EPA/ROD/R04-02/080
2002

EPA Superfund
Record of Decision:

USN ORLANDO TRAINING CTR
EPA ID: FL6170023711
OU 04
ORLANDO, FL
12/14/2001

TETRA TECH NUS, INC.
800 Oak Ridge Turnpike, A-600 ■ Oak Ridge, Tennessee 37830
(865) 483-9900 ■ FAX: (865) 483-2014 ■ www.tetratech.com

1201-A199

December 14, 2001

Commander, Southern Division
Naval Facilities Engineering Command
ATTN: Ms. Barbara Nwokike, Code ES333
P.O. Box 190010
2155 Eagle Drive
North Charleston, SC 29419-9010

Reference: CLEAN Contract No. N62467-94-D-0888
Contract Task Order No. 0180

Subject: Draft Record of Decision for Operable Unit 4
Former Naval Training Center, Orlando, Florida

Dear Ms. Nwokike:

Enclosed is the draft Record of Decision for Operable Unit 4 for your review and comment. A second copy has been mailed to your attention at Southern Division's Orlando office. Please contact me at (865) 220-4730 if you have any questions regarding the report.

Sincerely,

Michael F. Albert FOR

Steven B. McCoy, P.E.
Task Order Manager

SBM:ckf

Enclosure

c: Ms. Barbara Nwokike, Southern Division (Orlando Office)
Mr. David Grabka, FDEP
Mr. Gregory Fraley, USEPA Region 4
Ms. Debbie Wroblewski, Tetra Tech NUS (cover letter only)
Mr. Mark Perry, Tetra Tech NUS (unbound)
Mr. Steve Tsangaris, CH2M Hill
Mr. Mark Salvetti, Harding ESE
File/db

DRAFT
RECORD OF DECISION
for
OPERABLE UNIT 4

Naval Training Center
Orlando, Florida

Southern Division
Naval Facilities Engineering Command
Contract Number N62467-94-D-0888
Contract Task Order 0180

December 2001

DRAFT
RECORD OF DECISION
FOR
OPERABLE UNIT 4

NAVAL TRAINING CENTER
ORLANDO, FLORIDA

COMPREHENSIVE LONG-TERM
ENVIRONMENTAL ACTION NAVY (CLEAN) CONTRACT

Submitted to:

Department of the Navy, Southern Division
Naval Facilities Engineering Command
2155 Eagle Drive
North Charleston, South Carolina 29406

Submitted by:

Tetra Tech NUS
661 Andersen Drive
Foster Plaza
Pittsburgh, Pennsylvania 15220

CONTRACT NO. N62467-94-D-0888
CONTRACT TASK ORDER 0180

DECEMBER 2001

PREPARED UNDER THE SUPERVISION OF:

STEVEN B. McCOY, P.E.
TASK ORDER MANAGER
TETRA TECH NUS
OAK RIDGE, TENNESSEE

APPROVED FOR SUBMITTAL BY:

DEBBIE WROBLEWSKI
PROGRAM MANAGER
TETRA TECH NUS
PITTSBURGH, PENNSYLVANIA

TECHNICAL DATA CONFORMITY

The Contractor, Tetra Tech NUS, Inc., hereby certifies, to the best of its knowledge and belief, the technical data delivered herewith under Contract No. N62467-94-D-0888 is complete, accurate, and complies with all requirements of this contract. 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.

DATE:

NAME AND TITLE OF CERTIFYING OFFICIAL: Steven B. McCoy, P.E.
Task Order Manager

NAME AND TITLE OF CERTIFYING OFFICIAL: Michael Albert, P.E.
Task Technical Lead

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APPENDICES

TABLES

FIGURES

ACRONYMS

ABB-ES	ABB Environmental Services
ARAR	applicable or relevant and appropriate requirement
bls	below land surface
BRAC	Base Realignment and Closure
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	*Code of Federal Regulations*
COC	chemical of concern
COPC	chemical of potential concern
CSM	Conceptual Site Model
DCE	dichloroethene
DRMO	Defense Reutilization and Marketing Office
EBS	Environmental Baseline Survey
ECOPC	ecological chemical of potential concern
EO	Executive Order
ERA	ecological risk assessment
F.A.C.	*Florida Administrative Code*
FDEP	Florida Department of Environmental Protection
FS	Feasibility Study
GAC	granular activated carbon
GCTL	groundwater cleanup target level
g/L	grams per liter
gpm	gallons per minute
HHRA	human health risk assessment
HI	Hazard Index
HLA	Harding Lawson Associates
HRC™	hydrogen release compound
H_20_2	hydrogen peroxide
ICR	incremental cancer risk
IR	installation restoration
IRA	Interim Remedial Action
$KMnO_4$	potassium permanganate
LUC	Land Use Control
µg/L	micrograms per liter
MCL	Maximum Contaminant Level
MCLG	Maximum Contaminant Level Goal
MNA	monitored natural attenuation
M_nO_2	manganese dioxide
mg/kg	milligrams per kilogram
msl	mean sea level

NAPL	nonaqueous phase liquid
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NEPA	National Environmental Policy Act
NESHAP	National Emissions Standards for Hazardous Air Pollutants
NPL	National Priorities List
NTC	Naval Training Center
O&M	operation and maintenance
OPT	Orlando Partnering Team
OU	operable unit
PAH	polynuclear aromatic hydrocarbon
PCB	polychlorinated biphenyl
PCE	tetrachloroethene
RA	remedial action
RAB	Restoration Advisory Board
RAO	remedial action objective
RCRA	Resource Conservation and Recovery Act
RfD	reference dose
RG	remediation goal
RGO	Remedial Goal Objective
RI	Remedial Investigation
ROD	Record of Decision
SA	Study Area
SARA	Superfund Amendments and Reauthorization Act
SCTL	Soil Cleanup Target Level
SDWA	Safe Drinking Water Act
STP	sewage treatment plant
SVE	soil vapor extraction
SWCTL	surface water cleanup target level
TBC	to be considered
TCE	trichloroethene
TPH	total petroleum hydrocarbons
TtNUS	Tetra Tech NUS, Inc.
UIC	underground injection control
USEPA	U. S. Environmental Protection Agency
USGS	U. S. Geological Survey
UV	ultraviolet
VOC	volatile organic compound
WHPA	Wellhead Protection Area

1.0 DECLARATION OF THE RECORD OF DECISION

1.1 SITE NAME AND LOCATION

Operable Unit (OU) 4 is located at Area C of the former Naval Training Center (NTC), Orlando, Florida (Figure 1-1). OU 4 consists of three former study areas (SAs) which include the Defense Reutilization and Marketing Office [DRMO] Warehouse and Salvage Yard (SA 12), the former base laundry and dry cleaning facility (SA 13), and the DRMO Storage Area (SA 14) (Figure 1-2).

1.2 STATEMENT OF BASIS AND PURPOSE

This decision document presents the selected remedy for OU 4 and was chosen in accordance with the requirements of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA) and, to the extent practicable, the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). Information supporting the selection of this remedy is contained in the Administrative Record for the NTC. The NTC, Orlando Information Repository, including the Administrative Record, is located at the Orlando Public Library, Social Sciences Department, 2nd Floor, 101 East Central Boulevard, Orlando, FL 32801.

The purpose of the selected remedy at OU 4 is to implement a combination of actions to:

- Contain, remove, treat, or restrict access to contaminated groundwater.

- Restrict the future use of soil to nonresidential use through Land Use Controls (LUCs).

These actions must be taken to protect the public and the environment. The U. S. Environmental Protection Agency (USEPA) and the State of Florida concur with the Selected Remedy.

1.3 ASSESSMENT OF THE SITE

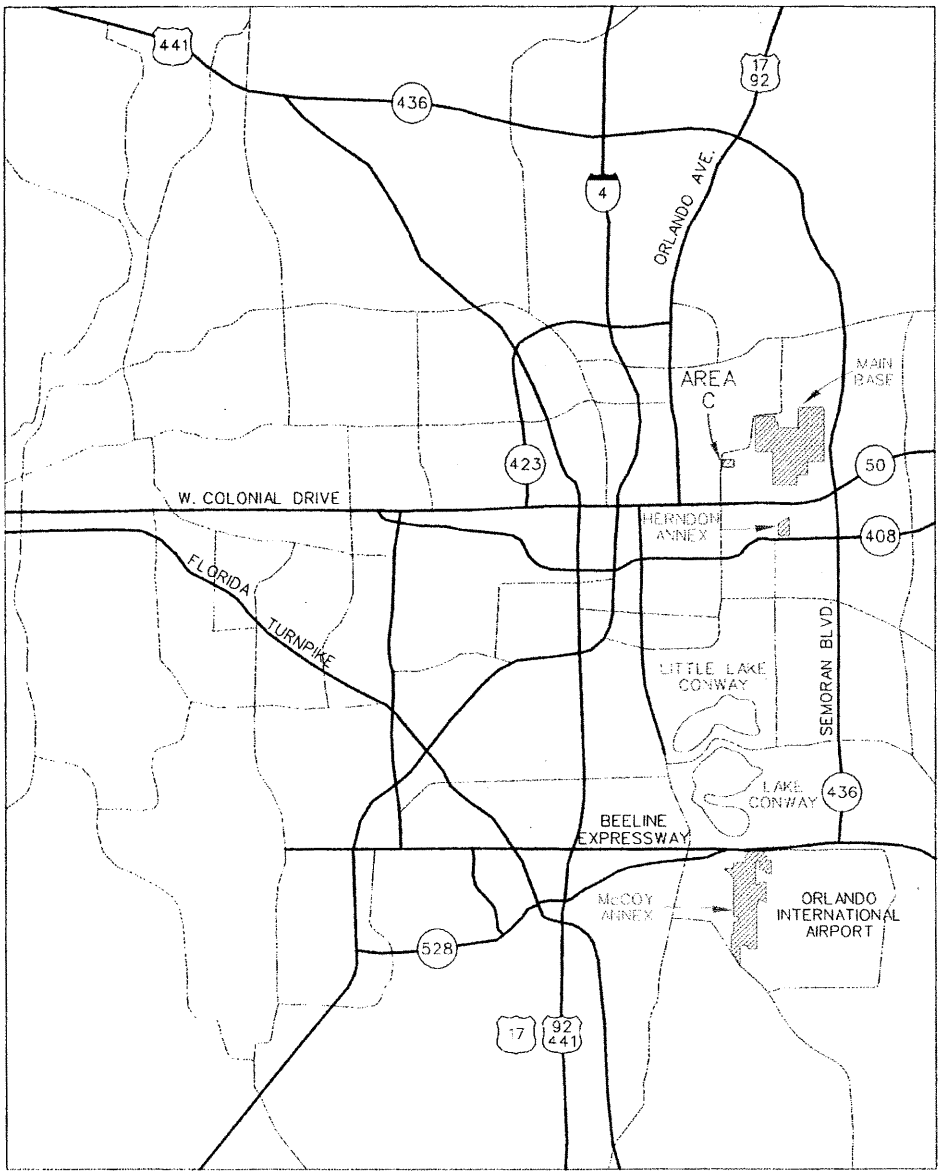
The nature and extent of contamination at OU 4 are described in the Remedial Investigation (RI) (HLA, 2001a). The chemicals of potential concern (COPCs) were identified as primarily tetrachloroethene (PCE) and its degradation products [trichloroethene (TCE), dichloroethene (cis-DCE) and vinyl chloride] in groundwater, and in the surface water and sediment at OU 4. Antimony was also identified as a groundwater COPC.

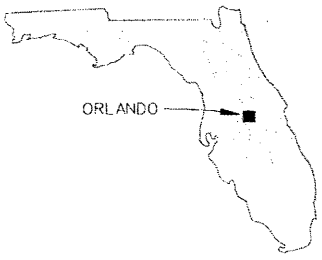
Low concentrations of polynuclear aromatic hydrocarbons (PAHs) were detected in soil at an area of the site that receives stormwater runoff from much of the paved area around OU 4.

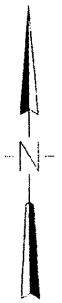
The Feasibility Study (FS) (HLA, 2001b) determined and evaluated the chemicals of concern (COCs) and their exposure routes and receptors for sediment, soil, surface water, and groundwater. Remedial Action Objectives (RAOs) were developed to establish media-specific goals to protect human health and the environment.

Under current site conditions, the potential for exposure to contaminants at OU 4 is minimal because the site is inactive. However, because Area C is expected to be transferred to the City of Orlando under Base Realignment and Closure (BRAC) for reuse, the potential exists that residences could be constructed, and potential exposure to groundwater through drinking and showering could occur.

The cumulative risk associated with future residential exposure to surface soil (5.0E-06), groundwater (2.0E-03), surface water (4.0E-05) exceeds the USEPA acceptable cancer risk range and the Florida Department of Environmental Protection (FDEP) level of concern. The FS (HLA, 2001b) established that the risk drivers are chlorinated volatile organic compounds (VOCs) and antimony in groundwater. Therefore, only RAOs for the groundwater







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SCALE IN MILES

FIGURE 1-1
FACILITY LOCATION MAP
OPERABLE UNIT 4

NAVAL TRAINING CENTER
ORLANDO, FLORIDA

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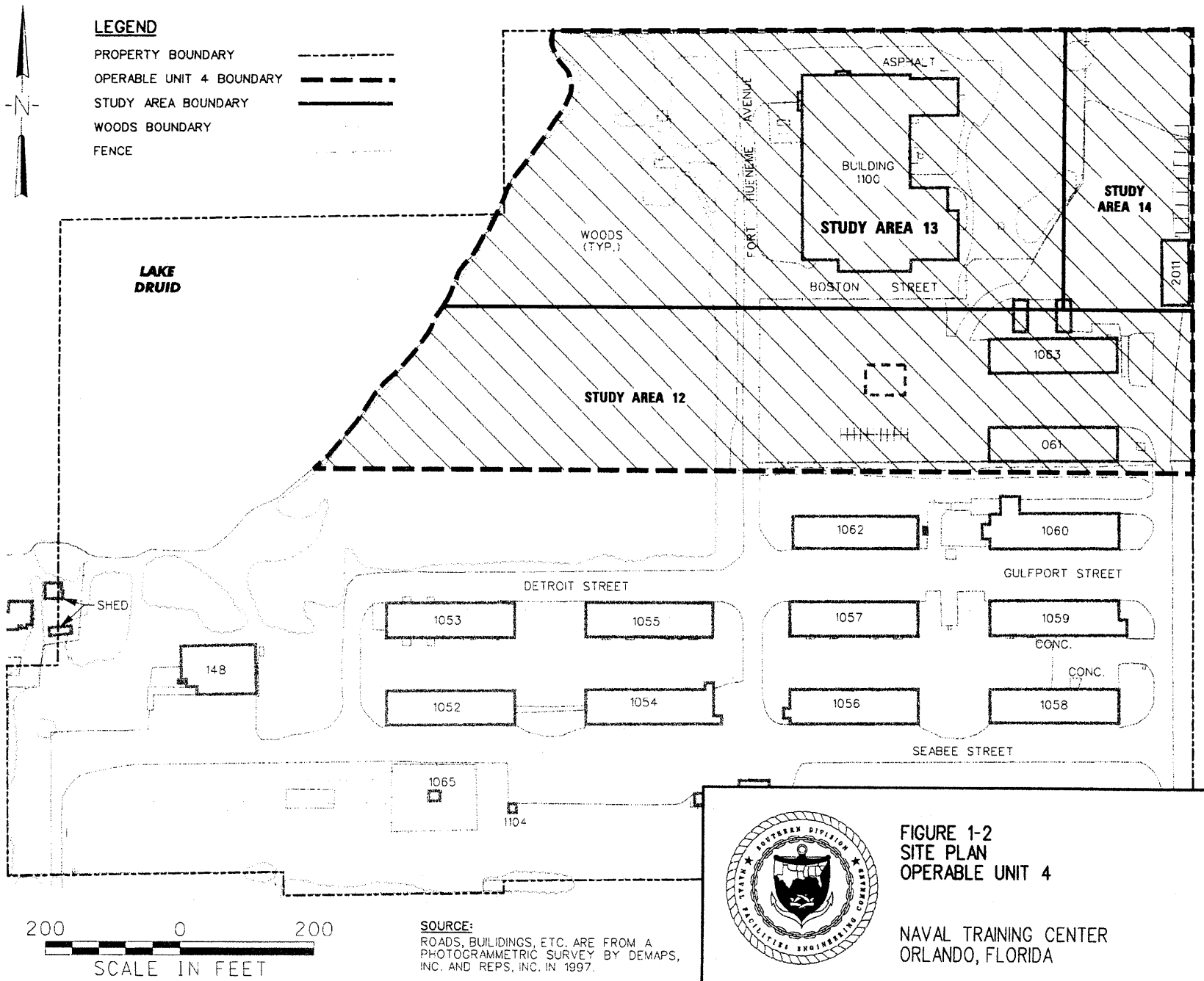

SOURCE:
ROADS, BUILDINGS, ETC. ARE FROM A PHOTOGRAMMETRIC SURVEY BY DEMAPS, INC. AND REPS, INC. IN 1997.

FIGURE 1-2
SITE PLAN
OPERABLE UNIT 4

NAVAL TRAINING CENTER
ORLANDO, FLORIDA

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medium were developed.

Actual or threatened releases of hazardous substances from this site, if not addressed by implementing the selected remedy in this Record of Decision (ROD), present a current and future potential threat to public health and welfare.

1.4 DESCRIPTION OF THE SELECTED REMEDY

This ROD presents the selected remedy which is the final action for OU 4 and is based on results of the RI (HLA, 2001a), the remedial action evaluations presented in the FS (HLA, 2001b) and the Proposed Plan (TtNUS, 2001) which presented the preferred remedy for public comment.

The selected remedy includes implementation of land use controls (LUCs) to restrict future use of the site to nonresidential. Although no RAOs were established for soil at the site, by agreement with the Orlando Partnering Team (OPT) future residential use of the site will be prohibited by deed. The selected remedy focuses on the RAOs established for groundwater.

Two VOC groundwater plumes exist and are referred to as the "northern" plume and the "southern" plume. These two plumes commingle and then discharge to Lake Druid. In addition, there is an antimony groundwater plume located in the southeastern corner of OU 4 that appears to be relatively stationary. Figure 1-3 shows the relative location of the three contamination plumes addressed in this ROD.

The selected remedy for OU 4 is a combination of two alternatives identified in the Proposed Plan: Alternative V-3P, Chemical Oxidation, Pump and Treat (air stripping), Natural Attenuation, and Phytoremediation; and Alternative A-2, Limited Action. Alternative V-3P addresses the VOC contamination in groundwater in the "northern" and "southern" plumes. Alternative A-2 addresses the antimony contamination in groundwater. The major components of the selected remedy are listed below.

- Continued operation of the existing groundwater pump and treat IRA
- In situ chemical oxidation using potassium permanganate ($KMnO_4$)
- Monitored natural attenuation (MNA)
- Phytoremediation
- Long-term groundwater monitoring program
- LUCs to restrict groundwater use and exposure to soil
- 5-year reviews

Overall site requirements include LUCs, long-term groundwater monitoring, and 5-year reviews. The remaining components are related specifically to either the northern VOC plume, the southern VOC plume, or the antimony plume. The following subsections describe the components of the selected remedy.

1.4.1 Overall Site Requirements

LUCs. LUCs will be implemented at OU 4 to prevent exposure to contaminated groundwater and soil. Groundwater use restrictions will minimize the potential risk of using groundwater for drinking water. To control potential exposure to soil, land use plans and property deeds will be annotated to indicate that land use in this area may pose an unacceptable health risk. Future residential use will be prohibited by deed.

Long-term groundwater monitoring. A groundwater monitoring plan will be implemented to:

- Observe the stability of the antimony plume and ensure it remains in the groundwater use restriction boundaries.

- Monitor the concentration of COCs in the Interim Remedial Action (IRA) treatment area.

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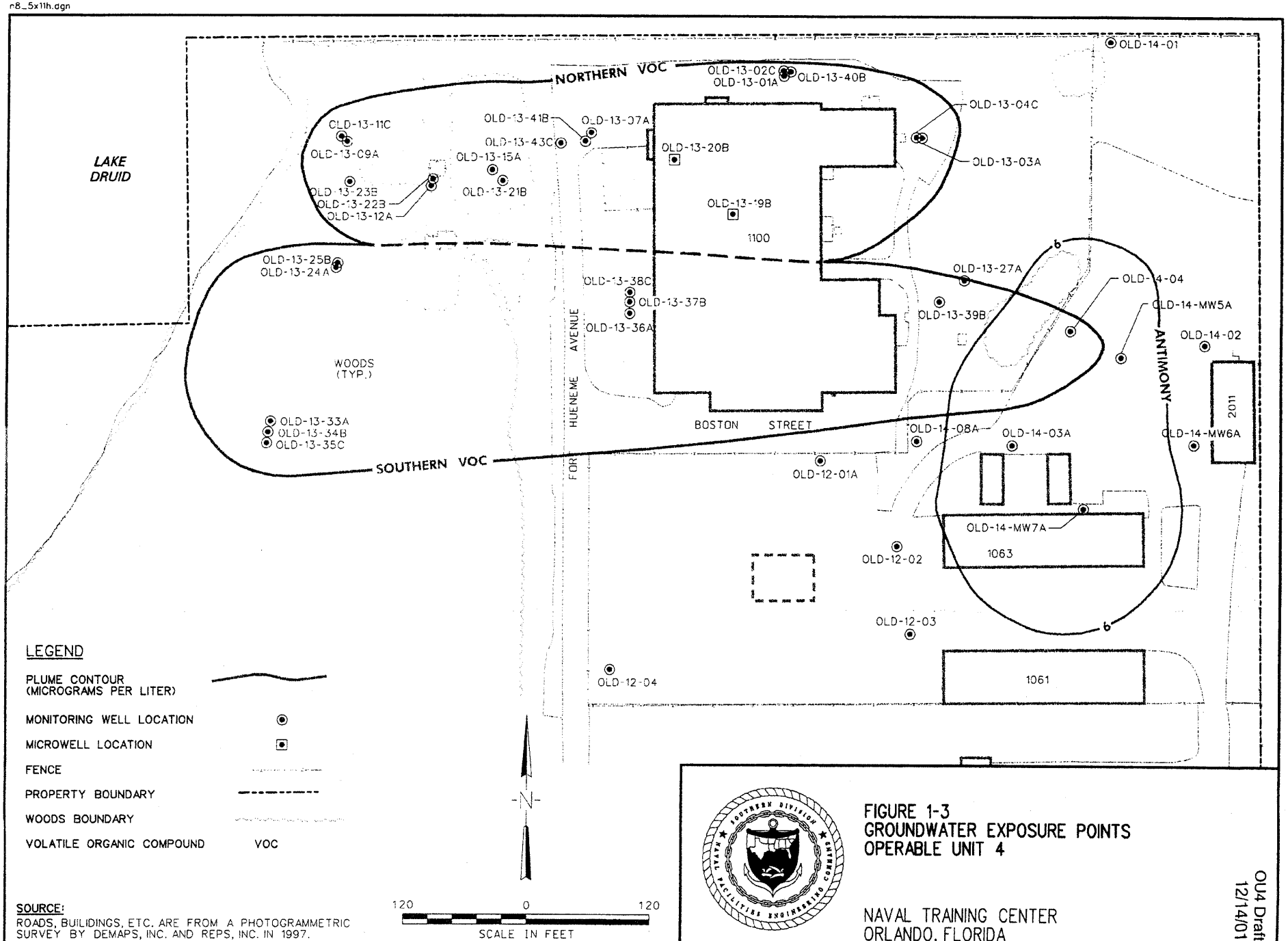

SOURCE:
ROADS, BUILDINGS, ETC. ARE FROM A PHOTOGRAMMETRIC SURVEY BY DEMAPS, INC. AND REPS, INC. IN 1997.

FIGURE 1-3
GROUNDWATER EXPOSURE POINTS
OPERABLE UNIT 4

NAVAL TRAINING CENTER
ORLANDO, FLORIDA

OU4 Draft
12/14/01

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- Monitor the natural attenuation processes to confirm the reduction in VOC concentrations.

- Monitor the phytoremediation process to evaluate its effectiveness in reducing VOC concentrations in northern and southern VOC plume areas.

5-year site reviews. Because hazardous substances will be left in place, this component is required to determine if the selected remedy remains appropriate. Reviews would consist of assessing changes in site conditions (e.g., construction or demolition of buildings overlying the plumes, receptors, or qualitative risks), and assessing field data that may be collected.

1.4.2 Northern VOC Plume

Continued operation of the existing groundwater IRA. This component of the selected remedy will be implemented until the concentrations of organic contaminants in the groundwater decrease to levels low enough that natural processes will "polish" the contaminants to Florida surface water standards. The groundwater IRA consists of two extraction wells and an air stripper. Operation of the IRA includes groundwater monitoring for the COCs in the treatment area. It is expected that the IRA will continue to operate until the extracted groundwater is less than five times the FDEP surface water standards. The estimated time for this operation is 10 years.

In situ chemical oxidation. This component involves injection of $KMnO_4$ into the groundwater (for approximately 6 to 12 months) to chemically destroy the organic contaminants in the source area of the northern VOC plume.

Monitored natural attenuation. Natural attenuation works through nondestructive mechanisms such as dispersion and adsorption and destructive mechanisms such as biodegradation to reduce the levels of contamination. Monitoring will confirm that VOC concentrations are reduced such that surface water standards will continue to be maintained at the Lake Druid shoreline without the IRA well operation.

Phytoremediation. This remediation process makes use of naturally occurring and genetically engineered vegetation to clean up or contain contaminated environmental media. Phytoremediation at OU 4 will include the installation of trees and vegetation such as willow, hybrid poplars and cottonwood trees. (PLANTECO Environmental Consultants, LLC., 2001). These specific trees were selected because they are fast growing, have a deep rooting ability (down to the surface of the groundwater), have large transpiration rates, and are native throughout most of the United States. Based on the results of treatability studies, coupling phytoremediation with natural attenuation processes should significantly enhance the cleanup of PCE and its reductive transformation products in the shallow aquifer at OU 4.

1.4.3 Southern VOC Plume

Continued operation of the existing IRA. The approximate boundary of the IRA capture zone extends into the southern VOC plume; therefore, this component of the selected remedy is part of the remediation for the southern plume.

Monitored natural attenuation. Natural attenuation, as described in Section 1.4.2, is a component of the selected remedy for the southern plume.

Phytoremediation. Phytoremediation, as discussed in Section 1.4.2, coupled with natural attenuation will be implemented for the southern VOC plume.

1.4.4 Antimony Plume

The Proposed Plan identified Alternative A-2, Limited Action, to address the antimony contamination in groundwater. The components of this alternative are LUCs, long-term

groundwater monitoring, and 5- year reviews as described in Section 1.4.1.

1.5 STATUTORY DETERMINATIONS

1.5.1 Statutory Requirements

The selected remedy for groundwater at OU 4 is protective of human health and the environment, complies with Federal and state requirements legally applicable or relevant and appropriate to the remedial action (RA), is cost effective, and utilizes permanent solutions and alternative treatment technologies to the maximum practicable extent.

1.5.2 Statutory Preference for Treatment

For the northern VOC plume and source area, as well as the southern VOC plume, this remedy does satisfy the statutory preference for treatment as a principal element of the remedy (i.e., reduces the toxicity, mobility, or volume of hazardous substances, pollutants, or contaminants through treatment as a principal element).

For the antimony plume, this remedy does not satisfy the statutory preference for treatment as a principal element of the remedy. Because this remedy will result in hazardous substances, pollutants, or contaminants remaining on- site above residential health- based standards, a statutory review will be conducted every 5 years after initiation of the remedial action to ensure the remedy continues to be protective of human health and the environment. If the 5-year review indicates that antimony levels still exceed Florida Maximum Contaminant Levels (MCLs), an appropriate active remedial action option will be selected.

1.6 DATA CERTIFICATION CHECKLIST

The information required to be included in the ROD is summarized on Table 1- 1. These data are presented in Section 2.0, Decision Summary of this ROD. Additional information can be found in the Administrative Record.

1.7 AUTHORIZING SIGNATURES

The undersigned members of the OPT concur with the findings and recommendations of this Record of Decision.

OPERABLE UNIT 4

_____ _____

Gregory Fraley
U. S. Environmental Protection Agency, Region 4 Date

_____ _____

David P. Grabka,
P. G Remedial Project Manager
Florida Department of Environmental Protection Date

_____ _____

Barbara Nwokike
BRAC Environmental Coordinator
U. S. Department of the Navy Date

TABLE 1-1

DATA CERTIFICATION CHECKLIST

OPERABLE UNIT 4
NTC, ORLANDO

Information	ROD Reference
Chemicals of concern (COCs) and their concentrations	Section 2.7.1, Table 2-2
Baseline risk represented by the COCs	Section 2.7.1, Table 2-3
Cleanup levels established for the COCs	Section 2.8
Disposition of source materials constituting principal threats	Section 2.11
Current and reasonably anticipated future land and groundwater use scenarios used for risk assessment and ROD	Section 2.6
Potential land and groundwater uses available at the site as a result of the selected remedy	Section 2.12
Estimated capital, operation and maintenance (O&M), and total present worth costs of selected remedy. Discount rate used and time frame over which these costs are projected	Section 2.12.3, Tables 2-8 and 2-9
Key factors that lead to the selection of the remedy	Section 2.12

2.0 DECISION SUMMARY

2.1 SITE NAME, LOCATION, AND DESCRIPTION

OU 4 is located at Area C of the former NTC, Orlando, Florida (see Figure 1-1). Area C is approximately 46 acres in size and is located approximately 1 mile west of the Main Base. Area C is surrounded by urban development to the north and south, an office park to the east, and Lake Druid to the west.

OU 4 consists of three former SAs which include the DRMO Warehouse and Salvage Yard (SA 12), the former base laundry and dry cleaning facility (SA 13), and the DRMO Storage Area (SA 14) (see Figure 1-2).

2.2 SITE HISTORY AND ENFORCEMENT ACTIVITIES

History of Site Activities

Area C served as a supply center for NTC, Orlando and included the base laundry and dry cleaning facility. The laundry facility is the primary focus for OU 4. The laundry building (Building 1100) was constructed in 1943, and dry cleaning operations began in 1958, possibly earlier. All laundry operations ceased in 1994, and all laundry equipment was removed from the building. Currently, with the pending closure of NTC, Orlando, all Navy activities at Area C have ceased.

Past site activities at OU 4 have caused contamination in both soil and groundwater. Soil contamination was likely caused in three small areas by (1) routine application of pesticides containing arsenic or (2) releases of either fuel or products of combustion in the form of polynuclear aromatic hydrocarbons (PAHs). Studies have shown that the improper handling of solvents used at the base laundry led to groundwater contamination.

History of Site Investigations and Removal and Remedial Actions

NTC, Orlando is not listed on the National Priorities List (NPL); therefore, RA is not directed by CERCLA. Remedial Action at NTC, Orlando is directed by the Navy's Installation Restoration (IR) program. The IR program is conducted using CERCLA for guidance. The program structure and terminology of the IR program are discussed in detail in Chapter 1.0 of the RI report (HLA, 2001 a).

A comprehensive RI was performed for OU 4 from September 1997 to March 1998. The final RI report was issued in January 2001 (HLA, 2001 a). The FS for OU 4 was issued in February 2001 (HLA, 2001 b). The Proposed Plan (TtNUS, 2001) was issued for public comment in October 2001. Table 2-1 summarizes the investigative history for this site.

Two IRAs have been implemented at OU 4: a groundwater IRA was initiated in January 1998 and is still underway, and a soil IRA was conducted in May 1999 (Figure 2-1).

The groundwater IRA originally consisted of two recirculation wells to reduce VOC concentrations in the groundwater entering Lake Druid. By the spring of 2000, mechanical problems in these wells prevented effective control of the flow of VOCs toward Lake Druid. In May 2000, an attempt was made to rehabilitate the wells, but was not successful. A replacement IRA was designed using the existing recirculation wells for a conventional groundwater extraction and treatment system featuring a tray-type air stripper. This system was installed and became operational in January 2001. The system is expected to remain operational during the implementation of the RA for this site.

The soil IRA remediated approximately 32 tons of contaminated soil at three locations by excavation and disposal in a landfill licensed and approved by the State of Florida. The soil was replaced with clean fill. Results of confirmation samples indicated the sites were cleaned up to FDEP Soil Cleanup Target Levels (SCTLs).

There is no history of CERCLA Enforcement Activities for this site.

2.3 HIGHLIGHTS OF COMMUNITY PARTICIPATION

The RI report (HLA, 2001 a), the FS report (HLA, 2001 b), and the Proposed Plan (TtNUS, 2001) for OU 4 were made available to the public for review in October 2001. These documents and other IR program information are contained within the Administrative Record in the Information Repository at the Orlando Public Library, Orlando, Florida.

Publication of the notice of availability of the RI report, FS report, and Proposed Plan in The Orlando Sentinel in October 2001 targeted the communities closest to NTC, Orlando. The notice of availability presented information on OU 4 and invited community members to submit written comments on the Proposed Plan.

A public comment period was held from October 1 through October 30, 2001, to solicit comments on the Proposed Plan. The comment period included an opportunity for the public to request a public meeting; however, a public meeting was not held because one was not requested. The RI report (HLA, 2001a), FS report (HLA, 2001b), and the Proposed Plan (TtNUS, 2001) were presented to the NTC, Orlando Restoration Advisory Board (RAB) and the public at advertised meetings. Representatives from NTC, Orlando, Southern Division Naval Facilities Engineering Command, USEPA, FDEP, and the Navy's environmental consultants participated in these meetings. No comments were received during the public comment period (Appendix A).

The RAB is a group consisting of representatives from various governmental agencies (NTC, USEPA, FDEP, Orlando NTC Reuse Commission) and community members. The RAB works as a partner in an advisory capacity with the NTC BRAC Base Cleanup Team on cleanup issues that involve the affected community. The RAB makes information available for public participation and provides a forum to discuss concerns and issues relating to the IR Program. RAB meetings are open to the public and their quarterly meetings are publicized in The Orlando Sentinel.

2.4 SCOPE AND ROLE OF REMEDY SELECTED FOR OU 4

There are four noncontiguous parcels of land that are collectively referred to as the former NTC, Orlando facility: Main Base, Area C, Herndon Annex, and McCoy Annex (see Figure 1-1). OU 4, the subject of this ROD, is the only operable unit at Area C.

Investigations at OU 4 have indicated that soil and groundwater contamination pose unacceptable risks to human receptors. The remedy selected for OU 4 will contain, remove, treat, or restrict access to contamination in order to protect the public and the environment.

2.5 SITE CHARACTERISTICS

The following subsections summarize the site characteristics for OU 4.

2.5.1 Site Overview

OU 4 is located within Area C of the former NTC, Orlando, Florida (see Figure 1-1). Area C is approximately 46 aces in size and is located approximately 1 mile west of the Main Base. Area C is surrounded by urban development to the north and south, an office park to the east, and Lake Druid to the west.

At Area C, the surface elevation ranges from 110 to 115 feet above mean sea level (msl) throughout most of the eastern and southern parts of the property. In the northwest corner of the property, the land surface slopes gently westerly down toward Lake Druid. The major surface water feature at Area C is Lake Druid, which straddles the western boundary of the property. Near the lake the land surface elevation measures approximately 100 feet above msl.

TABLE 2-1

INVESTIGATIVE HISTORY

OPERABLE UNIT 4
NTC, ORLANDO

PAGE 1 OF 3

Date	Investigation Title	Activities	Findings
1994	*Base Realignment and Closure (BRAC) Environmental Baseline Survey Report, Naval Training Center (NTC), Orlando, Florida* (ABB-ES, 1994)	• Aerial photos and site historical records were collected and reviewed. • Site walkovers were performed.	• Study Area (SA) 12, SA 13, and SA 14 were identified as areas of potential concern. • Reported several historical spills/releases of PCE.
1995	*BRAC Site-Screening Report, NTC, Orlando, FL* (ABB-ES, 1996a)	• Performed geophysical surveys, surface and subsurface soil sampling, monitor well installation. • Performed shallow and deep groundwater sampling.	• Confirmed that chlorinated VOCs (PCE, TCE and DCE) had been released to the environment at all three SA's. The SA's were combined as OU 4 for administrative purposes. Antimony was also detected in groundwater above Florida drinking water standards
1996	*Interim Remedial Action Focused Field Investigation Report, Operable Unit 4, NTC, Orlando, FL* (ABB-ES, 1996b)	• Sampled Lake Druid surface water to evaluate the source of contamination.	• Identified chlorinated VOC plume migrating westerly from Building 1100 and into Lake Druid.
1996	*Interim Remedial Action Study: Pumping Test Implementation and Results, NTC, Orlando, FL* (ABB-ES, 1996d)	• Implemented 18-hour constant rate pumping test to provide characteristic aquifer parameters.	• Test data were used to support modeling effort by US Geological Survey (USGS). Horizontal and vertical hydraulic conductivity values were calculated.
1997	*Focused Feasibility Study, Operable Unit 4, NTC, Orlando, FL* (ABB-ES,1997c)	• Evaluated technologies for an IRA to mitigate the chlorinated VOC contamination of the lake.	• Two recirculation wells were installed in December 1997 to intercept and treat the plume.
1997	*Technical Memorandum, Interim Remedial Action, Focused Investigation/Source Confirmation, Building 1100 Surge Tank, NTC Orlando, FL* (ABB-ES, 1997b)	• Performed soil and groundwater sampling beneath laundry building using Terra Probe^{SM} • Evaluated extent of source area.	• VOCs present within the surficial acquifer beneath the floor and on the north side of Building 1100. • A primary source area likely exists beneath the floor of the laundry. • Multiple source areas are likely contributes to groundwater VOC contamination.

TABLE 2-1

INVESTIGATIVE HISTORY

OPERABLE UNIT 4
NTC, ORLANDO
PAGE 2 OF 3

Date	Investigation Title	Activities	Findings
1997	*Interim Remedial Action Focused Field Investigation Report, Operable Unit 4, NTC Orlando, FL* (ABB-ES, 1997e)	• Sampled surface water, sediment, and groundwater, using a TerraProbe™, cone penetrometers, permanent wells.	• Determined pathway for VOC contaminant migration to Lake Druid is groundwater.
1998	*Assessment of the Potential Effects of Phytoremediation on Groundwater Flow Around Area C at Orlando NTC, Florida. Water-Resources Investigations Report* 98-41110 (USGS, 1998)	• USGS investigated applicability of phytoremediation at OU 4	• Under current conditions, phytoremediation alone at OU 4 cannot stop discharge of contaminants to Lake Druid, however, could have a role as a final remediation step.
1998	*Treatability Study, Technical Memorandum No. 1, Natural Attenuation Assessment, Operable Unit 4, NTC, Orlando, FL* (HLA, 1998)	• Evaluated the potential for natural attenuation of the chlorinated VOCs in groundwater.	• Evaluations confirmed that anaerobic dechlorination of source contaminants is occurring in situ. • Biodegradation was evident near the source and in deeper zones. • Conditions in plume were not sufficient for complete degradation of VOCs.
1998	*Treatability Study Work Plan No. 2, Data Collection Plan for Assessing Air Sparging, Operable Unit 4, NTC, Orlando, FL* (ABB-ES, 1998a)	• Conducted air sparge testing in May 1998.	• Pilot test indicated air sparging could be technically feasible.
1997-1998	*Remedial Investigation, Operable Unit 4, Study Areas 12, 13, and 14 (Area C), NTC, Orlando, FL* (HLA, 2001 a)	• Assessed nature and extent of contamination in soil and groundwater for all Study Areas at OU 4. • Performed Human Health Risk • Assessment and Ecological Risk Assessment.	• HHRA indicated risks to human health at OU 4. • Recommended FS to evaluate remedial alternatives.

TABLE 2-1

INVESTIGATIVE HISTORY

OPERABLE UNIT 4
NTC, ORLANDO

PAGE 3 OF 3

Date	Investigation Title	Activities	Findings
1999-2000	*Operable Unit 4-Interim Remedial Action Fourth Quarter Monitoring and Groundwater Quality Report, NTC, Orlando, FL* (CH2MHill Constructors, Inc., 2000)	• Began transition of system O&M to CCI. • Evaluated system performance and analytical data.	• Overall trend indicated decrease in total VOC concentrations. • Difficulties in maintaining hydraulic performance of system.
2000	*Treatability Study Work Plan No. 3, Data Collection Plan for Assessing In Situ Chemical Oxidation, Operable Unit 4, NTC, Orlando, FL* (HLA, 2000)	• Pilot study to evaluate in situ chemical oxidation issuing Km_nO_4 as a source remedial alternative	• PCE concentrations could be reduced by 99.995% with this technology, however, observed in the shallow zone. • Reductions in deeper zone occurred more slowly, but system improvements can be implemented to increase efficiency. • Pilot study indicated this is a viable, effective alternative and can be readily implemented.
2001	*Feasibility Study, Operable Unit 4, NTC, Orlando, FL* (HLA, 2001b)	• Evaluated several remedial technologies and estimated their costs.	• In situ VOC Plume remediation and Antimony Plume Monitoring Report demonstrated emphasis should be placed on findings.
2001	*Former NTC, Orlando, FL, Proposed Plan, Operable Unit 4* (Tetra Tech NUS, 2001)	• Preferred remedy for OU 4 was issued for public comment.	• Alternative V-3P, Chemical Oxidation, Natural Attenuation, and Phytoremediation are proposed to remediate VOCs in groundwater. • For the antimony plume, proposed Alternative A-2, Limited Action to monitor the apparently stable plume. • Selected remedy assumes continued operation of groundwater IRA pump and treat system.

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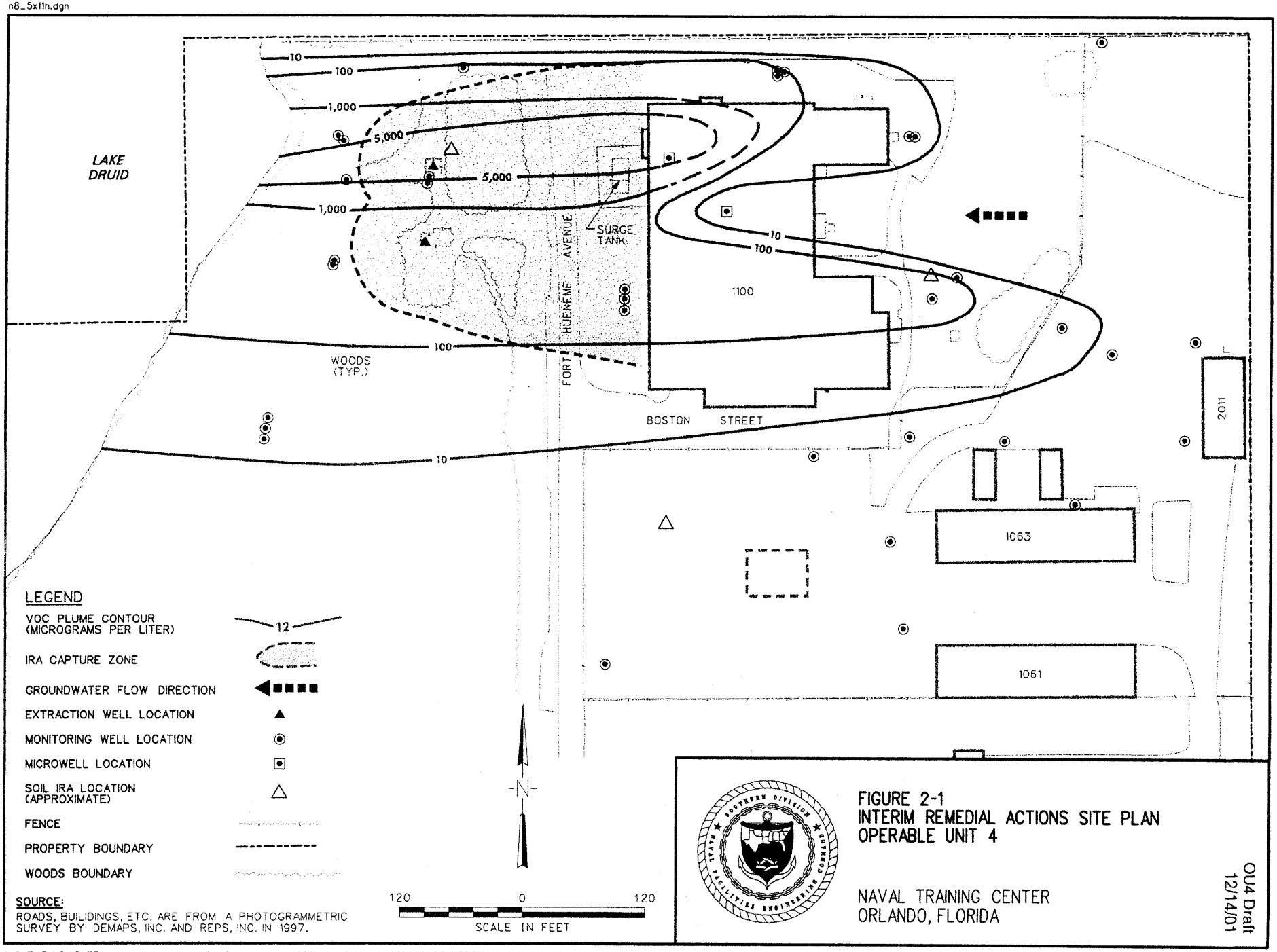

SOURCE:
ROADS, BUILDINGS, ETC. ARE FROM A PHOTOGRAMMETRIC SURVEY BY DEMAPS, INC. AND REPS, INC. IN 1997.

FIGURE 2-1
INTERIM REMEDIAL ACTIONS SITE PLAN
OPERABLE UNIT 4

NAVAL TRAINING CENTER
ORLANDO, FLORIDA

OU4 Draft
12/14/01

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The lake basin area is approximately 150 acres. The lake captures storm runoff from surrounding neighborhoods and small intermittent streams. No stormwater runoff from Area C is discharged directly to Lake Druid. The primary means of stormwater control is by infiltration. Approximately one-third of the lake is surrounded by the undeveloped portion of Area C. This land is mostly forested, and the shoreline is thick with floating emergent plants. A drainage swale east of Port Hueneme Avenue collects stormwater and is directed by a culvert into a wooded area to the west.

2.5.2 Geology and Hydrogeology

The RI report established that the aquifer of primary interest to the groundwater investigation at OU 4 is the Surficial Aquifer. The Holocene and Pleistocene unit that contains the Surficial Aquifer is primarily composed of sand with varying amounts of silt and clay. The Surficial Aquifer is present throughout central Florida and, with the exception of isolated areas, is an unconfined groundwater system. At OU 4, groundwater flow in the Surficial Aquifer is primarily horizontal and flows westerly toward Lake Druid. The entire thickness of the surficial sand (from the water table to the top of the Hawthorne Group) is available for the potential transport of contaminants.

The specific information below has a direct effect on the migration pathway.

- Stratigraphic information obtained within the surficial aquifer indicates the subsurface is relatively homogeneous, composed of fine sand.

- The soil density of the surficial aquifer typically ranges from medium dense to dense, with the exception of a hard layer approximately 15 to 20 feet below land surface (bls), with varying thickness averaging about 5 feet. However, this hard layer does not act as a hydraulic or chemical confining layer or barrier.

- Analysis of pumping test data indicated that the surficial aquifer can be separated into two zones. From the groundwater surface to approximately 20 to 25 feet bls, the horizontal hydraulic conductivity is about 10 ft/day. Below that point to approximately 55 feet bls, the horizontal hydraulic conductivity is about 40 ft/day. In both zones, the vertical hydraulic conductivity was determined to be about three times lower than the horizontal hydraulic conductivity.

During the source investigation (ABB-ES, 1997b), PCE concentrations analyzed from groundwater samples collected via TerraProbe™ suggested the strong possibility that a source area of residual nonaqueous phase liquid (NAPL) is present beneath the former laundry building, possibly at more than one location (Figure 2-2). The highest VOC concentrations in groundwater (up to 34,000 µg/L of PCE) were detected in the vicinity of the surge tank and beneath the laundry building. These concentrations (over 20 percent of the theoretical PCE solubility) are consistent with the presumed presence of residual PCE in the source area.

2.5.3 Conceptual Site Model

The Conceptual Site Model (CSM) provides the basis for the risk assessment and response action. The CSM provides the framework within which the source and release mechanism, transport of contaminants, and environmental pathways of concern are identified. The current version of the CSM is represented by the Project Logic Diagram (Figure 2-3). The contaminant sources are the fluids associated with the dry cleaning processes at Building 1100. Source areas and release mechanisms are identified as those areas where releases of chlorinated solvents are documented or believed to have occurred and have migrated into the environment. These contaminants may affect multiple receptors through one or more exposure pathways. The FS (HLA, 2001b) contains detailed discussions which elaborate on the components of the CSM.

2.5.4 Sampling Strategy

OU 4 was initially investigated during a BRAC Environmental Baseline Survey (EBS) conducted in 1994 which included a records search and site walkovers (ABB-ES, 1994). Based on the findings of the EBS, a site screening investigation at SAs 12, 13 and 14 began in January 1995. The Site Screening Report (ABB-ES, 1996a) included results of groundwater sampling, a soil gas survey, sediment sampling, and surface water sampling.

A Focused Field Investigation was conducted in May 1996 (ABB-ES 1996b) to delineate the VOC contamination in groundwater along the lakeshore and in surface water and sediment.

In March and April 1997, a Focused Investigation/Source Confirmation (ABB-ES 1997b) was conducted. The TerraProbe™ was used to collect groundwater and subsurface soil samples.

The RI field investigation was conducted between September 1997 and March 1998. Data were collected to determine the nature and extent of releases of site-derived contaminants in surface and subsurface soil; to identify potential pathways of migration in surface and subsurface soil, groundwater and surface water; and to evaluate risks to human and ecological receptors. The receptors evaluated in the human health and ecological risk assessments are discussed in Sections 2.7.1 and 2.7.2, respectively. The RI field investigation at OU 4 included

- Installation and sampling of 11 monitoring wells, and 5 microwells.
- Sampling of 25 existing monitoring wells and 5 drive points.
- Collection of 11 surface soil samples (grouped with results from 9 previously collected surface soil samples).
- Collection of 20 subsurface soil samples.
- Collection of 11 surface water and sediment samples.

Figures detailing sampling locations are provided in the RI report (HLA, 2001a).

2.5.5 Contaminants and the Affected Media

The RI identified contamination in OU 4 groundwater, surface soil, subsurface soil, surface water, and sediment. Surface soil contamination was addressed by an IRA in May 1999 (HLA, 2001a). Consideration of the fate and transport of the identified contaminants established that remediation of groundwater at OU 4 would also address contamination found in all other remaining media. Groundwater COCs at OU 4 include chlorinated VOCs (PCE, TCE, and DCE) and antimony.

The areal extent of the VOC contamination in groundwater reported in the RI is shown on Figure 2-2. The highest VOC concentrations in groundwater are in the shallow portion of the aquifer (less than 20 feet bls) and were detected in the vicinity of the surge tank and beneath the laundry building. These concentrations are consistent with the presumed presence of residual PCE in the source area. Figure 2-2 identifies this suspected source area.

Antimony was detected in groundwater at SA 14, but not in soil. Figure 2-4 shows the antimony plume. The affected area is approximately 300 feet in diameter and, as stated in the FS report, does not appear to have migrated substantially during the years 1995-1998.

2.5.6 Sources of Contamination

VOCs

The source of VOC contamination has been identified as PCE associated with the industrial laundry and dry cleaning facility during its operation from 1943 to 1994. The probable contaminant source and release mechanisms at OU 4 are:

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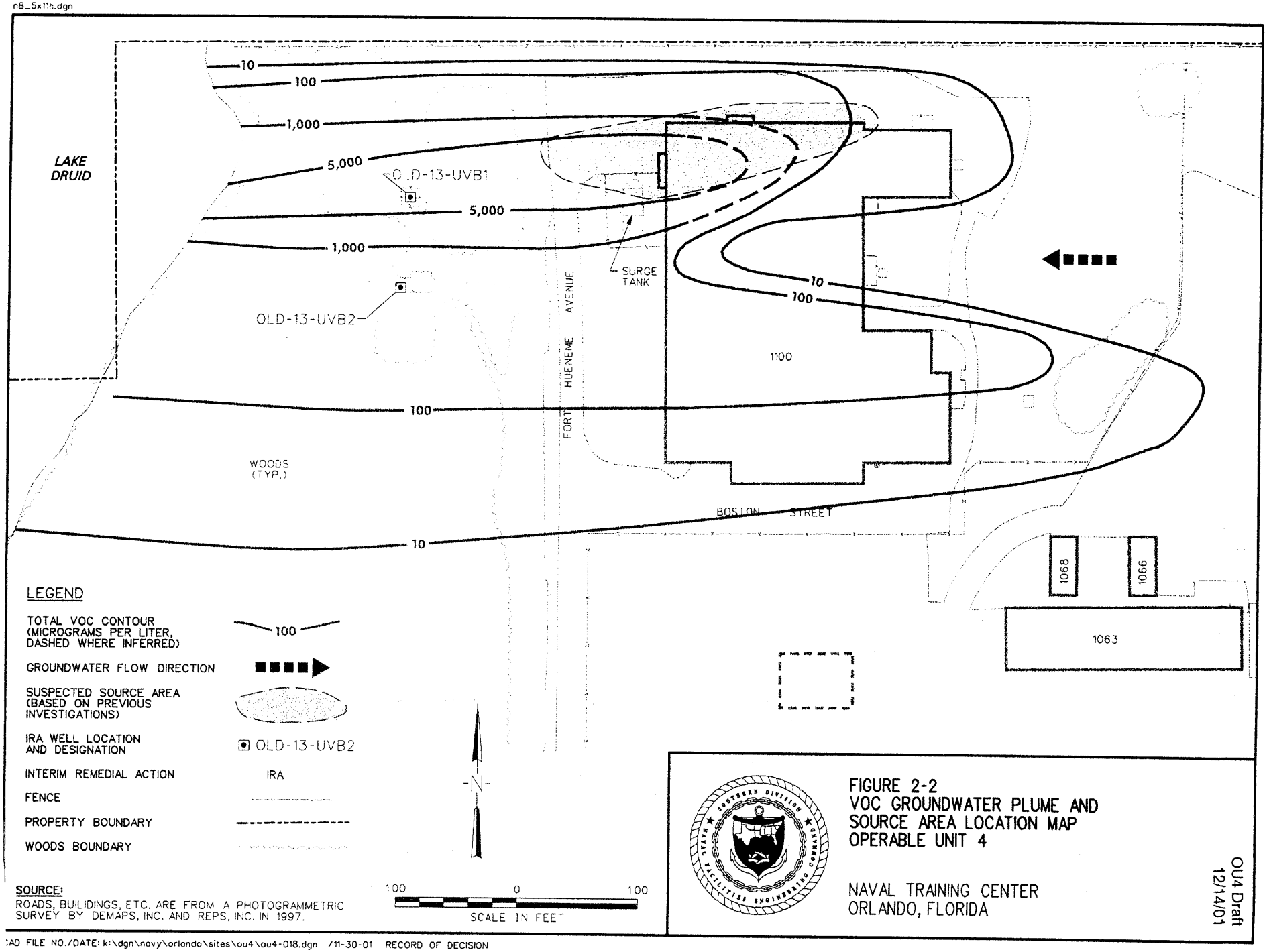

SOURCE:
ROADS, BUILIDINGS, ETC. ARE FROM A PHOTOGRAMMETRIC SURVEY BY DEMAPS, INC. AND REPS, INC. IN 1997.

FIGURE 2-2
VOC GROUNDWATER PLUME AND SOURCE AREA LOCATION MAP
OPERABLE UNIT 4

NAVAL TRAINING CENTER
ORLANDO, FLORIDA

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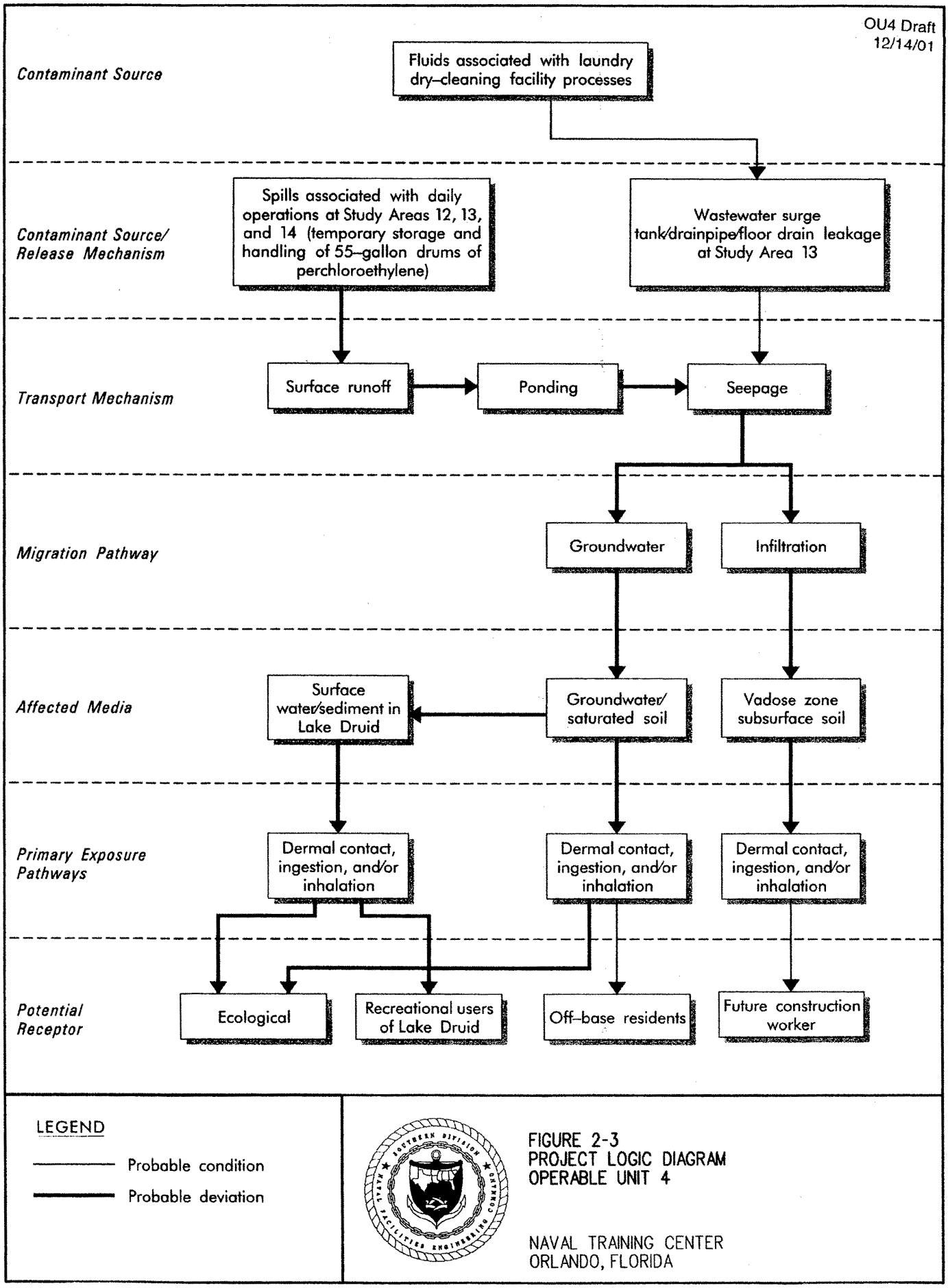

FIGURE 2-3
PROJECT LOGIC DIAGRAM
OPERABLE UNIT 4

NAVAL TRAINING CENTER
ORLANDO, FLORIDA

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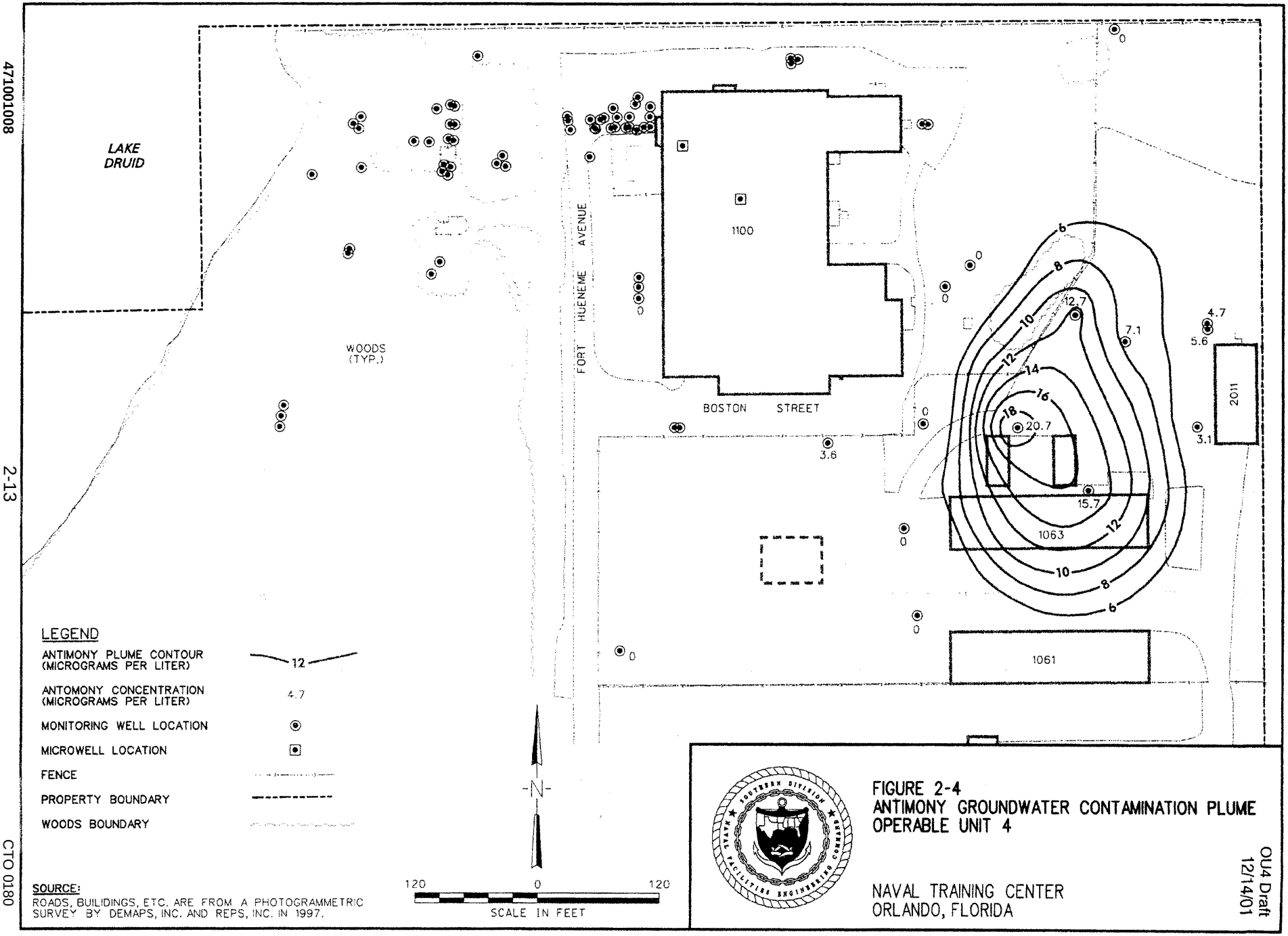

SOURCE:
ROADS, BUILDINGS, ETC. ARE FROM A PHOTOGRAMMETRIC SURVEY BY DEMAPS, INC. AND REPS, INC. IN 1997.

FIGURE 2-4
ANTIMONY GROUNDWATER CONTAMINATION PLUME
OPERABLE UNIT 4

NAVAL TRAINING CENTER
ORLANDO, FLORIDA

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- Operational spills on the ground surface outside the building during the loading and unloading of containers of PCE (ranging from 5-to 55-gallon containers).

- Leaks associated with the collection and transport of wastewater from laundry and dry cleaning machines.

- Spills inside the building transferring via leaks in floor drains, drainpipes, the surge tank, and/or sanitary sewer pipes and migrating to the subsurface.

- Contaminated groundwater appears to be the source of VOCs detected in Lake Druid. It has been estimated that approximately 25 pounds per year of total VOCs enter Lake Druid via groundwater. Approximately 1-5 pounds of VOCs are present in Lake Druid sediment (ABB-ES, 1997c).

Antimony

Antimony was detected in groundwater at SA 14. Antimony data are only available for the shallow (less than 20 feet bls) portion of the surficial aquifer. The affected area is limited (approximately 300 feet in diameter). No known site-related source for the antimony contamination has been identified. Antimony was not detected in soil at SA 14. However, antimony is often used as a flame retardant for clothing. It is possible that antimony was used by the laundry facility for this purpose, and an undocumented release occurred in the vicinity of SA 14.

2.5.7 Location of Contamination/Migration Pathways

VOCs detected in groundwater at depths ranging from 4 to 68 feet bls include the chlorinated solvent PCE and its degradation products TCE, cis-DCE, and vinyl chloride. The highest PCE concentrations are in the shallow portion of the aquifer (less than 20 feet bls). The migration pathways listed below show the route by which the chlorinated solvents migrate.

- Chlorinated solvents infiltrate through the vadose zone into the groundwater by separate phase gravity drainage as well as by dissolution into infiltrating rainwater.

- Groundwater in the vicinity of Building 1100 flows in a westerly direction toward Lake Druid, thereby "carrying" dissolved-phase VOCs to the lake.

Figure 2-2 shows that the "northern" chlorinated solvent plume originates at the suspected source area at the northern and northwestern end of Building 1100. A second much lower concentration chlorinated solvent plume exists at the southern end of Building 1100. This plume appears to originate near the southeast corner of Building 1100 or the southern end of SA 14. These two plumes, referred to as the Northern VOC Plume and the Southern VOC Plume, commingle then discharge to Lake Druid.

2.6 CURRENT AND POTENTIAL FUTURE LAND AND WATER USES

2.6.1 Land Uses

Current on-site land uses

With the pending closure of NTC, Orlando, all Navy activities at Area C have ceased. Laundry operations at SA 13 ceased in the fall of 1994, and the facility is currently inactive.

Current adjacent/surrounding land uses

Area C is surrounded by urban development, including single- and multifamily residential developments to the north and south, Lake Druid to the west, and an office park to the

east. Approximately one-third of the lake is surrounded by undeveloped land to the east, owned by NTC, Orlando. The remainder of the lake is surrounded by residential properties.

Future land uses

NTC, Orlando is currently undergoing closure under the BRAC program. The BRAC Cleanup Plan (ABB-ES, 1996c) proposes continued industrial use. As stated in the FS, " by agreement with the OPT, future residential use of the site will be prohibited by deed."

2.6.2 Groundwater and Surface Water Uses

Current uses – Groundwater

According to City of Orlando records, no permitted irrigation or domestic wells are present within the vicinity of OU 4. There are no production wells within ½ mile of OU 4.

Groundwater from the Surficial Aquifer at OU 4 is not currently used as a potable water source. All past and current drinking water at NTC, Orlando and surrounding areas has been derived from an aquifer at great depth (primarily the Floridan aquifer) and has been provided by the Orlando Utility Commission. There is no evidence of a direct connection between the shallow aquifer and the primary potable water supplies at NTC, Orlando; therefore, the water supply aquifer is not likely to be affected by the contamination at OU 4.

Current Uses – Surface Water

Lake Druid is a Class III surface water body, as described in Chapter 62-302 Florida Administrative Code (F.A.C.), Secondary Water Quality Standards. Class III water use is primarily for recreation and propagation/maintenance of a healthy, well-balanced population of fish and wildlife. Lake Druid is primarily used for recreational purposes (i.e., swimming, boating, and fishing).

Potential Future Uses - Groundwater

The State of Florida has classified groundwater at OU 4 as G-II, indicating that it is a potential future source of drinking water for the state.

Potential Future Use – Surface Water

Lake Druid will continue to be used for recreational purposes.

2.7 SUMMARY OF SITE RISKS

In the RI, a risk assessment was completed for OU 4 to predict whether the site would pose current or future threats to human health or the environment. Both a Human Health Risk Assessment (HHRA) and an Ecological Risk Assessment (ERA) were performed. The baseline risk assessment estimates the risks the site poses if no action were taken. It provides the basis for taking action and identifies the contaminants and exposure pathways that need to be addressed by the remedial action. The HHRA and the ERA evaluated the contaminants detected in site media during the RI and provided the basis for selecting the RA.

2.7.1 Human Health Risk Assessment

An HHRA was conducted for OU 4 to characterize the risks associated with potential exposures to site-related contaminants for human receptors. The HHRA is provided in Chapter 8 of the RI report (HLA, 2001a). The major sections of the HHRA included (1) identification of COCs, (2) exposure assessment, (3) toxicity assessment, and (4) risk characterization.

Identification of Chemicals of Concern. Table 2-2 summarizes the human health COCs selected for groundwater at OU 4. These chemicals were the focus of the baseline risk assessment.

TABLE 2-2

SUMMARY OF HUMAN HEALTH CHEMICALS OF CONCERN AND EXPOSURE POINT CONCENTRATIONS FOR GROUNDWATER

OPERABLE UNIT 4
NTC, ORLANDO

Exposure Point (ingestion of drinking water)	Chemical of Concern	Concentration Detected (µg/L)		Frequency of Detection(1)	Exposure Point Concentration (2) (µg/L)
		Min	Max		
Northern VOC Plume	cis-1,2,-Dichloroethene	1	1,650	10/16	350
	Tetrachloroethene	2	29,800	10/16	1,900
	Trichloroethene	0.7	2,475	11/16	410
Southern VOC Plume	cis-1,2,-Dichloroethene	1	43.6	5/8	12
	Tetrachloroethene	2	390	6/8	110
	Trichloroethene	2	105	7/8	23
Antimony Plume	Antimony	7.1	20.7	4/4	14.1

(1) Frequency of detection is the number of samples in which the analytes was detected over the total number of samples analyzed.
(2) Exposure point concentration is the lower of either the arithmetic mean or maximum detected concentration.

Exposure Assessment. The pathways by which humans are potentially exposed to COCs, the magnitude of actual or potential exposure, and frequency and duration of exposure is presented in Section 8.3 of the RI.

Currently, no humans reside at OU 4, and groundwater is not used for any potable or nonpotable use. However, if OU 4 were developed for residential use, exposure to future adult and child residents (ingestion of drinking water and inhalation of volatiles while showering) could occur and is therefore evaluated in the HHRA as a conservative measure.

Because of the shallow groundwater, the migration of VOCs to indoor air is possible even for the buildings constructed on slabs. The migration of VOCs to indoor air is identified as a potential exposure pathway for residential (adult and child) and occupational receptors.

Toxicity Assessment. The toxicity assessment is a two-step process whereby potential hazards associated with the route- specific exposure to a given chemical are (1) identified by reviewing relevant human and animal studies, and (2) quantified through analysis of dose-response relationships. USEPA has calculated numerous toxicity values having undergone extensive review within the scientific community. These values (published in the Integrated Risk Information System and other journals) are used in the baseline evaluation to calculate both carcinogenic and noncarcinogenic risks associated with each chemical of potential concern and rate of exposure.

Risk Characterization. In the final step of the risk assessment, results of the exposure and toxicity assessments are combined to estimate the overall risk from reasonable maximum exposure to site contamination. For cancer- causing chemicals, risk is estimated to be a probability. For example, a particular exposure to chemicals at a site may present a 1 in 1 million (or 1.0E-06) chance of development of cancer over an estimated lifetime of 70 years. The USEPA allowable carcinogen risk range is 1.0E-04 to 1.0E-06 and the FDEP

acceptable Incremental Cancer Risk (ICR) is 1.0E-06. Therefore, carcinogenic risks greater than 1.0E-06 are unacceptable.

For noncancer-causing chemicals, the chemical dose to which a receptor may be exposed is estimated and compared to the reference dose (RfD). The RfD is developed by USEPA scientists and represents an estimate of the amount of chemical a person (including the most sensitive persons) could be exposed to over a lifetime without developing adverse effects. The measure of the likelihood of adverse effects other than cancer occurring in humans is called the Hazard Index (HI). An HI greater than 1 suggests adverse effects are possible.

Table 2-3 provides a summary of the predicted risks for future potential groundwater exposure scenarios.

2.7.2 Ecological Risk Assessment

The ERA for this site evaluated actual and potential adverse effects to ecological receptors associated with exposure to contamination from OU 4. The ERA was completed in accordance with the current guidance materials for ERAs at Superfund sites.

The primary purpose of the OU 4 ERA was to provide a screening level evaluation of potential risks to semiaquatic and aquatic receptors posed by the presence of chlorinated VOCs in groundwater, and to VOCs, PAHs, pesticides, and metals in surface water and sediment. In addition, the OU 4 ERA contained a screening level evaluation of potential risks to terrestrial receptors from exposure to PAHs, pesticides and metals detected in surface soil. Components of the ERA included (1) problem formulation, (2) identification of COCs, (3) preliminary exposure estimate, (4) ecological effects evaluation, and (5) risk characterization.

A complete list of all constituents sampled and their detected concentrations is available in the RI Report. Table 2-4 provides a summary of the ecological chemicals of potential concern (ECOPCs) selected for OU 4. The following subsections summarize the media-specific risks evaluated in the ERA.

Surface Soil

Risks associated with exposure to ECOPCs in OU 4 surface soils were evaluated for terrestrial wildlife based on a model that estimates the amount of contaminant exposure obtained via the diet and incidental ingestion of surface soil. Comparison of estimated doses for wildlife species with reference toxicity doses representing thresholds for lethal and sublethal effects is the basis of wildlife risk evaluation. Lethal risks were not identified for terrestrial wildlife resulting from exposure to ECOPCs in surface soil; therefore, reductions in the survivability of wildlife receptor populations at OU 4 are not expected to occur. Sublethal risks (i.e., potential reductions in the reproduction and growth of terrestrial wildlife) associated with ingestion of aluminum and zinc in surface soil and food items are predicted for omnivorous small mammals at OU 4.

Reduction in terrestrial plant and soil invertebrate biomass used as forage material was evaluated by comparing exposure concentrations for surface soil with toxicity benchmarks. Based on this comparison, terrestrial plants could potentially experience adverse growth and reproduction effects from exposure to detected concentrations of aluminum, lead, silver, vanadium, and zinc in the surface soil at OU 4.

Although phytotoxicity benchmarks were exceeded for these inorganic constituents, no evidence of reduction in vegetative biomass was observed in the field at OU 4. Therefore, impacts to small mammals and birds that rely on plant biomass as a forage base are unlikely. The results of the invertebrate benchmark comparison indicate that it is unlikely that invertebrate biomass and/or abundance would be reduced such that small mammal and bird populations would be affected at OU 4.

TABLE 2-3

**RISK SUMMARY FUTURE POTENTIAL LAND USE
GROUNDWATER EXPOSURE SCENARIOS**

**OPERABLE UNIT 4
NTC, ORLANDO**

Receptor	Exposure Route	Excess Lifetime Cancer Risk	Hazard Index	Risk Driver
Occupational Worker (northern VOC plume)	Inhalation (indoor air)	1.0E-08	0.0001	
	Total	1.0E-08	0.0001	
Adult Resident (northern VOC plume)	Ingestion	**1.0E-03**	**8**	
	Inhalation (showering)	**2.0E-05**	0.1	
	Inhalation (indoor air)	**4.0E-06**	0.02	
	Total	**1.0E-03**	**8**	cis-DCE, PCE, TCE
Child Resident (northern VOC plume)	Ingestion	**6.0E-04**	**20**	
	Inhalation (indoor air)	9.0E-07	0.02	
	Total	**6.0E-04**	**20**	cis-DCE, PCE. TCE
Occupational Worker (southern VOC plume)	Inhalation	6.0E-10	0.000004	
	Total	6.0E-10	0.000004	
Adult resident (southern VOC plume)	Ingestion	**6.0E-05**	0.7	
	Inhalation (showering)	**1.0E-06**	0.007	
	Inhalation (indoor air)	2.0E-07	0.001	
	Total	**6.0E-05**	0.7	cis-DCE, PCE, TCE
Child Resident (southern VOC plume)	Ingestion	**3.0E-05**	**2**	
	Inhalation (indoor air)	5.0E-08	0.001	
	Total	**3.0E-05**	**2**	cis-DCE, PCE, TCE
Adult Resident (antimony plume)	Ingestion	**4.0E-06**	**1**	
	Total	**4.0E-06**	**1**	PCE, TCE
Child Resident (antimony plume)	Ingestion	**2.0E-06**	**2**	
	Total	**2.0E-06**	**2**	Antimony

Bold values exceed the FDEP ICR target of 1.0E-06 or the target HI of 1.0.

TABLE 2-4

SUMMARY OF ECOLOGICAL CHEMICALS OF POTENTIAL CONCERN

OPERABLE UNIT 4
NTC, ORLANDO

Environmental Medium	ECOPCs[(1)]
Surface Soil	**Volatiles:** Acetone, Tetrachloroethene **Semivolatiles:** Benzo(a)anthracene, Benzo(a)pyrene, Benzo(b)fluoranthene, Benzo(g,h,i)perylene, Benzo(k)fluoranthene, bis(2-ethylhexyl)phthalate, Carbazole, Chrysene, Fluoranthene, Indeno(1,2,3-cd)pyrene, Phenanthrene, and Pyrene **Pesticides/PCBs:** 4,4'-DDE, 4,4'-DDD, 4,4'-DDT, Aroclor-1254, and Endrin Ketone, Methoxychlor, gamma-BHC (Lindane) **Inorganics:** Aluminum, Barium, Cadmium, Chromium, Lead, Mercury, Selenium, Silver, Vanadium, and Zinc **TPH:** Total Petroleum Hydrocarbons
Surface Water	**Volatiles:** Carbon Disulfide, Trichloroethene, cis-1,2-Dichloroethene, Vinyl Chloride, Pesticides/PCBs: 4,4'-DDT, Endrin Ketone
Sediment	**Volatiles:** Carbon Disulfide, Trichloroethene, cis-1,2-Dichloroethene, Vinyl Chloride **Semivolatiles:** Fluoranthene, Pyrene, bis(2-ethylhexyl)phthalate **Pesticides/PCBs:** 4,4'-DDE, Aroclor-1254, Endosulan, Heptachlor, Alpha-Chlordane, Delta BHC **Inorganics:** Aluminum, Lead, Mercury
Groundwater	**Volatiles:** Trichloroethene, cis-1,2-Dichloroethene

(1) Most chemicals were selected based on the maximum detected concentrations exceeding USEPA ecological screening values.

Surface Soil

Risks associated with exposures to ECOPCs in OU 4 surface soil were evaluated for terrestrial wildlife

Surface Water and Sediment

Potential risks associated with exposures to ECOPCs in OU 4 surface water and sediment were evaluated for both semiaquatic wildlife and aquatic receptors. The evaluation of risks to semiaquatic wildlife indicates that lethal risks would not be expected to occur from exposure to ECOPCs in surface water and sediment; therefore, reductions in the survivability of wildlife receptor populations at OU 4 are unlikely. Sublethal risks (i.e., potential reductions in the reproduction and growth of terrestrial wildlife) associated with ingestion of mercury in sediment and food items are predicted for piscivorous birds at OU 4.

Potential risks associated with exposures to ECOPCs in OU 4 surface water were evaluated for pelagic aquatic organisms in the wetland area and for aquatic receptors in Lake Druid. Surface water ECOPCs were compared to surface water toxicity benchmarks, and the results of the risk assessment indicate that pelagic aquatic organisms are not at risk.

Potential risks associated with exposures to ECOPCs in OU 4 sediment were evaluated for betnhic aquatic organisms in the wetland area and for aquatic receptors in Lake Druid. Sediment ECOPCs were compared to sediment criteria and guidelines. Although several exposure concentrations slightly exceed sediment toxicity benchmarks, the results of the risk assessment indicate that benthic aquatic organisms are not at risk.

Groundwater

Potential risks associated with exposures to ECOPCs in OU 4 groundwater were evaluated for benthic aquatic organisms in the wetland area and for aquatic receptors in Lake Druid. Groundwater ECOPCs were compared to surface water toxicity benchmarks, and the results of the risk assessment indicate that pelagic aquatic organisms are not at risk from exposure to chlorinated VOCs or manganese. However, the low alkalinity detected in the groundwater discharge area (which may or may not be reflective of the natural alkalinity concentrations in Lake Druid) may cause adverse effects to aquatic organisms directly, or may not adequately form complexes with heavy metals (thus reducing their overall toxicity to aquatic life).

2.7.3 Basis for Action

Actual or threatened releases of hazardous substances from this site, if not addressed by implementing the RA selected in this ROD, present a current and future potential threat to public health and welfare.

Results of the HHRA indicate that the cumulative risk associated with potential future residential exposure to surface soil, groundwater, surface water, and sediment at OU 4 is 2.0E-03, which is above the USEPA acceptable cancer risk range (1.0E-04 to 1.0E-06) and the FDEP target level of concern (1.0E-06).

Cancer risks levels for theoretical future use of groundwater as drinking water are above the USEPA target cancer risk range and the FDEP target level of concern, primarily due to PCE and TCE. Noncancer risk levels for theoretical future use of groundwater as drinking water are above the USEPA and the FDEP target HI of one. The HI for the hypothetical future adult resident is 8, and for the future child resident is 20. A discussion of these potential human health risks is presented in Section 2.7.1.

2.8 REMEDIAL ACTION OBJECTIVES

Investigations at OU 4 have indicated contamination at the site poses unacceptable risks to human receptors from exposure to groundwater for both commercial/industrial and residential land-use scenarios. Based on the evaluation of environmental sampling data and the current and anticipated future use of the site, RAOs and chemical-specific action levels were identified. The RAOs for OU 4 are:

- Reduce the potential for human ingestion of groundwater containing COCs that exceed drinking water-based regulatory requirements or risk-based acceptable exposure levels.

- Gain control over groundwater migration of VOC concentrations that contribute to exceedances of FDEP surface water standards in Lake Druid.

Considering the RAOs, chemical-specific remediation goals (RGs) were developed. The RGs for the COCs are presented in the FS (HLA, 2001b) and summarized as follows:

COC	Groundwater RGS
DCE	70 µg/L
PCE	3 µg/L
TCE	3 µg/L
Antimony	6 µg/L

2.9 DESCRIPTION OF ALTERNATIVES

To achieve the RAOs and meet the chemical-specific RGs, the FS developed seven alternatives (V-1 through V-7) to consider for remediation of VOCs in groundwater at OU 4, and four treatment alternatives (A-1 through A-4) were evaluated to address antimony contamination in groundwater. The eighth VOC alternative, V-3P, was presented in the proposed plan as a variation of alternative V- 3. All these were developed by the OPT. They are listed below and summarized in Tables 2-5 and 2-6.

VOC Alternatives

Alternative V-1: No Action
Alternative V-2: Limited Action
Alternative V-3: Chemical Oxidation and Enhanced Biodegradation
Alternative V-3P: Chemical Oxidation, Natural Attenuation, and Phytoremediation
Alternative V-4: Air Sparging and Enhanced Biodegradation
Alternative V-5: Recirculation Wells and Enhanced Biodegradation
Alternative V-6: Groundwater Extraction, Air Stripping, and Discharge into Lake Druid
Alternative V-7: Groundwater Extraction, Ultraviolet (UV) Light/Oxidation, and Discharge Lake Druid

Antimony Alternatives

Alternative A-1: No Action
Alternative A-2: Limited Action
Alternative A-3: Extraction and Discharge to the Orlando Sewage Treatment Plant (STP)
Alternative A-4: Extraction, Treatment with NP™ Microfiltration, and Discharge into Lake Druid

These alternatives were developed with consideration for site risks and the anticipated future land use at OU 4. The alternatives primarily address protection of human health because, as discussed above, potential risks to ecological receptors appear to be acceptable.

2.9.1 Detailed Description of VOC Plume Remedial Alternatives

Alternative V-1, No Action. The No Action alternative typically is defined as doing no response and no long-term monitoring of the groundwater. However, a groundwater IRA is currently operating downgradient of the source area at OU 4. The continued operation will be retained as a component of the No Action alternative for comparison as a baseline condition. In addition to the continued operation of the IRA, this alternative includes downgradient groundwater/surface water monitoring and 5-year site reviews. The present worth cost is estimated to be $861,140.

TABLE 2-5

SUMMARY OF EVALUATED REMEDIAL ALTERNATIVES VOC PLUME

OPERABLE UNIT 4
NTC, ORLANDO
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Alternative[1]	Description of Key Components	Cost (Present Worth)	Duration[2]
Alternative V-1: No Action	No remedial actions are performed except the currently operating IRA is retained as a component of this alternative. Perform downgradient groundwater/surface water monitoring. Perform 5-year site reviews.	$861,000	30 years
Alternative V-2: Limited Action	Implement groundwater use restrictions. Perform downgradient groundwater/surface water monitoring. Perform 5-year site reviews.	$898,000	30 years
Alternative V-3: Chemical Oxidation (Northern VOC Plume) and Enhanced Biodegradation (Southern VOC plume)	Perform treatability studies. Implement groundwater use restrictions until RGs achieved. UIC variance for $KMnO_4$ injection. Install $KMnO_4$ injection and extraction wells. Install $KMnO_4$ storage and metering system. HRC™ injection (southern plume). Enhanced biodegradation monitoring network (southern plume). Phase-out operation of IRA system. Natural attenuation monitoring. Perform 5-year site reviews.	$1,474,000	40+ years
Alternative V-3P: Chemical Oxidation, Natural Attenuation, and Phytoremediation	Implement groundwater use restrictions until RGs achieved. UIC variance for $KMnO_4$ injection. Install $KMnO_4$ injection and extraction wells. Install $KMnO_4$ storage and metering system. Phase-out operation of IRA system. Installation of vegetation for phytoremediation. Natural attenuation monitoring. Perform 5-year site reviews.	$1,480,000	40+ years
Alternative V-4: Air Sparging and Enhanced Biodegradation	Continue IRA operation. Implement groundwater use restrictions until RGs achieved. Construction of air sparging system. Drill/drive holes through the hard layer. SVE with temporary GAC treatment. Air sparging system monitoring points. O&M of air sparge and SVE systems. HRC™ injection (southern plume). Enhanced biodegradation monitoring network (southern plume). Phase-out operation of IRA system. Natural attenuation monitoring. Perform 5-year site reviews.	$1,618,000	40+ years

TABLE 2-5

SUMMARY OF EVALUATED REMEDIAL ALTERNATIVES VOC PLUME

OPERABLE UNIT 4
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Alternative[1]	Description of Key Components	Cost (Present Worth)	Duration[2]
Alternative V-5: Recirculation Wells and Enhanced Biodegradation	Implement groundwater use restrictions until RGs achieved. Construction of recirculating well (northern plume). Recirculating well monitoring system points. HRC™ injection (southern plume). Enhanced biodegradation monitoring network (southern plume). Phase-out operation of IRA system. Natural attenuation monitoring. Perform 5-year site reviews.	$3,308,000	45+ years
Alternative V-6: Groundwater Extraction, Air Stripping, and Discharge into Lake Druid	Implement groundwater restrictions until RGs achieved. Installation of two groundwater extraction wells and a diffused air stripper. Monitoring of treatment system. Discharge of treated groundwater to Lake Druid. O&M of diffused air stripper. Groundwater monitoring. Phase-out operation of IRA system. Natural attenuation monitoring (for non-MCL RGO). Perform 5-year site reviews.	$1,849,000	108 years
Alternative V-7: Groundwater Extraction, UV Light/Oxidation and Discharge to Lake Druid	Implement groundwater use restrictions until RGs achieved. Installation of two groundwater extraction wells. Installation of UV/oxidation with H_2O_2. Installation of chemical storage and metering system. Discharge of treated groundwater to Lake Druid. O&M of treatment system. Phase-out operation of IRA system. Groundwater monitoring. Natural attenuation monitoring (for non-MCL RGO). Perform 5-year reviews.	$3,151,000	108 years

[1] All alternatives include continued use of existing groundwater IRA (two extraction wells pumping to an air stripper treatment system). All alternatives except V-1 include implementing LUCs to prohibit residential use of OU4.

[2] A period of 30 years was chosen for present worth costing purposes only. Under CERCLA, remedial actions must continue as long as hazardous substances, pollutants, or contaminants remain at the site.

Notes: GAC = granular activated carbon
H_2O_2 = hydrogen peroxide
HRC ™ = Hydrogen Release Compound
IRA = Interim Remedial Action
$KMnO_4$ = potassium permanganate
LUC = Land Use Control
MCL = maximum contaminant level
O&M = Operation and Maintenance
RAO = Remedial Action Objective
RG = Remediation Goal
RGO = Redmedial Goal Objective
SVE = Soil Vapor Extraction
UIC = underground injection control
UV = ultraviolet

TABLE 2-6

SUMMARY OF EVALUATED REMEDIAL ALTERNATIVES ANTIMONY PLUME

OPERABLE UNIT 4
NTC, ORLANDO

Alternative	Description of Key Components	Cost (Present Worth)	Duration[2]
Alternative A-1: No Action	No treatment, containment, or restricted use of groundwater. Perform 5-year site reviews.	$81,000	30 years
Alternative A-2: Limited Action	Groundwater use restrictions maintained until antimony concentrations in groundwater are below the Florida MCL. Implement long-term groundwater monitoring program. Implement LUCs to prohibit residential use of OU 4. Perform 5-year site reviews.	$222,000	30 years
Alternative A-3: Extraction and Discharge to Orlando STP	Groundwater use restrictions until RGs achieved. Installation of one groundwater extraction well. Discharge of untreated water to sanitary sewer. Monitoring of groundwater going to sewer. O&M of extraction well and pump. Installation of one groundwater extraction well. Implement LUCs to prohibit residential use of OU 4. Perform 5-year site reviews.	$553,000	19 years
Alternative A-4: Extraction, Treatment via NP™ Microfiltration System, and Discharge to Lake Druid	Groundwater use restrictions until RGs achieved. Installation of one groundwater extraction well. NP™ microfiltation Chemical storage and metering system. Discharge of treated groundwater to Lake Druid. O&M of microfiltration system and metering system. Installation of one groundwater extraction well. Implement LUCs to prohibit residential use of OU 4. Perform 5-year site reviews.	$725,000	19 years

[1] A period of 30 years was chosen for present worth costing purposes only. Under CERCLA, remedial actions must continue as long as hazardous substances, pollutants, or contaminants remain at the site.

Notes: MCL - maximum contaminant level
O&M - Operation and Maintenance
RAO -Remedial Action Objective
RG - Remediation Goal
STP - sewage treatment plant

Alternative V-2, Limited Action. Under this Limited Action alternative, similar components of the No Action alternative would be implemented to meet Florida surface water standards, plus LUCs in the form of groundwater use restrictions would be implemented to restrict the use of the groundwater in the Building 1100 area. The present worth cost is estimated to be $897,763. This cost includes operating and maintaining the IRA system and associated groundwater monitoring between the wells and the lake, implementing LUCs for the entire VOC plume at OU 4, and performing 5-year site reviews over a 30-year period.

Alternative V-3, Chemical Oxidation and Enhanced Biodegradation. This alternative is intended to reduce concentrations of PCE, TCE, and cis- DCE to Florida surface water standards prior to flowing into Lake Druid by treating VOC contamination within the northern and southern plumes at OU 4. The chemical oxidation component of this remedy consists of injecting KMnO4 into the groundwater at the source area of the northern plume to chemically destroy the chlorinated compounds in dissolved and nonaqueous phases. The enhanced biodegradation component of this remedy consists of injecting a lactic acid producing compound [Hydrogen Release Compound™(HRC™)] within the southern plume to enhance ongoing natural biodegradation of chlorinated compounds. The existing IRA would continue to operate to treat groundwater in the downgradient plume west of the source area remediation. After completion of the chemical oxidation in the source area, MNA would be used to achieve surface water standards at Lake Druid and eventually MCLs.

Northern VOC Plume

In situ chemical oxidation within the northern plume source area would be able to reduce source area groundwater concentrations to site-specific standards, based on the results of a field pilot test conducted from February to July 2000 at OU 4. The downgradient portion of the northern plume would continue to be treated by operating the existing IRA wells until the downgradient groundwater (between Port Hueneme Avenue and Lake Druid) has met Florida surface water standards. MNA would in time further reduce the contaminant levels to drinking water standards.

In situ chemical oxidation treatment would remediate contaminant concentrations in the source area to a site-specific remedial goal, defined as the concentration at which MNA would be capable of meeting surface water standards (8 µ/L for PCE) by the time groundwater naturally discharges into Lake Druid. Based on a previous natural attenuation study of OU 4, the contaminant concentration decreases by a factor of 3 to 10 within the groundwater plume between Building 1100 and Lake Druid (HLA, 1998). With a Florida surface water standard of 8 µg/L for PCE and an attenuation reduction factor of 3 to 10, PCE concentrations in groundwater leaving the source area must be in the range of 24 to 80 µg/L. It is estimated that chemical oxidation treatment in the source area will take 1 year to meet this site-specific RGO. Upon completion of the 1-year treatment period, the remaining low-level contaminants within the source area plume would be treated to surface water standards using MNA.

The downgradient VOC plume would be addressed by the existing IRA as discussed previously. It is anticipated that it will require approximately 10 years before the untreated zone of contaminated water (located between the downgradient extraction well of the chemical oxidation system/HRCTM injection points and the IRA wells) is treated by the IRA wells. The IRA wells would be shut down once this zone of water is treated to surface water standards.

In situ chemical oxidation will likely affect subsurface conditions within the source area and may temporarily cause cessation of biological activity. Treatment byproducts of chemical oxidation at neutral pH are carboxylic acids, manganese dioxide (Mn02), chloride, and water. The effects of chemical oxidation will likely decrease biological activity within the source area, but will not significantly affect natural attenuation downstream of the source area. Although natural attenuation should achieve surface water standards prior to the plume discharging into the lake, MCLs will not be achieved until dissolution of any remaining unoxidized source has occurred.

Southern VOC Plume

Enhanced biodegradation using HRC™ would be used to enhance the ongoing natural biodegradation of chlorinated compounds in the southern plume. HRC™ is a polyacetate ester specifically formulated for the slow release of lactic acid upon hydration. The lactic acid is metabolized by indigenous anaerobic bacteria to produce hydrogen. The resulting hydrogen can be used by reductive dehalogenators to dechlorinate chlorinated hydrocarbons.

The HRC™ compound, which has the consistency of thick paste, would be injected into the groundwater via small diameter boreholes by reciprocating pump. Prior to design, a predesign investigation would be performed to better refine the vertical and horizontal confines of the southern plume area.

It is estimated that contaminant concentrations would be reduced to Florida drinking water standards from the source area down to the IRA wells within a 3-year period.

Summary

Major components of Alternative V-3 include the following:

- Treatability studies to evaluate the enhanced biodegradation component
- LUCs for deed restriction to limit future use of the site to nonresidential
- LUCs in the form of groundwater-use restrictions until RAOs are achieved
- Florida underground injection control variance for KMnO4 injection
- KMnO4 injection and extraction wells (northern plume)
- KMnO4 storage and metering system
- Chemical oxidation monitoring points
- HRCTM injection (southern plume)
- Enhanced biodegradation monitoring network (southern plume)
- Phase-out operation of IRA system
- Natural attenuation monitoring
- 5-year site reviews

The present worth cost for Alternative V-3 is estimated to be $1,474,000. This includes direct, indirect, and O&M costs for groundwater treatment using chemical oxidation (12 months) and enhanced biodegradation (3 years) for the northern and southern plumes, respectively, and the IRA wells (10 years) for the downgradient plume. Groundwater monitoring of the downgradient plume would be conducted during the 10 years of the IRA operation, and natural attenuation monitoring would be conducted to ensure that the VOC plume achieves drinking water standards. The total duration for remediation of the VOC contamination (both the northern and southern plumes) using this alternative would be 40 years.

Alternative V-3P. Chemical Oxidation, Natural Attenuation, and Phytoremediation. This alternative is a variation of Alternative V- 3 with chemical oxidation and natural attenuation to destroy the organic contaminants, but without the introduction of nutrients to enhance bacterial growth. Phytoremediation would be used to treat residual groundwater contaminants not eliminated by natural attenuation processes. Phytoremediation is a set of in situ biological processes that involve the use of plants and the microbes associated with their growth for the remediation of contaminated sediment, soil, and water. Phytoremediation has been selected as a polishing step following source removal of a shallow chlorinated solvent plume, consisting of PCE and its reductive transformation products. The source would be treated using in situ chemical oxidation with potassium permanganate. Treatability studies suggest that phytoremediation can be used to treat the residual contamination following chemical oxidation. A dense plantation of poplars and willows will be grown over the plume to enhance natural attenuation, which is already occurring at the site to some degree.

Summary

Major components of Alternative V-3P include the following:

- LUCs for deed restriction to limit future use of the site to nonresidential
- LUCs in the form of groundwater-use restrictions until RAOs are achieved
- Florida underground injection control (UIC) variance for KMnO4 injection
- KMnO4 injection and extraction wells (northern plume)
- KMnO4 storage and metering system
- Chemical oxidation monitoring points
- Phase- out operation of IRA system
- Natural attenuation monitoring
- Phytoremediation (northern and southern plume)
- 5-year site reviews

The present worth cost for Alternative V-3P is estimated to be $1,480,000. This includes direct, indirect, and O&M costs for groundwater treatment using chemical oxidation (12 months) and phytoremediation for the northern and southern plumes, and the IRA wells (10 years) for the downgradient plume. Groundwater monitoring of the downgradient plume would be conducted during the 10 years of the IRA operation, and natural attenuation monitoring would be conducted for 30 years upon the shutdown of the IRA wells to endure that the VOC plume achieves drinking water standards. The total duration for remediation of the VOC contamination using this alternative would be 40 years.

Alternative V-4: Air Sparging and Enhanced Biodegradation. This alternative consists of sparging air into the groundwater at the source area of the northern plume to enhance volatilization of the VOCs and reduce the concentration of the PCE and its chlorinated degradation products. All other components of this alternative are identical to Alternative V-3, including enhanced bioremediation of the southern plume, continued operation of the IRA to complete treatment of the downgradient plume, and the use of MNA to achieve surface water standards at Lake Druid and eventually MCLs. The present worth cost for this alternative is estimated to be $1,617,711 over a 40-year period.

Alternative V-5: Recirculation Wells and Enhanced Biodegradation. This alternative consists of four new recirculation wells at the source area of the northern plume to physically remove (strip) the chlorinated compounds from the groundwater. All other components of this alternative are identical to Alternative V-3, including enhanced bioremediation of the southern plume, continued operation of the IRA to complete treatment of the downgradient plume, and the use of MNA to achieve surface water standards at Lake Druid and eventually MCLs. The present worth cost for this alternative is estimated to be $3,308,022.

Alternative V-6: Groundwater Extraction, Air Stripping, and Discharge into Lake Druid. This alternative consists of hydraulic control of the source area through the extraction of contaminated groundwater, treatment via a diffused aeration stripper, and discharge of the treated effluent to Lake Druid.

Based on modeling of the contaminated aquifer, two groundwater extraction wells would be installed within the source area of the VOC plume. The zone of influence would eventually cover the groundwater plumes (northern and southern) located beneath and east of Building 1100. The groundwater extracted from the source area would be treated by passing the water through a diffused aeration tank and forcing air up through the water to transfer the VOCs into the air stream. The extracted groundwater would be treated to Florida surface water standards, and then discharged to Lake Druid. This alternative also makes use of MNA in the downgradient plume to achieve surface water standards at Lake Druid, and eventually MCLs. The estimated time to reach cleanup goals is 108 years. The present worth cost for this alternative is estimated to be $1,848,590.

Alternative V-7: Groundwater Extraction, Ultraviolet Light/Oxidation, Discharge to Lake Druid. This alternative involves the extraction of VOC-contaminated groundwater and ex

situ treatment using UV light and H202 to destroy the organic contaminants. Two groundwater extraction wells would be installed within the source area of the VOC plume. The zone of influence would eventually cover the groundwater plume located beneath and east of Building 1100. The remainder of the plume downgradient of Port Hueneme Avenue would continue to be treated by the existing IRA wells. The extracted groundwater would be treated through the addition of H202 and then the enhanced groundwater would flow through one or more UV reactors where the destruction of the organics would occur. The UV light splits the H202 molecules creating hydroxyl radicals capable of breaking down the VOCs into nontoxic compounds. The UV/oxidation process would reduce the VOC concentrations to Florida drinking water standards prior to being discharged into Lake Druid. This alternative also makes use of MNA in the downgradient plume to achieve surface water standards at Lake Druid, and eventually MCLs. The estimated time to reach cleanup goals is 108 years. The present worth cost for this alternative is estimated to be $3,151,344.

2.9.2 Detailed Description of Antimony Plume Remedial Alternatives

Alternative A-1, No Action. This alternative is required by CERCLA as a baseline for comparison with the other alternatives. This alternative assumes no remedial action, containment, or restricted use of the groundwater would occur and establishes a basis for comparison with the other alternatives. Because there would be no treatment of the antimony plume and hazardous substances would be left in place, the assumed duration is expected to be indefinite. Based on USEPA guidance, the assumed duration to determine costs for this alternative is 30 years. The present worth cost is estimated to be $81,174 and includes the cost of performing site reviews and associated groundwater monitoring over the assumed 30-year period.

Alternative A-2, Limited Action. This alternative includes groundwater use restrictions to prevent exposure. These restrictions would be maintained until antimony concentrations in groundwater are below the Florida MCL. A long-term groundwater monitoring program would be implemented, and site reviews would be conducted every 5 years to assess water quality without treatment. The present worth cost is estimated to be $221,683 and includes the cost of implementing groundwater-use restrictions, performing site reviews, and groundwater monitoring every 5 years over the assumed 30-year period.

Alternative A-3, Extraction and Discharge to the Orlando STP. This alternative would include installation of a vertical groundwater extraction well in the center of the antimony plume. Groundwater would be pumped directly to the sanitary sewer without treatment because antimony concentrations in groundwater are less than the discharge limits to the Orlando STP. The estimated time to reach cleanup goals is 19 years. The total present worth cost for this remedial alternative is estimated to be $553,276.

Alternative A-4, Extraction, Treatment via NPTM Microfiltration System, and Discharge to Lake Druid. This alternative includes the installation of a vertical groundwater extraction well in the center of the antimony plume and treatment of the extracted groundwater using a Microfiltration system to remove antimony. The treated water would then be discharged to Lake Druid. This alternative is proposed because of the high cost of discharging water to the Orlando STP. The estimated time to reach cleanup goals is 19 years. The total present worth cost for this remedial alternative is estimated to be $724,521.

2.10 SUMMARY OF THE COMPARATIVE ANALYSIS OF ALTERNATIVES

In selecting the preferred alternatives for OU 4 to address the VOC Plume and the Antimony Plume, the nine CERCLA criteria were used to evaluate the alternatives developed in the FS. The first seven are technical criteria, based on the degree of protection of the environment, cost, and engineering feasibility issues. The alternatives were further evaluated, based on the final two criteria: acceptance by the USEPA and FDEP and acceptance by the community. These nine criteria can be categorized into three groups: threshold criteria, primary balancing criteria, and modifying criteria as shown below.

TABLE 2-7

SUMMARY OF COMPARATIVE EVALUATION OF ALTERNATIVES

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Evaluation Criteria	Alternative V-1: No Action	Alternative V-2: Limited Action	Alternative V-3: Chemical Oxidation and Enhanced Biodegradation	Alternative V-3P: Chemical Oxidation, Natural Attenuation, and Phytoremediation
Overall Protection of Human Health and Environment	Would not be protective because there would be a continued risk from human exposure to contaminated groundwater. Would prevent potential surface water exposure by continuing IRA operation, thereby minimizing migration of VOCs to Lake Druid.	Would be protective by preventing risk from exposure to contaminated groundwater through institutional controls and monitoring. Groundwater use restrictions would last for an indefinite period of time. Would prevent potential surface water exposure by continuing IRA operation, thereby minimizing migration of VOCs to Lake Druid.	Would be protective by preventing risk from exposure to contaminated groundwater through institutional controls and monitoring. Temporary groundwater use restrictions would be implemented until FDEP drinking water standards are attained through treatment.	Would be protective by preventing risk from exposure to contaminated groundwater through institutional controls and monitoring. Temporary groundwater use restrictions would be implemented until FDEP drinking water standards are attained through treatment..
Compliance with ARARs and TBCs:				
Chemical-Specific	Would not comply except that surface water standards at Lake Druid would be achieved through the continued operation of the IRA for an indefinite period of time.	Would comply with surface water standards at Lake Druid through the continued operation of the IRA and natural processes for an indefinite period of time.	Would eventually comply	Would eventually comply
Location-Specific	Would not comply	Would not comply	Would comply	Would comply
Action-Specific	Not applicable	Would comply	Would comply	Would comply
Long-Term Effectiveness and Permanence	Would not have long-term effectiveness and permanence because contaminants would remain on-site and not be monitored.	Would provide long-term effectiveness and permanence because groundwater use restrictions would last for an indefinite period of time.	Would be long-term effective and permanent. Ultimately provides permanent reduction in contaminant concentrations. V-3, V-3P, and V-7 produce the least treatment residuals.	Would be long-term effective and permanent. Ultimately provides permanent reduction in contaminant concentrations. V-3, V-3P and V-7 produce the least treatment residuals.
Reduction of Contaminant Toxicity, Mobility, or Volume through treatment	Unmonitored natural transformation processes may reduce toxicity, mobility or volume of contaminants within the source areas. Continued operation of the IRA would reduce the toxicity and volume of contaminants in the downgradient plume.	Unmonitored natural transformation processes may reduce toxicity, mobility or volume of contaminants within the source areas. Continued operation of the IRA would reduce the toxicity and volume of contaminants in the downgradient plume.	Would provide reduction of toxicity of contamiants in northern VOC source area through in situ treatment. Would achieve reduction of containment mobility and volume (to a lesser degree than V-6 and V-7) by hydraulic control afforded by groundwater extraction and chemical treatment.	Would achieve reduction of containment toxicity through MNA and Phytoremediation. Would achieve reduction of contaminant mobility and volume (to a lesser degree than V-6 and V-7) by hydraulic control afforded by groundwater extraction and chemical treatment.
Short-Term Effectiveness	Would be high because there is no remedy to implement.	Groundwater use restrictions would prevent exposure and would last for an indefinite period of time. Worker exposure would only result if additional monitoring wells are installed.	Temporary groundwater use restrictions would be implemented to protect residential receptors for the short-term until drinking water standards were achieved through treatment. In situ chemical oxidation is estimated to treat the suspected VOC source area within 12 months. Estimated time to reach cleanup goals is 40+ years.	Temporary groundwater use restrictions would be implement to protect residential receptors for the short-term until drinking water standards were achieved through treatment. In situ chemical oxidation is estimated to treat the suspected VOC source area within 12 months. Estimated time to reach cleanup goals is 40+ years.
Implementability	Would be easiest alternative to implement because no action except for the continued operation and groundwater monitoring of the IRA system would occur.	Would be the next easiest alternative to implement. The only actions would be the continued operation and groundwater monitoring of the IRA system and implementation of groundwater use restrictions.	Would be easy to implement. Resources, materials, and equipment are readily available. V-3 and V-3P involves installation of several injection and extraction wells. Would require treatability studies for final design.	Would be easy to implement. Resources, materials, and equipment are readily available. Phytoremediation system would include installation of trees and vegetation over approximately 2.5 acres. V-3 and V-3P involves installation of several injection and extraction wells.
Costs:				
Capital	$0	$16,500	$312,727	$TBD
NPW of O&M	$782,854	$799,649	$843,250	$TBD
NPW[(1)]	$861,140	$898,000	$1,474,000	$1,480,000 (will be provided)

TABLE 2-7

SUMMARY OF COMPARATIVE EVALUATION OF ALTERNATIVES

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Evaluation Criteria	Alternative V-4: Air Sparging and Enhanced Biodegradation	Alternative V-5: Recirculation Wells and Enhanced Biodegradation	Alternative V-6: Groundwater Extraction, Air Stripping, and Discharge into Lake Druid	Alternative V-7: UVLight/Oxidation and Discharge to Lake Druid
Overall Protection of Human Health and Environment	Would be protective by preventing risk from exposure to contaminated groundwater through institutional controls and monitoring. Temporary groundwater use restrictions would be implemented until FDEP drinking water standards are attained.	Would be protective by preventing risk from exposure to contaminated groundwater through institutional controls and monitoring. Temporary groundwater use restrictions would be implemented until FDEP drinking water standards are attained.	Would be protective by preventing risk from exposure to contaminated groundwater through institutional controls and monitoring. Temporary groundwater use restrictions would be implemented until FDEP drinking water standards are attained.	Would be protective by preventing risk from exposure to contaminated groundwater through institutional controls and monitoring. Temporary groundwater use restrictions would be implemented until FDEP drinking water standards are attained.
Compliance with ARARs and TBCs:				
Chemical-Specific	Would eventually comply	Would eventually comply	Would eventually comply	Would eventually comply
Location-Specific	Would comply	Would comply	Would comply	Would comply
Action-Specific	Would comply	Would comply	Would comply	Would comply
Long-Term Effectiveness and Permanence	Would be long-term effective and permanent. Ultimately provides permanent reduction in contaminant concentrations.	Would be long-term effective and permanent. Ultimately provides permanent reduction in contaminant concentrations.	Would be long-term effective and permanent. Ultimately provides permanent reduction in contaminant concentrations.	Would be long-term effective and permanent. Ultimately provides permanent reduction in contaminant concentrations. V-3, V-3P, and V-7 produce the least treatment residuals.
Reduction of Contaminant Toxicity, Mobility, or Volume through Treatment	Provides reduction of volume through stripping contaminants from groundwater.	Provides reduction of volume through stripping contaminants from groundwater.	Provides reduction of volume through stripping contaminants from groundwater.	Would achieve reduction of contaminant toxicity, mobility and volume through extraction and treatment.
Short-Term Effectiveness	Temporary groundwater use restrictions would be implemented to protect residential receptors for the short-term until drinking water standards were achieved through treatment. Estimated time to reach cleanup goals is 40+ years.	Temporary groundwater use restrictions would be implemented to protect residential receptors for the short-term until drinking water standards were achieved through treatment. Estimated time to reach cleanup goals is 45+ years.	Temporary groundwater use restrictions would be implemented to protect residential receptors for the short-term until drinking water standards were achieved through treatment. Estimated time to reach cleanup goals is 108 years.	Temporary groundwater use restrictions would be implemented to protect residential receptors for the short-term until drinking water standards were achieved through treatment. Estimated time to reach cleanup goals is 108 years.
Implementability	Easy to implement since it uses basic construction practices and readily available equipment.	Installation of four recirculating wells in the northern VOC source area would require hydraulic modeling, use of specially designed equipment and contractors trained in this innovative system construction. May not be technically feasible based on previous experiences with the former IRA system.	V-6 and V-7 are the most labor intensive due to ex situ treatment duration, associated utilities and system maintenance. V-6 would be easier to maintain than V-7.	V-6 and V-7 are the most labor intensive due to ex situ treatment duration, associated utilities and system maintenance. V-6 would be easier to maintain than V-7.
Costs:				
Capital	$663,832	$938,027	$305,505	$386,732
NPW of O&M	$806,814	$2,069,265	$1,375,030	$2,478,126
NPW[(1)]	$1,618,000	$3,308,000	$1,849,000	$3,151,000

TABLE 2-7

SUMMARY OF COMPARATIVE EVALUATION OF ALTERNATIVES

OPERABLE UNIT 4
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Evaluation Criteria	Alternative A-1: No Action	Alternative A-2: Limited Action	Alternative A-3: Extraction and Discharge to Orlando STP	Alternative A-4: Extraction, Treatment via NP™ Microfiltration System and Discharge to Lake Druid
Overall Protection of Human Health and Environment	Would not be protective because there would be a continued risk from human exposure to contaminated groundwater.	Permanent groundwater use restrictions would protect future residential receptors from ingestion of contaminated groundwater.	Would be protective by preventing risk from exposure to contaminated groundwater through temporary groundwater use restrictions until FDEP drinking water standards are attained through groundwater extraction and discharge to the STP.	Would be protective by preventing risk from exposure to contaminated groundwater through temporary groundwater use restrictions until FDEP drinking water standards are attained through groundwater extraction and treatment.
Compliance with ARARs and TBCs:				
Chemical-Specific	Would not comply	Would not comply	Would eventually comply	Would eventually comply
Location-Specific	Would not comply	Would not comply	Would comply	Would comply
Action-Specific	Not applicable	Would comply	Would comply	Would comply
Long-Term Effectiveness and Permanence	Would not be long-term effective and permanent since contaminants would remain on-site. Any long-term effectiveness would not be known because monitoring would not occur.	Although contaminants would remain on-site, groundwater use restrictions would last indefinitely to protect future residential receptors from ingestion of contaminated groundwater.	A-3 and A-4 would be equal in long-term effectiveness and permanence.	Would be long-term effective and permanent.
Reduction of Contaminant Toxicity, Mobility, or Volume through Treatment	Would not achieve reduction of toxicity, mobility, or volume of contaminants through treatment but might achieve reduction through natural processes.	Would not achieve reduction of toxicity, mobility, or volume of contaminants through treatment but might achieve reduction through natural processes.	Would achieve reduction of mobility of the plume by hydraulic control afforded by groundwater extraction.	Would achieve reduction of mobility of the plume by hydraulic control afforded by groundwater extraction.
Short-Term Effectiveness	No exposures to workers or the community during implementation because no action is taken. Would not comply because there would be no treatment of the source area.	Permanent groundwater use restrictions would protect future residential receptors from ingestion of contaminated groundwater.	Temporary groundwater use restrictions would protect residential receptors in the short term. Implementation of A-3 and A-4 would be delayed 10 years because the antimony plume and VOC plumes are collocated at the eastern edge of the southern VOC plume. This adversely affects the short-term effectiveness. Estimated time to reach cleanup goals is 19 years.	Temporary groundwater use restrictions would protect residential receptors in the short term. Implementation of A-3 and A-4 would be delayed 10 years due to the antimony plume and VOC plumes are collocated at the eastern edge of the southern VOC plume. This adversely affects the short-term effectiveness. Requires on-site system maintenance, and possible exposure to workers. Estimated time to reach cleanup goals is 19 years.
Implementability	Would be easiest to implement since no action would occur.	A-2 is easier to implement than A-3 and A-4 because it only includes groundwater use restrictions, groundwater monitoring and 5-year site reviews.	Would be easy to implement. Resources, materials, and equipment are readily available. Basic construction practices used.	A-4 would be the most labor intensive due to the ex situ treatment processes, associated utilities, and system maintenance.
Costs:				
Capital	$0	$16,500	$92,500	$251,000
NPW of O&M	$73,794	$185,030	$410,522	$407,614
NPW[(1)]	$81,000	$222,000	$553,000	$725,000

(1) Sum of Capital and O&M plus a 10% contingency, rounded to the nearest thousand dollars.

Threshold Criteria

1. Overall protection of human health and the environment
2. Compliance with ARARs

Primary Balancing Criteria

1. Long-term effectiveness and permanence
2. Reduction of toxicity, mobility, or volume through treatment
3. Short-term effectiveness
4. Implementability
5. Cost

Modifying Criteria

1. Federal and state acceptance
2. Community acceptance

Based on the alternatives evaluation against these criteria, Alternative V-3P (to remediate groundwater VOC contamination) and Alternative A-2 (to address antimony contamination in groundwater) were selected as the preferred alternatives for OU 4.

Table 2-7 contains a summary of the comparative evaluation of alternatives for OU 4.

2.11 PRINCIPAL THREAT WASTES

This section identifies the source materials constituting principal threats at the site and discuss how the alternatives will address them. Wastes considered to constitute principal threats include liquid source material such as free product (NAPLs) containing contaminants of concern.

Identification of Source Materials Constituting Principal Threat Wastes

During the Focused Investigation/Source Confirmation (ABB-ES, 1997b), PCE concentrations analyzed from groundwater samples collected via TerraProbe™ suggested a strong possibility that a source area of NAPL is present beneath the former laundry building, possibly at more than one location (see Figure 2-2). The highest VOC concentrations in groundwater (up to 34,000 µg/L of PCE) were detected in the vicinity of the surge tank and beneath the laundry building. These concentrations (over 20 percent of the theoretical PCE solubility) are consistent with the presumed presence of residual PCE in the source area.

How the Alternatives Address Principal Threat Wastes

The following list briefly identifies how each groundwater cleanup alternative for VOC contamination (V-1 through V-7) addresses the source area, or principal threat waste, for OU 4.

- V-1: No Action; VOCs in source area not treated; principal threat wastes not addressed.

- V-2: Limited Action; deed restrictions to limit groundwater use at the site; VOCs in source area not treated; principal threat wastes remain in groundwater.

- V-3: Chemical Oxidation with Enhanced Biodegradation; injection of $KMnO_4$ to chemically destroy organic contaminants; principal threat wastes destroyed in situ.

- V-3P: Chemical Oxidation, Natural Attenuation, and Phytoremediation; injection of $KMnO_4$ to chemically destroy organic contaminants; principal threat wastes destroyed in situ.
- V-4: Air Sparging and Enhanced Biodegradation: Injection of air into the groundwater

to cause volatilization of organic contaminants; vapor extraction to remove vapors; treatment of vapors ex situ; principal threat wastes destroyed.

- V-5: Recirculation Wells and Enhanced Biodegradation; strips organic contaminants from groundwater within the well; vapor collection and treatment through vapor phase GAC; principal threat wastes destroyed.

- V-6 : Groundwater Extraction, Air Stripping, and Discharge into Lake Druid; principal threat wastes removed and destroyed.

- V-7: Groundwater Extraction, UV Light/Oxidation, and Discharge into Lake Druid; principal threat wastes removed and destroyed.

2.12 SELECTED REMEDY

2.12.1 Summary of Rationale for Remedy Selection

Based on consideration of the requirements of CERCLA, the NCP, the USEPA, and the FDEP and public comments, a remedy has been selected to address the groundwater contaminants at OU 4. After consideration of the conditions at OU 4, comparison of cleanup alternatives, and consideration of the proposed reuse of the area, the OPT proposed a combination of two alternatives to address the potential risk from groundwater contamination in the shallow aquifer. These two alternatives are:

- Alternative V-3P, Chemical Oxidation, Natural Attenuation, and Phytoremediation
- Alternative A-2, Limited Action

Alternative V-3P addresses the VOC contamination including the suspected source area which is presumed to contain pure residual PCE. Alternative A-2 addresses the antimony groundwater contamination.

The preferred remedial action was presented in the Proposed Plan which was available for public comment in October 2001. No comments were received from the public regarding the plan.

The antimony plume is expected to remain stable, and plume migration is estimated at 0.5 ft/year. Therefore, the limited action alternative for antimony contamination will implement LUCs to prevent exposure to contaminated groundwater along with a long- term groundwater monitoring program and 5-year reviews. Because the antimony plume is not expected to be of major concern, it is prudent to focus on active remediation of the VOC contamination at OU 4.

The selected remedy will provide aggressive treatment of VOCs in the suspected source area of the northern plume by in situ chemical oxidation. Site-specific treatability studies suggest that phytoremediation coupled with monitored natural attenuation can be used to treat residual contamination following chemical oxidation (Nzengung, not dated). Compared to other conventional technologies, the use of plants to remediate contaminated environments is cost-effective and ecologically sound.

2.12.2 Remedy Description

Alternative V-3P, in situ Chemical Oxidation, Natural Attenuation, and Phytoremediation addresses VOC contamination within the source areas of the northern and southern plumes at OU 4, reducing concentrations of PCE, TCE, and cis-DCE to Florida surface water standards and eventually to Florida drinking water standards.

It is assumed that 40 years would be required for Alternative V-3P to achieve all RAOs. Because of this duration, LUCs in the form of groundwater-use restrictions will be required to minimize potential risk to future residents from using groundwater as a drinking water source. Groundwater-use restrictions should be implemented prior to

chemical oxidation remedial activities. These restrictions will be continued throughout the operation of the IRA and use of MNA until contaminant levels meet MCLs in both the northern and southern plumes. Once the entire groundwater plume has been treated to Florida drinking water standards, the groundwater use restrictions will be eliminated.

In addition, LUCs in the form of deed restrictions will be implemented to prohibit future residential development at OU 4.

Northern VOC Plume. In situ chemical oxidation consists of injecting $KMnO_4$ into the groundwater at the source area of the northern plume at OU 4 to chemically destroy the chlorinated compounds in dissolved and nonaqueous phases. It is anticipated that chemical oxidation within the northern plume source area will be able to reduce source area groundwater concentrations to site-specific standards, based on the results of a field pilot test conducted at OU 4. When combined with MNA and phytoremediation, Florida surface water standards at Lake Druid would be achieved.

The downgradient portion of the northern plume will continue to be treated by operating the existing IRA system until the downgradient groundwater (between Port Hueneme Avenue and Lake Druid, see Figure 2-1) concentrations have been reduced to levels that allow for MNA to meet Florida surface water standards. MNA coupled with phytoremediation will be used to reduce the contaminant levels down to drinking water standards.

A numerical, three-dimensional groundwater flow model (Visual MODFLOW or VMODFLOW) was used to prepare a conceptual design for the $KMnO_4$ injection system. An estimated three groundwater circulation cells will be required to adequately treat the source area. Each circulation cell will consist of two injection/extraction well pairs, one pair screened to the base of the hard layer (shallow zone, approximately 0 to 20 feet bls), and one pair screened below the hard layer (deep zone, approximately 20 to 35 feet bls). This arrangement will allow separate treatment of the shallow and deep zones (i.e., above and below the hard layer). The injection/ extraction wells for the central circulation cell (four wells total) will be installed within Building 1100. The western and central circulation cells will be operating at approximately 6 gallons per minute (gpm) total (2 gpm in the shallow zone and 4 gpm in the deep zone), while the eastern circulation cell will operate at approximately 3 gpm (1 gpm in the shallow zone and 2 gpm in the deep zone). These flow rates were selected to ensure the source area is within the treatment zone.

Groundwater from each extraction well will be pumped via a submersible pump to a single equalization tank. A transfer pump will circulate water from the equalization tank to the $KMnO_4$ feed system and then back to the tank. Based upon pilot test results, it is assumed that over the period of treatment, an average of 1.5 grams per liter (g/L) of $KMnO_4$ will be added to the extracted groundwater stream. After dosage, the treated groundwater will be pumped to two settling tanks piped in series. These tanks will provide the required residence time to allow the $KMnO_4$ to oxidize any VOCs present in the extracted groundwater to below Florida drinking water standards. The treated water would then be pumped through filters to remove particulates and distributed via appropriate valving and flow meters to the three injection well pairs. Reinjected water will comply with State of Florida regulatory limits and the terms of the UIC permit for the site.

The $KMnO_4$ pilot study conducted in February 2000 established that approximately two pore volumes are required to treat the source area. Based upon numerical modeling results, approximately two pore volumes can be flushed through the shallow zone (0 to 20 feet bls) within approximately 1 year of operation. However, the time required for two pore volumes to flush through the deep zone is likely to be much shorter (4 to 6 months) due to higher hydraulic conductivity and it was assumed for estimating purposes that the entire system will operate for one year.

Based on various treatability studies, phytoremediation has been selected as a polishing step following source removal of a shallow chlorinated solvent plume, consisting of PCE and its reductive transformation products. Phytoremediation is a set of in situ biological

processes that involve the use of plants and the microbes associated with their growth for the remediation of contaminated sediment, soil, and water. Treatability studies suggest that phytoremediation can be used to treat low concentrations of VOCs in the groundwater following chemical oxidation.

Phytoremediation will consist of planting trees in the plume area and upgradient areas of OU 4. A small wetlands area will be created in the plume area near Lake Druid. A successful phytoremediation system will reduce the time of operation of the existing IRA pump and treat air stripper system. A dense plantation of poplars and willows will be grown over the plume to enhance natural attenuation, which is already occurring at the site to some degree.

Natural attenuation in combination with phytoremediation will be used to treat the low levels of VOC contamination remaining after the active treatment processes have been shut down. Natural attenuation works through nondestructive mechanisms such as dispersion, adsorption, dilution, volatilization, and/or chemical and biological stabilization of contaminants, and destructive mechanisms such as biodegradation. Natural attenuation will be incorporated into the long-term groundwater monitoring plan for OU 4.

Southern VOC Plume. The contaminant concentrations in the southern plume are much lower than those in the northern VOC plume. Phytoremediation coupled with natural attenuation processes will be used to treat these low level VOC contaminant concentrations.

Antimony Plume. Alternative A-2, Limited Action, has been selected to address the antimony contamination in groundwater at OU 4. During this period the antimony plume will be closely monitored, although the plume currently appears to be stable and is not expected to be of major concern in the future. If the 5-year review indicates that antimony levels still exceed Florida GCTLs, an appropriate active remedial option, such as Alternative A-3, Extraction and Discharge to the Orlando STP, will be selected. Given that the antimony plume appears to be stationary, concentrating on VOC remediation while only monitoring the antimony plume is prudent. The present worth cost to implement Alternative A-2 is estimated to be $221,683 and includes the cost of implementing groundwater-use restrictions, performing site reviews, and groundwater monitoring every 5 years over the assumed 30-year period.

2.12.3 Cost Summary

The sum of the present worth costs for Alternative V-3P and A-2 is $1,702,000. This represents the estimated cost to implement the remedial actions to address the VOC and antimony contamination at OU 4. The information in the cost estimate summary tables (Tables 2-8 and 2-9) is based on the best available information regarding the anticipated scope of the remedial alternative. Changes in cost elements are likely to occur as a result of new information and data collected during the engineering design of the remedial alternative. Major changes may be documented in the form of a memorandum in the Administrative Record file, an explanation of significant differences, or a ROD amendment. The estimate is an order-of-magnitude engineering cost estimate expected to be within the range of +50 to -30 percent of the actual project cost.

2.12.4 Expected Outcome of Selected Remedy

The selected remedy is expected to ultimately restore the shallow groundwater aquifer to FDEP drinking water levels for all VOC contaminants. The estimated time to reach this goal is a minimum of 40 years.

For the antimony contamination, the plume is expected to remain stable and not be of concern in the future. Implementation of LUCs in the form of groundwater use restrictions for an indefinite period of time will prevent exposure to this contaminant.

The selected remedy will meet the RAOs established for the site by active remediation and

TABLE 2-8

SELECTED ALTERNATIVE FOR VOC PLUME COST ESTIMATE SUMMARY

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CAPITAL COSTS			
	Description		**Cost**
	DIRECT COSTS		
1.	Groundwater Use Restrictions		$10,000
2.	Site Preparation and Mobilization (Northern Plume)		$15,052
3.	In Situ Chemical Oxidation System (Northern Plume)		$239,175
4.	Phytoremediation		TBD
		Subtotal Direct Costs	TBD
	INDIRECT COSTS		
1.	Health and Safety		$11,000
2.	Administration/Permits		$22,500
3.	Engineering & Design		$40,000
4.	Construction Support Services		$50,000
		Subtotal Indirect Costs	TBD
		Total Capital Cost	TBD
OPERATION AND MAINTENANCE COSTS			
	Description		**Cost**
1.	In situ Chemical Oxidation O&M (12 months)		182,444
2.	IRA System O&M (years 1-10)		$42,602
3.	IRA Groundwater Monitoring within Downgradient Plume (10 years)		$10,650
4.	Monitored Natural Attenuation (years 1-40)		$18,250
5.	Five-year Site Reviews (every 5 years for 40 years)		$18,220
6.	Phytoremediation (years 1-40)		TBD
		Total O&M Costs	TBD

TABLE 2-8
SELECTED ALTERNATIVE FOR VOC PLUME
COST ESTIMATE SUMMARY

OPERABLE UNIT 4
NTC, ORLANDO
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PRESENT WORTH ANALYSIS					
Year	Capital Cost	Operation and Maintenance Cost	Total Yearly Cost	Present Worth Factor (i=6%)	Present Worth
0				1.000	
1				0.943	
2				0.890	
3				0.840	
4				0.792	
5				0.747	
6				0.705	
7				0.665	
8				0.627	
9				0.592	
10				0.558	
11				0.527	
12				0.497	
13				0.469	
14				0.442	
15				0.417	
16				0.394	
17				0.371	
18				0.350	
19				0.331	
20				0.312	
21				0.294	
22				0.278	
23				0.262	
24				0.247	
25				0.233	
26				0.220	
27				0.207	
28				0.196	
29				0.185	
30				0.174	
31				0.164	
32				0.155	
33				0.146	
34				0.138	
35				0.130	
36				0.124	
37				0.117	
38				0.110	
39				0.104	
40				0.097	
				Total Present Worth	**$**

TABLE 2-9
SELECTED ALTERNATIVE FOR ANTIMONY PLUME COST ESTIMATE SUMMARY

OPERABLE UNIT 4
NTC, ORLANDO

CAPITAL COSTS		
Description		**Cost**
Direct Costs		
1. Groundwater Use Restrictions		$10,000
	Total Direct Costs	$10,000
Indirect Costs		
1. Health and Safety		$ 500
2. Administration Fees		$ 1000
3. Engineering		$4000
4. Construction Support Services		$1000
	Subtotal	$6,500
	Total Capital Cost	**$16,500**

OPERATION AND MAINTENANCE COSTS	
Description	**Cost**
1. Five-Year Site Reviews (every 5 years for 30-year period)	$18,220
2. Groundwater Monitoring (for 30-year period)	$10,210

TABLE 2-8
SELECTED ALTERNATIVE FOR ANTIMONY PLUME
COST ESTIMATE SUMMARY

OPERABLE UNIT 4
NTC, ORLANDO
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PRESENT WORTH ANALYSIS					
Year	**Capital Cost**	**Operation and Maintenance Cost**	**Total Yearly Cost**	**Present Worth Factor (I=6%)**	**Present Worth**
0	16,500		$16,500	1.000	$16,500
1		10,210	10,210	0.943	9,628
2		10,210	10,210	0.890	9,087
3		10,210	10,210	0.840	8,576
4		10,210	10,210	0.792	8,086
5		28,430	28,430	0.747	21,237
6		10,210	10,210	0.705	7,198
7		10,210	10,210	0.665	6,790
8		10,210	10,210	0.627	6,402
9		10,210	10,210	0.592	6,044
10		28,430	28,430	0.558	15,864
11		10,210	10,210	0.527	5,381
12		10,210	10,210	0.497	5074
13		10,210	10,210	0.469	4,789
14		10,210	10,210	0.442	4,513
15		28,430	28,430	0.417	11,855
16		10,210	10,210	0.394	4,023
17		10,210	10,210	0.371	3,788
18		10,210	10,210	0.350	3,574
19		10,210	10,210	0.331	3,380
20		28,430	28,430	0.312	8,870
21		10,210	10,210	0.294	3,002
22		10,210	10,210	0.278	2,838
23		10,210	10,210	0.262	2,675
24		10,210	10,210	0.247	2,522
25		28,430	28,430	0.233	6,624
26		10,210	10,210	0.220	2,246
27		10,210	10,210	0.207	2,113
28		10,210	10,210	0.196	2,001
29		10,210	10,210	0.185	1,889
30		28,430	28,430	0.174	4,497
				Total Capital and O&M Present Worth	**$201,516**
				Contingency @ 10 Percent	**$20,152**
			Total Present Worth Cost of Alternative A-2 for Antimony Plume		**$221,668**

by implementing LUCs for the site.

2.13 STATUTORY DETERMINATIONS

This section provides a brief, site-specific description of how the Selected Remedy satisfies the statutory requirements of CERCLA 121 [as required by NCP 300.430 (f) (5) (ii)], and explains the 5-year review requirements for the selected remedy. The Selected Remedy is a combination of Alternative V-3P (for the VOC plume) and Alternative A-2 (for the antimony plume).

Protection of Human Health and the Environment

The alternatives selected for implementation at OU 4 (Alternatives V-3P and A-2) are consistent with the Navy's IR program, CERCLA, and the NCP. The selected remedy for groundwater cleanup is protective of human health and the environment.

The selected remedy eliminates, reduces, or controls risks by the in situ treatment of chlorinated VOCs in the source area, operation of the existing groundwater IRA (extraction and treatment), and implementation of groundwater use restrictions. No unacceptable short-term risks or cross-media impacts will be caused by implementation of the remedy. Comparison of the selected remedy to the nine USEPA evaluation criteria is summarized in Tables 2-10 (for the VOC plume) and 2-11 (for the antimony plume).

Compliance with ARARs

In the short term, this alternative would comply with the chemical-specific ARARs for VOCs in groundwater discharging into Lake Druid. However, it will not comply with State drinking water standards until MNA of the downgradient plume is complete. This alternative emphasizes treatment of the VOC source area, reducing operation of the IRA, and expediting the time to achieve these ARARs. Monitoring of the groundwater quality at the point of compliance near the lake edge and at the source area would be used to ensure compliance with the ARARs. $KMnO_4$ injection may cause an exceedance of certain Florida secondary drinking water standards and would therefore require a petition to the FDEP for a UIC variance to exceed these standards. The variance is company-specific and must be acquired by the firm responsible for the full-scale remedial action.

Table 2-12 provides a summary of ARARs and to be considered (TBC) guidance specific to the selected remedy.

Cost-Effectiveness and Utilization of Permanent Solutions

The selected remedy is cost effective and provides a balance between cost and overall effectiveness in the protection of human health and the environment. Permanent solutions and treatment are utilized to the maximum practicable extent. However, the selected remedy does not provide for treatment of the antimony plume. Groundwater use restrictions and monitoring will be used to ensure the public health and environment are protected. The remedy provides the best trade-off among the alternatives evaluated with respect to the balancing and modifying evaluation criteria listed in Table 2-7.

Preference for Treatment

The statutory preference for treatment is met for the VOC groundwater contamination by (1) continued operation of the IRA, (2) in situ chemical oxidation, (3) phytoremediation, and (4) natural attenuation.

For the antimony plume, this remedy does not satisfy the statutory preference for treatment as a principal element of the remedy.

Five-Year Review Requirements

TABLE 2-10
SUMMARY EVALUATION OF SELECTED REMEDY ALTERNATIVE V-3P FOR VOC PLUME

OPERABLE UNIT 4
NTC, ORLANDO

Evaluation Criteria	Assessment
Overall Protection of Human Health and the Environment	• Provides a high level of human health protection. The combination of chemical oxidation treatment, continued operation of the existing IRA, and implementation of groundwater-use restrictions will ensure that public health and the environment are properly protected.
Compliance with ARARs	• In the short term, complies with chemical-specific ARARs for VOCs in groundwater discharging to a surface water body. It will not comply with State drinking water standards until MNA of the downgradient plume is complete. • Emphasizes treatment of the VOC source area reducing the overall operation of the IRA and expediting the time to achieve these ARARs. Monitoring at the point of compliance near the lake edge and at the source area would be used to ensure compliance with the ARARs. • May need to petition FDEP for a UIC variance because injection of $KMnO_4$ may cause an exceedence of some secondary drinking water standards.
Long-term Effectiveness and Permanence	• This alternative focuses on treatment of VOC contamination within the source area and the downgradient plume prior to discharge into Lake Druid. Chemical oxidation would chemically destroy the organic COCs permanently, and site-specific standards would be met. • The IRA permanently removes VOCs from groundwater. • Use of MNA and phytoremediation will achieve MCLs. • Management is required for estimated 40 years.
Reduction of Toxicity, Mobility, or Volume through Treatment	• Reduces the toxicity, mobility and volume of VOCs in groundwater. Chemical oxidation would destroy VOCs in situ in the northern plume. The IRA treats the downgradient plume by intercepting and physically removing the VOCs. Off-gas emissions from the air stripper would be compliant with Florida air quality requirements, but the contaminants would not be destroyed except through natural processes. • Phytoremediation, which uses naturally occurring or genetically engineered vegetation to remove or destroy contaminants, will be used to treat residual VOC contamination. • MNA, implemented once surface water criteria can be achieved without IRA operation, uses naturally occurring in situ biodegradation to reduce toxicity and volume of VOCs.
Short-term Effectiveness	• Achieves the remedial goals by treatment of the VOCs using in situ chemical oxidation, IRA wells, phytoremediation, and natural attenuation. Chemical oxidation will take approximately one year; however, contaminant reduction to drinking water standard is assumed to require 40 years. • Groundwater use restrictions will provide short-term effectiveness in protecting the public from existing contaminants. • There would be slight exposure to workers performing monitoring well installations, treatment process operations, and groundwater monitoring during these time frames.
Implementability	• Chemical oxidation treatment system would be relatively easy to implement using a mobile $KMnO_4$ storage and feed system. Low profile drill rigs will be used to install extraction/injection wells inside Building 1100. Building 1100 is vacant and construction and treatment will not interfere with any ongoing operations at NTC, Orlando. • The phytoremediation component of this alternative would be relatively easy to implement. • All permits and/or permit modifications are obtainable. • Equipment, specialists, materials and utilities are readily available .
Total Cost	• Present worth cost estimate is $1,480,000.
Federal and State Acceptance	• The USEPA and FDEP have concurred with the selected remedy.
Community Acceptance	• The community has been given the opportunity to review and comment on the selected remedy. No comments were received.

Notes: ARAR = applicable or relevant and appropriate requirement
IRA = Interim Remedial Action
COC = Chemical of concern
FDEP = Florida Department of Environmental Protection
MCL = Maximum Contaminant Level
MNA = monitored natural attenuation
UIC = underground injection control
USEPA = U. S. Environmental Protection Agency

TABLE 2-11
SUMMARY EVALUATION OF SELECTED REMEDY ALTERNATIVE A-2 FOR ANTIMONY PLUME

OPERABLE UNIT 4
NTC, ORLANDO

Evaluation Criteria	Assessment
Overall Protection of Human Health and the Environment	• Protective of future residential groundwater-use receptors by implementing groundwater-use restrictions. Groundwater monitoring will determine if plume migrates from within the groundwater-use restriction boundary.
Compliance with ARARs	• Meets chemical-specific ARARs for surface water standards. • Not compliant with Florida drinking water standards except through groundwater-use restrictions. Groundwater-use restrictions and monitoring would not help to achieve this ARAR.
Long-term Effectiveness and Permanence	• Human health risks from the antimony plume would likely remain without a remedial action to reduce antimony concentrations down to drinking water standards. • Groundwater-use restrictions coupled with monitoring would effectively prevent human exposure from groundwater ingestion. • Natural Processes will reduce the concentration of antimony over time. • Requires 5-year review.
Reduction of Toxicity, Mobility, or Volume through Treatment	• This alternative would not reduce toxicity, mobility, or volume of antimony in groundwater. No treatment would be implemented.
Short-term Effectiveness	• Drinking water standards would not be achieved in the foreseeable future because there would be no treatment of the antimony in the source area. • Groundwater-use restrictions coupled with monitoring would effectively prevent human exposure from groundwater ingestion. • Short-term effectiveness will be high because no one will be exposed to antimony during implementation.
Implementability	• Groundwater-use restrictions, groundwater monitoring, and 5-year reviews are easily implemented.
Total Cost	• Present worth cost estimate is $222,000. • Cost includes implementing groundwater-use restrictions for the antimony plume, performing site reviews and associated groundwater monitoring every 5 years over the assumed 30-year period.
Federal and State Acceptance	• The USEPA and FDEP have concurred with the selected remedy.
Community Acceptance	• The community has been given the opportunity to review and comment on the selected remedy. No comments were received.

Notes: ARAR = applicable or relevant and appropriate requirement
FDEP = Florida Department of Environmental Protection
USEPA = U. S. Environmental Protection Agency

TABLE 2-12
SUMMARY OF FEDERAL AND STATE ARARs AND GUIDANCE SPECIFIC TO THE SELECTED REMEDY

OPERABLE UNIT 4
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Name and Regulatory Citation	Description	Consideration in the Remedial Action Process	Type
Federal Guidance Material			
USEPA Region III Risk-Based Concentration Table	Contains reference doses and carcinogenic potency slopes for nearly 600 chemicals. These toxicity constants have been combined with standard exposure scenarios to calculate chemical concentrations corresponding to fixed levels of risk.	The chemical-specific soil and groundwater values provided in this guidance are TBC values when evaluating these media in the risk assessment and the FS.	TBC
Federal Regulatory Requirements			
National Environmental Policy Act (NEPA) Wetlands, Floodplains, Important Farmland, Coastal Zones, etc. (40 CFR Part 6)	Sets forth policy for carrying out Floodplains EO 11988. Requires cleanup in a floodplain not to be selected unless no practicable alternative exists.	For the Phytoremediation portion of the alternative, willow trees will be planted up to the border of Lake Druid. The regulatory requirement is to reduce the risk of flood loss and preserve and restore the floodplains.	Location-specific
National Emissions Standards for Hazardous Air Pollutants (NESHAP) (40 CFR Part 61)	Regulates specific sources of pollution. Requires sources to meet emission standards based on maximum available control technology. Section contains NESHAP for PCE dry cleaning sources.	TBC. Emission limitations for certain pollutants (e.g., PCE) may be considered. Air stripping off-gas from IRA may result in release of hazardous air pollutants (PCE).	TBC (chemical-specific)
Resource Conservation and Recovery Act (RCRA) Regulations, Identification and Listing of Hazardous Waste (40 CFR Part 261)	Defines listed and characteristic hazardous wastes subject to RCRA. Contains the toxicity characteristic leaching procedure.	Applicable when determining whether or not waste on-site is hazardous by being listed or by exhibiting a hazardous characteristic. (Any excavated materials would be sampled and analyzed for hazardous characteristics, as defined by 40 CFR Part 261.)	Chemical-specific Action-specific
RCRA Regulations, Standards applicable to transporters of hazardous Waste (40 CFR 263)	Establishes procedures for transporting manifested hazardous waste within the United States.	Relevant and appropriate. If off-site transportation of hazardous waste for treatment and/or disposal occurs, transporters must meet these requirements.	Action-specific

TABLE 2-12
SUMMARY OF FEDERAL AND STATE ARARs AND GUIDANCE SPECIFIC TO THE SELECTED REMEDY

OPERABLE UNIT 4
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Name and Regulatory Citation	Description	Consideration in the Remedial Action Process	Type
Federal Regulatory Requirements (Continued)			
Safe Drinking Water Act (SDWA) Regulations, Maximum Contaminant Levels (MCLs), and Maximum Contaminant Level Goals (MCLGs) (40 CFR Part 141, Subparts B and F)	Establishes enforceable standards (MCLs) for potable water for specific contaminants. MCLGs are nonenforceable health goals.	MCLs are applicable because they are used for potential drinking water sources. Nonzero MCLGs can be considered potential relevant and appropriate requirements for groundwater used as a current or potential drinking water source.	Chemical-specific
SDWA Regulations, Underground Injection Control Program (40 CFR Parts 144, 146, 147 and 1000)	Outlines the minimum program and performance standards for underground injection programs.	Applicable. In situ chemical oxidation at OU 4 will involve underground injection.	Action-specific
State Guidance Materials			
Florida SCTLs (Chapter 62-777, F.A.C.)	Provides risk-based and/or toxicity-based cleanup target levels for contaminants in groundwater (GCTL), surface water (SWCTL), and soil (SCTL) based on direct human contact.	TBC. Should be considered when determining cleanup levels for groundwater, surface water, and soil.	TBC
State Regulatory Requirements			
Florida Rules on Permits (Chapter 62-4, F.A.C.)	Provides permitting requirements for water pollution sources and air emission units.	Would apply to off-site CERCLA activities or non-CERCLA remedial activities requiring air emissions or water discharge permits.	Action-specific
Florida Groundwater Classes, Standards and Exemptions (Chapter 62-520, F.A.C.)	Specifies Class I and II waters must meet primary and secondary drinking water standards in Chapter 62-550, F.A.C.	Applicable. Used to determine cleanup levels for groundwater at OU 4.	Chemical-specific

TABLE 2-12
SUMMARY OF FEDERAL AND STATE ARARs AND GUIDANCE SPECIFIC TO THE SELECTED REMEDY

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Federal Regulatory Requirements (Continued)			
Florida Underground Injection Control Regulations (Chapter 62-522, F.A.C.)	This rule establishes a State underground injection control program consistent with the Federal requirements and appropriate to the hydrology of Florida. Five classes of injection wells are defined.	Applicable. In situ chemical oxidation at OU 4 will involve groundwater injection.	Action-specific
Florida Drinking Water Standards (Chapter 62-550, F.A.C.)	Rule adopts Federal primary and secondary drinking water standards and also creates additional rules to fulfill State and Federal requirements for community water distribution systems.	Applicable. The standards in this rule will be used when evaluating cleanup levels for groundwater at OU 4.	Chemical-specific
Florida Hazardous Waste Rules (Chapter 62-730, F.A.C.)	These rules adopt by reference appropriate sections of 40 CFR Parts 260 through 268 and establish minor additions and exceptions concerning the generation, storage, treatment, transportation, and disposal of hazardous waste.	Applicable. Based on the history of operations at OU 4 and the solvents used during operations, the wastes encountered at the OU would be classified as hazardous wastes.	Action-specific

Notes: ARAR = applicable or relevant and appropriate requirement
CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act
CFR = *Code of Federal Regulations*
EO = Executive Order
F.A.C. = *Florida Administrative Code*
FS = Feasibility Study
IRA = Interim Remedial Action
PCE = tetrachloroethene
TBC = to be considered (guidance materials).
USEPA = U.S. Environmental Protection Agency.

VOC Plume. Site reviews will occur every 5 years until the action levels (Florida surface water and drinking water standards) are attained in the source area of both the northern and southern VOC plumes and in the downgradient area where the two plumes merge before discharging into Lake Druid. Additionally, treatment performance and groundwater monitoring data would be summarized and evaluated. This evaluation will include an assessment of the reduction in contaminant concentrations in both VOC plumes, the effectiveness of the chemical oxidation for the period of operation, and an assessment for supporting the IRA shutdown. Once these treatment processes are complete and IRA operation has ceased, reviews will include assessing the effectiveness of natural attenuation to maintain contaminant concentrations below Secondary Water Quality Standards at the shoreline of Lake Druid and to reduce concentrations further to drinking water standards.

Antimony Plume. Because the remedy selected for the Antimony plume (A-2, Limited Action) will result in hazardous substances, pollutants, or contaminants remaining on-site above residential health-based standards, a statutory review will be conducted every 5 years after initiation of the RA to ensure the remedy continues to be protective of human health and the environment. The plume appears to be stable and is not expected to be of major concern in the future. If the 5-year review indicates that antimony levels still exceed Florida GCTLs, an appropriate active RA option will be selected.

2.14 DOCUMENTATION OF SIGNIFICANT CHANGES

The Proposed Plan for OU 4 was released for public comment in October 2001. The Proposed Plan identified Alternative V-3P, Chemical Oxidation, Natural Attenuation, and Phytoremediation as the preferred alternative for VOC remediation. Alternative A-2, Limited Action, was selected as the preferred alternative to address the Antimony plume.

No comments were submitted during the public comment period; therefore, there are no significant changes in the selected alternative.

3.0 RESPONSIVENESS SUMMARY

There have been no issues raised by stakeholders, nor are there any technical or legal issues to discuss concerning this ROD.

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APPENDIX A

COMMUNITY RELATIONS RESPONSIVENESS SUMMARY

Responsiveness Summary
Operable Unit 4

Naval Training Center
Orlando, Florida

A public comment period on the OU 4 Proposed Plan was held from October 1 through October 30, 2001. No public comments were received, and because a public meeting was not requested one was not held.