 4.

Copper was detected in only the filtered sample at CEF-10-MW5S at a concentration of 11.2 μg/ℓ, which slightly exceeds the available surface water guidelines and criteria (6 μg/ℓ). In addition, the detected concentration exceeds the lowest adverse effect concentration in the AQUIRE database (1.5 μg/ℓ for water flea reproduction). A review of the AQUIRE database (Appendix G, Table G-6) reveals that the majority of species for which effects data exist can tolerate higher concentrations of copper in water than were detected in the dissolved phase at CEF-10-MW5S. Few species (including some species of trout, minnow, algae, and water fleas) exhibit adverse reproductive, growth, or survival effects at concentrations less than 11.2 μg/ℓ. Furthermore, there is uncertainty associated with copper being detected in the dissolved phase but not in the total phase. It is unlikely that concentrations of copper in groundwater at OU 4 are causing adverse effects to aquatic organisms in Rowell Creek or in the floodplain swamp in the southern portion of the site.

To investigate whether any simple trends in the analytical data show a correlation between concentrations of ECPCs in Rowell Creek surface water and unfiltered concentrations of ECPCs in groundwater discharging to Rowell Creek,

the data collected from the monitoring wells screened in the surficial aquifer were compared to the surface water data collected for the OU 1 ERA (ABB-ES, 1994a). A comparison of ECPC data for upgradient monitoring wells and downgradient surface water sample locations is provided in Table 7-12. The sample locations used for this comparison are depicted on Figure 7-4. The following discussion provides an evaluation of the potential impacts for each ECPC.

Bis(2-ethylhexyl)phthalate was detected in monitoring wells CEF-10-4S and CEF-10-3S; this analyte was not detected in any of the surface water samples collected downgradient of the monitoring wells. These data suggest that concentrations of bis(2-ethylhexyl)phthalate detected in groundwater may not be present in Rowell Creek surface water. Furthermore, it is possible that bis(2-ethylhexyl)phthalate is not site-related and may actually be a laboratory artifact.

Aluminum, iron, and manganese were all detected in OU 4 groundwater. Aluminum and manganese were both detected at lower concentrations in all the downgradient surface water samples collected in Rowell Creek, whereas iron was detected at lower concentrations in two upgradient monitoring wells than in downgradient surface water samples. Based on these data, it is reasonable to assume that ECPCs in groundwater from the surficial aquifer may be discharging to Rowell Creek surface water. However, some other source (i.e., possibly flocculation from the Site 2 tributary) may also contribute to the iron contamination in Rowell Creek, as indicated by the higher downstream concentrations. In addition, because manganese is not detected at concentrations in groundwater that are likely to cause adverse effects to aquatic organisms, concentrations of manganese in groundwater are not a concern. Detected concentrations of bis(2-ethylhexyl) - phthalate in groundwater do not appear to be contributing to surface water contamination; therefore, it is unlikely that adverse effects to aquatic organisms estimated from exposure to bis(2-ethylhexyl)phthalate would occur.

The results of the risk evaluation and the evidence provided in Table 7-12 suggest that concentrations of aluminum and iron detected in groundwater may cause adverse effects to aquatic organisms. However, considering the conservative nature of the RTVs (i.e., based on endpoints for aquatic receptors not likely to be found in Rowell Creek or the floodplain swamp), the sporadic nature of the detected concentrations (i.e., for aluminum), and the relative amounts that background concentrations of aluminum and iron contribute to detected concentrations at OU 4, it is unlikely that adverse effects to aquatic organisms would occur. It is also unlikely that many aquatic organisms would be exposed to the full concentration of groundwater as it discharges to surface water (i.e., groundwater concentrations would be diluted upon discharge to surface water).

7.6 UNCERTAINTY ANALYSES. The objective of the uncertainty analysis is to discuss the assumptions of the ERA process that may influence the risk assessment results and conclusions. General uncertainties inherent in the risk assessment process and in the OU 4 ERA are included in Table 7-13.

Specific uncertainties associated with the assessment of ecological risks associated with contamination at OU 4 include the following:

Table 7-12
Comparison of Total Groundwater Concentrations from Upgradient Monitoring Wells with Total Surface Water Concentrations in Downgradient Portions of Rowell Creek

Remedial Investigation, Operable Unit 4
Naval Air Station Cecil Field
Jacksonville, Florida

Analyte	Concentration in Upgradient Monitoring Well (CEF-10-4S)[1]	Concentration in Downgradient Surface Water[2]	
		RCSW4	RCSW5
bis(2-Ethylhexyl)phthalate	6	--	--
Aluminum	669	184	137
Iron	1,320	750	647

Analyte	Concentration in Upgradient Monitoring Well (CEF-10-3S)[1]	Concentration in Downgradient Surface Water[2]	
		RCSW6	RCSW7
bis(2-Ethylhexyl)phthalate	2	--	--
Iron	537	738	1,130

Analyte	Concentration in Upgradient Monitoring Well (CEF-10-5S)[1]	Concentration in Downgradient Surface Water[2]	
		RCSW8	RCSW8A
Aluminum	1,060	93.2	153
Iron	2,185	653	785
Manganese	49.4	17.8	19.2

Analyte	Concentration in Upgradient Monitoring Well (CEF-10-2S)[1]	Concentration in Downgradient Surface Water (RCSW9)[2,3]
Iron	529	587

[1] Analytical data for the total fraction in groundwater for upgradient monitoring well is presented in Appendix A. Results for CEF-10-5S are an average of a duplicate pair.
[2] Analytical data for the total fraction in surface water for downgradient portions of Rowell Creek are presented in Appendix A of the OU 1 Risk Assessment Report (ABB-ES, 1994).
[3] Surface water sample RCSW9 is slightly upstream of the area where groundwater would discharge to Rowell Creek (if passing through CEF-10-2S in a straight line), but it is closer in proximity to the discharge area than any other surface water data for this portion of Rowell Creek. It is possible that due to dispersion of analytes in groundwater, RCSW9 would be on the fringe of the range of discharge for ECPCs detected in groundwater at CEF-10-2S.

Notes: -- = analyte was not detected in the downgradient surface water sample.
▒ = concentration of analytes that exceed surface water benchmarks.

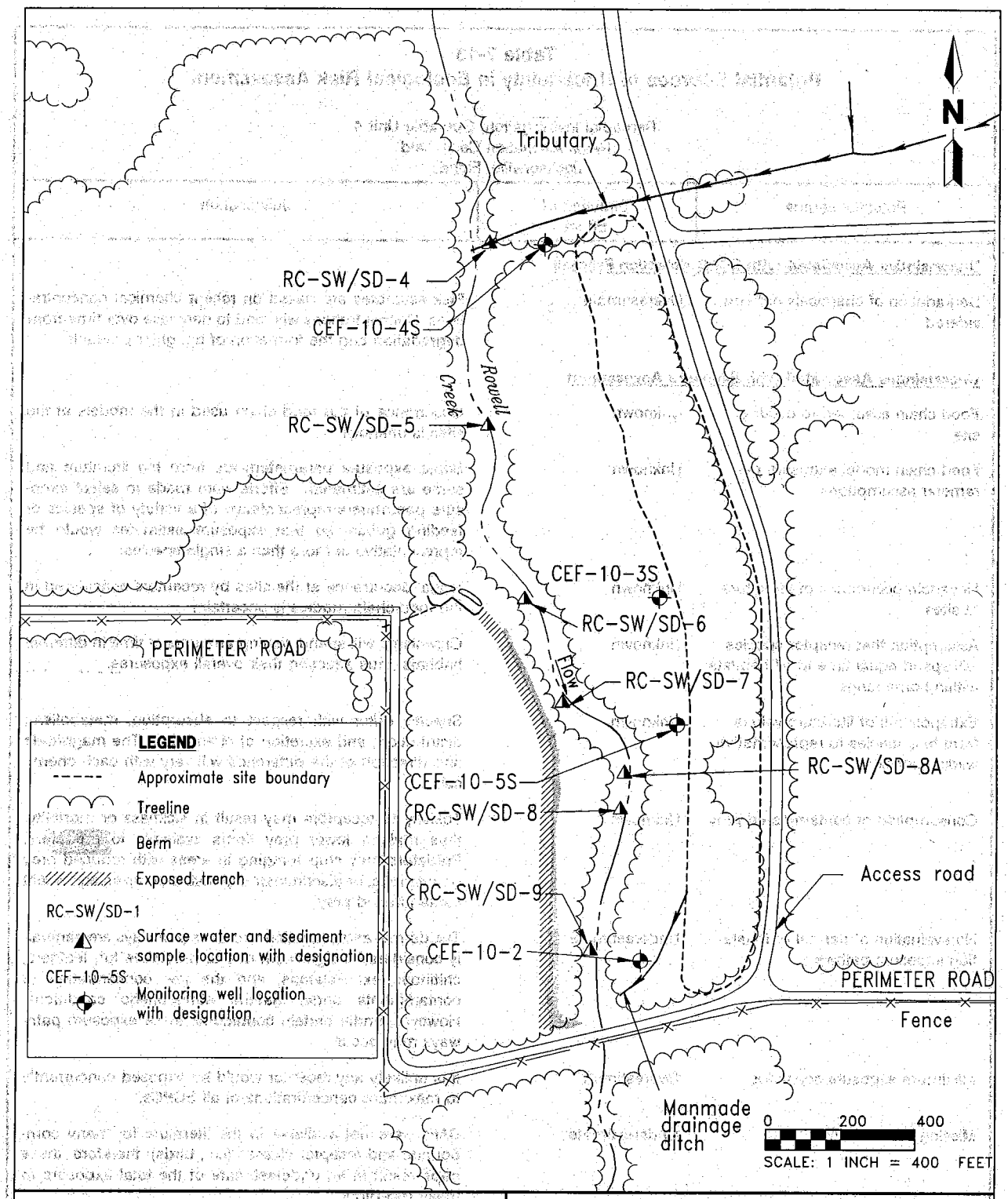

FIGURE 7-4
UPGRADIENT GROUNDWATER MONITORING WELLS AND DOWNGRADIENT SURFACE WATER SAMPLE LOCATIONS

H:\CEF\OU4\RI\RI04\PS\06-04-96

REMEDIAL INVESTIGATION
OPERABLE UNIT 4

NAVAL AIR STATION CECIL FIELD
JACKSONVILLE, FLORIDA

Table 7-13
Potential Sources of Uncertainty in Ecological Risk Assessment

Remedial Investigation, Operable Unit 4
Naval Air Station Cecil Field
Jacksonville, Florida

Potential source	Direction of Effect	Justification
Uncertainties Associated with ECPC Selection Process		
Degradation of chemicals not considered	Overestimate	Risk estimates are based on recent chemical concentrations. Concentrations will tend to decrease over time from degradation and the formation of daughter products.
Uncertainties Associated with Exposure Assessment		
Food chain assumed to occur at site	Unknown	Occurrence of the food chain used in the models at the sites is unknown.
Food chain model exposure parameter assumptions	Unknown	Some exposure parameters are from the literature and some are estimated. Efforts were made to select exposure parameters representative of a variety of species or feeding guilds, so that exposure estimates would be representative of more than a single species.
Uncertain occurrence of receptors at sites	Unknown	Actual occurrence at the sites by receptors considered in the food-chain models is uncertain.
Assumption that receptor species will spend equal time at all habitats within home range	Unknown	Organisms will spend varying amounts of time in different habitats, thus affecting their overall exposures.
Extrapolation of literature values from test species to representative wildlife species	Unknown	Species differ with respect to absorption, metabolism, distribution, and excretion of chemicals. The magnitude and direction of the difference will vary with each chemical.
Consumption of contaminated prey	Unknown	Toxicity to receptors may result in sickness or mortality, thus making fewer prey items available to predators. Predators may stop foraging in areas with reduced prey populations, or discriminate against, or, conversely, select contaminated prey.
No evaluation of dermal or inhalation exposure pathways	Underestimate	The dermal and inhalation exposure pathways are generally considered insignificant due to protective fur, feathers, chitinous exoskeletons, and the low concentration of contaminants under natural atmospheric conditions. However, under certain conditions, these exposure pathways may occur.
Maximum exposure scenarios	Overestimate	It is unlikely any receptor would be exposed concurrently to maximum concentrations of all ECPCs.
Missing BAF values	Underestimate	BAFs were not available in the literature for many compounds and receptor classes (i.e., birds); therefore, these gaps result in an underestimate of the total exposure to these receptors.

See notes at end of table

Table 7-13 (Continued)
Potential Sources of Uncertainty in Ecological Risk Assessment

Remedial Investigation, Operable Unit 4
Naval Air Station Cecil Field
Jacksonville, Florida

Potential source	Direction of Effect	Justification
BAF estimation	Unknown	As many literature values were not available for some species and analytes, therefore alternate BAFs were derived using other assumptions or regressions (Table 7-7 lists the rationale for the generation of alternate BAFs).
Continuous uptake and bioaccumulation of ECPCs by soil biota	Unknown	Tissue and organ responses to ECPC uptake were represented by a linear function, that is an oversimplification of a more complex system (i.e., trophic states and lipid concentrations may affect bioaccumulation, or contaminants may only be seasonally available).
Bioaccumulation of ECPCs in leafy portions of plants	Overestimate	Ryan and others (1988) states that compounds with log K_{ow}s > 5 are unavailable to plants due to soil sorption. Compounds with log K_{ow}s > 5 will be taken into the roots of plants, but are not easily transported into the leafy parts of plants (Briggs and others, 1982; 1983). The surface soil ingestion exposure model overestimates ECPC exposure via plant ingestion to those receptors that only eat the leafy portions of plants.
Relative uptake of inorganics by different plant species	Unknown	Estimated plant BAFs for certain inorganics were based on BAF data for leafy produce grown in sewage sludge. Variability in type of plant and substrate may make the chosen BAF values an overestimate or underestimate of actual uptake.
Uncertainties Associated with Effects		
Lack of dietary toxicity information for reptile species	Unknown	Information is not available on the toxicity of contaminants to reptilian species resulting from dietary or oral exposures; as a result, dietary exposures to reptiles were not quantitatively evaluated in the OU 4 ERA. Assuming the toxicities of analytes to mammals and birds are similar for reptiles, and to the extent that the dietary exposures for reptiles are the same as for the tertiary consumers evaluated in the OU 4 ERA, an assumption can be made that dietary exposures to reptiles would result in similar risk levels that were predicted for predatory mammals and birds. Since no food-chain risks were predicted to these receptors, it is possible that there are no food-chain risks to reptiles. However, risks to reptiles remain unknown.
Use of measurement endpoints	Overestimate	Although an attempt was made to have measurement endpoints reflect assessment endpoints, limited available ecotoxicological literature resulted in the selection of certain measurement endpoints that may overestimate assessment endpoints.
Missing reference toxicity values	Underestimate	Reference toxicity values for certain compounds and receptor groups were not available thereby underestimating the risk predicted by the summary HI.

See notes at end of table

Table 7-13 (Continued)
Potential Sources of Uncertainty in Ecological Risk Assessment

Remedial Investigation, Operable Unit 4
Naval Air Station Cecil Field
Jacksonville, Florida

Potential source	Direction of Effect	Justification
Lack of site-specific toxicity and bioaccumulation data	Unknown	Effects characterization is based solely on literature values. No site-specific biological data has been collected at OU 4.
Uncertainties Associated with Risk Characterization		
Risk evaluated for individual terrestrial receptors only	Overestimate	Effects on individual terrestrial organisms may occur with little population or community level effects. However, as the number of affected individuals increases, the likelihood of population-level effects increases.
Effect of decreased prey item populations on predatory receptors	Unknown	Adverse population effects to prey items may reduce the foraging population for predatory receptors, but may not necessarily adversely impact the population of predatory species.
Multiple conservative assumptions	Overestimate	Cumulative impact of multiple conservative assumptions yields high risk to ecological receptors, and may result in risk at background concentrations or the prediction of risks when there is no potential for adverse effects.
Summation of effects (HIs)	Unknown	The assumption that effects are additive ignores potential synergistic or antagonistic effects. It assumes similarity in mechanism of action, which is not the case for many substances. Compounds may induce toxic effects in different organs or systems.

Notes: ECPC = ecological contaminant of potential concern.
BAF = bioaccumulation factor.
HIs = hazard indices.

- Because surface water and sediment samples were not collected in the floodplain in the southern portion of the site, it is not possible to evaluate actual exposures to aquatic organisms. Furthermore, risk conclusions for aquatic organisms in Rowell Creek are compounded by the fact that several source areas (e.g., OU 1) potentially contribute to contamination in this area.

- Risk to aquatic organisms from exposure to analytes detected in filtered groundwater samples may have been overestimated. Because no filtered background groundwater data were available to screen ECPCs, more analytes may have been retained for the risk assessment than were necessary.

- Although no migration pathway to the tributary in the northern portion of the site is evident, risks to aquatic organisms may be underestimated by excluding these samples from the ERA. However, based on the runoff patterns in the vicinity of the tributary, it is likely that contaminants in the tributary surface water and sediment are the result of contamination from another source, possibly the flightline area.

- There is uncertainty associated with using unfiltered groundwater data for inorganic analytes detected in groundwater from the surficial aquifer (i.e., filtered data were only collected from one monitoring well). Risks to aquatic organisms may have been overestimated because unfiltered groundwater represent the total fraction of analytes that occur in the water column, including those that are sorbed to particulates and may not be bioavailable. Furthermore, there is uncertainty associated with the detected concentration of dissolved copper at CEF-10-MW5S since copper was not detected in the total phase.

- Terrestrial invertebrate exposures to groundwater that is at or near the ground surface (i.e., within 1 foot during high groundwater periods) in the southern portion of the site were not evaluated. Therefore, risks to terrestrial invertebrates may have been underestimated. However, terrestrial invertebrates are most likely repelled by saturated conditions and probably do not inhabit these areas.

- Risks to terrestrial receptors associated with exposure to TPH in surface soil may have been underestimated. Although selected as an ECPC for surface soil, TPH was not evaluated in the ERA as there are no toxicological benchmarks. However, results of toxicity testing at OU 2 (Site 5) (ABB-ES, 1995) indicated that plants (represented by the test species *Lactuca sativa*) and invertebrates (represented by the test species *Eisenia foetida*) did not exhibit adverse effects from exposure to concentrations of up to 600 mg/kg TPH in soil. Based on this information, it is possible to assume that plants and invertebrates at OU 4 are not at risk from exposure to TPH in soil. However, without site-specific information, these assumptions cannot be confirmed because site conditions, relative toxicities to ecological receptors, and the composition of TPH are highly variable.

No conclusions can be made regarding risks to wildlife from exposure to TPH.

- Risks to avian species from dietary exposures may have been underestimated because bioaccumulation and toxicity data for this taxonomic group are generally lacking in the literature. Toxicological data for mammals were not used as surrogates due to concerns about extrapolations between these two taxonomic groups. As a result, potential risks associated with several ECPCs were not evaluated. If the toxicological data obtained from studies conducted on mammals were used for estimating risks to avian species, then risk estimates for birds would be higher because risks would have been quantified for more chemicals. However, since risks to small mammals were not predicted, it is possible that risks to birds would not be identified either.

- Several analytes detected in surface soil and groundwater were reported at concentrations below analytical detection limits. There is uncertainty associated with the actual presence of the following analytes detected in OU 4 surface soil: methylene chloride, di-n-butylphthalate, arsenic, barium, calcium, cobalt, magnesium, potassium, and sodium. There is also uncertainty associated with the actual presence of the following analytes detected in OU 4 groundwater: bis(2-ethylhexyl)phthalate, barium, chromium, copper (dissolved only), magnesium, nickel, potassium, and vanadium.

- Risks to plants and invertebrates may have been underestimated because phytotoxicity and invertebrate benchmarks for several analytes are lacking for these receptors. Specifically, soil invertebrate benchmarks are not available for aluminum, barium, copper, manganese, vanadium, and TPH; similarly, plant benchmarks for groundwater are not available for bis(2-ethylhexyl)phthalate or barium. Risks to these receptors from exposure to these analytes are unknown.

7.7 CONCLUSIONS. Potential risks for ecological receptors were evaluated for ECPCs in surface soil and groundwater at OU 4.

7.7.1 Surface Soil The following analytes were selected as surface soil ECPCs and retained in the ERA for OU 4: methylene chloride, di-n-butylphthalate, aluminum, arsenic, barium, chromium, cobalt, lead, manganese, vanadium, and total petroleum hydrocarbons.

Risks associated with exposures to ECPCs in OU 4 surface soil were evaluated for wildlife based on a model that estimates the amount of contaminant exposure obtained via the diet and incidental ingestion of these media. Comparison of estimated doses for wildlife species with reference toxicity doses representing thresholds for both lethal and sublethal effects is the basis of the wildlife risk evaluation. No risks were estimated for wildlife exposed to OU 4 surface soil.

Risks to soil invertebrates and plants were evaluated by comparing exposure concentrations for surface soil with toxicity benchmarks. Based on this

comparison, plants exposed to surface soil concentrations of aluminum, chromium, and vanadium at OU 4 may be adversely affected. However, adverse effects to plants are unlikely considering the site history, the conservative nature employed in selecting phytotoxicity benchmarks, and the sporadic detection of chromium and vanadium in OU 4 surface soil. No risks to invertebrates were estimated.

7.7.2 Groundwater The following analytes were selected as groundwater ECPCs and retained in the ERA for OU 4: bis(2-ethylhexyl)phthalate, aluminum, barium (dissolved only), copper (dissolved only), iron, manganese, and vanadium (dissolved only).

Risks to plants from exposure to groundwater at or near the surface at OU 4 were evaluated by comparing exposure concentrations with phytotoxicity benchmarks in solution. The results suggest that plants exposed to unfiltered concentrations of aluminum could be adversely affected. However, the dissolved concentration of aluminum (which represents the bioavailable fraction of aluminum) only slightly exceeded its benchmark, suggesting that adverse effects to plants are unlikely. In addition, the site history and the sporadic detection of aluminum in OU 4 groundwater minimize the potential for adverse effects to plants.

The potential for adverse effects to aquatic receptors from exposure to groundwater as it discharges to Rowell Creek and the floodplain swamp was evaluated by comparing site-specific filtered and unfiltered contaminant concentrations to aquatic benchmarks. Although some concentrations of analytes that may be discharging to Rowell Creek (i.e., aluminum and iron) slightly exceeded available surface water quality guidelines, it is unlikely aquatic receptors at OU 4 would exhibit substantial adverse effects.

In summary, the results of this ERA suggest that ecological receptors are not likely to be at risk from exposure to analytes detected in OU 4 surface soil or groundwater.

8.0 CONCLUSIONS AND RECOMMENDATIONS

8.1 CONCLUSIONS. Conclusions regarding the physical characteristics of the OU 4 study area and the contaminants detected in surface water, sediment, surface soil, and groundwater include the following:

- Sufficient information was collected in the field or compiled from historical records to confirm that past waste disposal activities at OU 4 have not had a negative impact on the environmental quality of the site or surrounding area.

- There is no risk to human health or the ecological receptors evaluated from exposure to analytes detected in OU 4 surface soil or groundwater.

8.2 RECOMMENDATION. Based on the evaluation of data gathered during this RI and the results of the BRA, no further assessment of the environmental conditions at OU 4 is warranted. Preparation of a No Further Action decision document is recommended.

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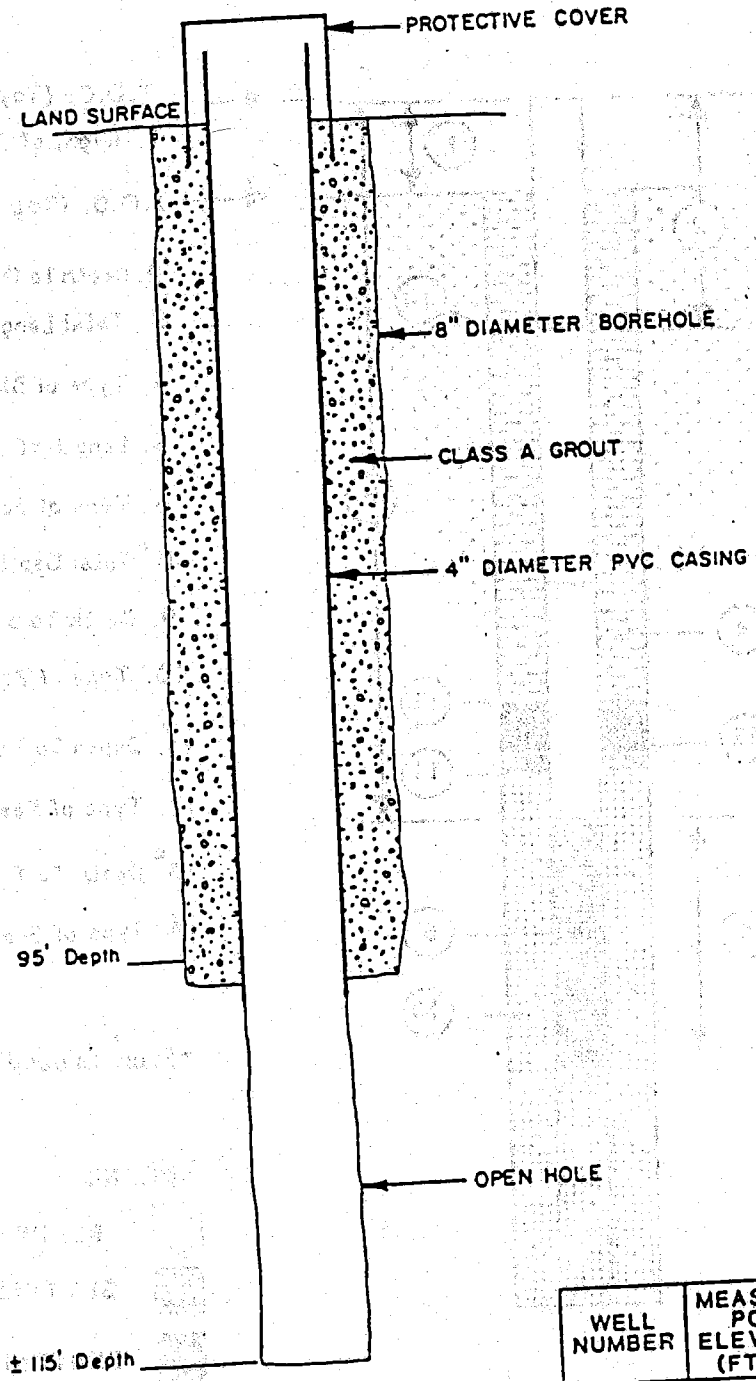
APPENDIX C

LITHOLOGIC LOGS/CONSTRUCTION DIAGRAMS



NOT TO SCALE

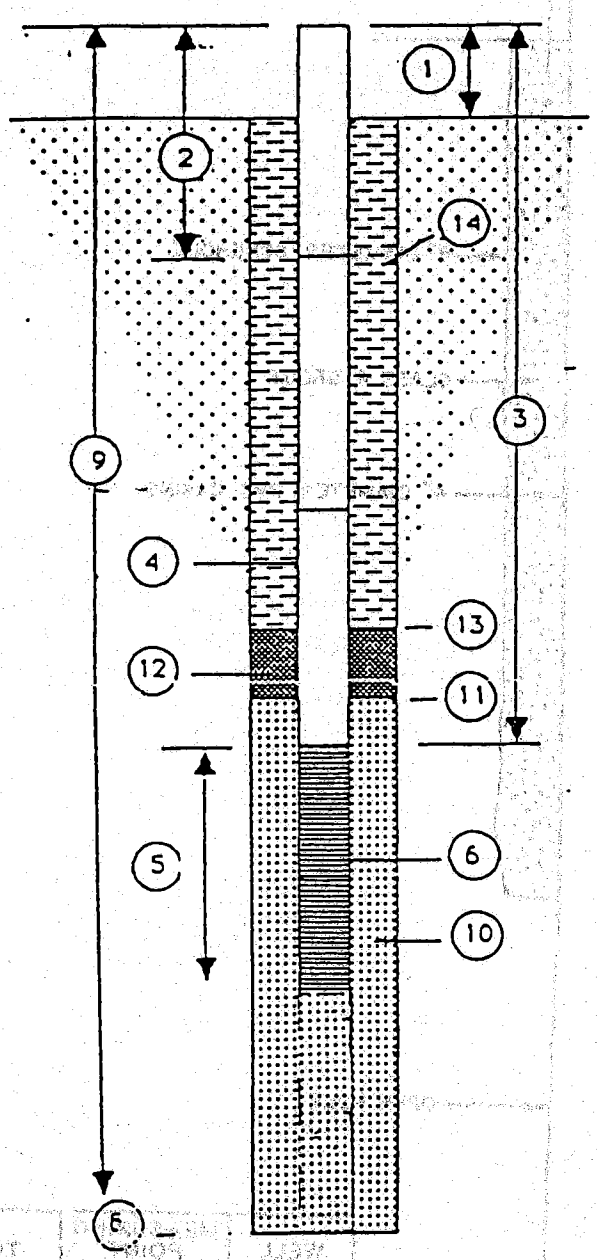
WELL NUMBER	MEASURING POINT ELEVATION (FT.MSL)	TOTAL DEPTH
SA-1	73.40	120
* SA-2	70.05	115 *

CEF 10-1

MEASUREMENT FROM TOP OF PVC CASING

* Well renamed CEF-10-1D.

FIGURE 2. Construction Details of Installed Secondary Artesian Monitor Wells.



T.O.C. (Top of Casing)

1. Height of Casing above ground

T.O.D. (Top of Disk) 3' x 4' x 6" Concrete Pad

2. Depth to first Coupling
3. Total Length of Blank Pipe
4. Type of Blank Pipe
5. Length of Screen
6. Type of Screen
8.* Total Depth of Boring
9. Depth To Bottom of Screen
10. Type of Screen Filter
11.* Depth To Top of Filter
12. Type of Seal
13.* Depth To Top of Seal
14. Type of Grout

*From Ground Surface

LEGEND

- BLANK PVC PIPE
- SLOTTED PVC PIPE
- BENTONITE PELLET SEAL
- SAND FILTER PACK
- CEMENT BENTONITE GROUT SEAL

Harding Lawson Associates
Engineers, Geologists & Geophysicists

TYPICAL GROUNDWATER MONITORING WELL CONSTRUCTION DIAGRAM, CEF-10-2, CEF-10-3, CEF-10-4

NAS Cecil Field
Jacksonville, Florida

PLATE

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED	DATE
	2176,098.12	JT	3/3/88		

DEPARTMENT OF THE NAVY
SOUTHERN DIVISION
NAVAL FACILITIES ENGINEERING COMMAND
2155 EAGLE DR. P O BOX 10068
CHARLESTON, S C 29411-0068

WELL DATA REPORT

WELL NUMBER CEF10-2 AREA Site 10

DATE OF INSTALLATION 6/8/87

WELL HOLE DATA

Drill Date 6/6/87 Well Driller Southwestern Laboratories, Inc.

Depth of Boring 38 feet Purpose of Boring Monitoring Well

Drilling Method Hollow Stem Auger Mud Type Not Applicable

WATER LEVEL DATA (All measurements from top of casing)

Water Level 6.45 feet Date of Measurement 6/26/87

DEVELOPMENT DATA

Development Method Air Lift

Length of Time Developed 60 minutes

LOCATION OF BOREHOLE INFORMATION

Drillers Log X Geophysical Log Not Applicable

Physical Core X Cutting Samples Not Applicable

Water Level Observations 6.45 feet (6/26/87) / 2.05 feet (7/10/87)

DRILLED BY Southwestern Laboratories SCCWD# _____

DEVELOPED BY Harding Lawson Associates SCCWD# _____

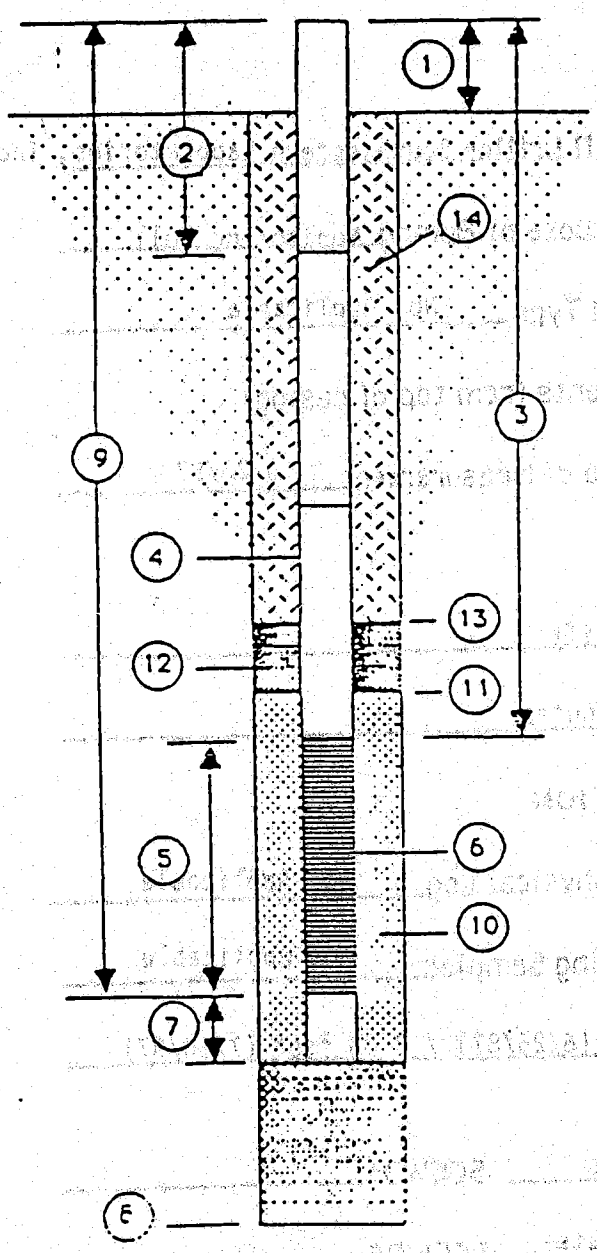
TECHNICAL OVERSIGHT BY Harding Lawson Associates

DEPARTMENT OF THE NAVY
SOUTHERN DIVISION
NAVAL FACILITIES ENGINEERING COMMAND
2155 EAGLE DR. P.O BOX 10068
CHARLESTON S C 29411-0068

WELL CONSTRUCTION DETAILS

WELL NUMBER CEF10-2

DATE OF INSTALLATION 6/8/87



1. Height of Casing above ground 2.7 feet
2. Depth to first Coupling 2.5 feet

   Coupling Interval Depths 12.5 feet, 22.5 feet
3. Total Length of Blank Pipe 12.5 feet
4. Type of Blank Pipe Schedule 40 PVC
5. Length of Screen 20 feet
6. Type of Screen Schedule 40 PVC, 0.020 in. sl
7. Length of Sump 8.2 ft.
8*. Total Depth of Boring 38 ft. Hole Diameter 6-3/4
9. Depth To Bottom of Screen 32.5 feet
10. Type of Screen Filter No. 1 Standard Silica

    Quantity Used 400 lbs. Size 6-20 U/C
11*. Depth To Top of Filter 6 feet
12. Type of Seal 1/2-inch Bentonite Pellets

    Quantity Used 30 lbs.
13*. Depth To Top of Seal 4 feet
14. Type of Grout Cement-Bentonite

    Grout Mixture 20:1

    Method of Placement Tremie Pipe

COMMENTS ON INSTALLATION

*From Ground Surface

DEPARTMENT OF THE NAVY
SOUTHERN DIVISION
NAVAL FACILITIES ENGINEERING COMMAND
2155 EAGLE DR. P O BOX 10068
CHARLESTON, S C 29411-0068

WELL DATA REPORT

WELL NUMBER CEF10-3 AREA Site 10

DATE OF INSTALLATION 6/11/87

WELL HOLE DATA

Drill Date 6/11/87 Well Driller Southwestern Laboratories, Inc.

Depth of Boring 24 feet Purpose of Boring Monitoring Well

Drilling Method Hollow Stem Auger Mud Type Not Applicable

WATER LEVEL DATA (All measurements from top of casing)

Water Level 4.75 feet Date of Measurement 6/26/87

DEVELOPMENT DATA

Development Method Hand Bailed

Length of Time Developed 120 minutes

LOCATION OF BOREHOLE INFORMATION

Drillers Log X Geophysical Log Not Applicable

Physical Core X Cutting Samples Not Applicable

Water Level Observations 4.75 feet (6/26/87) / 6.30 feet (7/10/87)

DRILLED BY Southwestern Laboratories SCCWD#

DEVELOPED BY Harding Lawson Associates SCCWD#

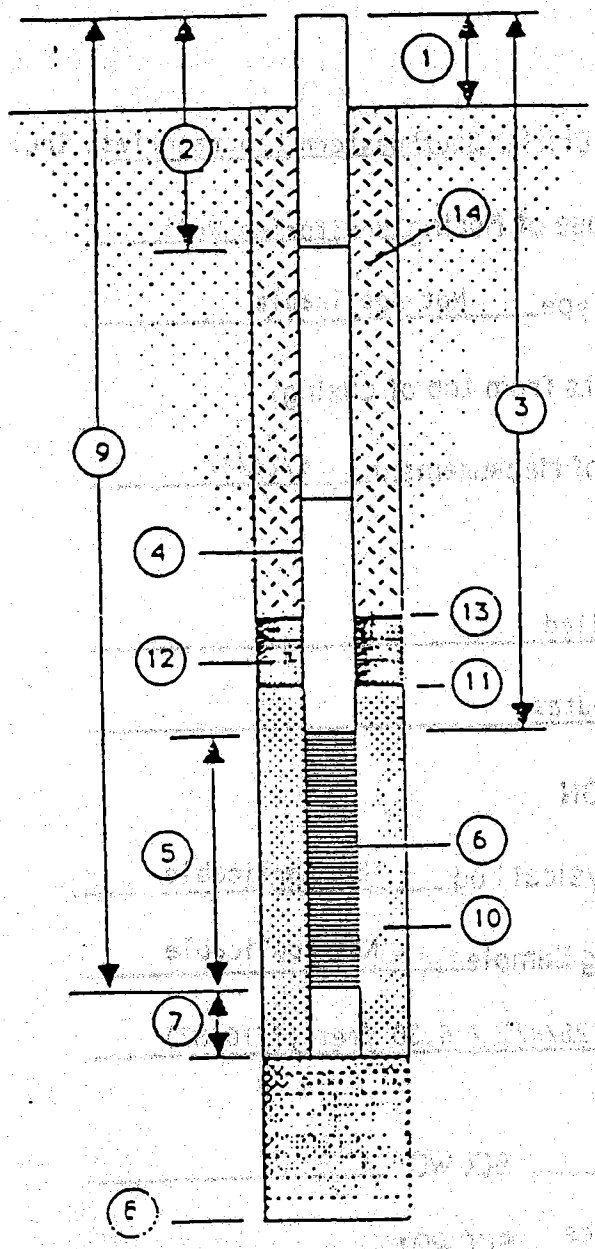
TECHNICAL OVERSIGHT BY Harding Lawson Associates

DEPARTMENT OF THE NAVY
SOUTHERN DIVISION
NAVAL FACILITIES ENGINEERING COMMAND
2155 EAGLE DR. P.O BOX 10068
CHARLESTON S C 29411-0068

WELL CONSTRUCTION DETAILS

WELL NUMBER CEF10-3

DATE OF INSTALLATION 6/11/87



1. Height of Casing above ground 2.5 feet
2. Depth to first Coupling 2.5 feet
   Coupling Interval Depths 12.5 feet
3. Total Length of Blank Pipe 12.5 feet
4. Type of Blank Pipe Schedule 40 PVC
5. Length of Screen 10 feet
6. Type of Screen Schedule 40 PVC, 0.020 in. sl
7. Length of Sump 4 ft.
8*. Total Depth of Boring 24 ft. Hole Diameter 6-3/4 i
9. Depth To Bottom of Screen 22.5 feet
10. Type of Screen Filter No. 1 Standard Silica
    Quantity Used 250 lbs. Size 6-20 U/C
11*. Depth To Top of Filter 6 feet
12. Type of Seal 1/2 inch Bentonite Pellets
    Quantity Used 25 lbs.
13*. Depth To Top of Seal 4 feet
14. Type of Grout Cement-Bentonite
    Grout Mixture 20:1
    Method of Placement Tremie Pipe

COMMENTS ON INSTALLATION

*From Ground Surface

DEPARTMENT OF THE NAVY
SOUTHERN DIVISION
NAVAL FACILITIES ENGINEERING COMMAND
2155 EAGLE DR P O BOX 10068
CHARLESTON, S C 29411-0068

WELL DATA REPORT

WELL NUMBER CEF10-4 AREA Site 10

DATE OF INSTALLATION 6/11/87

WELL HOLE DATA

Drill Date 6/11/87 Well Driller Southwestern Laboratories, Inc.

Depth of Boring 30 feet Purpose of Boring Monitoring Well

Drilling Method Hollow Stem Auger Mud Type Not Applicable

WATER LEVEL DATA (All measurements from top of casing)

Water Level 8.60 feet Date of Measurement 6/26/87

DEVELOPMENT DATA

Development Method Air Lift

Length of Time Developed 90 minutes

LOCATION OF BOREHOLE INFORMATION

Drillers Log X Geophysical Log Not Applicable

Physical Core X Cutting Samples Not Applicable

Water Level Observations 8.60 feet (6/26/87) / 6.50 feet (7/10/87)

DRILLED BY Southwestern Laboratories SCCWD# _____

DEVELOPED BY Harding Lawson Associates SCCWD# _____

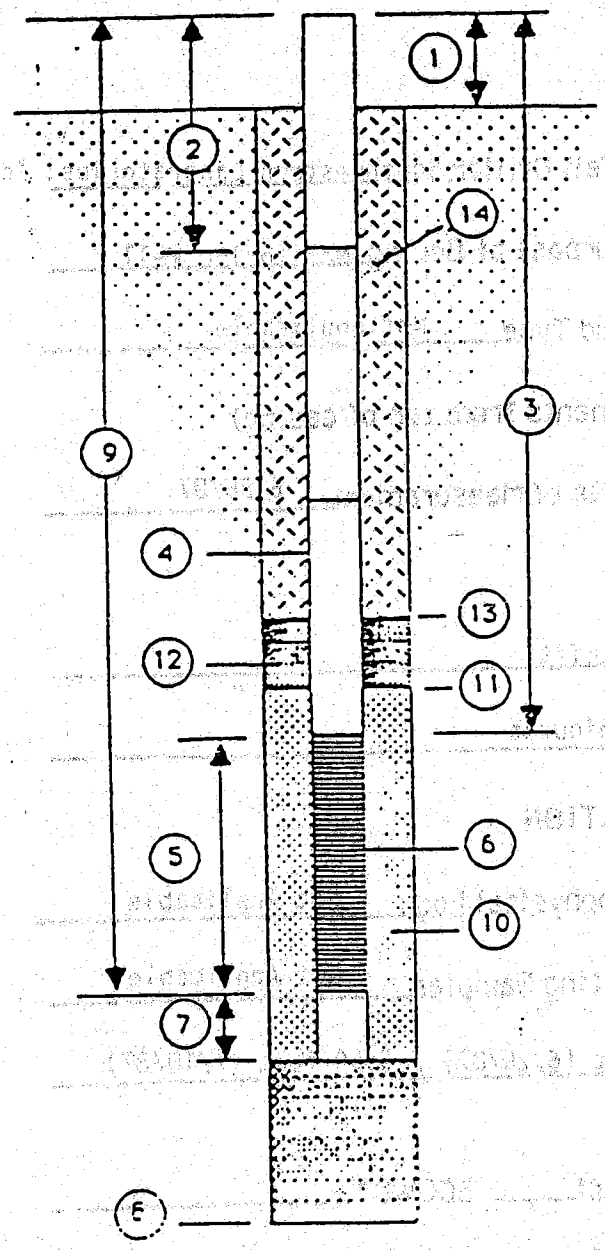
TECHNICAL OVERSIGHT BY Harding Lawson Associates

DEPARTMENT OF THE NAVY
SOUTHERN DIVISION
NAVAL FACILITIES ENGINEERING COMMAND
2155 EAGLE DR. P.O. BOX 10068
CHARLESTON S.C. 29411-0068

WELL CONSTRUCTION DETAILS

WELL NUMBER CEF10-4

DATE OF INSTALLATION 6/11/87



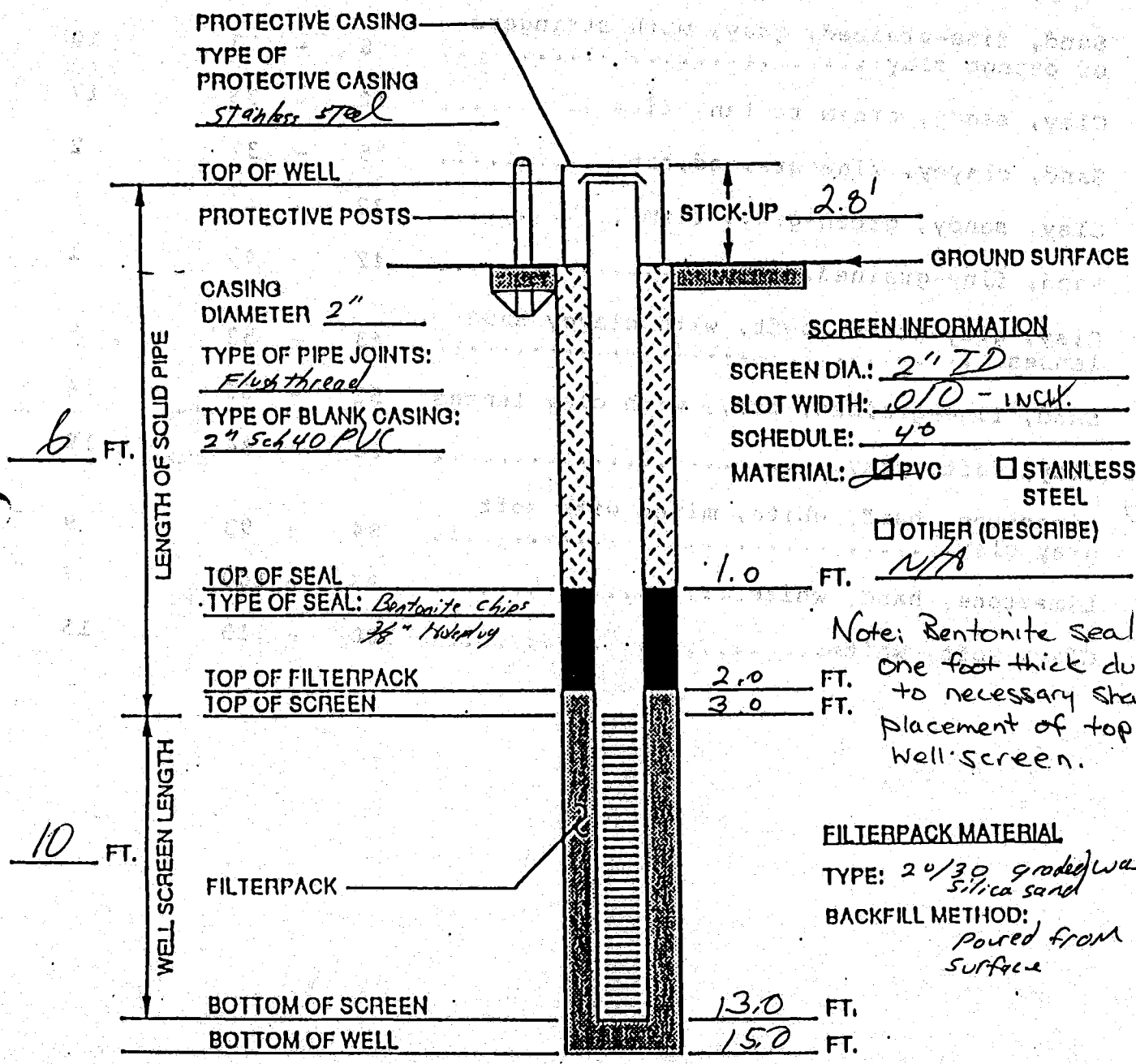
1. Height of Casing above ground 2.58 feet
2. Depth to first Coupling 2.5 feet
   Coupling Interval Depths 12.5 feet, 22.5 feet
3. Total Length of Blank Pipe 12.5 feet
4. Type of Blank Pipe Schedule 40 PVC
5. Length of Screen 20 feet
6. Type of Screen Schedule 40 PVC, 0.020 in. sl
7. Length of Sump 0 ft.
8. * Total Depth of Boring 30 ft. Hole Diameter 6-3/4 i
9. Depth To Bottom of Screen 32.5 feet
10. Type of Screen Filter No. 1 Standard Silica
    Quantity Used 300 lbs. Size 6-20 U/C
11. * Depth To Top of Filter 6 feet
12. Type of Seal 1/2-inch Bentonite Pellets
    Quantity Used 30 lbs.
13. * Depth To Top of Seal 4 feet
14. Type of Grout Cement-Bentonite
    Grout Mixture 20:1
    Method of Placement Tremie Pipe

COMMENTS ON INSTALLATION

*From Ground Surface

ELEVATION GROUNDWATER			PROJECT RI OU's 3,4,5,6
DATE INSTALLED 2 MAR 95	STARTED 2 MAR 95	COMPLETED 2 MAR 95	LOCATION (Coordinates or Station) CEF-10-5S site 10 was cecil Field
ELEVATION TOP OF HOLE			SIGNATURE OF INSPECTOR Bus Mcaffee
TOTAL DEPTH OF HOLE 15' B/S			HOLE NO. (As shown on drawing title and file number) CEF-10-5S

ABOVE GROUND MONITORING WELL CONSTRUCTION DIAGRAM



WELL DEVELOPMENT

METHOD: Centrifugal pump

TIME SPENT DEVELOPMENT: 50 min | 17 1/2 hrs

VOLUME OF WATER REMOVED: ~~[illegible]~~ 65 gal | 200 gal

VOLUME OF WATER ADDED: Ø

DESCRIPTION OF PREDEVELOPMENT WATER: Dark Brown No odor Final Turbidity 17.3 NTU

DESCRIPTION OF POST DEVELOPMENT WATER: [illegible]

DEPTH FROM TOP CASING AFTER DEVELOPMENT:

WATER LEVEL SUMMARY

WATER LEVEL MEASUREMENTS

DATE/TIME/LEVEL 3/2/95 ~3.0' bls 1050 hrs

Geraghty & Miller, Inc.

LITHOLOGIC LOG FOR MONITOR WELL SA-2 - AKA CEF-10-1D

Description	Depth (ft)	Thickness (ft)
Sand, fine-grained, tan.....	0 - 4	4
Clay, red to orange, soft.....	4 - 8	4
Sand, fine-grained, gray, with stringers of orange clay.....	8 - 18	10
Clay, sandy, cream to tan, firm.....	18 - 35	17
Sand, clayey, fine-grained, tan.....	35 - 37	2
Clay, sandy, green-gray, firm.....	37 - 42	5
Sand, fine-grained, tan.....	42 - 43	1
Clay, gray-green, soft, with clayey sand lenses.....	43 - 52	9
Sand, fine-grained, gray, with clay lenses	52 - 66	14
Clay, soft, gray.....	66 - 84	18
Limestone, hard, white, mixed with soft gray clay.....	84 - 93	9
Limestone, hard, white.....	93 - 100	7
Clay, soft, white.....	100 - 115	15

WELL AND PUMP DATA

Location of Well: CEF10-2

County:

Township: Township Number N or S: Range Number E or W: Section No.: Fraction:

Address and City or Distance and Direction from Road Intersections

Property owner's name and address: NAS Cecil Field

Show exact location of well in section grid with an 'x'

N

S

1 mile

Addition Name

Block Number

Lot Number

Sketch map of well location

Well depth: 38.0 ft.

Datum point from which all measurements are taken: Ground Surface

Method of Drilling
☐ Cable tool ☐ Hollow rod ☐ Driven ☐ Dug
☐ Direct rotary ☐ Air rotary ☐ Bucket auger ☐ Hollow Stem Auge
☐ Reverse rotary ☐ Jetted ☐ Flight auger

Use
☐ Domestic ☐ Public supply ☐ Industrial ☐ ____
☐ Irrigation ☐ Municipal ☐ Commercial
☐ Test Well ☐ Heating or cooling ☐ Monitoring

Casing Type
☐ Steel ☐ Threaded Height above/below surface 2.7 ft.
☐ Galv ☐ Welded
☐ PVC ☐ Solvent welded Drive shoe? Yes ___ No ___
☐ SS

					Hole diameter
2 in	to 9.8 ft	Wgt ___ lb/ft	Sch No 40		6-3/4 in to 38
___ in	to ___ ft	Wgt ___ lb/ft	Sch No ___		___ in to ___
___ in	to ___ ft	Wgt ___ lb/ft	Sch No ___		___ in to ___

Remarks, Elevation, Source of Data, etc.

Elevation T.O.C. 50.86

Elevation T.O.D. 48.63

Borehole data

Formation Log	Color	Hardness	From	To
Sandy Silt	Dk. Brown	Loose	0	2'
Silty Sand	Lt. Brown	Loose	2'	12.25'
Clayey Sand	GreenGray	Loose	12.25'	18.5'
Sand	Lt. Gray	Dense	18.5'	33.75'
Clayey Sand	Gray	MedDnse	33.75'	34.5'
Sandy Lean Clay	Gray	Stiff	34.5'	38.0'

Intake Portion of Well
Screen type: Schedule 40 or open hole from ___ ft to ___
Manufacturer: Triloc
Material: PVC Dia: 2 inches
Fittings: Threaded Length: 20 ft.
Set between 9.8 ft and 29.8 ft Slot: 0.020 inches
___ ft and ___ ft Slot: ___
___ ft and ___ ft Slot: ___
Method of installation: ___

Filter Pack
Source: ___ Gradation: 6 - 20
Method of installation: Poured Composition: Silica
Volume used: 500 lbs. Depth to top of f p: 6 ft.

Grout
Used? ☐ Yes ☐ No Volume used: 15 gal.
☐ Neat Cement ☐ Bentonite ☐ Cement-Bentonite
Method of installation: Tremied
Depth from 0 ft to 4
from ___ ft to ___ ft

Development
Method: Air Lift Duration: 60 min.
Dates: 6/26/87 Sand content after 50 min. 0
Chemicals used: Not Applicable

Static Water Level (6.45 - 2.67)
3.78 ft ☐ below ☐ above grade
Date measured: 6/20/87

Pumping Water Level
Not Applicable ft ☐ below ☐ above grade Date: ___
After ___ hrs pumping at ___ gpm

Specific Capacity
Not Applicable gpm/ft of drawdown at ___ hours
Date: ___

Pump
Date installed: Not Applicable Type: ___
Manufacturer: ___ Model No: ___
H.P. ___ Volts ___ Capacity ___
Depth of pump intake setting ___ No of stages ___
☐ Oil ☐ Water lubrication Power source ___
Material of drop pipe ___ bowls ___
shafting ___ impellers ___ Bowl dia ___
Column pipe dia ___ Length ___ Modifications ___

Well Head Completion
Pitless adaptor Basement offset Distance above grade 2.7 ft.

Nearest Sources of Possible Contamination
___ ft Direction ___ Type ___

Well disinfected upon completion? Yes No

Geophysical Logs Run
Not Applicable

Driller Name and Address

Name of Driller: Southwestern Laboratories, Inc.

State License No.: ___

Water Quality
Sample taken? Yes No
Where analyzed: JTC Environmental Consultants 7/10/87

Date completed: 6/25/87

WELL AND PUMP DATA

Location of Well: CEF10-3

County:

Township Number: N or S

Range Number: E or W

Section No.:

Fraction:

Property owner's name and address: NAS Cecil Field

Street address and City or Distance and Direction from Road Intersections:

Show exact location of well in section grid with an "X"

Sketch map of well location

N

S

1 mile

Addition Name

Block Number

Lot Number

Well depth: 24 ft.

Datum point from which all measurements are taken: Ground Surface

Method of Drilling: Cable tool; Direct rotary; Reverse rotary; Hollow rod; Air rotary; Jetted; Driven; Bucket auger; Flight auger; Dug; Hollow Stem Auge

Use: Domestic; Irrigation; Test Well; Public supply; Municipal; Heating or cooling; Industrial; Commercial; Monitoring

Casing Type: Steel; Galv; PVC; SS; Threaded; Welded; Solvent welded

Height above/below surface 2.5 ft.

Drive shoe? Yes ___ No ✓

2 in	to 10 ft	Wgt ___ lb/ft	Sch No 40	6-3/4in	to 26
___ in	to ___ ft	Wgt ___ lb/ft	Sch No ___	___ in	to ___
___ in	to ___ ft	Wgt ___ lb/ft	Sch No ___	___ in	to ___

Hole diameter

Remarks, Elevation, Source of Data, etc.

Elevation T.O.C. 58.67

Elevation T.O.D. 56.67

Intake Portion of Well

Screen type: Schedule 40 or open hole from ___ ft to ___

Manufacturer: Triloc

Material: PVC Dia: 2 inches

Fittings: Threaded Length: 10 ft.

Set between 10 ft and 20 ft Slot: 0.020 inches

___ ft and ___ ft Slot ___

___ ft and ___ ft Slot ___

Method of installation ___

Filter Pack

Source ___ Gradation: 6 - 20

Method of installation: Poured Composition: Silica

Volume used: 6.0 ft³ Depth to top of f.p. 6 ft.

Grout

Used? ■ Yes ☐ No Volume used: 10 gal.

☐ Neat Cement ☐ Bentonite ☐ Cement-Bentonite

Method of installation: Tremied

Depth from 0 ft to 4 ft

from ___ ft to ___ ft

Development

Method: Hand Bailed Duration ___

Dates ___ Sand content: 0

Chemicals used ___

Static Water Level

2.42 ft ■ below ☐ above grade (4.75 - 2.33)

Date measured ___

Pumping Water Level

Not Applicable ft ☐ below ☐ above grade Date ___

After ___ hrs pumping at ___ gpm

Specific Capacity

Not Applicable gpm/ft of drawdown at ___ hours

Date ___

Pump

Date installed: Not Applicable Type ___

Manufacturer ___ Model No ___

H.P. ___ Volts ___ Capacity ___

Depth of pump intake setting ___ No of stages ___

☐ Oil ☐ Water lubrication Power source ___

Material of drop pipe ___ Bowls ___

Shafting ___ Impellers ___ Bowl dia ___

Column pipe dia ___ Length ___ Modifications ___

Well Head Completion

Pitless adapter Basement offset Distance above grade 2.50 ft.

Nearest Sources of Possible Contamination

___ ft Direction ___ Type ___

Well disinfected upon completion? Yes No

Geophysical Logs Run

Not Applicable

Water Quality

Sample taken? Yes No

Where analyzed: JTC Environmental Consultants 7/10/87

Borehole data

Formation Log	Color	Hardness	From	To
Silty Sand	Lt. Brown	MedDnse	0	4.5'
Sand	Lt. Gray	Dense	4.5'	20.25'
Clavey Sand	Gray	Loose	20.25'	20.8'
Sandy Lean Clay	Gray	MedStff	20.8'	24.0'

Driller Name and Address

Name of Driller: Southwestern Laboratories, Inc.

State License Number:

Date completed: 6/26/87

WELL AND PUMP DATA

Location of Well CEF10-4

County | Township | Township Number N or S | Range Number E or W | Section No. | Fraction

Address and City or Distance and Direction from Road Intersections

Property owner's name and address
NAS Cecil Field

Show exact location of well in section grid with an "x" — Sketch map of well location

N — S — 1 mile

Addition Name

Block Number

Lot Number

Well depth 30.0 ft.

Datum point from which all measurements are taken Ground Surface

Method of Drilling
☐ Cable tool ☐ Hollow rod ☐ Driven ☐ Dug
☐ Direct rotary ☐ Air rotary ☐ Bucket auger ☒ Hollow Stem Auge
☐ Reverse rotary ☐ Jetted ☐ Flight auger

Use
☐ Domestic ☐ Public supply ☐ Industrial ☐ ____
☐ Irrigation ☐ Municipal ☐ Commercial
☐ Test Well ☐ Heating or cooling ☒ Monitoring

Casing Type
☐ Steel ☒ Threaded Height above/below surface 2.58 ft.
☐ Galv ☐ Welded
☒ PVC ☐ Solvent welded Drive shoe? Yes ___ No ✓
☐ SS

					Hole diameter
2 in	to 9.92 ft	Wgt ___ lb/ft	Sch No 40		6-3/4 in to 30
___ in	to ___ ft	Wgt ___ lb/ft	Sch No ___		___ in to ___
___ in	to ___ ft	Wgt ___ lb/ft	Sch No ___		___ in to ___

Remarks, Elevation, Source of Data, etc.
Elevation T.O.C. 58.57
Elevation T.O.D. 56.31

Intake Portion of Well
Screen type Schedule 40 or open hole from ___ ft to ___
Manufacturer Triloc
Material PVC Dia 2 inches
Fittings Threaded Length 20 ft.
Set between 9.92 ft and 29.92 ft Slot 0.020 inches
___ ft and ___ ft Slot ___
___ ft and ___ ft Slot ___
Method of installation ___

Borehole data

Formation Log	Color	Hardness	From	To
Silty Sand	Brown	Loose	0	3.8'
Sand	Lt. Brown	MedDnse	3.8'	7.9'
Silty Sand	Gray	MedDnse	7.9'	10.1'
Sand	Lt. Gray	VryDnse	10.1'	16.8'
Clayey Sand	Lt. Gray	Loose	16.8'	22.5'
Sand	Lt. Gray	Dense	22.5'	28'
Lean Clay	Lt. Gray	Stiff	28'	30.0'

Filter Pack
Source ___ Gradation 6 - 20
Method of installation Poured Composition Silica
Volume used 300 lbs. Depth to top of f.p. 5 ft.

Grout
Used? ☒ Yes ☐ No Volume used 15 gal.
☐ Neat Cement ☐ Bentonite ☒ Cement-Bentonite
Method of installation Tremie Pipe
Depth from 0 ft to 4 ft
from ___ ft to ___ ft

Development
Method Air Lift Duration 90 min.
Dates 6/26/87 Sand content after 90 min. 0
Chemicals used Not Applicable

Static Water Level
6.02 ft ☒ below ☐ above grade (8.6 - 2.58)
Date measured 6/26/87

Pumping Water Level
Not Applicable ft ☐ below ☐ above grade Date ___
After ___ hrs pumping at ___ gpm

Specific Capacity
Not Applicable gpm/ft of drawdown at ___ hours
Date ___

Pump
Date installed Not Applicable Type ___
Manufacturer ___ Model No ___
H.P. ___ Volts ___ Capacity ___
Depth of pump intake setting ___ No of stages ___
☐ Oil ☐ Water lubrication Power source ___
Material of drop pipe ___ bowls ___
shafting ___ impellers ___ Bowl dia ___
Column pipe dia ___ Length ___ Modifications ___

Well Head Completion
Pitless adaptor Basement offset Distance above grade 2.58 ft.

Nearest Sources of Possible Contamination
___ ft Direction ___ Type ___
Well disinfected upon completion? ☐ Yes ☐ No

Geophysical Logs Run
Not Applicable

Water Quality
Sample taken? ✓ Yes ☐ No
Where analyzed JTC Environmental Consultants 7/10/87

Name and Address of Driller
Name of Driller Southwestern Laboratories, Inc.
State License Number ___

Date well completed 6/25/87

DRILLING LOG

HOLE NO. CEF-10-5S

SHEET 1 OF 1 SHEETS

1. COMPANY NAME: ARAES
2. DRILLING SUBCONTRACTOR: Groundwater Protection Inc
3. PROJECT: RI OU's 3456
4. LOCATION: Site 10 NAS Cecil Field
5. NAME OF DRILLER: Glen Cobb
6. MANUFACTURER'S DESIGNATION OF DRILL: Mobil B-59
7. SIZES AND TYPES OF DRILLING AND SAMPLING EQUIPMENT: Mobil B-59 ORV 6¼" HSA NW rod 2" s/steel split spoon, PVC slug
8. HOLE LOCATION: CEF-10-5S
9. SURFACE ELEVATION:
10. DATE STARTED: 2 MAR 95
11. DATE COMPLETED: 2 MAR 95
12. OVERBURDEN THICKNESS: N/A
13. DEPTH DRILLED INTO ROCK: N/A
14. TOTAL DEPTH OF HOLE: 15' bls
15. DEPTH GROUNDWATER ENCOUNTERED: 3.0' B/s
16. DEPTH TO WATER AND ELAPSED TIME AFTER DRILLING COMPLETED: —
17. OTHER WATER LEVEL MEASUREMENTS (SPECIFY): —
18. GEOTECHNICAL SAMPLES: N/A — DISTURBED: — UNDISTURBED: —
19. TOTAL NUMBER OF CORE BOXES: —
20. SAMPLES FOR CHEMICAL ANALYSIS: VOC: — METALS: — OTHER (SPECIFY): — OTHER (SPECIFY): — OTHER (SPECIFY): —
21. TOTAL CORE RECOVERY: %
22. DISPOSITION OF HOLE: BACKFILLED: — MONITORING WELL: YES OTHER (SPECIFY): —
23. SIGNATURE OF INSPECTOR: [signature]

ELEV. A	DEPTH B	DESCRIPTION OF MATERIALS C	FIELD SCREENING RESULTS D	GEOTECH SAMPLE OR CORE BOX NO. E	ANALYTICAL SAMPLE NO. F	BLOW COUNTS G	REMARKS H
		0.0 - 15.0 Sand (SP) 100%, Dark brown to light brown Colorless, otz fine-to medium-grained, sub angular to sub. round, poorly sorted, silty.					Auger hole 0-4.0'
	2						
	4						
	6						
	8						well set at 13.0' B/s
	10						
	12						
	14						
	15	End of Boring 15.0' B/S					

PROJECT: RI OU's 3456

HOLE NO. CEF-10-5S

HITS TABLES

NAS CECIL FIELD OPERABLE UNIT 4 / SITE 10
SURFACE SOIL -- HITS REPORT -- REPORT NO. 6433

Lab Sample Number:	A5D0600280				A3TA8				A5D0600280				A3TAC			
Site	CECIL4				CECIL4				CECIL4				CECIL4			
Locator	CF10SS1				CF10SS1				CF10SS2				CF10SS2			
Collect Date:	05-APR-95				05-APR-95				05-APR-95				05-APR-95			
	VALUE	QUAL	UNITS	DL	VALUE	QUAL	UNITS	DL	VALUE	QUAL	UNITS	DL	VALUE	QUAL	UNITS	DL
CLP VOLATILES 90-SOW																
Methylene chloride	-				-	U	ug/kg	6	-				-	U	ug/kg	6
CLP SEMIVOLATILES 90-SOW																
Di-n-butylphthalate	-				39	J	ug/kg	380	-				-	U	ug/kg	400
CLP METALS AND CYANIDE																
Aluminum	-				1960		mg/kg	40	-				7830		mg/kg	40
Arsenic	-				-	U	mg/kg	20	-				2.7		mg/kg	20
Barium	-				-	U	mg/kg	40	-				-	U	mg/kg	40
Calcium	-				-	U	mg/kg	1000	-				179		mg/kg	1000
Chromium	-				-	U	mg/kg	2	-				17		mg/kg	2
Cobalt	-				-	U	mg/kg	10	-				.67		mg/kg	10
Iron	-				1910	J	mg/kg	20	-				9150	J	mg/kg	20
Lead	-				3.6		mg/kg	.6	-				7.1		mg/kg	.6
Magnesium	-				48.7		mg/kg	1000	-				94.1		mg/kg	1000
Manganese	-				2.2		mg/kg	3	-				2.1		mg/kg	3
Potassium	-				-	UJ	mg/kg	1000	-				59.4		mg/kg	1000
Sodium	-				-	U	mg/kg	1000	-				200		mg/kg	1000
Vanadium	-				5.6		mg/kg	10	-				28.5		mg/kg	10
TPH																
Total petroleum hydrocarbons	51	J	mg/kg	12	-				26	J	mg/kg	12	-			

U = NOT DETECTED J = ESTIMATED VALUE
UJ = REPORTED QUANTITATION LIMIT IS QUALIFIED AS ESTIMATED
R = RESULT IS REJECTED AND UNUSABLE

NAS CECIL FIELD OPERABLE UNIT 4 / SITE 10
SURFACE SOIL -- HITS REPORT -- REPORT NO. 6433

Lab Sample Number:	A5D0600280			A3TAD			A5D0600280			A3TAE		
Site	CECIL4			CECIL4			CECIL4			CECIL4		
Locator	CF10SS3			CF10SS3			CF10SS4			CF10SS4		
Collect Date:	05-APR-95			05-APR-95			05-APR-95			05-APR-95		
	VALUE QUAL	UNITS	DL	VALUE QUAL	UNITS	DL	VALUE QUAL	UNITS	DL	VALUE QUAL	UNITS	DL
CLP VOLATILES 90-SOW												
Methylene chloride	-			- U	ug/kg	6	-			- U	ug/kg	7
CLP SEMIVOLATILES 90-SOW												
Di-n-butylphthalate	-			21 J	ug/kg	400	-			39 J	ug/kg	450
CLP METALS AND CYANIDE												
Aluminum	-			144	mg/kg	40	-			582	mg/kg	40
Arsenic	-			- U	mg/kg	20	-			- U	mg/kg	20
Barium	-			- U	mg/kg	40	-			10.3	mg/kg	40
Calcium	-			- U	mg/kg	1000	-			6350	mg/kg	1000
Chromium	-			- U	mg/kg	2	-			- U	mg/kg	2
Cobalt	-			- U	mg/kg	10	-			- U	mg/kg	10
Iron	-			140 J	mg/kg	20	-			406 J	mg/kg	20
Lead	-			1.3 J	mg/kg	.6	-			6.8	mg/kg	.6
Magnesium	-			15	mg/kg	1000	-			115	mg/kg	1000
Manganese	-			1.8	mg/kg	3	-			8.7	mg/kg	3
Potassium	-			- UJ	mg/kg	1000	-			- UJ	mg/kg	1000
Sodium	-			- U	mg/kg	1000	-			- U	mg/kg	1000
Vanadium	-			.74	mg/kg	10	-			2.6	mg/kg	10
TPH												
Total petroleum hydrocarbons	140 J	mg/kg	12	-			270 J	mg/kg	14	-		

U = NOT DETECTED J = ESTIMATED VALUE
UJ = REPORTED QUANTITATION LIMIT IS QUALIFIED AS ESTIMATED
R = RESULT IS REJECTED AND UNUSABLE

NAS CECIL FIELD OPERABLE UNIT 4 / SITE 10
SURFACE SOIL -- HITS REPORT -- REPORT NO. 6433

Lab Sample Number:	A5D0600280				A3TAF				A5D0600280				A3TAH			
Site	CECIL4				CECIL4				CECIL4				CECIL4			
Locator	CF10SS5				CF10SS5				CF10SS5D				CF10SS5D			
Collect Date:	05-APR-95				05-APR-95				05-APR-95				05-APR-95			
	VALUE	QUAL	UNITS	DL	VALUE	QUAL	UNITS	DL	VALUE	QUAL	UNITS	DL	VALUE	QUAL	UNITS	DL
CLP VOLATILES 90-SOW																
Methylene chloride	-				-	U	ug/kg	7	-				-	U	ug/kg	7
CLP SEMIVOLATILES 90-SOW																
Di-n-butylphthalate	-				-	U	ug/kg	440	-				53	J	ug/kg	440
CLP METALS AND CYANIDE																
Aluminum	-				323		mg/kg	40	-				361		mg/kg	40
Arsenic	-				-	U	mg/kg	20	-				-	U	mg/kg	20
Barium	-				-	U	mg/kg	40	-				-	U	mg/kg	40
Calcium	-				3590		mg/kg	1000	-				3830		mg/kg	1000
Chromium	-				-	U	mg/kg	2	-				-	U	mg/kg	2
Cobalt	-				-	U	mg/kg	10	-				-	U	mg/kg	10
Iron	-				285	J	mg/kg	20	-				302	J	mg/kg	20
Lead	-				2.7		mg/kg	.6	-				2.9		mg/kg	.6
Magnesium	-				103		mg/kg	1000	-				107		mg/kg	1000
Manganese	-				6		mg/kg	3	-				6.3		mg/kg	3
Potassium	-				-	UJ	mg/kg	1000	-				-	UJ	mg/kg	1000
Sodium	-				-	U	mg/kg	1000	-				-	U	mg/kg	1000
Vanadium	-				1.3		mg/kg	10	-				1.5		mg/kg	10
TPH																
Total petroleum hydrocarbons	99	J	mg/kg	13	-				92	J	mg/kg	14	-			

U = NOT DETECTED J = ESTIMATED VALUE
UJ = REPORTED QUANTITATION LIMIT IS QUALIFIED AS ESTIMATED
R = RESULT IS REJECTED AND UNUSABLE

NAS CECIL FIELD OPERABLE UNIT 4 / SITE 10
SURFACE SOIL -- HITS REPORT -- REPORT NO. 6433

Lab Sample Number:	A5D0600280				A3TAJ			
Site	CECIL4				CECIL4			
Locator	CF10SS6				CF10SS6			
Collect Date:	05-APR-95				05-APR-95			
	VALUE	QUAL	UNITS	DL	VALUE	QUAL	UNITS	DL
CLP VOLATILES 90-SOW								
Methylene chloride	-				3	J	ug/kg	14
CLP SEMIVOLATILES 90-SOW								
Di-n-butylphthalate	-				41	J	ug/kg	480
CLP METALS AND CYANIDE								
Aluminum	-				1020		mg/kg	40
Arsenic	-				-	U	mg/kg	20
Barium	-				-	U	mg/kg	40
Calcium	-				6010		mg/kg	1000
Chromium	-				-	U	mg/kg	2
Cobalt	-				-	U	mg/kg	10
Iron	-				1210	J	mg/kg	20
Lead	-				7.2		mg/kg	.6
Magnesium	-				94.2		mg/kg	1000
Manganese	-				11.7		mg/kg	3
Potassium	-				-	UJ	mg/kg	1000
Sodium	-				253	J	mg/kg	1000
Vanadium	-				3.4		mg/kg	10
TPH								
Total petroleum hydrocarbons	31	J	mg/kg	15	-			

U = NOT DETECTED J = ESTIMATED VALUE
UJ = REPORTED QUANTITATION LIMIT IS QUALIFIED AS ESTIMATED
R = RESULT IS REJECTED AND UNUSABLE

NAS CECIL FIELD -- OPERABLE UNIT 4 / SITE 10 REPORT NO. 6664
GROUNDWATER -- HITS REPORT -- REPORT NO. 6664

Lab Sample Number:	A5D2900200			A49E8			A5E0300050			A4ARD		
Site	CECIL4			CECIL4			CECIL4			CECIL4		
Locator	CF10MW1			CF10MW1			CF10MW2			CF10MW2		
Collect Date:	28-APR-95			28-APR-95			02-MAY-95			02-MAY-95		
	VALUE QUAL	UNITS	DL	VALUE QUAL	UNITS	DL	VALUE QUAL	UNITS	DL	VALUE QUAL	UNITS	DL
CLP SEMIVOLATILES 90-SOW												
bis(2-Ethylhexyl) phthalate	-			5 J	ug/l	10	-			- U	ug/l	10
CLP METALS AND CYANIDE												
Aluminum	-			- U	ug/l	200	-			- U	ug/l	200
Barium	-			- U	ug/l	200	-			18.5	ug/l	200
Calcium	-			37500	ug/l	5000	-			11400	ug/l	5000
Chromium	-			- U	ug/l	10	-			- U	ug/l	10
Iron	-			- U	ug/l	100	-			529 J	ug/l	100
Magnesium	-			19400	ug/l	5000	-			2670	ug/l	5000
Manganese	-			- U	ug/l	15	-			- U	ug/l	15
Nickel	-			- U	ug/l	40	-			- U	ug/l	40
Potassium	-			1950	ug/l	5000	-			704	ug/l	5000
Sodium	-			19600	ug/l	5000	-			4150	ug/l	5000
Vanadium	-			- U	ug/l	50	-			- U	ug/l	50
Cyanide	-			2.8	ug/l	10	-			- U	ug/l	10
TOC												
Total organic carbon	3	mg/l	1	-			2	mg/l	1	-		

U = NOT DETECTED J = ESTIMATED VALUE
UJ = REPORTED QUANTITATION LIMIT IS QUALIFIED AS ESTIMATED
R = RESULT IS REJECTED AND UNUSABLE

NAS CECIL FIELD -- OPERABLE UNIT 4 / SITE 10 REPORT NO. 6664
GROUNDWATER -- HITS REPORT -- REPORT NO. 6664

Lab Sample Number:	A5D2900200			A49E7			A5D2900200			A49E4		
Site	CECIL4			CECIL4			CECIL4			CECIL4		
Locator	CF10MW3			CF10MW3			CF10MW4			CF10MW4		
Collect Date:	28-APR-95			28-APR-95			28-APR-95			28-APR-95		
	VALUE QUAL	UNITS	DL	VALUE QUAL	UNITS	DL	VALUE QUAL	UNITS	DL	VALUE QUAL	UNITS	DL
CLP SEMIVOLATILES 90-SOW												
bis(2-Ethylhexyl) phthalate	-			2 J	ug/l	10	-			6 J	ug/l	10
CLP METALS AND CYANIDE												
Aluminum	-			- U	ug/l	200	-			669	ug/l	200
Barium	-			- U	ug/l	200	-			- U	ug/l	200
Calcium	-			- U	ug/l	5000	-			2380	ug/l	5000
Chromium	-			- U	ug/l	10	-			- U	ug/l	10
Iron	-			537 J	ug/l	100	-			1320 J	ug/l	100
Magnesium	-			544	ug/l	5000	-			605	ug/l	5000
Manganese	-			- U	ug/l	15	-			- U	ug/l	15
Nickel	-			- U	ug/l	40	-			- U	ug/l	40
Potassium	-			215 J	ug/l	5000	-			270	ug/l	5000
Sodium	-			2710	ug/l	5000	-			5020	ug/l	5000
Vanadium	-			2.7	ug/l	50	-			- U	ug/l	50
Cyanide	-			- U	ug/l	10	-			- U	ug/l	10
TOC												
Total organic carbon	-			-			2	mg/l	1	-		

U = NOT DETECTED J = ESTIMATED VALUE
UJ = REPORTED QUANTITATION LIMIT IS QUALIFIED AS ESTIMATED
R = RESULT IS REJECTED AND UNUSABLE

NAS CECIL FIELD -- OPERABLE UNIT 4 / SITE 10 REPORT NO. 6664
GROUNDWATER -- HITS REPORT -- REPORT NO. 6664

Lab Sample Number:	A5E0200490			A4AHJ			A5E0200490			A4AHK		
Site	CECIL4			CECIL4			CECIL4			CECIL4		
Locator	CF10MW5S			CF10MW5S			CF10MW5SD			CF10MW5SD		
Collect Date:	01-MAY-95			01-MAY-95			01-MAY-95			01-MAY-95		
	VALUE	QUAL UNITS	DL	VALUE	QUAL UNITS	DL	VALUE	QUAL UNITS	DL	VALUE	QUAL UNITS	DL
CLP SEMIVOLATILES 90-SOW												
bis(2-Ethylhexyl) phthalate	-			-	U ug/l	10	-			-	U ug/l	10
CLP METALS AND CYANIDE												
Aluminum	-			949	ug/l	200	-			1170	ug/l	200
Barium	-			16.3	ug/l	200	-			16.6	ug/l	200
Calcium	-			14400	ug/l	5000	-			13900	ug/l	5000
Chromium	-			-	U ug/l	10	-			2.5	ug/l	10
Iron	-			1680	J ug/l	100	-			2690	J ug/l	100
Magnesium	-			1330	ug/l	5000	-			1360	ug/l	5000
Manganese	-			49.1	ug/l	15	-			49.6	ug/l	15
Nickel	-			6.9	ug/l	40	-			-	U ug/l	40
Potassium	-			672	ug/l	5000	-			664	ug/l	5000
Sodium	-			5690	ug/l	5000	-			5460	ug/l	5000
Vanadium	-			3.1	J ug/l	50	-			5.6	ug/l	50
Cyanide	-			-	U ug/l	10	-			-	U ug/l	10
TOC												
Total organic carbon	-			-			-			-		

U = NOT DETECTED J = ESTIMATED VALUE
UJ = REPORTED QUANTITATION LIMIT IS QUALIFIED AS ESTIMATED
R = RESULT IS REJECTED AND UNUSABLE

NAS CECIL FIELD -- OPERABLE UNIT 4 / SITE 10
SURFACE WATER -- HITS REPORT -- REPORT NO. 7420

Lab Sample Number:	A3REM				A3REMF				A3RF1				A3RF1F			
Site	CECIL4				CECIL4				CECIL4				CECIL4			
Locator	CF10SW1				CF10SW1F				CF10SW2				CF10SW2F			
Collect Date:	04-APR-95				04-APR-95				04-APR-95				04-APR-95			
	VALUE	QUAL	UNITS	DL	VALUE	QUAL	UNITS	DL	VALUE	QUAL	UNITS	DL	VALUE	QUAL	UNITS	DL
CLP METALS AND CYANIDE																
Aluminum	1030		ug/l	200	-	U	ug/l	200	340		ug/l	200	-	U	ug/l	200
Calcium	14000		ug/l	5000	13100	J	ug/l	5000	10600		ug/l	5000	10000	J	ug/l	5000
Iron	330		ug/l	100	-	U	ug/l	100	-	U	ug/l	100	-	U	ug/l	100
Magnesium	1000		ug/l	5000	928		ug/l	5000	922		ug/l	5000	863		ug/l	5000
Manganese	12		ug/l	15	6.1		ug/l	15	10.7		ug/l	15	7.4		ug/l	15
Sodium	1770		ug/l	5000	1840		ug/l	5000	2000		ug/l	5000	2030		ug/l	5000
Vanadium	3.9		ug/l	50	1.8		ug/l	50	1.9		ug/l	50	1.1		ug/l	50

U = NOT DETECTED J = ESTIMATED VALUE
UJ = REPORTED QUANTITATION LIMIT IS QUALIFIED AS ESTIMATED
R = RESULT IS REJECTED AND UNUSABLE

NAS CECIL FIELD -- OPERABLE UNIT 4 / SITE 10
SURFACE WATER -- HITS REPORT -- REPORT NO. 7420

Lab Sample Number:	A3RF5			A3RF5F		
Site	CECIL4			CECIL4		
Locator	CF10SW2D			CF10SW2DF		
Collect Date:	04-APR-95			04-APR-95		
	VALUE QUAL	UNITS	DL	VALUE QUAL	UNITS	DL
CLP METALS AND CYANIDE						
Aluminum	- U	ug/l	200	- U	ug/l	200
Calcium	9750	ug/l	5000	9280 J	ug/l	5000
Iron	- U	ug/l	100	- U	ug/l	100
Magnesium	880	ug/l	5000	831	ug/l	5000
Manganese	10.7	ug/l	15	6.6	ug/l	15
Sodium	1990	ug/l	5000	1880	ug/l	5000
Vanadium	1.6	ug/l	50	1.2	ug/l	50

U = NOT DETECTED J = ESTIMATED VALUE
UJ = REPORTED QUANTITATION LIMIT IS QUALIFIED AS ESTIMATED
R = RESULT IS REJECTED AND UNUSABLE

NAS CECIL FIELD -- OPERABLE UNIT 4 / SITE 10 REPORT NO. 6435
SURFACE WATER -- HITS REPORT -- REPORT NO. 6435

Lab Sample Number:	A5D0500160			A3REM			A5D0500160			A3RF1		
Site	CECIL4			CECIL4			CECIL4			CECIL4		
Locator	CF10SW1			CF10SW1			CF10SW2			CF10SW2		
Collect Date:	04-APR-95			04-APR-95			04-APR-95			04-APR-95		
	VALUE	QUAL UNITS	DL	VALUE	QUAL UNITS	DL	VALUE	QUAL UNITS	DL	VALUE	QUAL UNITS	DL

No "HITS" — Volatiles
Semivolatiles
Pesticides/PCBs

U = NOT DETECTED J = ESTIMATED VALUE
UJ = REPORTED QUANTITATION LIMIT IS QUALIFIED AS ESTIMATED
R = RESULT IS REJECTED AND UNUSABLE

NAS CECIL FIELD -- OPERABLE UNIT 4 / SITE 10 REPORT NO. 6435
SURFACE WATER -- HITS REPORT -- REPORT NO. 6435

Lab Sample Number:		A5D0500160				A3RF5	
Site		CECIL4				CECIL4	
Locator		CF10SW2D				CF10SW2D	
Collect Date:		04-APR-95				04-APR-95	
	VALUE	QUAL UNITS	DL	VALUE		QUAL UNITS	DL

U = NOT DETECTED J = ESTIMATED VALUE
UJ = REPORTED QUANTITATION LIMIT IS QUALIFIED AS ESTIMATED
R = RESULT IS REJECTED AND UNUSABLE

NAS CECIL FIELD -- OPERABLE UNIT 4 / SITE 10
SEDIMENT -- HITS REPORT -- REPORT NO. 7419

Lab Sample Number:	A5D0600090			A3T6T			A5D0600090			A3T6V		
Site	CECIL4			CECIL4			CECIL4			CECIL4		
Locator	CF10SD1			CF10SD1			CF10SD2			CF10SD2		
Collect Date:	04-APR-95			04-APR-95			04-APR-95			04-APR-95		
	VALUE	QUAL UNITS	DL	VALUE	QUAL UNITS	DL	VALUE	QUAL UNITS	DL	VALUE	QUAL UNITS	DL
CLP VOLATILES 90-SOW												
2-Butanone	-			4 J	ug/kg	13	-			6 J	ug/kg	19
Toluene	-			6 J	ug/kg	13	-			13	ug/kg	19
CLP SEMIVOLATILES 90-SOW												
Di-n-butylphthalate	-			92 J	ug/kg	440	-			57 J	ug/kg	620
Benzo (b) fluoranthene	-			46 J	ug/kg	440	-			- U	ug/kg	630
Benzo (a) pyrene	-			46 J	ug/kg	440	-			- U	ug/kg	630
Indeno (1,2,3-cd) pyrene	-			40 J	ug/kg	440	-			- U	ug/kg	630
Benzo (g,h,i) perylene	-			43 J	ug/kg	440	-			- U	ug/kg	630
CLP PESTICIDES/PCBS 90-SOW												
4,4-DDE	-			- U	ug/kg	4.4	-			.37 J	ug/kg	6
4,4-DDD	-			- R	ug/kg	4	-			1.5 J	ug/kg	6
4,4-DDT	-			- U	ug/kg	4.4	-			- U	ug/kg	6.2
CLP METALS AND CYANIDE												
Aluminum	-			1700	mg/kg	40	-			1810	mg/kg	40
Barium	-			3.1	mg/kg	40	-			7.6	mg/kg	40
Calcium	-			186	mg/kg	1000	-			1470	mg/kg	1000
Chromium	-			3.3	mg/kg	2	-			2.5 J	mg/kg	2
Iron	-			519	mg/kg	20	-			478 J	mg/kg	20
Lead	-			- U	mg/kg	.6	-			5.4	mg/kg	.6
Magnesium	-			- U	mg/kg	1000	-			- U	mg/kg	1000
Manganese	-			4.3	mg/kg	3	-			9.6	mg/kg	3
Selenium	-			2.8 J	mg/kg	1	-			- UJ	mg/kg	1
Sodium	-			293 J	mg/kg	1000	-			422 J	mg/kg	1000
Vanadium	-			5.1	mg/kg	10	-			4.4	mg/kg	10
TPH												
Total petroleum hydrocarbons	710	mg/kg	67	-			300	mg/kg	19	-		
TOC												
Total organic carbon	4600	mg/kg	130	-			39000	mg/kg	380	-		

U = NOT DETECTED J = ESTIMATED VALUE
UJ = REPORTED QUANTITATION LIMIT IS QUALIFIED AS ESTIMATED
R = RESULT IS REJECTED AND UNUSABLE

NAS CECIL FIELD -- OPERABLE UNIT 4 / SITE 10
SEDIMENT -- HITS REPORT -- REPORT NO. 7419

Lab Sample Number:	A5D0600090				A3T6W			
Site	CECIL4				CECIL4			
Locator	CF10SD2D				CF10SD2D			
Collect Date:	04-APR-95				04-APR-95			
	VALUE	QUAL	UNITS	DL	VALUE	QUAL	UNITS	DL
CLP VOLATILES 90-SOW								
2-Butanone	-				7	J	ug/kg	16
Toluene	-				-	U	ug/kg	8
CLP SEMIVOLATILES 90-SOW								
Di-n-butylphthalate	-				99	J	ug/kg	520
Benzo (b) fluoranthene	-				-	U	ug/kg	520
Benzo (a) pyrene	-				-	U	ug/kg	520
Indeno (1,2,3-cd) pyrene	-				-	U	ug/kg	520
Benzo (g,h,i) perylene	-				-	U	ug/kg	520
CLP PESTICIDES/PCBS 90-SOW								
4,4-DDE	-				-	U	ug/kg	5.2
4,4-DDD	-				1.5	J	ug/kg	5
4,4-DDT	-				3.7	J	ug/kg	5
CLP METALS AND CYANIDE								
Aluminum	-				1580		mg/kg	40
Barium	-				7.1		mg/kg	40
Calcium	-				1900		mg/kg	1000
Chromium	-				3	J	mg/kg	2
Iron	-				559	J	mg/kg	20
Lead	-				4.5		mg/kg	.6
Magnesium	-				75.9		mg/kg	1000
Manganese	-				10		mg/kg	3
Selenium	-				-	UJ	mg/kg	1
Sodium	-				282	J	mg/kg	1000
Vanadium	-				4.9		mg/kg	10
TPH								
Total petroleum hydrocarbons	200		mg/kg	16	-			
TOC								
Total organic carbon	58000		mg/kg	790	-			

U = NOT DETECTED J = ESTIMATED VALUE
UJ = REPORTED QUANTITATION LIMIT IS QUALIFIED AS ESTIMATED
R = RESULT IS REJECTED AND UNUSABLE

APPENDIX F.3

TOXICOLOGICAL DOSE-RESPONSE VALUES

Table F.3-1
Oral Dose-Response Data for Carcinogenic Effects

Remedial Investigation, Operable Unit 4
Naval Air Station Cecil Field
Jacksonville, Florida

Chemical	Weight of Evidence[1]	Oral Slope Factor (mg/kg/day)(-1)	Source	Test Species	Exposure Route	Tumor Type	Study Source
Semivolatile Organic Compounds							
bis(2-Ethylhexyl)phthalate	B2	1.4E-02	IRIS	Rat-mouse	Oral-diet	Liver	IRIS
Inorganic Analytes							
Aluminum	D	NE					
Arsenic	A	1.5E+00	IRIS	Human	Oral-drinking water	Skin Liver Kidney Lung Bladder	IRIS
Iron	D	NE					
Manganese	D	NE					

[1] Weight of Evidence (route-specific):
A = Human carcinogen.
B = Probable human carcinogen (B1 = limited human evidence; B2 = sufficient human evidence).
C = Possible human carcinogen.
D = Not classifiable as to human carcinogenicity.

Notes: IRIS = Integrated Risk Information System on-line database search, current as of March 1996.
HEAST = Health Effects Assessment Summary Tables, current as of November 1995.
mg = milligram.
kg = kilogram.
ND = no data.
NE = not evaluated.

Table F.3-2
Inhalation Dose-Response Data for Carcinogenic Effects

Remedial Investigation, Operable Unit 4
Naval Air Station Cecil Field
Jacksonville, Florida

Chemical	Weight of Evidence[1]	Inhalation Slope Factor (mg/kg/day)(-1)	Source	Inhalation Unit Risk ($\mu g/m^3$)(-1)	Source	Test Species	Exposure Route	Tumor Type	Study Source
Semivolatile Organic Compounds									
bis(2-Ethylhexyl)phthalate	D	NE		NE					
Inorganic Analytes									
Aluminum	D	NE		NE					
Arsenic	A	15	IRIS	4.3E-03	IRIS	Human	Inhalation	Lung	IRIS
Iron	D	NE		NE					
Manganese	D	NE		NE					

[1] Weight of Evidence (route-specific):
- A = Human carcinogen
- B = Probable human carcinogen (B1 = limited human evidence; B2 = sufficient human evidence)
- C = Possible human carcinogen
- D = Not classifiable as to human carcinogenicity

Notes: IRIS = integrated Risk Information System on-line database search, current as of March 1996.
HEAST = Health Effects Assessment Summary Tables, current as of November 1995.
mg = milligram.
kg = kilogram.
μg = microgram.
m^3 = cubic meter.
NE = not evaluated.

Table F.3-3
Oral Dose-Response Data for Noncarcinogenic Effects

Remedial Investigation, Operable Unit 4
Naval Air Station Cecil Field
Jacksonville, Florida

Chemical	Chronic		Subchronic		Study Type	Confidence Level	Critical Effect	Test Animal	Uncertainty Factor [1]	Study Source
	Oral RfD (mg/kg-day)	Source	Oral RfD (mg/kg-day)	Source						
Semivolatile Organic Compounds										
bis(2-Ethylhexyl)phthalate	2.0E-02	IRIS	ND		Oral-diet	Medium	Increased liver weight	Guinea pig	1000 H,A,S,L	IRIS
Inorganic Analytes										
Aluminum	1.0E+00	ECAO	ND							
Arsenic	3.0E-04	IRIS	3.0E-04	HEAST	Oral-drinking water	Medium	Hyper-pigmentation, keratosis, possible vascular complications	Human	3 D	IRIS
Iron	3.0E-01	ECAO	ND							
Manganese Food	1.4E-01	IRIS	1.4E-01	HEAST	Oral-diet	NA	CNS effects	Human	1	IRIS
All other media	4.7E-02	IRIS	ND		Oral-diet	NA	CNS effects	Human	3 M	IRIS

[1] Uncertainty factors:
H = Variation in human sensitivity.
A = Animal to human extrapolation.
S = Extrapolation from subchronic to chronic NOAEL.
L = Extrapolation from LOAEL to NOAEL.
D = Inadequate data.
M = Modifying factor.

Notes:
IRIS = Integrated Risk Information System on-line database search, current as of March 1996.
HEAST = Health Effects Assessment Summary Tables, current as of November 1995.
ECAO = Environmental Criteria and Assessment Office of the USEPA in response to a specific request.
mg = milligram.
kg = kilogram.
RfD = reference dose.
CNS = central nervous system.
ND = no data.
NA = not applicable.

Table F.3-4
Inhalation Dose-Response Data for Noncarcinogenic Effects

Remedial Investigation, Operable Unit 4
Naval Air Station Cecil Field
Jacksonville, Florida

Chemical	Chronic		Subchronic		Study Type	Confidence Level	Critical Effect	Test Animal	Uncertainty Factor [1]	Study Source
	RfC ($\mu g/m^3$)	Source	RfC ($\mu g/m^3$)	Source						
Semivolatile Organic Compounds										
bis(2-Ethylhexyl)phthalate	ND		ND							
Inorganic Analytes										
Aluminum	ND		ND							
Arsenic	ND		ND							
Iron	ND		ND							
Manganese	5.0E-02	IRIS	ND		Inhalation	Medium	Impaired neuro-behavioral function	Human	1000 H,L,D	IRIS

[1] Uncertainty factors:
A = Animal to human extrapolation.
H = Variation in human sensitivity.
S = Extrapolation from subchronic to chronic NOAEL.
L = Extrapolation from LOAEL to NOAEL.
D = Inadequate data.
M = Modifying factor.

Notes:
IRIS = Integrated Risk Information System on-line database search, current as of March 1996
μg = microgram.
m^3 = cubic meter.
RfC = reference concentration.
ND = no data.
NA = not applicable.

Table F.3-5
Dermal Dose-Response Data for Carcinogenic Effects

Remedial Investigation, Operable Unit 4
Naval Air Station Cecil Field
Jacksonville, Florida

Compound	Weight of Evidence[1]	Oral Slope Factor (mg/kg-day)-1	Oral Absorption Efficiency	Reference	Dermal Slope Factor (mg/kg-day)-1
Semivolatile Organic Compounds					
bis(2-Ethylhexyl)phthalate	B2	1.4E-02	100%	Chadwick et al., 1982	1.4E-02
Inorganic Analytes					
Aluminum	D	NE			NE
Arsenic	A	1.5E+00	98%	Vahter, 1983	1.5E+00
Iron	D	NE			NE
Manganese	D	NE			NE

[1] Weight of Evidence (route-specific):
A = Human carcinogen.
B = Probable human carcinogen (B1 = limited human evidence; B2 = sufficient human evidence).
C = Possible human carcinogen.
D = Not classifiable as to human carcinogenicity.

Notes: For documentation concerning oral slope factors, refer to Table 1.
mg = milligram.
kg = kilogram.
NE = not evaluated.

Table F.3-6
Dermal Dose-Response Data for Noncarcinogenic Effects

Remedial Investigation, Operable Unit 4
Naval Air Station Cecil Field
Jacksonville, Florida

Compound	Chronic Oral RfD (mg/kg-day)	Subchronic Oral RfD (mg/kg-day)	Oral Absorption Efficiency	Reference	Dermal Chronic RfD (mg/kg-day)	Dermal Subchronic RfD (mg/kg-day)
Semivolatile Organic Compounds						
bis(2-Ethylhexyl)phthalate	2.0E-02	ND	100%	Chadwick et al., 1982	2.0E-02	ND
Inorganic Analytes						
Aluminum	1.0E+00	ND	20%	(1)	2.0E-01	ND
Arsenic	3.0E-04	3.0E-04	98%	Vahter, 1983	2.9E-04	2.9E-04
Iron	3.0E-01	ND	2%	Goyer, 1991	6.0E-03	ND
Manganese	4.7E-02	ND	4%	ATSDR, 1991b	1.9E-03	ND

(1) Inorganics lacking specific information on absorption efficiency are assigned a default value of 20% (USEPA Region IV, 1995).

Notes: For documentation concerning chronic and subchronic oral RfDs, refer to Table M.3-3.
mg = milligram.
kg = kilogram.
RfD = reference dose.
ND = no data.

APPENDIX F.5

RISK CALCULATIONS SPREAD SHEETS

TABLE F.5-1

DIRECT CONTACT WITH AND INCIDENTAL INGESTION OF SURFACE SOIL
ADULT RESIDENT
Site 10
NAS Cecil Field
Jacksonville, Florida

EXPOSURE PARAMETERS

PARAMETER	SYMBOL	VALUE	UNITS	SOURCE
CONCENTRATION SOIL	CS	chemical-specific	chemical-specific	
INGESTION RATE	IR	100	mg/day	USEPA, 1995
FRACTION INGESTED	FI	100%	unitless	USEPA, 1995
ADHERENCE FACTOR	AF	1	mg/cm^2-event	USEPA, 1995
ABSORPTION FRACTION	ABS_d	chemical-specific	unitless	USEPA, 1995
SURFACE AREA EXPOSED	SA	5,750	cm^2	USEPA, 1992a
DOSE ABSORBED PER EVENT	DA_{event}	chemical-specific	mg/cm^2-event	USEPA, 1992a
CONVERSION FACTOR	CF	1.00E-09	kg/ug	Organic conversion
CONVERSION FACTOR	CF	1.00E-06	kg/mg	Inorganic conversion
BODY WEIGHT	BW	70	kg	USEPA, 1991
EXPOSURE FREQUENCY	EF	350	days/year [1]	USEPA, 1995
EXPOSURE DURATION	ED	24	years	USEPA, 1995
AVERAGING TIME				
CANCER	AT	70	years	USEPA, 1991
NONCANCER	AT	24	years	USEPA, 1995

[1] Units for exposure frequency are events/year in the calculation of the dermally absorbed dose.

USEPA, 1991. Human Health Evaluation Manual, Supplemental Guidance: "Standard Default Exposure Factors"; OSWER Directive 9285.6-03.

USEPA, 1992a. Dermal Exposure Assessment: Principles and Applications; EPA/600/8-91/011B; January 1992.

USEPA, 1995. Supplemental Guidance to RAGS : Region IV, Human Health Risk Assessment Bulletin No. 3.

EQUATIONS

$$\text{CANCER RISK} = \text{INTAKE (mg/kg-day)} \times \text{CANCER SLOPE FACTOR (mg/kg-day)}^{-1}$$

$$\text{HAZARD QUOTIENT} = \text{INTAKE (mg/kg-day)} / \text{REFERENCE DOSE (mg/kg-day)}$$

$$\text{INTAKE}_{\text{INGESTION}} = \frac{CS \times IR \times FI \times CF \times EF \times ED}{BW \times AT \times 365\ \text{days/yr}}$$

$$\text{INTAKE}_{\text{DERMAL}} = \frac{DA_{event} \times SA \times EF \times ED}{BW \times AT \times 365\ \text{days/yr}}$$

Where:

$$DA_{event} = CS \times AF \times ABS_d \times CF$$

Note: For noncarcinogenic effects, AT = ED.

TABLE F.5-1

DIRECT CONTACT WITH AND INCIDENTAL INGESTION OF SURFACE SOIL
ADULT RESIDENT
Site 10
NAS Cecil Field
Jacksonville, Florida

CARCINOGENIC EFFECTS

COMPOUND	INORGANIC OR ORGANIC I/O	SOIL CONCENTRATION	UNITS	INTAKE INGESTION (mg/kg-day)	ORAL CSF [1] $(mg/kg\text{-}day)^{-1}$	CANCER RISK INGESTION	DERMAL ABS [2]	INTAKE DERMAL (mg/kg-day)	DERMAL CSF [3] $(mg/kg\text{-}day)^{-1}$	CANCER RISK DERMAL	TOTAL CANCER RISK
Arsenic	I	2.7	mg/kg	1.3E-06	1.5	1.9E-06	0.001	7.3E-08	1.5	1.1E-07	2.0E-06
SUMMARY CANCER RISK						2E-06				1E-07	2E-06

[1]Relative potency factors were applied to the CSFs for carcinogenic PAHs. Relative potency factors are derived in "Provisional Guidance for Quantitative Risk Assessment of Polycyclic Aromatic Hydrocarbons," USEPA, 1993.
[2] USEPA Region IV guidance specifies absorption factors of 1% for organics and 0.1% for inorganics (November,1995)
[3] Calculated from oral CSFs.
ND = no data available.

TABLE F.5-1

DIRECT CONTACT WITH AND INCIDENTAL INGESTION OF SURFACE SOIL
ADULT RESIDENT
Site 10
NAS Cecil Field
Jacksonville, Florida

NONCARCINOGENIC EFFECTS

COMPOUND	INORGANIC OR ORGANIC I/O	SOIL CONCENTRATION	UNITS	INTAKE INGESTION (mg/kg-day)	ORAL RfD (mg/kg-day)	HAZARD QUOTIENT INGESTION	DERMAL ABS [1]	INTAKE DERMAL (mg/kg-day)	DERMAL RfD [2] (mg/kg-day)	HAZARD QUOTIENT DERMAL	TOTAL HAZARD QUOTIENT
Aluminum	I	7830	mg/kg	1.1E-02	1	1.1E-02	0.001	6.2E-04	0.2	3.1E-03	1.4E-02
Arsenic	I	2.7	mg/kg	3.7E-06	0.0003	1.2E-02	0.001	2.1E-07	0.00029	7.3E-04	1.3E-02
Iron	I	9150	mg/kg	1.3E-02	0.3	4.2E-02	0.001	7.2E-04	0.006	1.2E-01	1.6E-01
TRPH	O	270000	ug/kg	3.7E-04	0.03	1.2E-02	0.01	2.1E-04	0.03	7.1E-03	1.9E-02
SUMMARY HAZARD INDEX						8E-02				1E-01	2E-01

[1] USEPA Region IV guidance specifies absorption factors of 1% for organics and 0.1% for inorganics (November,1995)
[2] Calculated from oral RfDs.
ND = no data available.

TABLE F.5-2

INHALATION OF PARTICULATES - SURFACE SOIL
ADULT RESIDENT
Site 10
NAS Cecil Field
Jacksonville, Florida

EXPOSURE PARAMETERS

PARAMETER	SYMBOL	VALUE	UNITS	SOURCE
SOIL CONCENTRATION	C	chemical-specific	chemical-specific	
PART. EMISSION FACTOR	PEF	1.24E+09	m^3/kg	default [1]
CONCENTRATION AIR	CA	chemical-specific	mg/m^3	
INHALATION RATE	IR	0.833	m^3/hour	USEPA, 1995
BODY WEIGHT	BW	70	kg	USEPA, 1991
EXPOSURE TIME	ET	24	hours/day	Assumption
EXPOSURE FREQUENCY	EF	350	days/year	USEPA, 1995
EXPOSURE DURATION	ED	24	years	USEPA, 1995
CONVERSION FACTOR	CF	0.001	mg/ug	Organics only
AVERAGING TIME				
CANCER	AT	70	years	USEPA, 1991
NONCANCER	AT	24	years	USEPA, 1995

[1] PEF has been derived in the PEF Appendix to this report.
USEPA, 1991. Human Health Evaluation Manual, Supplemental Guidance: "Standard Default Exposure Factors"; OSWER Directive 9285.6-03.
USEPA, 1995. Supplemental Guidance to RAGS : Region IV, Human Health Risk Assessment Bulletin No. 3.

EQUATIONS

CANCER RISK = INTAKE (mg/kg-day) x INHALATION CANCER SLOPE FACTOR $(mg/kg\text{-}day)^{-1}$

HAZARD QUOTIENT = INTAKE (mg/kg-day) / INHALATION REFERENCE DOSE (mg/kg-day)

$$\text{INTAKE} = \frac{CA \times IR \times ET \times EF \times ED}{BW \times AT \times 365\ days/yr}$$

Where:

CA = C x CF x (1/PEF)

Note:

For noncarcinogenic effects: AT = ED

TABLE F.5-2

INHALATION OF PARTICULATES - SURFACE SOIL
ADULT RESIDENT
Site 10
NAS Cecil Field
Jacksonville, Florida

CARCINOGENIC EFFECTS

COMPOUND	INORGANIC OR ORGANIC I/O	SOIL CONCENTRATION	UNITS	AIR CONCENTRATION (mg/m³)	INTAKE (mg/kg-day)	INHALATION CSF (mg/kg-day)-1	CANCER RISK
Arsenic	I	2.7	mg/kg	2.18E-09	2.0E-10	1.5	3.1E-10
					SUMMARY CANCER RISK		3E-10

ND = no data available.

TABLE F.5-2

INHALATION OF PARTICULATES - SURFACE SOIL
ADULT RESIDENT
Site 10
NAS Cecil Field
Jacksonville, Florida

NONCARCINOGENIC EFFECTS

COMPOUND	INORGANIC OR ORGANIC I/O	SOIL CONCENTRATION	UNITS	AIR CONCENTRATION (mg/m³)	INTAKE (mg/kg-day)	INHALATION RfD (mg/kg-day)	HAZARD QUOTIENT
Aluminum	I	7830	mg/kg	6.31E-06	1.7E-06	ND	
Arsenic	I	2.7	mg/kg	2.18E-09	6.0E-10	ND	
Iron	I	9150	mg/kg	7.38E-06	2.0E-06	ND	
TRPH	O	270000	ug/kg	2.18E-07	6.0E-08	ND	
						SUMMARY HAZARD INDEX	0E+00

ND = no data available.

TABLE F.5-3

DIRECT CONTACT WITH AND INCIDENTAL INGESTION OF SURFACE SOIL
ADULT TRESPASSER
Site 10
NAS Cecil Field
Jacksonville, Florida

EXPOSURE PARAMETERS

PARAMETER	SYMBOL	VALUE	UNITS	SOURCE
CONCENTRATION SOIL	CS	chemical-specific	chemical-specific	
INGESTION RATE	IR	100	mg/day	USEPA, 1995
FRACTION INGESTED	FI	100%	unitless	USEPA, 1995
ADHERENCE FACTOR	AF	1	mg/cm^2-event	USEPA, 1995
ABSORPTION FRACTION	ABS_d	chemical specific	unitless	USEPA, 1995
SURFACE AREA EXPOSED	SA	5,750	cm^2	USEPA, 1992a
DOSE ABSORBED PER EVENT	DAevent	chemical specific	mg/cm^2-event	USEPA, 1992a
CONVERSION FACTOR	CF	1.00E-06	kg/mg	inorganics
	CF	1.00E-09	kg/ug	organics
BODY WEIGHT	BW	70	kg	USEPA, 1991
EXPOSURE FREQUENCY	EF	45	days/year [1]	Assumption
EXPOSURE DURATION	ED	20	years	USEPA,1995
AVERAGING TIME				
CANCER	AT	70	years	USEPA, 1991
NONCANCER	AT	20	years	USEPA,1995

[1] Units for exposure frequency are events/year in the calculation of the dermally absorbed dose.

USEPA, 1991. Human Health Evaluation Manual, Supplemental Guidance: "Standard Default Exposure Factors"; OSWER Directive 9285.6-03.

USEPA, 1992a. Dermal Exposure Assessment: Principles and Applications; EPA/600/8-91/011B; 1/92.

USEPA, 1995. Supplemental guidance to RAGS: Region IV, Human Health Risk Assessment Bulletin No. 3.

EQUATIONS

CANCER RISK = INTAKE (mg/kg-day) x CANCER SLOPE FACTOR $(mg/kg\text{-}day)^{-1}$

HAZARD QUOTIENT = INTAKE (mg/kg-day) / REFERENCE DOSE (mg/kg-day)

$$INTAKE_{INGESTION} = \frac{CS \times IR \times FI \times CF \times EF \times ED}{BW \times AT \times 365\ days/yr}$$

$$INTAKE_{DERMAL} = \frac{DAevent \times SA \times EF \times ED}{BW \times AT \times 365\ days/yr}$$

Where:

$DAevent = AF \times ABS_d \times CF$

Note: For noncarcinogenic effects: AT = ED

TABLE F.5-3

DIRECT CONTACT WITH AND INCIDENTAL INGESTION OF SURFACE SOIL
ADULT TRESPASSER
Site 10
NAS Cecil Field
Jacksonville, Florida

CARCINOGENIC EFFECTS

COMPOUND	INORGANIC OR ORGANIC I/O	SOIL CONCENTRATION	UNITS	INTAKE INGESTION (mg/kg-day)	ORAL CSF $(mg/kg\text{-}day)^{-1}$	CANCER RISK INGESTION	DERMAL ABS [1]	INTAKE DERMAL (mg/kg-day)	DERMAL CSF [2] $(mg/kg\text{-}day)^{-1}$	CANCER RISK DERMAL	TOTAL CANCER RISK
Arsenic	I	2.7	mg/kg	1.4E-07	1.5	2.0E-07	0.001	7.8E-09	1.5	1.2E-08	2.2E-07
					SUMMARY CANCER RISK	2E-07				1E-08	2E-07

[1] USEPA Region IV guidance specifies absorption factors of 1% for organics and 0.1% for inorganics (November,1995)
[2] Calculated from oral CSFs.

TABLE F.5-3

DIRECT CONTACT WITH AND INCIDENTAL INGESTION OF SURFACE SOIL
ADULT TRESPASSER
Site 10
NAS Cecil Field
Jacksonville, Florida

NONCARCINOGENIC EFFECTS

COMPOUND	INORGANIC OR ORGANIC I/O	SOIL CONCENTRATION	UNITS	INTAKE INGESTION (mg/kg-day)	ORAL RfD (mg/kg-day)	HAZARD QUOTIENT INGESTION	DERMAL ABS [1]	INTAKE DERMAL (mg/kg-day)	DERMAL RfD [2] (mg/kg-day)	HAZARD QUOTIENT DERMAL	TOTAL HAZARD QUOTIENT
Aluminum	I	7830	mg/kg	1.4E-03	1	1.4E-03	0.001	7.9E-05	0.2	4.0E-04	1.8E-03
Arsenic	I	2.7	mg/kg	4.8E-07	0.0003	1.6E-03	0.001	2.7E-08	0.00029	9.4E-05	1.7E-03
Iron	I	9150	mg/kg	1.6E-03	0.3	5.4E-03	0.001	9.3E-05	0.006	1.5E-02	2.1E-02
TRPH	O	270000	ug/kg	4.8E-05	0.03	1.6E-03	0.01	2.7E-05	0.03	9.1E-04	2.5E-03
SUMMARY HAZARD INDEX						1E-02				2E-02	3E-02

[1] USEPA Region IV guidance specifies absorption factors of 1% for organics and 0.1% for inorganics (November, 1995)
[2] Calculated from oral RfDs.
ND = no data available.

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TABLE F.5-4

INHALATION OF PARTICULATES - SURFACE SOIL
ADULT TRESPASSER
Site 10
NAS Cecil Field

EXPOSURE PARAMETERS

PARAMETER	SYMBOL	VALUE	UNITS	SOURCE
SOIL CONCENTRATION	C	chemical-specific	chemical-specific	
PART. EMISSION FACTOR	PEF	1.24E+09	m^3/kg	default [1]
CONCENTRATION AIR	CA	chemical-specific	mg/m^3	
INHALATION RATE	IR	0.833	m^3/hour	USEPA, 1995
BODY WEIGHT	BW	70	kg	USEPA, 1991
EXPOSURE TIME	ET	4	hours/day	Assumption
EXPOSURE FREQUENCY	EF	45	days/year	Assumption
EXPOSURE DURATION	ED	20	years	Assumption
CONVERSION FACTOR	CF	0.001	mg/ug	Organics only
AVERAGING TIME				
CANCER	AT	70	years	USEPA, 1991
NONCANCER	AT	20	years	USEPA, 1991

[1] PEF has been derived in the PEF Appendix to this report.
USEPA, 1991. Human Health Evaluation Manual, Supplemental Guidance: "Standard Default Exposure Factors"; OSWER Directive 9285.6-03.
USEPA, 1995. Supplemental Guidance to RAGS : Region IV, Human Health Risk Assessment Bulletin No. 3.

EQUATIONS

CANCER RISK = INTAKE (mg/kg-day) x INHALATION CANCER SLOPE FACTOR $(mg/kg\text{-}day)^{-1}$

HAZARD QUOTIENT = INTAKE (mg/kg-day) / INHALATION REFERENCE DOSE (mg/kg-day)

$$\text{INTAKE} = \frac{CA \times IR \times ET \times EF \times ED}{BW \times AT \times 365\ days/yr}$$

Where:

CA = C x CF x (1/PEF)

Note: **For noncarcinogenic effects, AT = ED**

TABLE F.5-4

INHALATION OF PARTICULATES - SURFACE SOIL
ADULT TRESPASSER
Site 10
NAS Cecil Field

CARCINOGENIC EFFECTS

COMPOUND	INORGANIC OR ORGANIC I/O	SOIL CONCENTRATION	UNITS	AIR CONCENTRATION (mg/m³)	INTAKE (mg/kg-day)	INHALATION CSF (mg/kg-day)$^{-1}$	CANCER RISK
Arsenic	I	2.7	mg/kg	2.18E-09	3.7E-12	1.5	5.5E-12
						SUMMARY CANCER RISK	5E-12

NE = not evaluated.

TABLE F.5-4

INHALATION OF PARTICULATES - SURFACE SOIL
ADULT TRESPASSER
Site 10
NAS Cecil Field

NONCARCINOGENIC EFFECTS

COMPOUND	INORGANIC OR ORGANIC I/O	SOIL CONCENTRATION	UNITS	AIR CONCENTRATION (mg/m³)	INTAKE (mg/kg-day)	INHALATION RfD (mg/kg-day)	HAZARD QUOTIENT
Aluminum	I	7830	mg/kg	6.31E-06	3.7E-08	ND	
Arsenic	I	2.7	mg/kg	2.18E-09	1.3E-11	ND	
Iron	I	9150	mg/kg	7.38E-06	4.3E-08	ND	
TRPH	O	270000	ug/kg	2.18E-07	1.3E-09	ND	
				SUMMARY HAZARD INDEX			0E+00

ND = no data available.

TABLE F.5-5

DIRECT CONTACT WITH AND INCIDENTAL INGESTION OF SURFACE SOIL
CHILD RESIDENT
Site 10
NAS Cecil Field
Jacksonville, Florida

EXPOSURE PARAMETERS

PARAMETER	SYMBOL	VALUE	UNITS	SOURCE
CONCENTRATION SOIL	CS	chemical-specific	chemical-specific	
INGESTION RATE	IR	200	mg/day	USEPA, 1995
FRACTION INGESTED	FI	100%	unitless	USEPA, 1995
ADHERENCE FACTOR	AF	1	mg/cm^2-event	USEPA, 1995
AGE-SPECIFIC SURFACE AREA	SA	age-specific	cm^2	USEPA, 1989
ABSORPTION FRACTION	ABS	chemical-specific	unitless	USEPA, 1995
CONVERSION FACTOR	CF	1.00E-06	kg/mg	Inorganic conversion
CONVERSION FACTOR	CF	1.00E-09	kg/ug	Organic conversion
BODY WEIGHT	BW	15	kg	USEPA, 1991
AGE-SPECIFIC BODY WEIGHT	BW	age-specific	kg	USEPA, 1989
EXPOSURE FREQUENCY	EF	350	days/year [1]	USEPA, 1995
EXPOSURE DURATION	ED	6	years	USEPA, 1995
AGE-SPECIFIC EXPOSURE DURATION	ED	age-specific	years	Assumption
AGE-WEIGHTED SURFACE AREA [2]	$SA_{soil/adj}$	766	cm^2-year/kg	USEPA, 1992a
DOSE ABSORBED PER EVENT	DA_{event}	chemical-specific	mg/cm^2-event	USEPA, 1992a
AVERAGING TIME				
CANCER	AT	70	years	USEPA, 1991
NONCANCER	AT	6	years	USEPA, 1995

[1] Units for exposure frequency are in events/year in the calculation of the dermally absorbed dose.

[2] In estimating the dermally absorbed dose for children age1 through 6, the time-weighted, bodyweight normalized surface area exposed is calculated from surface area, exposure duration, and body weight for each of 6 age periods, age 1 through 6, per USEPA, 1992.

USEPA, 1989. Exposure Factors Handbook;EPA/600/8-89/043; May 1989.
USEPA, 1991. Human Health Evaluation Manual, Supplemental Guidance: "Standard Default Exposure Factors"; OSWER Directive 9285.6-03.
USEPA, 1992a. Dermal Exposure Assessment: Principles and Applications; EPA/600/8-91/011B; January 1992.
USEPA, 1995. Supplemental Guidance to RAGS : Region IV, Human Health Risk Assessment Bulletin No. 3.

EQUATIONS

CANCER RISK = INTAKE (mg/kg-day) x CANCER SLOPE FACTOR ($mg/kg\text{-}day^{-1}$)

HAZARD QUOTIENT = INTAKE (mg/kg-day) / REFERENCE DOSE (mg/kg-day)

$$INTAKE_{INGESTION} = \frac{CS \times IR \times FI \times CF \times EF \times ED}{BW \times AT \times 365\ days/yr}$$

$$INTAKE_{DERMAL} = (DA_{event} \times EF / AT \times 365\ days/year) \times SA_{soil/adj}$$

Where:

$SA_{soil/adj}$ = SUM (SA x ED / BW)

DA_{event} = CS x AF x ABS x CF

Note: For noncarcinogenic effects, AT = ED.

TABLE F.5-5

DIRECT CONTACT WITH AND INCIDENTAL INGESTION OF SURFACE SOIL
CHILD RESIDENT
Site 10
NAS Cecil Field
Jacksonville, Florida

CARCINOGENIC EFFECTS

COMPOUND	INORGANIC OR ORGANIC I/O	SOIL CONCENTRATION	UNITS	INTAKE INGESTION (mg/kg-day)	ORAL CSF [1] $(mg/kg\text{-}day)^{-1}$	CANCER RISK INGESTION	DERMAL ABS [2]	INTAKE DERMAL (mg/kg-day)	DERMAL CSF [1, 3] $(mg/kg\text{-}day)^{-1}$	CANCER RISK DERMAL	TOTAL CANCER RISK
Arsenic	I	2.7	mg/kg	3.0E-06	1.5	4.4E-06	0.001	2.8E-08	1.5	4.2E-08	4.5E-06
					SUMMARY CANCER RISK	4E-06				4E-08	4E-06

[1] Relative potency factors were applied to the CSFs of carcinogenic PAHs. Relative potency factors are derived in "Provisional Guidance for Quantitative Risk Assessment of Polycyclic Aromatic Hydrocarbons," USEPA, 1993.
[2] USEPA Region IV guidance specifies absorption factors of 1% for organics and 0.1% for inorganics (November, 1995)
[3] Calculated from oral CSFs.
NE = not evaluated.

TABLE F.5-5

DIRECT CONTACT WITH AND INCIDENTAL INGESTION OF SURFACE SOIL
CHILD RESIDENT
Site 10
NAS Cecil Field
Jacksonville, Florida

NONCARCINOGENIC EFFECTS

COMPOUND	INORGANIC OR ORGANIC I/O	SOIL CONCENTRATION	UNITS	INTAKE INGESTION (mg/kg-day)	ORAL RfD (mg/kg-day)	HAZARD QUOTIENT INGESTION	DERMAL ABS [1]	INTAKE DERMAL (mg/kg-day)	DERMAL RfD [2] (mg/kg-day)	HAZARD QUOTIENT DERMAL	TOTAL HAZARD QUOTIENT
Aluminum	I	7830	mg/kg	1.0E-01	1	1.0E-01	0.001	9.6E-04	0.2	4.8E-03	1.0E-01
Arsenic	I	2.7	mg/kg	3.5E-05	0.0003	1.2E-01	0.001	3.3E-07	0.00029	1.1E-03	1.2E-01
Iron	I	9150	mg/kg	1.2E-01	0.3	3.9E-01	0.001	1.1E-03	0.006	1.9E-01	5.8E-01
TRPH	O	270000	ug/kg	3.5E-03	0.03	1.2E-01	0.01	3.3E-04	0.03	1.1E-02	1.3E-01
					SUMMARY HAZARD INDEX	7E-01				2E-01	9E-01

[1] USEPA Region IV guidance specifies absorption factors of 1% for organics and 0.1% for inorganics (November, 1995)
[2] Calculated from oral RfDs.
ND = no data available.

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TABLE F.5-6

INHALATION OF PARTICULATES - SURFACE SOIL
CHILD RESIDENT
Site 10
NAS Cecil Field

EXPOSURE PARAMETERS

PARAMETER	SYMBOL	VALUE	UNITS	SOURCE
SOIL CONCENTRATION	C	chemical-specific	chemical-specific	
PART. EMISSION FACTOR	PEF	1.24E+09	m^3/kg	default [1]
CONCENTRATION IN AIR	CA	chemical-specific	mg/m^3	
INHALATION RATE	IR	0.625	$m^3/hour$	USEPA, 1995
BODY WEIGHT	BW	15	kg	USEPA, 1991
EXPOSURE TIME	ET	24	hours/day	Assumption
EXPOSURE FREQUENCY	EF	350	days/year	USEPA, 1991
EXPOSURE DURATION	ED	6	years	USEPA, 1991
CONVERSION FACTOR	CF	0.001	mg/ug	Organics only
AVERAGING TIME				
CANCER	AT	70	years	USEPA, 1991
NONCANCER	AT	6	years	USEPA, 1991

[1] PEF has been derived in the PEF Appendix to this report.
USEPA, 1991. Human Health Evaluation Manual, Supplemental Guidance: "Standard Default Exposure Factors"; OSWER Directive 9285.6-03.
USEPA, 1995. Supplemental Guidance to RAGS: Region 4 Bulletins, Bulletin No. 3, November 1995.

EQUATIONS

CANCER RISK = INTAKE (mg/kg-day) x INHALATION CANCER SLOPE FACTOR $(mg/kg\text{-}day)^{-1}$

HAZARD QUOTIENT = INTAKE (mg/kg-day) / INHALATION REFERENCE DOSE (mg/kg-day)

$$\text{INTAKE} = \frac{CA \times IR \times ET \times EF \times ED}{BW \times AT \times 365\ days/yr}$$

Where:

CA = C x CF x (1/PEF)

Note:

For noncarcinogenic effects: AT = ED

TABLE F.5-6

INHALATION OF PARTICULATES - SURFACE SOIL
CHILD RESIDENT
Site 10
NAS Cecil Field

CARCINOGENIC EFFECTS

COMPOUND	INORGANIC OR ORGANIC I/O	SOIL CONCENTRATION	UNITS	AIR CONCENTRATION (mg/m³)	INTAKE (mg/kg-day)	INHALATION CSF (mg/kg-day)-1	CANCER RISK
Arsenic	I	2.7	mg/kg	2.18E-09	1.8E-10	1.5	2.7E-10
					SUMMARY CANCER RISK		3E-10

NE = not evaluated.

TABLE F.5-6

INHALATION OF PARTICULATES - SURFACE SOIL
CHILD RESIDENT
Site 10
NAS Cecil Field

NONCARCINOGENIC EFFECTS

COMPOUND	INORGANIC OR ORGANIC I/O	SOIL CONCENTRATION	UNITS	AIR CONCENTRATION (mg/m³)	INTAKE (mg/kg-day)	INHALATION RfD (mg/kg-day)	HAZARD QUOTIENT
Aluminum	I	7830	mg/kg	6.31E-06	6.1E-06	ND	
Arsenic	I	2.7	mg/kg	2.18E-09	2.1E-09	ND	
Iron	I	9150	mg/kg	7.38E-06	7.1E-06	ND	
TRPH	O	270000	ug/kg	2.18E-07	2.1E-07	ND	
				SUMMARY HAZARD INDEX			0E+00

ND = no data available.

TABLE F,5-7

DIRECT CONTACT WITH AND INCIDENTAL INGESTION OF SURFACE SOIL
ADOLESCENT TRESPASSER
Site 10
NAS Cecil Field
Jacksonville, Florida

EXPOSURE PARAMETERS

PARAMETER	SYMBOL	VALUE	UNITS	SOURCE
CONCENTRATION SOIL	CS	chemical-specific	chemical-specific	
INGESTION RATE	IR	100	mg/day	USEPA, 1995
FRACTION INGESTED	FI	100%	unitless	Assumption
ADHERENCE FACTOR	AF	1	mg/cm²-event	USEPA, 1995
AGE-SPECIFIC SURFACE AREA	SA_i	age-specific	cm²	USEPA, 1989
ABSORPTION FRACTION	ABS_d	chemical-specific	unitless	USEPA, 1995
CONVERSION FACTOR	CF	1.00E-06	kg/mg	Inorganics
	CF	1.00E-09	kg/mg	Organics
BODY WEIGHT	BW	45	kg	USEPA, 1995
AGE-SPECIFIC BODY WEIGHT	BW_i	age-specific	kg	USEPA, 1989
EXPOSURE FREQUENCY	EF	45	days/year [1]	Assumption
EXPOSURE DURATION	ED	10	years	USEPA, 1995
AGE-SPECIFIC EXPOSURE DURATION	ED_i	age-specific	years	Assumption
AGE-WEIGHTED SURFACE AREA [2]	$SA_{adj/adj}$	1013	cm²-year/kg	Per USEPA, 1992a
DOSE ABSORBED PER EVENT	DA_{event}	chemical-specific	mg/cm²-event	Per USEPA, 1992a
AVERAGING TIME				
CANCER	AT	70	years	USEPA, 1991
NONCANCER	AT	10	years	USEPA, 1995

[1] Units for exposure frequency are in events/year in the calculation of the dermally absorbed dose.
[2] In estimating the dermally absorbed dose for children age 7 through 16, the time-weighted, bodyweight normalized surface area exposed is calculated from surface area, exposure duration, and body weight for each of 10 age periods, age 7 through 16, per USEPA, 1992.
USEPA, 1989. Exposure Factors Handbook; EPA/600/8-89/043; May 1989.
USEPA, 1991. Human Health Evaluation Manual, Supplemental Guidance: "Standard Default Exposure Factors"; OSWER Directive 9285.6-03.
USEPA, 1992a. Dermal Exposure Assessment: Principles and Applications; EPA/600/8-91/011B; January 1992 and Appendix to this report.
USEPA, 1995. Supplemental Guidance to RAGS: Region 4 Bulletins, Bulletin No. 3, November 1995.

EQUATIONS

$$\text{CANCER RISK} = \text{INTAKE (mg/kg-day)} \times \text{CANCER SLOPE FACTOR (mg/kg-day)}^{-1}$$

$$\text{HAZARD QUOTIENT} = \text{INTAKE (mg/kg-day)} / \text{REFERENCE DOSE (mg/kg-day)}$$

$$\text{INTAKE}_{\text{INGESTION}} = \frac{\text{CS} \times \text{IR} \times \text{FI} \times \text{CF} \times \text{EF} \times \text{ED}}{\text{BW} \times \text{AT} \times 365 \text{ days/yr}}$$

$$\text{INTAKE}_{\text{DERMAL}} = \text{AT} \times 365 \text{ days/year)} \times SA_{adj/adj}$$

Where:

$$SA_{adj/adj} = \text{SUM } (SA_i \times ED_i / BW_i)$$

$$DA_{event} = \text{CS} \times \text{AF} \times ABS_d \times \text{CF}$$

Note: For noncarcinogenic effects: AT = ED.

TABLE F,5-7

DIRECT CONTACT WITH AND INCIDENTAL INGESTION OF SURFACE SOIL
ADOLESCENT TRESPASSER
Site 10
NAS Cecil Field
Jacksonville, Florida

CARCINOGENIC EFFECTS

COMPOUND	INORGANIC OR ORGANIC I/O	SOIL CONCENTRATION	UNITS	INTAKE INGESTION (mg/kg-day)	ORAL CSF [1] (mg/kg-day)$^{-1}$	CANCER RISK INGESTION	DERMAL ABS [2]	INTAKE DERMAL (mg/kg-day)	DERMAL CSF [1,3] (mg/kg-day)$^{-1}$	CANCER RISK DERMAL	TOTAL CANCER RISK
Arsenic	I	2.7	mg/kg	1.1E-07	1.5	1.6E-07	0.001	4.8E-09	1.5	7.2E-09	1.7E-07
					SUMMARY CANCER RISK	2E-07				7E-09	2E-07

[1] Relative potency factors were applied to the CSFs for carcinogenic PAHs. Relative potency factors are derived in "Provisional Guidance for Quantitative Risk Assessment for Polycyclic Aromatic Hydrocarbons," USEPA, 1993.
[2] USEPA Region IV guidance specifies absorption factors of 1% for organics and 0.1% for inorganics (November,1995)
[3] Calculated from oral CSFs.
NE = not evaluated.

TABLE F.5-7

DIRECT CONTACT WITH AND INCIDENTAL INGESTION OF SURFACE SOIL
ADOLESCENT TRESPASSER
Site 10
NAS Cecil Field
Jacksonville, Florida

NONCARCINOGENIC EFFECTS

COMPOUND	INORGANIC OR ORGANIC I/O	SOIL CONCENTRATION	UNITS	INTAKE INGESTION (mg/kg-day)	ORAL RfD (mg/kg-day)	HAZARD QUOTIENT INGESTION	DERMAL ABS [1]	INTAKE DERMAL (mg/kg-day)	DERMAL RfD [2] (mg/kg-day)	HAZARD QUOTIENT DERMAL	TOTAL HAZARD QUOTIENT
Aluminum	I	7830	mg/kg	2.1E-03	1	2.1E-03	0.001	9.8E-05	0.2	4.9E-04	2.6E-03
Arsenic	I	2.7	mg/kg	7.4E-07	0.0003	2.5E-03	0.001	3.4E-08	0.00029	1.2E-04	2.6E-03
Iron	I	9150	mg/kg	2.5E-03	0.3	8.4E-03	0.001	1.1E-04	0.006	1.9E-02	2.7E-02
TRPH	O	270000	ug/kg	7.4E-05	0.03	2.5E-03	0.01	3.4E-05	0.03	1.1E-03	3.6E-03
					SUMMARY HAZARD INDEX	2E-02				2E-02	4E-02

[1] USEPA Region IV guidance specifies absorption factors of 1% for organics and 0.1% for inorganics (November, 1995)
[2] Calculated from oral RfDs.
ND = no data available.

ABB-Environmental Services, Inc.
SOIL_ING.XLS
10/9/96

TABLE F.5-8

INHALATION OF PARTICULATES - SURFACE SOIL
ADOLESCENT TRESPASSER
Site 10
NAS Cecil Field

EXPOSURE PARAMETERS

PARAMETER	SYMBOL	VALUE	UNITS	SOURCE
SOIL CONCENTRATION	C	chemical-specific	chemical-specific	
PART. EMISSION FACTOR	PEF	1.24E+09	m^3/kg	default [1]
CONCENTRATION AIR	CA	chemical-specific	mg/m^3	
INHALATION RATE	IR	0.625	$m^3/hour$	USEPA, 1995
BODY WEIGHT	BW	45	kg	USEPA, 1995
EXPOSURE TIME	ET	4	hours/day	Assumption
EXPOSURE FREQUENCY	EF	45	days/year	Assumption
EXPOSURE DURATION	ED	10	years	USEPA, 1995
CONVERSION FACTOR	CF	0.001	mg/ug	Organics only
AVERAGING TIME				
CANCER	AT	70	years	USEPA, 1991
NONCANCER	AT	10	years	USEPA, 1995

[1] PEF has been derived in the PEF Appendix to this report.
USEPA, 1991. Human Health Evaluation Manual, Supplemental Guidance: "Standard Default Exposure Factors"; OSWER Directive 9285.6-03.
USEPA 1995. Supplemental Guidance to RAGS, Region 4 Bulletins, Bulletin No. 3, November 1995.

EQUATIONS

CANCER RISK = INTAKE (mg/kg-day) x INHALATION CANCER SLOPE FACTOR $(mg/kg\text{-}day)^{-1}$

HAZARD QUOTIENT = INTAKE (mg/kg-day) / INHALATION REFERENCE DOSE (mg/kg-day)

$$\text{INTAKE} = \frac{CA \times IR \times ET \times EF \times ED}{BW \times AT \times 365\ days/yr}$$

Where:

CA = C x CF x (1/PEF)

Note: For noncarcinogenic effects: AT = ED

TABLE F.5-8

INHALATION OF PARTICULATES - SURFACE SOIL
ADOLESCENT TRESPASSER
Site 10
NAS Cecil Field

CARCINOGENIC EFFECTS

COMPOUND	INORGANIC OR ORGANIC I/O	SOIL CONCENTRATION	UNITS	AIR CONCENTRATION (mg/m³)	INTAKE (mg/kg-day)	INHALATION CSF (mg/kg-day)^-1	CANCER RISK
Arsenic	I	2.7	mg/kg	2.18E-09	2.1E-12	1.5	3.2E-12
						SUMMARY CANCER RISK	3E-12

NE = not evaluated.

TABLE F.5-8

INHALATION OF PARTICULATES - SURFACE SOIL
ADOLESCENT TRESPASSER
Site 10
NAS Cecil Field

NONCARCINOGENIC EFFECTS

COMPOUND	INORGANIC OR ORGANIC I/O	SOIL CONCENTRATION	UNITS	AIR CONCENTRATION (mg/m³)	INTAKE (mg/kg-day)	INHALATION RfD (mg/kg-day)	HAZARD QUOTIENT
Aluminum	I	7830	mg/kg	6.31E-06	4.3E-08	ND	
Arsenic	I	2.7	mg/kg	2.18E-09	1.5E-11	ND	
Iron	I	9150	mg/kg	7.38E-06	5.1E-08	ND	
TRPH	O	270000	ug/kg	2.18E-07	1.5E-09	ND	
				SUMMARY HAZARD INDEX			0E+00

ND = no data available.

TABLE F.5-9

DIRECT CONTACT WITH AND INCIDENTAL INGESTION OF SURFACE SOIL
SITE MAINTENANCE WORKER
Site 10
NAS Cecil Field
NAS Cecil Field

EXPOSURE PARAMETERS

PARAMETER	SYMBOL	VALUE	UNITS	SOURCE
CONCENTRATION SOIL	CS	chemical-specific	chemical-specific	
INGESTION RATE	IR	50	mg/day	USEPA, 1995
FRACTION INGESTED	FI	100%	unitless	Assumption
ADHERENCE FACTOR	AF	1	mg/cm^2-event	USEPA, 1995
ABSORPTION FRACTION	ABS	chemical-specific	unitless	USEPA, 1995
SURFACE AREA EXPOSED	SA	5,750	cm^2	USEPA, 1992a
DOSE ABSORBED PER EVENT	DA_{event}	chemical-specific	mg/cm^2-event	USEPA, 1992a
CONVERSION FACTOR	CF	1.00E-09	kg/ug	Organic conversion
CONVERSION FACTOR	CF	1.00E-06	kg/mg	Inorganic conversion
BODY WEIGHT	BW	70	kg	USEPA, 1991
EXPOSURE FREQUENCY	EF	24	days/year [1]	Assumption
EXPOSURE DURATION	ED	25	years	USEPA, 1995
AVERAGING TIME				
CANCER	AT	70	years	USEPA, 1991
NONCANCER	AT	25	years	USEPA, 1995

[1] Units for exposure frequency are events/year in the calculation of the dermally absorbed dose.
USEPA, 1991. Human Health Evaluation Manual, Supplemental Guidance: "Standard Default Exposure Factors"; OSWER Directive 9285.6-03.
USEPA, 1992a. Dermal Exposure Assessment: Principles and Applications; EPA/600/8-91/011B; January 1992.
USEPA, 1995. Supplemental Guidance to RAGS : Region IV, Human Health Risk Assessment Bulletin No. 3.

EQUATIONS

CANCER RISK = INTAKE (mg/kg-day) x CANCER SLOPE FACTOR $(mg/kg\text{-}day)^{-1}$

HAZARD QUOTIENT = INTAKE (mg/kg-day) / REFERENCE DOSE (mg/kg-day)

$$INTAKE_{INGESTION} = \frac{CS \times IR \times FI \times CF \times EF \times ED}{BW \times AT \times 365\ days/yr}$$

$$INTAKE_{DERMAL} = \frac{DA_{event} \times SA \times EF \times ED}{BW \times AT \times 365\ days/yr}$$

Where:

$$DA_{event} = CS \times AF \times ABS \times CF$$

Note: For noncarcinogenic effects, AT = ED

TABLE F.5-9

DIRECT CONTACT WITH AND INCIDENTAL INGESTION OF SURFACE SOIL
SITE MAINTENANCE WORKER
Site 10
NAS Cecil Field
NAS Cecil Field

CARCINOGENIC EFFECTS

COMPOUND	INORGANIC OR ORGANIC I/O	SOIL CONCENTRATION	UNITS	INTAKE INGESTION (mg/kg-day)	ORAL CSF (mg/kg-day)$^{-1}$	CANCER RISK INGESTION	DERMAL ABS [1]	INTAKE DERMAL (mg/kg-day)	DERMAL CSF [2] (mg/kg-day)$^{-1}$	CANCER RISK DERMAL	TOTAL CANCER RISK
Arsenic	I	2.7	mg/kg	4.5E-08	1.5	6.8E-08	0.001	5.2E-09	1.5	7.8E-09	7.6E-08
SUMMARY CANCER RISK						7E-08				8E-09	8E-08

[1] USEPA Region IV guidance specifies absorption factors of 1% for organics and 0.1% for inorganics (November,1995)
[2] Calculated from oral CSFs.
NE = not evaluated.

TABLE F.5-9

DIRECT CONTACT WITH AND INCIDENTAL INGESTION OF SURFACE SOIL
SITE MAINTENANCE WORKER
Site 10
NAS Cecil Field
NAS Cecil Field

NONCARCINOGENIC EFFECTS

COMPOUND	INORGANIC OR ORGANIC I/O	SOIL CONCENTRATION	UNITS	INTAKE INGESTION (mg/kg-day)	ORAL RfD (mg/kg-day)	HAZARD QUOTIENT INGESTION	DERMAL ABS [1]	INTAKE DERMAL (mg/kg-day)	DERMAL RfD [2] (mg/kg-day)	HAZARD QUOTIENT DERMAL	TOTAL HAZARD QUOTIENT
Aluminum	I	7830	mg/kg	3.7E-04	1	3.7E-04	0.001	4.2E-05	0.2	2.1E-04	5.8E-04
Arsenic	I	2.7	mg/kg	1.3E-07	0.0003	4.2E-04	0.001	1.5E-08	0.00029	5.0E-05	4.7E-04
Iron	I	9150	mg/kg	4.3E-04	0.3	1.4E-03	0.001	4.9E-05	0.006	8.2E-03	9.7E-03
TRPH	O	270000	ug/kg	1.3E-05	0.03	4.2E-04	0.01	1.5E-05	0.03	4.9E-04	9.1E-04
SUMMARY HAZARD INDEX						3E-03				9E-03	1E-02

[1] USEPA Region IV guidance specifies absorption factors of 1% for organics and 0.1% for inorganics (November, 1995)
[2] Calculated from oral RfDs.
ND = no data available.

TABLE F.5-10

INHALATION OF PARTICULATES - SURFACE SOIL
SITE MAINTENANCE WORKER
Site 10
NAS Cecil Field
Jacksonville, Florida

EXPOSURE PARAMETERS

PARAMETER	SYMBOL	VALUE	UNITS	SOURCE
SOIL CONCENTRATION	C	chemical-specific	chemical-specific	
PART. EMISSION FACTOR	PEF	1.24E+09	m^3/kg	default [1]
CONCENTRATION AIR	CA	chemical-specific	mg/m^3	
INHALATION RATE	IR	2.5	$m^3/hour$	USEPA, 1995
BODY WEIGHT	BW	70	kg	USEPA, 1991
EXPOSURE TIME	ET	8	hours/day	Assumption
EXPOSURE FREQUENCY	EF	24	days/year	Assumption
EXPOSURE DURATION	ED	25	years	USEPA, 1995
CONVERSION FACTOR	CF	0.001	mg/ug	Organics only
AVERAGING TIME				
CANCER	AT	70	years	USEPA, 1991
NONCANCER	AT	25	years	USEPA, 1995

[1] PEF has been derived in the PEF Appendix to this report.
USEPA, 1991. Human Health Evaluation Manual, Supplemental Guidance: "Standard Default Exposure Factors"; OSWER Directive 9285.6-03.
USEPA, 1995. Supplemental Guidance to RAGS: Region 4 Bulletins, Bulletin No. 3, November 1995.

EQUATIONS

CANCER RISK = INTAKE (mg/kg-day) x INHALATION CANCER SLOPE FACTOR $(mg/kg\text{-}day)^{-1}$

HAZARD QUOTIENT = INTAKE (mg/kg-day) / INHALATION REFERENCE DOSE (mg/kg-day)

$$\text{INTAKE} = \frac{\text{CA x IR x ET x EF x ED}}{\text{BW x AT x 365 days/yr}}$$

Where:

CA = C x CF x (1/PEF)

Note: For noncarcinogenic effects, AT = ED

TABLE F.5-10

INHALATION OF PARTICULATES - SURFACE SOIL
SITE MAINTENANCE WORKER
Site 10
NAS Cecil Field
Jacksonville, Florida

CARCINOGENIC EFFECTS

COMPOUND	INORGANIC OR ORGANIC I/O	SOIL CONCENTRATION	UNITS	AIR CONCENTRATION (mg/m³)	INTAKE (mg/kg-day)	INHALATION CSF (mg/kg-day)^-1	CANCER RISK
Arsenic	I	2.7	mg/kg	2.18E-09	1.5E-11	1.5	2.2E-11
					SUMMARY CANCER RISK		2E-11

NE = not evaluated.

TABLE F.5-10

INHALATION OF PARTICULATES - SURFACE SOIL
SITE MAINTENANCE WORKER
Site 10
NAS Cecil Field
Jacksonville, Florida

NONCARCINOGENIC EFFECTS

COMPOUND	INORGANIC OR ORGANIC I/O	SOIL CONCENTRATION	UNITS	AIR CONCENTRATION (mg/m³)	INTAKE (mg/kg-day)	INHALATION RfD (mg/kg-day)	HAZARD QUOTIENT
Aluminum	I	7830	mg/kg	6.31E-06	1.2E-07	ND	
Arsenic	I	2.7	mg/kg	2.18E-09	4.1E-11	ND	
Iron	I	9150	mg/kg	7.38E-06	1.4E-07	ND	
TRPH	O	270000	ug/kg	2.18E-07	4.1E-09	ND	
						SUMMARY HAZARD INDEX	0E+00

ND = no data available.

TABLE F.5-11

INGESTION OF GROUNDWATER AS DRINKING WATER FROM SURFICIAL AQUIFER (UNFILTERED SAMPLES)
ADULT RESIDENT
Site 10
NAS Cecil Field

EXPOSURE PARAMETERS

PARAMETER	SYMBOL	VALUE	UNITS	SOURCE
CONCENTRATION WATER	CW	chemical specific	ug/liter	
INGESTION RATE	IR	2	liters/day	USEPA, 1991
BODY WEIGHT	BW	70	kg	USEPA, 1991
CONVERSION FACTOR	CF	0.001	mg/ug	
EXPOSURE FREQUENCY	EF	350	days/year	USEPA, 1991
EXPOSURE DURATION	ED	24	years	USEPA, 1991
AVERAGING TIME				
CANCER	AT	70	years	USEPA, 1991
NONCANCER	AT	24	years	USEPA, 1991

USEPA, 1991. Human Health Evaluation Manual, Supplemental Guidance: "Standard Default Exposure Factors"; OSWER Directive 9285.6-03.

CANCER RISK = INTAKE (mg/kg-day) x CANCER SLOPE FACTOR $(mg/kg\text{-}day)^{-1}$

HAZARD QUOTIENT = INTAKE (mg/kg-day) / REFERENCE DOSE (mg/kg-day)

$$\text{INTAKE} = \frac{CW \times IR \times EF \times ED \times CF}{BW \times AT \times 365\ days/year}$$

TABLE F.5-11

INGESTION OF GROUNDWATER AS DRINKING WATER FROM SURFICIAL AQUIFER (UNFILTERED SAMPLES)
ADULT RESIDENT
Site 10
NAS Cecil Field

CARCINOGENIC EFFECTS

COMPOUND	WATER CONCENTRATION	UNITS	INTAKE INGESTION (mg/kg-day)	CANCER SLOPE FACTOR $(mg/kg\text{-}day)^{-1}$	CANCER RISK INGESTION
bis(2-Ethylhexyl)phthalate	6	ug/liter	5.6E-05	0.014	7.9E-07
TOTAL CANCER RISK					8E-07

TABLE F.5-11

INGESTION OF GROUNDWATER AS DRINKING WATER FROM SURFICIAL AQUIFER (UNFILTERED SAMPLES)
ADULT RESIDENT
Site 10
NAS Cecil Field

NONCARCINOGENIC EFFECTS

COMPOUND	WATER CONCENTRATION	UNITS	INTAKE INGESTION (mg/kg-day)	REFERENCE DOSE (mg/kg-day)	HAZARD QUOTIENT INGESTION
bis(2-Ethylhexyl)phthalate	6	ug/liter	1.6E-04	0.02	8.2E-03
Aluminum	1059.5	ug/liter	2.9E-02	1	2.9E-02
Iron	2185	ug/liter	6.0E-02	0.3	2.0E-01
Manganese	49.35	ug/liter	1.4E-03	0.047	2.9E-02
TOTAL HAZARD INDEX					3E-01

APPENDIX I

RESULTS OF HYDRAULIC CONDUCTIVITY TESTING

PROJECT	COMP. BY	JOB NO.
OU4 RI	JM	8500.13.TK1
	CHK. BY	DATE

Calculation of K in ft/day using K in ft/min generated by AQTESOLV program.

$$ft/min \cdot \frac{60\ min}{1\ hr} \cdot \frac{24\ hr}{1\ day} = 1440$$

CEF-10-2

K ft/min = 0.003407 × 1440 = 4.9 ft/day

CEF-10-3S

K ft/min = 0.001329 × 1440 = 1.9 ft/day

CEF-10-4S

K ft/min = 0.0009726 × 1440 = 1.4 ft/day

CEF-10-5S

K ft/min = 0.0004483 × 1440 = 0.6 ft/day

<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>

AQTESOLV RESULTS

Version 1.10

06/07/95 09:11:01

==

TEST DESCRIPTION

Data set........... cf1011.set
Data set title..... CEF-10-1 RUN 1

Knowns and Constants:
No. of data points.................. 195
Radius of well casing.............. 0.1666
Radius of well...................... 0.3333
Aquifer saturated thickness......... 120
Well screen length.................. 20
Static height of water in well...... 109.1
Log(Re/Rw)......................... 3.603
A, B, C........................... 3.377, 0.539, 0.000

==

ANALYTICAL METHOD

Bouwer-Rice (Unconfined Aquifer Slug Test)

==

RESULTS FROM VISUAL CURVE MATCHING

VISUAL MATCH PARAMETER ESTIMATES

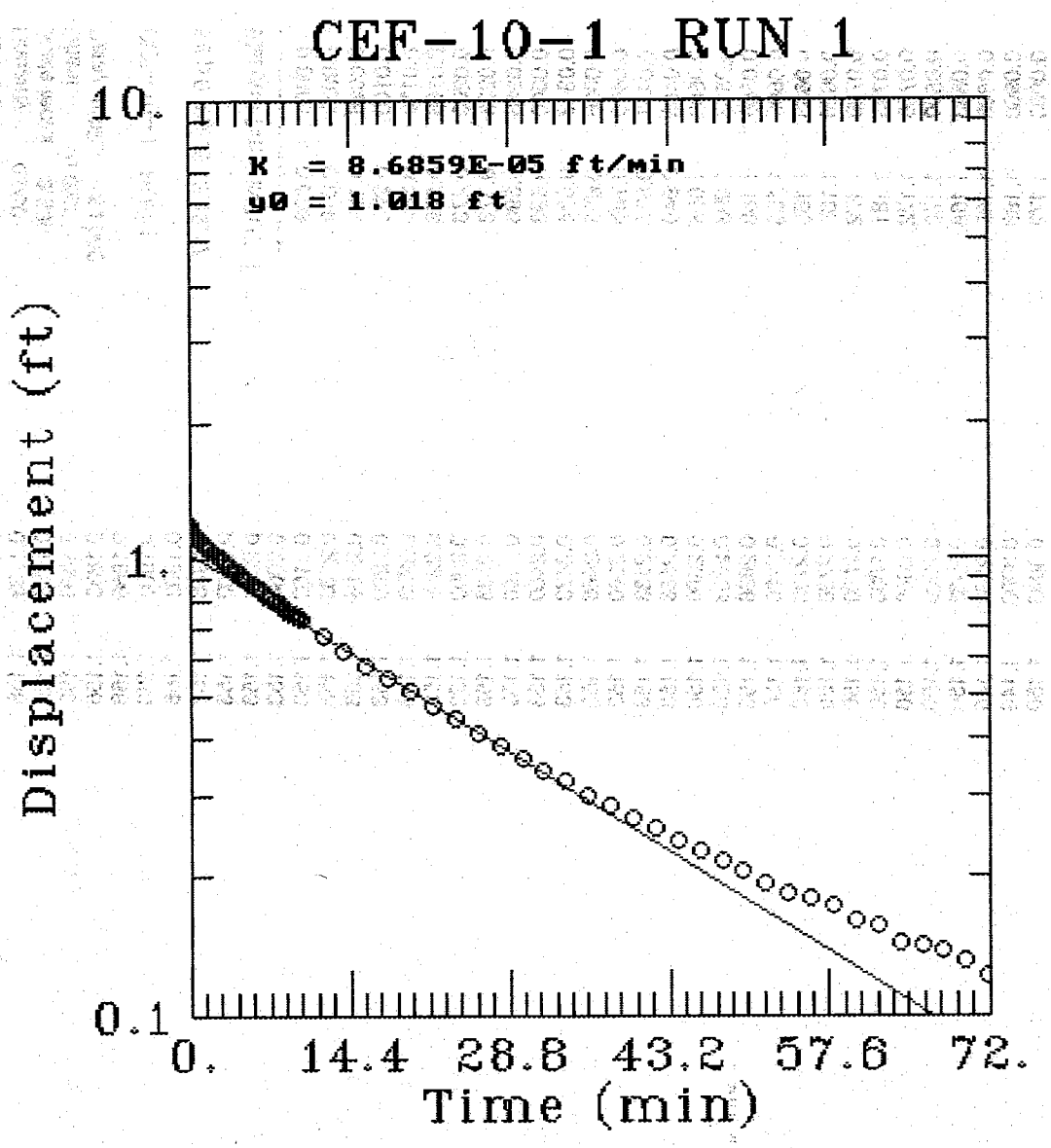
	Estimate
K =	8.3897E-005
y0 =	0.0000E+000

<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>

TYPE CURVE DATA

K = 8.68591E-005
y0 = 1.01758E+000

Time	Drawdown	Time	Drawdown
0.000E+000	1.018E+000	7.200E+001	8.340E-002


CEF-10-1 RUN 1
K = 8.6859E-05 ft/min
y0 = 1.018 ft
10.
1.
0.1
Displacement (ft)
0.
14.4
28.8
43.2
57.6
72.
Time (min)

SE1000C
Environmental Logger
06/07 06:37

Unit# 00008 Test 0

Setups: INPUT 1

Type	Level (F)
Mode	TOC
I.D.	15868
Reference	0.000
Linearity	0.050
Scale factor	9.990
Offset	0.020
Delay mSEC	50.000

CEF-10-1 RUN 1

Step 0 06/06 15:19:17

Elapsed Time	INPUT 1
0.0000	0.003
0.0033	0.018
0.0066	0.185
0.0100	0.223
0.0133	0.345
0.0166	0.276
0.0200	0.273
0.0233	0.373
0.0266	0.396
0.0300	0.593
0.0333	0.634
0.0366	0.656
0.0400	0.785
0.0433	0.873
0.0466	0.949
0.0500	1.008
0.0533	1.093
0.0566	1.168
0.0600	1.156
0.0633	1.165
0.0666	1.165
0.0700	1.172
0.0733	1.181
0.0766	1.172
0.0800	1.172
0.0833	1.168
0.0866	1.168
0.0900	1.168
0.0933	1.172
0.0966	1.168
0.1000	1.165
0.1033	1.168
0.1066	1.168
0.1100	1.165
0.1133	1.165
0.1166	1.153
0.1200	1.156
0.1233	1.159
0.1266	1.159
0.1300	1.162
0.1333	1.159
0.1366	1.159
0.1400	1.159
0.1433	1.159
0.1466	1.159

CEF-10-1 RUN 1

Step 0 06/06 15:19:17

Elapsed Time	INPUT 1
0.1500	1.156
0.1533	1.159
0.1566	1.156
0.1600	1.156
0.1633	1.156
0.1666	1.156
0.1700	1.156
0.1733	1.156
0.1766	1.156
0.1800	1.156
0.1833	1.156
0.1866	1.156
0.1900	1.156
0.1933	1.156
0.1966	1.153
0.2000	1.153
0.2033	1.153
0.2066	1.153
0.2100	1.153
0.2133	1.153
0.2166	1.153
0.2200	1.153
0.2233	1.153
0.2266	1.153
0.2300	1.153
0.2333	1.153
0.2366	1.153
0.2400	1.153
0.2433	1.153
0.2466	1.153
0.2500	1.153
0.2533	1.153
0.2566	1.153
0.2600	1.150
0.2633	1.150
0.2666	1.153
0.2700	1.150
0.2733	1.150
0.2766	1.150
0.2800	1.150
0.2833	1.150
0.2866	1.150
0.2900	1.150
0.2933	1.150
0.2966	1.146
0.3000	1.146
0.3033	1.150
0.3066	1.150
0.3100	1.146
0.3133	1.146
0.3166	1.146
0.3200	1.146
0.3233	1.146
0.3266	1.146
0.3300	1.146
0.3333	1.146
0.3500	1.146
0.3666	1.143
0.3833	1.143
0.4000	1.140
0.4166	1.140
0.4333	1.137
0.4500	1.134

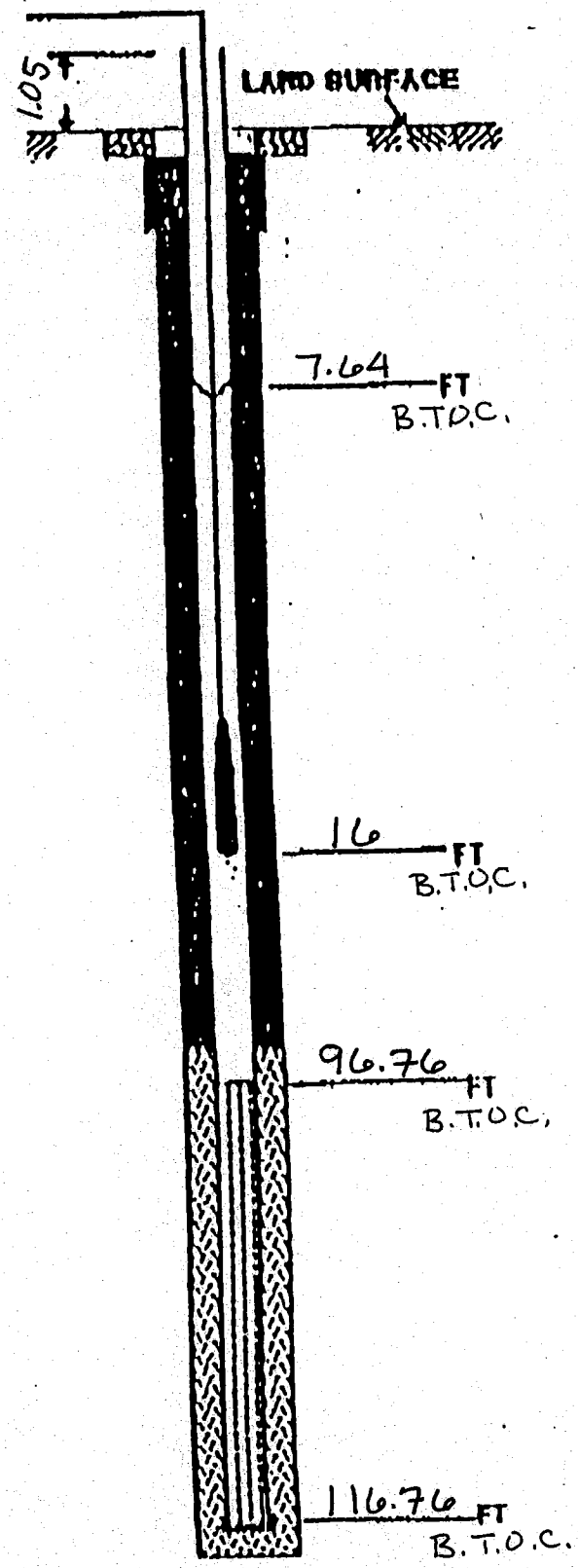
CEF-10-1 RUN 1
(CON'T) PAGE 2
Step 0 06/06 15:19:17

Elapsed Time	INPUT 1
0.4666	1.134
0.4833	1.134
0.5000	1.131
0.5166	1.131
0.5333	1.128
0.5500	1.128
0.5666	1.128
0.5833	1.124
0.6000	1.124
0.6166	1.124
0.6333	1.121
0.6500	1.121
0.6666	1.121
0.6833	1.121
0.7000	1.118
0.7166	1.118
0.7333	1.118
0.7500	1.115
0.7666	1.115
0.7833	1.115
0.8000	1.112
0.8166	1.112
0.8333	1.109
0.8500	1.109
0.8666	1.109
0.8833	1.106
0.9000	1.106
0.9166	1.106
0.9333	1.102
0.9500	1.102
0.9666	1.099
0.9833	1.099
1.0000	1.099
1.2000	1.084
1.4000	1.074
1.6000	1.065
1.8000	1.052
2.0000	1.043
2.2000	1.030
2.4000	1.021
2.6000	1.011
2.8000	1.002
3.0000	0.993
3.2000	0.983
3.4000	0.974
3.6000	0.964
3.8000	0.955
4.0000	0.945
4.2000	0.939
4.4000	0.930
4.6000	0.920
4.8000	0.914
5.0000	0.905
5.2000	0.898
5.4000	0.889
5.6000	0.883
5.8000	0.876
6.0000	0.867
6.2000	0.861
6.4000	0.851
6.6000	0.845
6.8000	0.839
7.0000	0.826

CEF-10-1 RUN 1
(CON'T) PAGE 2
Step 0 06/06 15:19:17

Elapsed Time	INPUT 1
7.2000	0.820
7.4000	0.817
7.6000	0.807
7.8000	0.804
8.0000	0.795
8.2000	0.791
8.4000	0.785
8.6000	0.776
8.8000	0.766
9.0000	0.763
9.2000	0.757
9.4000	0.754
9.6000	0.747
9.8000	0.741
10.0000	0.735
12.0000	0.675
14.0000	0.628
16.0000	0.581
18.0000	0.546
20.0000	0.509
22.0000	0.471
24.0000	0.443
26.0000	0.411
28.0000	0.386
30.0000	0.364
32.0000	0.342
34.0000	0.323
36.0000	0.301
38.0000	0.286
40.0000	0.270
42.0000	0.254
44.0000	0.241
46.0000	0.229
48.0000	0.216
50.0000	0.207
52.0000	0.194
54.0000	0.185
56.0000	0.179
58.0000	0.172
60.0000	0.160
62.0000	0.157
64.0000	0.144
66.0000	0.141
68.0000	0.138
70.0000	0.131
72.0000	0.122

AQUIFER PERFORMANCE TEST
TRANSDUCER CALIBRATION LOG



PROJECT R1/FS OUs 3 4 5 6

PROJECT NUMBER 8520.22

WELL NO. CEF-10-1 PUMPING WELL ____

DATE 6-6-95 TIME 15:23

DATALOGGER SERIAL NO. 1KC01828

TRANSDUCER SERIAL NO. 203736

TRANSDUCER RANGE 10 PSI

CHANNEL NO. Input #1 R1 ~~R2~~ ~~R3~~

TEST DURATION 73 MINS SEL Ø

TIME OF INSTALLATION 15:23

STATIC DEPTH TO WATER 7.64 FT. ____ PSI

DEPTH OF TRANSDUCER 16' B.T.O.C.

CALIBRATION
DEPTH 10 FT 2.84 PSI
DEPTH 11 FT 3.87 PSI
DEPTH 12 FT 4.94 PSI

CLOCKS SYNCHRONIZED? ____

STATIC DEPTH TO WATER 7.64' B.T.O.C.

TIME PUMPING STARTS ____

____ VERIFICATION OF DATA ACQUISITION (HH)
____ VERIFICATION OF DATA ACQUISITION (HH)
____ VERIFICATION OF DATA ACQUISITION (HH)

MAXIMUM PUMPING DEPTH TO WATER ____ FT ____ PSI

TIME PUMPING STOPS ____

MAXIMUM RECOVERY DEPTH TO WATER ____ FT ____ PSI

END RECOVERY ____

RECALIBRATION OF TRANSDUCER
DEPTH ____ FT ____ PSI
DEPTH ____ FT ____ PSI
DEPTH ____ FT ____ PSI

<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>

AQTESOLV RESULTS

Version 1.10

06/06/95 16:13:32

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TEST DESCRIPTION

Data set........... cf1023.set
Data set title..... CEF-10-2 RUN 3

Knowns and Constants:
- No. of data points.................. 165
- Radius of well casing............... 0.08333
- Radius of well...................... 0.25
- Aquifer saturated thickness......... 80
- Well screen length.................. 20
- Static height of water in well...... 29.17
- Log(Re/Rw).......................... 3.105
- A, B, C............................. 3.934, 0.629, 0.000

==

ANALYTICAL METHOD

Bouwer-Rice (Unconfined Aquifer Slug Test)

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RESULTS FROM VISUAL CURVE MATCHING

VISUAL MATCH PARAMETER ESTIMATES

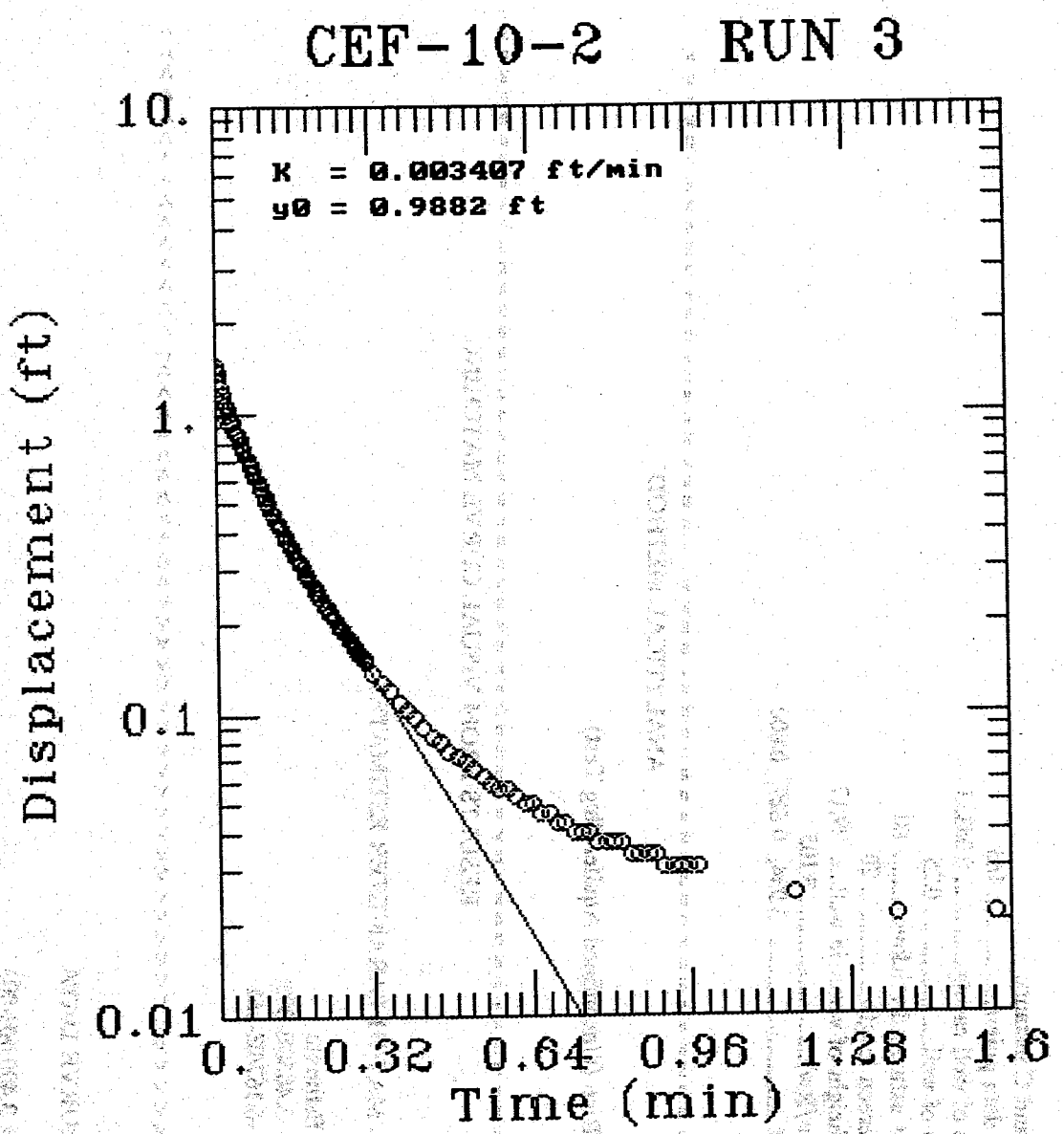
	Estimate
K =	3.4068E-003
y0 =	-6.1674E-261

<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>

TYPE CURVE DATA

K = 3.40678E-003
y0 = 9.88214E-001

Time	Drawdown	Time	Drawdown
0.000E+000	9.882E-001	1.600E+000	4.010E-005


CEF-10-2 RUN 3
K = 0.003407 ft/min
y0 = 0.9882 ft
10.
1.
0.1
0.01
Displacement (ft)
0.
0.32
0.64
0.96
1.28
1.6
Time (min)

SE1000C
Environmental Logger
06/06 12:26

Unit# 00008 Test 2

Setups: INPUT 1

Type	Level (F)
Mode	TOC
I.D.	15868
Reference	0.000
Linearity	0.050
Scale factor	9.990
Offset	0.020
Delay mSEC	50.000

CEF-10-2 RUN 3

Step 2 06/06 11:37:55

Elapsed Time INPUT 1

0.0000	0.000
0.0033	-0.012
0.0066	0.109
0.0100	0.499
0.0133	0.612
0.0166	0.530
0.0200	0.568
0.0233	1.365
0.0266	1.183
0.0300	1.446
0.0333	1.393
0.0366	1.365
0.0400	1.289
0.0433	1.220
0.0466	1.158
0.0500	1.111
0.0533	1.070
0.0566	1.032
0.0600	0.998
0.0633	0.966
0.0666	0.932
0.0700	0.903
0.0733	0.872
0.0766	0.847
0.0800	0.819
0.0833	0.794
0.0866	0.768
0.0900	0.746
0.0933	0.725
0.0966	0.703
0.1000	0.684
0.1033	0.665
0.1066	0.646
0.1100	0.627
0.1133	0.608
0.1166	0.593
0.1200	0.577
0.1233	0.561
0.1266	0.546
0.1300	0.533
0.1333	0.517
0.1366	0.505
0.1400	0.492
0.1433	0.480
0.1466	0.467

CEF-10-2 RUN 3

Step 2 06/06 11:37:55

Elapsed Time INPUT 1

0.1500	0.455
0.1533	0.445
0.1566	0.433
0.1600	0.423
0.1633	0.414
0.1666	0.401
0.1700	0.392
0.1733	0.382
0.1766	0.373
0.1800	0.367
0.1833	0.357
0.1866	0.351
0.1900	0.342
0.1933	0.335
0.1966	0.326
0.2000	0.320
0.2033	0.313
0.2066	0.307
0.2100	0.298
0.2133	0.291
0.2166	0.288
0.2200	0.282
0.2233	0.276
0.2266	0.269
0.2300	0.263
0.2333	0.257
0.2366	0.254
0.2400	0.247
0.2433	0.244
0.2466	0.238
0.2500	0.235
0.2533	0.229
0.2566	0.226
0.2600	0.219
0.2633	0.216
0.2666	0.213
0.2700	0.210
0.2733	0.207
0.2766	0.200
0.2800	0.197
0.2833	0.194
0.2866	0.191
0.2900	0.188
0.2933	0.185
0.2966	0.182
0.3000	0.178
0.3033	0.175
0.3066	0.172
0.3100	0.169
0.3133	0.166
0.3166	0.163
0.3200	0.160
0.3233	0.160
0.3266	0.156
0.3300	0.153
0.3333	0.150
0.3500	0.138
0.3666	0.128
0.3833	0.119
0.4000	0.109
0.4166	0.103
0.4333	0.097
0.4500	0.091

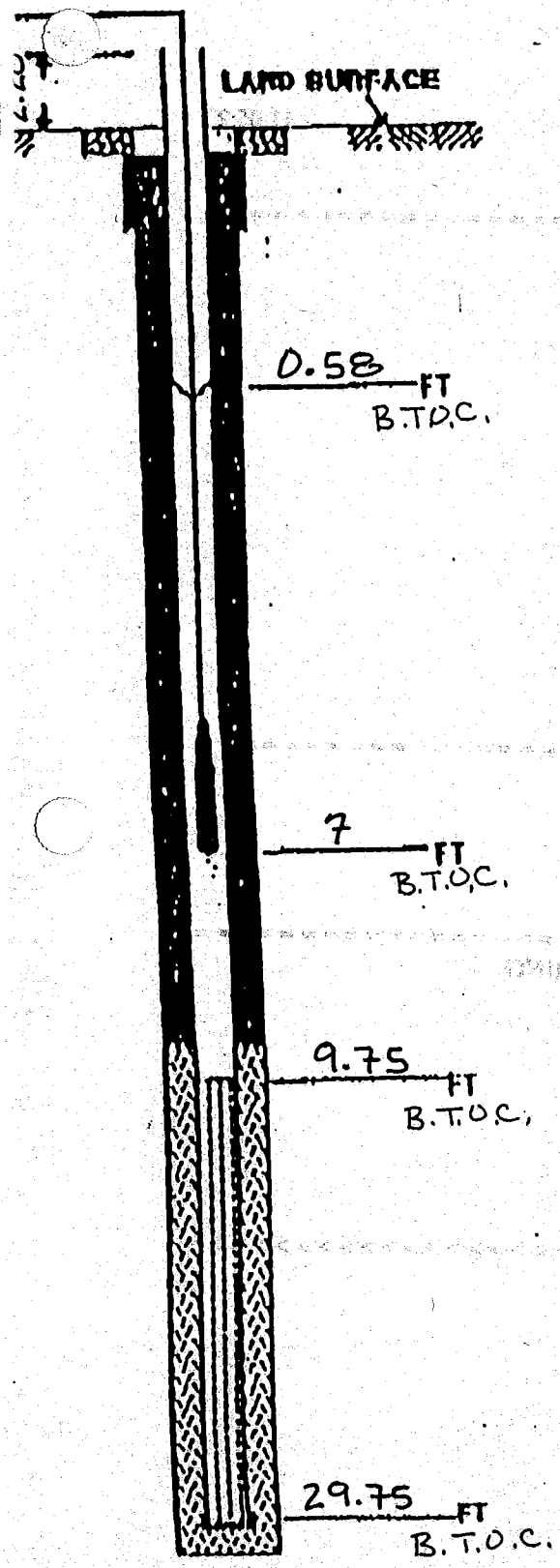
CEF-10-2 RUN 3
(CON'T) PAGE 2
Step 2 06/06 11:37:55

Elapsed Time	INPUT 1
0.4666	0.084
0.4833	0.081
0.5000	0.075
0.5166	0.072
0.5333	0.069
0.5500	0.065
0.5666	0.062
0.5833	0.059
0.6000	0.056
0.6166	0.056
0.6333	0.053
0.6500	0.050
0.6666	0.050
0.6833	0.047
0.7000	0.047
0.7166	0.043
0.7333	0.043
0.7500	0.040
0.7666	0.040
0.7833	0.040
0.8000	0.037
0.8166	0.037
0.8333	0.037
0.8500	0.037
0.8666	0.034
0.8833	0.034
0.9000	0.034
0.9166	0.034
0.9333	0.031
0.9500	0.031
0.9666	0.031
0.9833	0.031
1.0000	0.031
1.2000	0.025
1.4000	0.021
1.6000	0.021
1.8000	0.018
2.0000	0.018
2.2000	0.018
2.4000	0.018
2.6000	0.015
2.8000	0.015
3.0000	0.015
3.2000	0.015
3.4000	0.015
3.6000	0.015
3.8000	0.012
4.0000	0.015
4.2000	0.015
4.4000	0.015
4.6000	0.012
4.8000	0.012
5.0000	0.012
5.2000	0.012
5.4000	0.012
5.6000	0.012
5.8000	0.012
6.0000	0.012
6.2000	0.012
6.4000	0.012
6.6000	0.015
6.8000	0.012
7.0000	0.015

CEF-10-2 RUN 3
(CON'T) PAGE 2
Step 2 06/06 11:37:55

Elapsed Time	INPUT 1
7.2000	0.015
7.4000	0.012
7.6000	0.012
7.8000	0.015
8.0000	0.015
8.2000	0.012
8.4000	0.015
8.6000	0.015
8.8000	0.015
9.0000	0.015
9.2000	0.012
9.4000	0.012
9.6000	0.012
9.8000	0.012
10.0000	0.012

AQUIFER PERFORMANCE TEST
TRANSDUCER CALIBRATION LOG



PROJECT R1/FS OUs 3 4 5 6

PROJECT NUMBER 8520.22

WELL NO. CEF-10-2 PUMPING WELL ____

DATE 6-6-95 TIME 11:15

DATA LOGGER SERIAL NO. 1KC01828

TRANSDUCER SERIAL NO. 203736

TRANSDUCER RANGE 10 PSI

CHANNEL NO. Input #1

TEST DURATION R1 10 SEL 2 / R2 10 Step 1 / R3 10 Step 2

TIME OF INSTALLATION 11:15

STATIC DEPTH TO WATER 0.58 FT. ____ PSI

DEPTH OF TRANSDUCER 7' B.T.O.C.

CALIBRATION
DEPTH 3 FT 2.33 PSI
DEPTH 4 FT 3.30 PSI
DEPTH 5 FT 4.25 PSI

CLOCKS SYNCHRONIZED? ____

STATIC DEPTH TO WATER 0.58' B.T.O.C.

TIME PUMPING STARTS ____

____ VERIFICATION OF DATA ACQUISITION (HH)
____ VERIFICATION OF DATA ACQUISITION (HH)
____ VERIFICATION OF DATA ACQUISITION (HH)

MAXIMUM PUMPING DEPTH TO WATER ____ FT ____ PSI

TIME PUMPING STOPS ____

MAXIMUM RECOVERY DEPTH TO WATER ____ FT ____ PSI

END RECOVERY ____

RECALIBRATION OF TRANSDUCER
DEPTH ____ FT ____ PSI
DEPTH ____ FT ____ PSI
DEPTH ____ FT ____ PSI

<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>

AQTESOLV RESULTS

Version 1.10

06/06/95 11:05:23

===

TEST DESCRIPTION

Data set........... cf1032.set
Data set title..... CEF-10-3 RUN 2

Knowns and Constants:
No. of data points.................. 177
Radius of well casing.............. 0.08333
Radius of well...................... 0.25
Aquifer saturated thickness......... 80
Well screen length.................. 10
Static height of water in well...... 12.36
Log(Re/Rw)......................... 2.417
A, B, C............................ 2.760, 0.448, 0.000

===

ANALYTICAL METHOD

Bouwer-Rice (Unconfined Aquifer Slug Test)

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RESULTS FROM VISUAL CURVE MATCHING

VISUAL MATCH PARAMETER ESTIMATES

Estimate
K = 5.6422E-004
y0 = 2.6570E+301

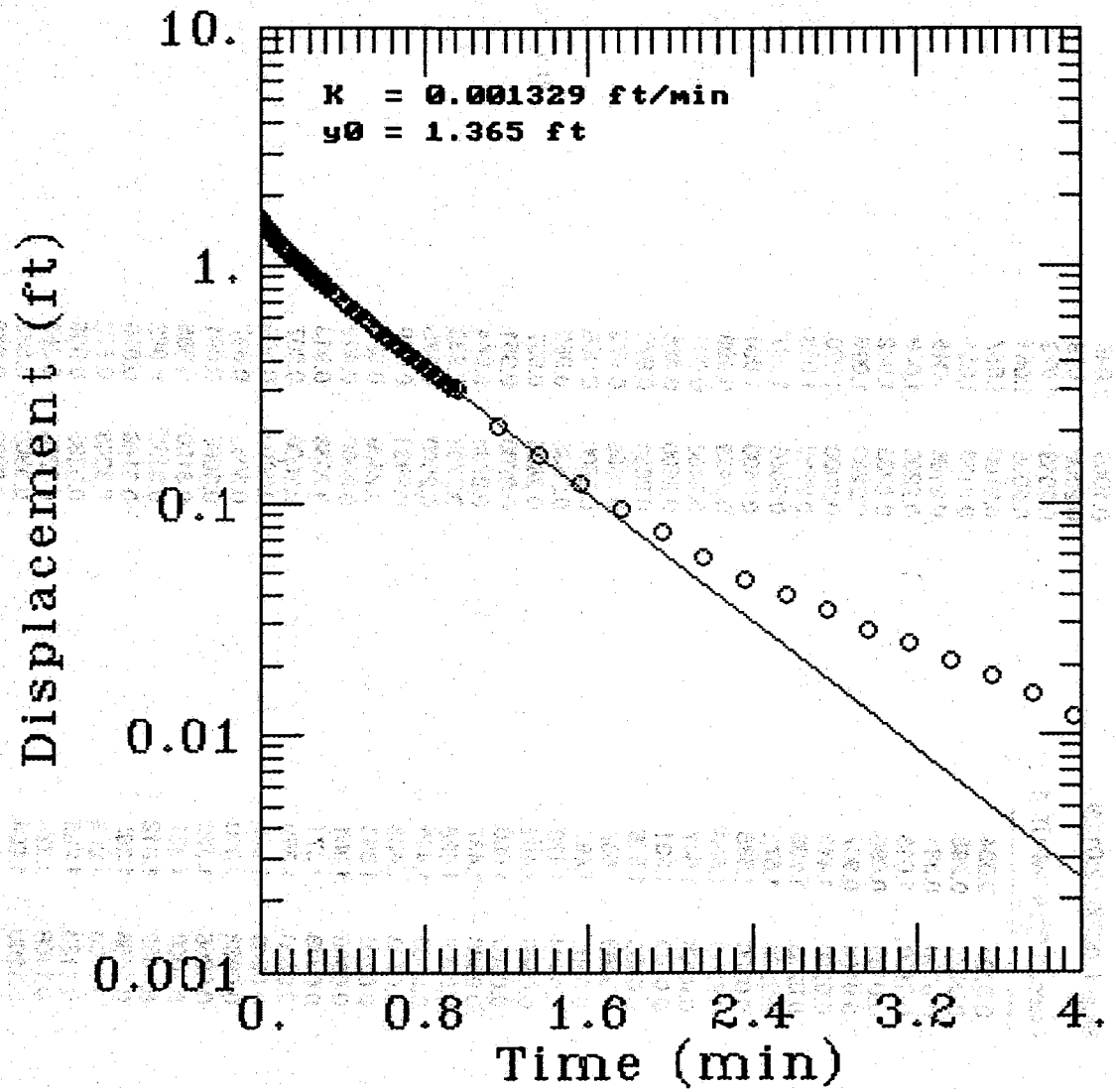
<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>

TYPE CURVE DATA

K = 1.32879E-003
y0 = 1.36507E+000

Time	Drawdown	Time	Drawdown
0.000E+000	1.365E+000	4.000E+000	2.425E-003

CEF-10-3 RUN 2


K = 0.001329 ft/min
y0 = 1.365 ft
10.
1.
0.1
0.01
0.001
Displacement (ft)
0.
0.8
1.6
2.4
3.2
4.
Time (min)

SE1000C
Environmental Logger
06/05 15:05

Unit# 00008 Test 2

Setups: INPUT 1

Type	Level (F)
Mode	TOC
I.D.	15868
Reference	0.000
Linearity	0.050
Scale factor	9.990
Offset	0.020
Delay mSEC	50.000

CEF-10-3 RUN 2

Step 1 06/05 12:01:29

Elapsed Time	INPUT 1
0.0000	0.034
0.0033	0.298
0.0066	0.831
0.0100	1.013
0.0133	0.690
0.0166	0.957
0.0200	1.443
0.0233	1.669
0.0266	1.572
0.0300	1.585
0.0333	1.566
0.0366	1.547
0.0400	1.531
0.0433	1.516
0.0466	1.503
0.0500	1.487
0.0533	1.478
0.0566	1.462
0.0600	1.450
0.0633	1.437
0.0666	1.428
0.0700	1.415
0.0733	1.403
0.0766	1.393
0.0800	1.381
0.0833	1.371
0.0866	1.359
0.0900	1.349
0.0933	1.340
0.0966	1.330
0.1000	1.321
0.1033	1.312
0.1066	1.302
0.1100	1.293
0.1133	1.283
0.1166	1.274
0.1200	1.264
0.1233	1.255
0.1266	1.246
0.1300	1.239
0.1333	1.230
0.1366	1.221
0.1400	1.214
0.1433	1.205
0.1466	1.199

CEF-10-3 RUN 2

Step 1 06/05 12:01:29

Elapsed Time	INPUT 1
0.1500	1.189
0.1533	1.180
0.1566	1.173
0.1600	1.167
0.1633	1.158
0.1666	1.151
0.1700	1.142
0.1733	1.136
0.1766	1.130
0.1800	1.120
0.1833	1.114
0.1866	1.108
0.1900	1.098
0.1933	1.092
0.1966	1.086
0.2000	1.079
0.2033	1.073
0.2066	1.064
0.2100	1.057
0.2133	1.051
0.2166	1.045
0.2200	1.039
0.2233	1.032
0.2266	1.026
0.2300	1.020
0.2333	1.013
0.2366	1.007
0.2400	1.004
0.2433	0.998
0.2466	0.991
0.2500	0.985
0.2533	0.979
0.2566	0.973
0.2600	0.966
0.2633	0.960
0.2666	0.957
0.2700	0.951
0.2733	0.944
0.2766	0.938
0.2800	0.935
0.2833	0.929
0.2866	0.922
0.2900	0.919
0.2933	0.913
0.2966	0.907
0.3000	0.900
0.3033	0.897
0.3066	0.891
0.3100	0.885
0.3133	0.882
0.3166	0.875
0.3200	0.872
0.3233	0.866
0.3266	0.863
0.3300	0.856
0.3333	0.853
0.3500	0.828
0.3666	0.803
0.3833	0.778
0.4000	0.756
0.4166	0.734
0.4333	0.715
0.4500	0.693

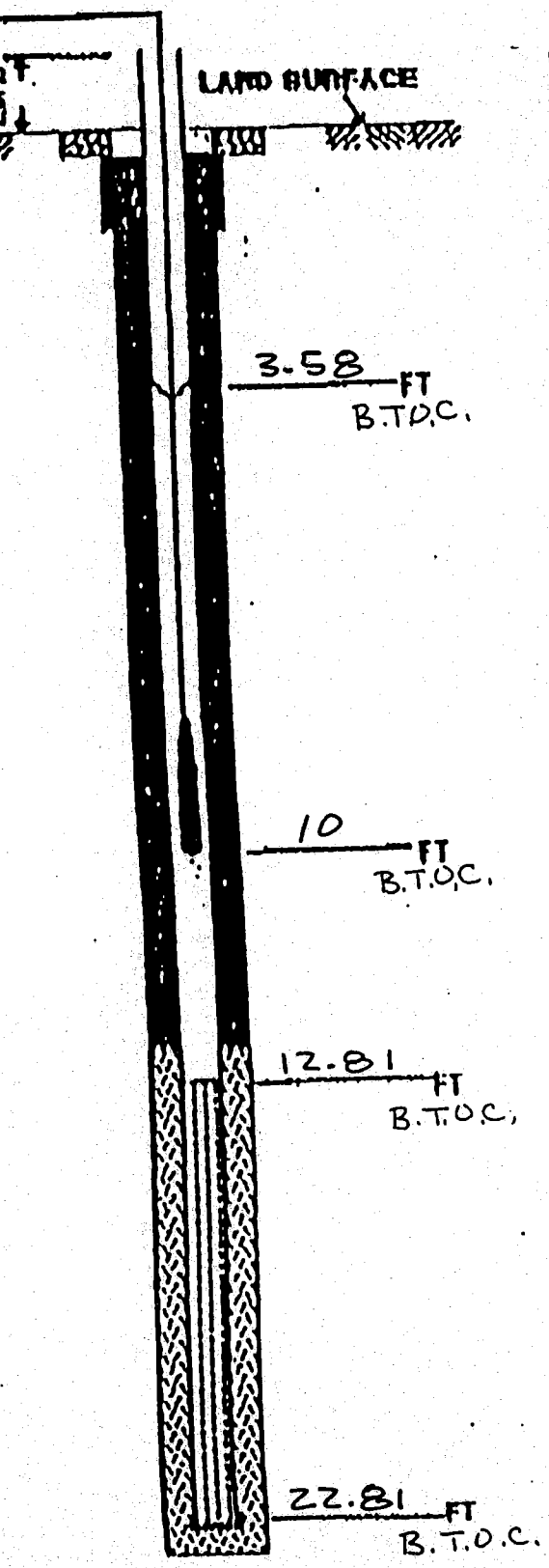
CEF-10-3 RUN 2
(CON'T) PAGE 2
Step 1 06/05 12:01:29

Elapsed Time	INPUT 1
0.4666	0.674
0.4833	0.656
0.5000	0.637
0.5166	0.618
0.5333	0.602
0.5500	0.587
0.5666	0.571
0.5833	0.555
0.6000	0.539
0.6166	0.527
0.6333	0.511
0.6500	0.499
0.6666	0.486
0.6833	0.470
0.7000	0.461
0.7166	0.448
0.7333	0.436
0.7500	0.426
0.7666	0.414
0.7833	0.405
0.8000	0.395
0.8166	0.383
0.8333	0.376
0.8500	0.367
0.8666	0.357
0.8833	0.348
0.9000	0.342
0.9166	0.332
0.9333	0.326
0.9500	0.317
0.9666	0.310
0.9833	0.304
1.0000	0.298
1.2000	0.210
1.4000	0.160
1.6000	0.122
1.8000	0.094
2.0000	0.075
2.2000	0.059
2.4000	0.047
2.6000	0.040
2.8000	0.034
3.0000	0.028
3.2000	0.025
3.4000	0.021
3.6000	0.018
3.8000	0.015
4.0000	0.012
4.2000	0.012
4.4000	0.012
4.6000	0.012
4.8000	0.012
5.0000	0.012
5.2000	0.009
5.4000	0.009
5.6000	0.009
5.8000	0.009
6.0000	0.009
6.2000	0.009
6.4000	0.009
6.6000	0.009
6.8000	0.009
7.0000	0.009

CEF-10-3 RUN 2
(CON'T) PAGE 2
Step 1 06/05 12:01:29

Elapsed Time	INPUT 1
7.2000	0.009
7.4000	0.009
7.6000	0.009
7.8000	0.009
8.0000	0.009
8.2000	0.009
8.4000	0.006
8.6000	0.006
8.8000	0.006
9.0000	0.006
9.2000	0.006
9.4000	0.006
9.6000	0.006
9.8000	0.006
10.0000	0.006

AQUIFER PERFORMANCE TEST
TRANSDUCER CALIBRATION LOG



PROJECT R1/FS OUs 3 4 5 6

PROJECT NUMBER 8520.22

WELL NO. CEF-10-3 PUMPING WELL ____

DATE 6-5-95 TIME 11:47

DATALOGGER SERIAL NO. 1KC01828

TRANSDUCER SERIAL NO. 203736

TRANSDUCER RANGE 10 PSI

CHANNEL NO. Input #1

TEST DURATION R1 10 (SEL 2) R2 10 (Step 1) R3 10 (Step 2)

TIME OF INSTALLATION 11:47

STATIC DEPTH TO WATER 3.58 FT. ____ PSI

DEPTH OF TRANSDUCER 10' B.T.O.C.

CALIBRATION
DEPTH 6 FT 2.55 PSI
DEPTH 7 FT 3.59 PSI
DEPTH 8 FT 4.64 PSI

CLOCKS SYNCHRONIZED? ____

STATIC DEPTH TO WATER 3.58' B.T.O.C.

TIME PUMPING STARTS ____

____ VERIFICATION OF DATA ACQUISITION (HH)
____ VERIFICATION OF DATA ACQUISITION (HH)
____ VERIFICATION OF DATA ACQUISITION (HH)

MAXIMUM PUMPING DEPTH TO WATER ____ FT ____ PSI

TIME PUMPING STOPS ____

MAXIMUM RECOVERY DEPTH TO WATER ____ FT ____ PSI

END RECOVERY ____

RECALIBRATION OF TRANSDUCER
DEPTH ____ FT ____ PSI
DEPTH ____ FT ____ PSI
DEPTH ____ FT ____ PSI

<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>

AQTESOLV RESULTS
Version 1.10

06/05/95 16:05:53

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TEST DESCRIPTION

Data set........... cf1043.set
Data set title..... CEF-10-4 RUN 3

Knowns and Constants:
No. of data points.................. 352
Radius of well casing............... 0.08333
Radius of well...................... 0.25
Aquifer saturated thickness......... 80
Well screen length.................. 20
Static height of water in well...... 24.29
Log(Re/Rw).......................... 3.012
A, B, C............................. 3.934, 0.629, 0.000

==

ANALYTICAL METHOD

Bouwer-Rice (Unconfined Aquifer Slug Test)

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RESULTS FROM VISUAL CURVE MATCHING

VISUAL MATCH PARAMETER ESTIMATES

	Estimate
K =	2.8883E-004
y0 =	-1.2881E+209

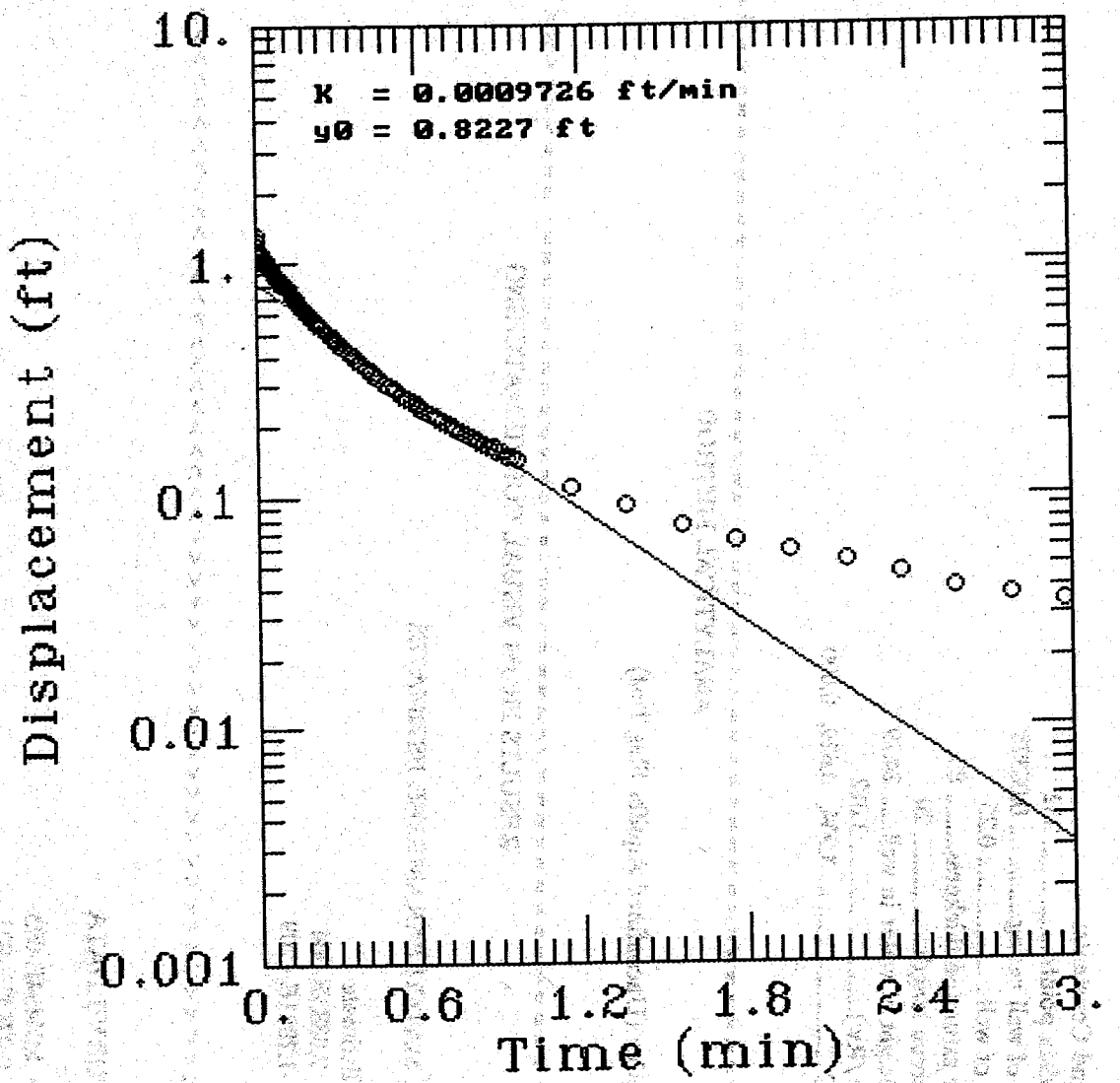
<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>

TYPE CURVE DATA

K = 1.26434E-003
y0 = 9.97843E-001

Time	Drawdown	Time	Drawdown
0.000E+000	9.978E-001	4.000E+000	6.285E-005

CEF-10-4 RUN 3



AQTESOLV

GERAGHTY & MILLER, INC.

Modeling Group

SE1000C
Environmental Logger
06/02 15:10

Unit# 00008 Test 2

Setups: INPUT 1

Type	Level (F)
Mode	TOC
I.D.	15868
Reference	0.000
Linearity	0.050
Scale factor	9.990
Offset	0.020
Delay mSEC	50.000

CEF-10-4 RUN 3

Step 2 06/02 12:09:53

Elapsed Time	INPUT 1
0.0000	0.000
0.0033	0.003
0.0066	0.433
0.0100	0.706
0.0133	0.721
0.0166	0.728
0.0200	0.797
0.0233	0.856
0.0266	0.907
0.0300	0.907
0.0333	1.314
0.0366	1.255
0.0400	1.189
0.0433	1.154
0.0466	1.145
0.0500	1.139
0.0533	1.126
0.0566	1.104
0.0600	1.082
0.0633	1.063
0.0666	1.048
0.0700	1.035
0.0733	1.020
0.0766	1.007
0.0800	0.991
0.0833	0.976
0.0866	0.963
0.0900	0.950
0.0933	0.938
0.0966	0.925
0.1000	0.913
0.1033	0.900
0.1066	0.888
0.1100	0.878
0.1133	0.869
0.1166	0.856
0.1200	0.847
0.1233	0.831
0.1266	0.822
0.1300	0.822
0.1333	0.822
0.1366	0.816
0.1400	0.812
0.1433	0.806
0.1466	0.800

CEF-10-4 RUN 3

Step 2 06/02 12:09:53

Elapsed Time	INPUT 1
0.1500	0.794
0.1533	0.784
0.1566	0.775
0.1600	0.762
0.1633	0.753
0.1666	0.743
0.1700	0.734
0.1733	0.725
0.1766	0.715
0.1800	0.709
0.1833	0.699
0.1866	0.693
0.1900	0.684
0.1933	0.677
0.1966	0.671
0.2000	0.665
0.2033	0.659
0.2066	0.652
0.2100	0.646
0.2133	0.640
0.2166	0.634
0.2200	0.627
0.2233	0.621
0.2266	0.618
0.2300	0.612
0.2333	0.605
0.2366	0.599
0.2400	0.596
0.2433	0.590
0.2466	0.586
0.2500	0.580
0.2533	0.574
0.2566	0.571
0.2600	0.565
0.2633	0.561
0.2666	0.555
0.2700	0.549
0.2733	0.546
0.2766	0.543
0.2800	0.536
0.2833	0.533
0.2866	0.527
0.2900	0.524
0.2933	0.521
0.2966	0.514
0.3000	0.511
0.3033	0.505
0.3066	0.502
0.3100	0.499
0.3133	0.495
0.3166	0.489
0.3200	0.486
0.3233	0.483
0.3266	0.480
0.3300	0.473
0.3333	0.470
0.3500	0.452
0.3666	0.436
0.3833	0.417
0.4000	0.401
0.4166	0.386
0.4333	0.373
0.4500	0.357

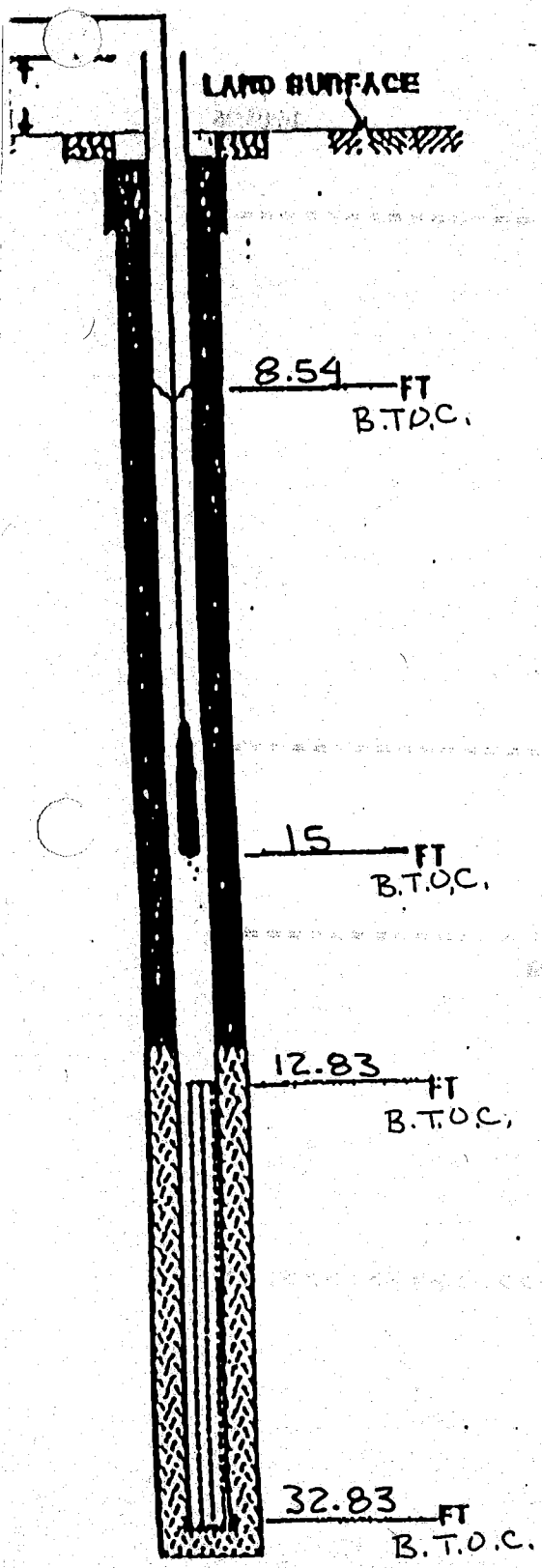
CEF-10-4 RUN 3
(CON'T) PAGE 2
Step 2 06/02 12:09:53

Elapsed Time	INPUT 1
0.4666	0.345
0.4833	0.332
0.5000	0.323
0.5166	0.310
0.5333	0.301
0.5500	0.291
0.5666	0.282
0.5833	0.273
0.6000	0.266
0.6166	0.257
0.6333	0.251
0.6500	0.241
0.6666	0.235
0.6833	0.229
0.7000	0.222
0.7166	0.216
0.7333	0.210
0.7500	0.204
0.7666	0.200
0.7833	0.194
0.8000	0.191
0.8166	0.185
0.8333	0.182
0.8500	0.178
0.8666	0.172
0.8833	0.169
0.9000	0.166
0.9166	0.163
0.9333	0.156
0.9500	0.156
0.9666	0.150
0.9833	0.150
1.0000	0.144
1.2000	0.109
1.4000	0.091
1.6000	0.075
1.8000	0.065
2.0000	0.059
2.2000	0.053
2.4000	0.047
2.6000	0.040
2.8000	0.037
3.0000	0.034
3.2000	0.031
3.4000	0.028
3.6000	0.028
3.8000	0.025
4.0000	0.025
4.2000	0.021
4.4000	0.021
4.6000	0.018
4.8000	0.018
5.0000	0.018
5.2000	0.018
5.4000	0.015
5.6000	0.015
5.8000	0.015
6.0000	0.015
6.2000	0.015
6.4000	0.012
6.6000	0.012
6.8000	0.012
7.0000	0.012

CEF-10-4 RUN 3
(CON'T) PAGE 2
Step 2 06/02 12:09:53

Elapsed Time	INPUT 1
7.2000	0.012
7.4000	0.012
7.6000	0.012
7.8000	0.009
8.0000	0.009
8.2000	0.009
8.4000	0.009
8.6000	0.009
8.8000	0.009
9.0000	0.009
9.2000	0.009
9.4000	0.009
9.6000	0.009
9.8000	0.006
10.0000	0.009

AQUIFER PERFORMANCE TEST
TRANSDUCER CALIBRATION LOG



PROJECT RI/FS OUs 3 4 5 6

PROJECT NUMBER 8520.22

WELL NO. CEF-10-4D PUMPING WELL ____

DATE 6-2-95 TIME 11:36

DATA LOGGER SERIAL NO. 1KC01828

TRANSDUCER SERIAL NO. 203736

TRANSDUCER RANGE 10 PSI

CHANNEL NO. Input #1

TEST DURATION R1 10 SEL 2; R2 10 Step 1; R3 10 Step 2

TIME OF INSTALLATION 11:36

STATIC DEPTH TO WATER 8.54 FT. ____ PSI

DEPTH OF TRANSDUCER 15' B.T.O.C.

CALIBRATION
DEPTH 10 FT 1.26 PSI
DEPTH 11 FT 2.33 PSI
DEPTH 12 FT 3.29 PSI

CLOCKS SYNCHRONIZED? ____

STATIC DEPTH TO WATER 8.54' B.T.O.C.

TIME PUMPING STARTS ____

____ VERIFICATION OF DATA ACQUISITION (HR)
____ VERIFICATION OF DATA ACQUISITION (HR)
____ VERIFICATION OF DATA ACQUISITION (HR)

MAXIMUM PUMPING DEPTH TO WATER ____ FT ____ PSI

TIME PUMPING STOPS ____

MAXIMUM RECOVERY DEPTH TO WATER ____ FT ____ PSI

END RECOVERY ____

RECALIBRATION OF TRANSDUCER
DEPTH ____ FT ____ PSI
DEPTH ____ FT ____ PSI
DEPTH ____ FT ____ PSI

<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>

A Q T E S O L V   R E S U L T S
Version 1.10

06/06/95 16:05:26

==

TEST DESCRIPTION

Data set........... cf105s1.set
Data set title..... CEF-10-5S RUN 1

Knowns and Constants:
No. of data points.................. 129
Radius of well casing.............. 0.08333
Radius of well...................... 0.25
Aquifer saturated thickness......... 80
Well screen length.................. 10
Static height of water in well...... 12.88
Log(Re/Rw)......................... 2.435
A, B, C............................ 2.760, 0.448, 0.000

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ANALYTICAL METHOD

Bouwer-Rice (Unconfined Aquifer Slug Test)

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RESULTS FROM VISUAL CURVE MATCHING

VISUAL MATCH PARAMETER ESTIMATES

	Estimate
K =	4.4834E-004
y0 =	-6.1674E-261

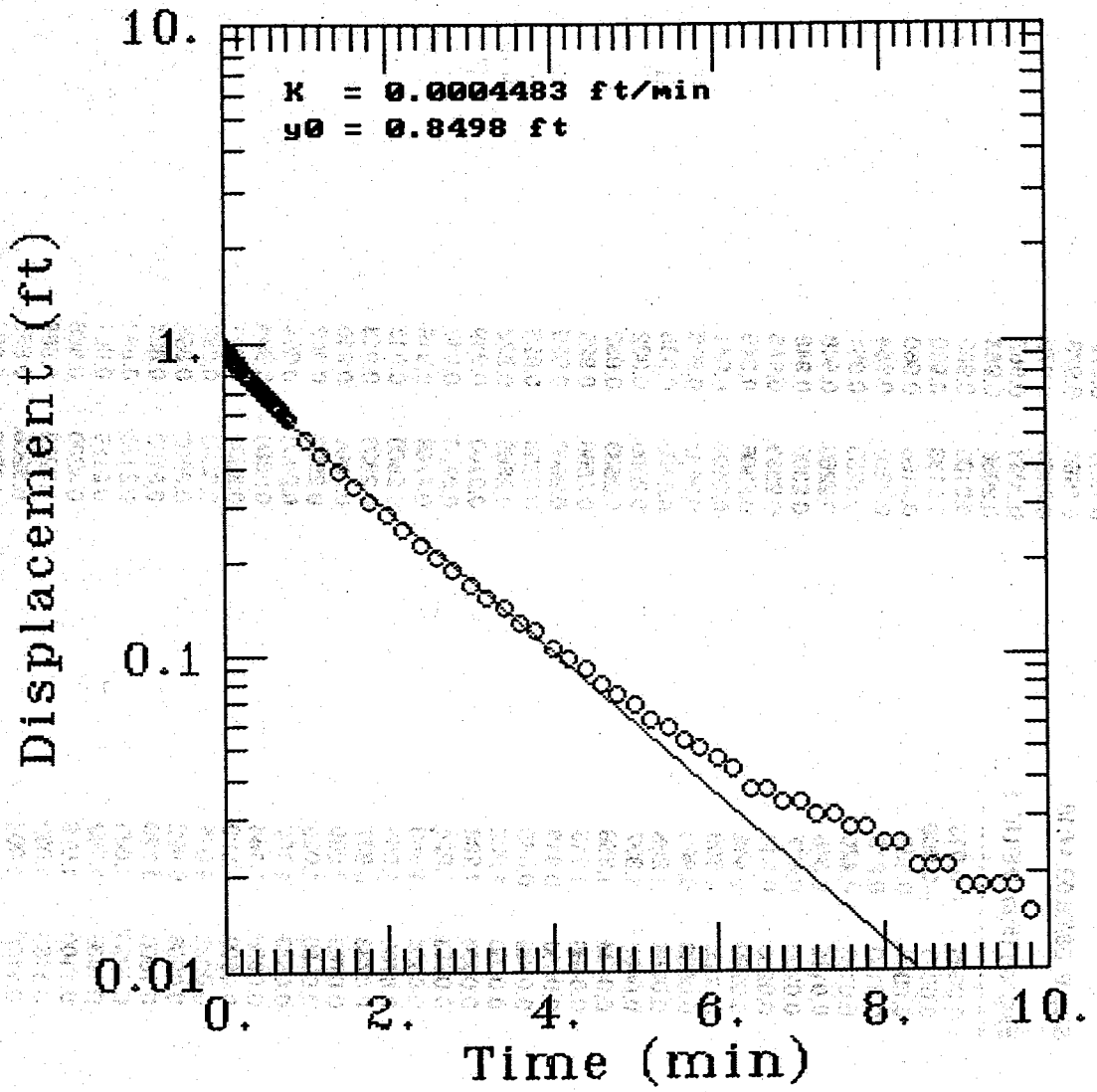
<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>

TYPE CURVE DATA

K = 4.48339E-004
y0 = 8.49801E-001

Time	Drawdown	Time	Drawdown
0.000E+000	8.498E-001	1.000E+001	4.229E-003

CEF-10-5S RUN 1



SE1000C
Environmental Logger
06/06 12:14

Unit# 00008 Test 1

Setups: INPUT 1

Type	Level (F)
Mode	TOC
I.D.	15868
Reference	0.000
Linearity	0.050
Scale factor	9.990
Offset	0.020
Delay mSEC	50.000

CEF-10-5S RUN 1

Step 0 06/06 09:44:18

Elapsed Time	INPUT 1
0.0000	-0.015
0.0033	-0.009
0.0066	0.122
0.0100	0.273
0.0133	0.420
0.0166	0.546
0.0200	0.577
0.0233	0.514
0.0266	0.442
0.0300	0.606
0.0333	0.963
0.0366	1.268
0.0400	1.337
0.0433	1.356
0.0466	1.215
0.0500	0.919
0.0533	0.869
0.0566	1.032
0.0600	1.208
0.0633	1.274
0.0666	1.243
0.0700	1.058
0.0733	0.957
0.0766	0.989
0.0800	1.089
0.0833	1.167
0.0866	1.164
0.0900	1.089
0.0933	1.011
0.0966	0.992
0.1000	1.029
0.1033	1.083
0.1066	1.102
0.1100	1.076
0.1133	1.032
0.1166	1.004
0.1200	1.007
0.1233	1.032
0.1266	1.054
0.1300	1.051
0.1333	1.029
0.1366	1.004
0.1400	0.998
0.1433	1.007
0.1466	1.020

CEF-10-5S RUN 1

Step 0 06/06 09:44:18

Elapsed Time	INPUT 1
0.1500	1.023
0.1533	1.014
0.1566	1.001
0.1600	0.992
0.1633	0.989
0.1666	0.995
0.1700	0.998
0.1733	0.998
0.1766	0.989
0.1800	0.979
0.1833	0.976
0.1866	0.976
0.1900	0.979
0.1933	0.979
0.1966	0.973
0.2000	0.970
0.2033	0.963
0.2066	0.963
0.2100	0.960
0.2133	0.960
0.2166	0.960
0.2200	0.954
0.2233	0.951
0.2266	0.948
0.2300	0.948
0.2333	0.945
0.2366	0.945
0.2400	0.941
0.2433	0.938
0.2466	0.935
0.2500	0.932
0.2533	0.932
0.2566	0.929
0.2600	0.929
0.2633	0.926
0.2666	0.923
0.2700	0.919
0.2733	0.916
0.2766	0.916
0.2800	0.913
0.2833	0.913
0.2866	0.910
0.2900	0.907
0.2933	0.904
0.2966	0.904
0.3000	0.901
0.3033	0.898
0.3066	0.898
0.3100	0.894
0.3133	0.894
0.3166	0.891
0.3200	0.888
0.3233	0.888
0.3266	0.885
0.3300	0.882
0.3333	0.882
0.3500	0.869
0.3666	0.860
0.3833	0.847
0.4000	0.838
0.4166	0.828
0.4333	0.819
0.4500	0.810

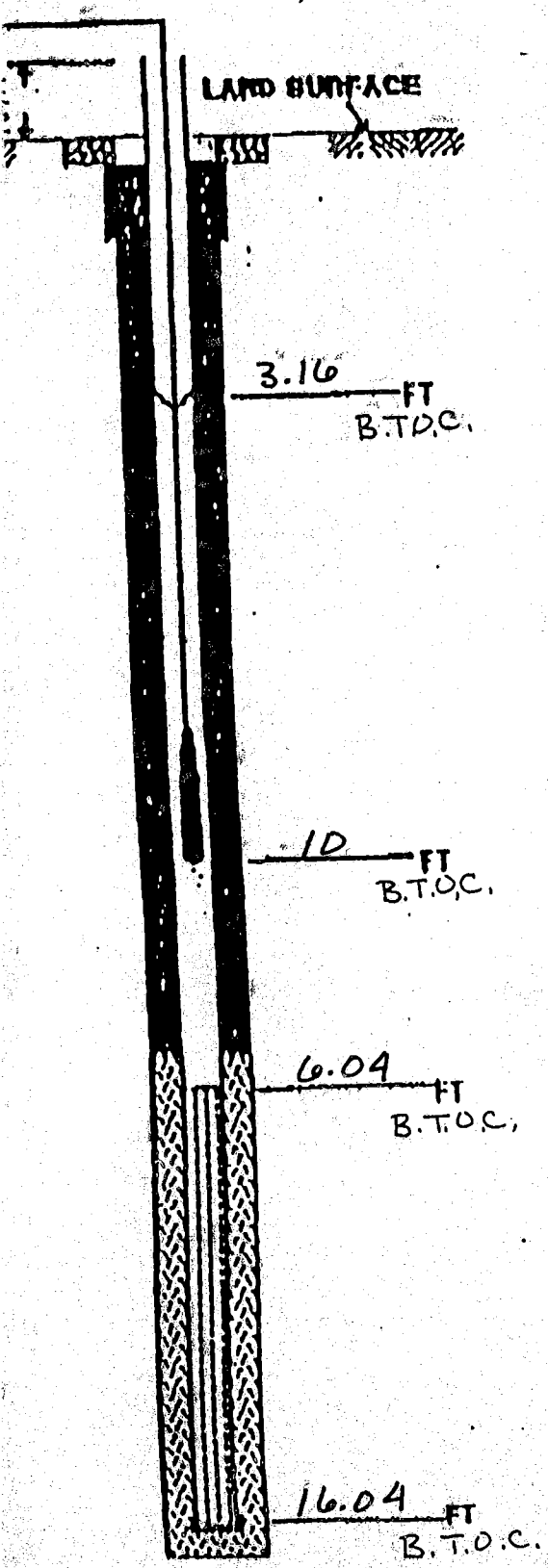
CEF-10-5S RUN 1
(CON'T) PAGE 2
Step 0 06/06 09:44:18

Elapsed Time	INPUT 1
0.4666	0.800
0.4833	0.791
0.5000	0.781
0.5166	0.775
0.5333	0.766
0.5500	0.756
0.5666	0.750
0.5833	0.741
0.6000	0.734
0.6166	0.725
0.6333	0.719
0.6500	0.709
0.6666	0.703
0.6833	0.697
0.7000	0.687
0.7166	0.681
0.7333	0.675
0.7500	0.668
0.7666	0.662
0.7833	0.656
0.8000	0.646
0.8166	0.640
0.8333	0.634
0.8500	0.628
0.8666	0.621
0.8833	0.615
0.9000	0.609
0.9166	0.602
0.9333	0.596
0.9500	0.590
0.9666	0.587
0.9833	0.580
1.0000	0.574
1.2000	0.496
1.4000	0.445
1.6000	0.395
1.8000	0.354
2.0000	0.317
2.2000	0.285
2.4000	0.257
2.6000	0.229
2.8000	0.207
3.0000	0.188
3.2000	0.169
3.4000	0.153
3.6000	0.141
3.8000	0.128
4.0000	0.119
4.2000	0.106
4.4000	0.097
4.6000	0.091
4.8000	0.081
5.0000	0.075
5.2000	0.069
5.4000	0.062
5.6000	0.059
5.8000	0.053
6.0000	0.050
6.2000	0.047
6.4000	0.043
6.6000	0.037
6.8000	0.037
7.0000	0.034

CEF-10-5S RUN 1
(CON'T) PAGE 2
Step 0 06/06 09:44:18

Elapsed Time	INPUT 1
7.2000	0.034
7.4000	0.031
7.6000	0.031
7.8000	0.028
8.0000	0.028
8.2000	0.025
8.4000	0.025
8.6000	0.021
8.8000	0.021
9.0000	0.021
9.2000	0.018
9.4000	0.018
9.6000	0.018
9.8000	0.018
10.0000	0.015

AQUIFER PERFORMANCE TEST
TRANSDUCER CALIBRATION LOG



PROJECT R1/FS OUS 3 4 5 6

PROJECT NUMBER 8520.22

WELL NO. CEF-10-5S PUMPING WELL ____

DATE 6-6-95 TIME 0948

DATA LOGGER SERIAL NO. 1KC01828

TRANSDUCER SERIAL NO. 203736

TRANSDUCER RANGE 10 PSI

CHANNEL NO. Input #1

	R1	R2	R3
TEST DURATION	10	10	10
	SEL 1	step 1	Step 2

TIME OF INSTALLATION 0948

STATIC DEPTH TO WATER 3.16 FT. ____ PSI

DEPTH OF TRANSDUCER 10' B.T.O.C.

CALIBRATION
DEPTH 6 FT 3.01 PSI
DEPTH 7 FT 4.03 PSI
DEPTH 8 FT 5.07 PSI

CLOCKS SYNCHRONIZED? ____

STATIC DEPTH TO WATER 3.16' B.T.O.C.

TIME PUMPING STARTS ____

____ VERIFICATION OF DATA ACQUISITION (HR)
____ VERIFICATION OF DATA ACQUISITION (HR)
____ VERIFICATION OF DATA ACQUISITION (HR)

MAXIMUM PUMPING DEPTH TO WATER ____ FT ____ PSI

TIME PUMPING STOPS ____

MAXIMUM RECOVERY DEPTH TO WATER ____ FT ____ PSI

END RECOVERY ____

RECALIBRATION OF TRANSDUCER
DEPTH ____ FT ____ PSI
DEPTH ____ FT ____ PSI
DEPTH ____ FT ____ PSI