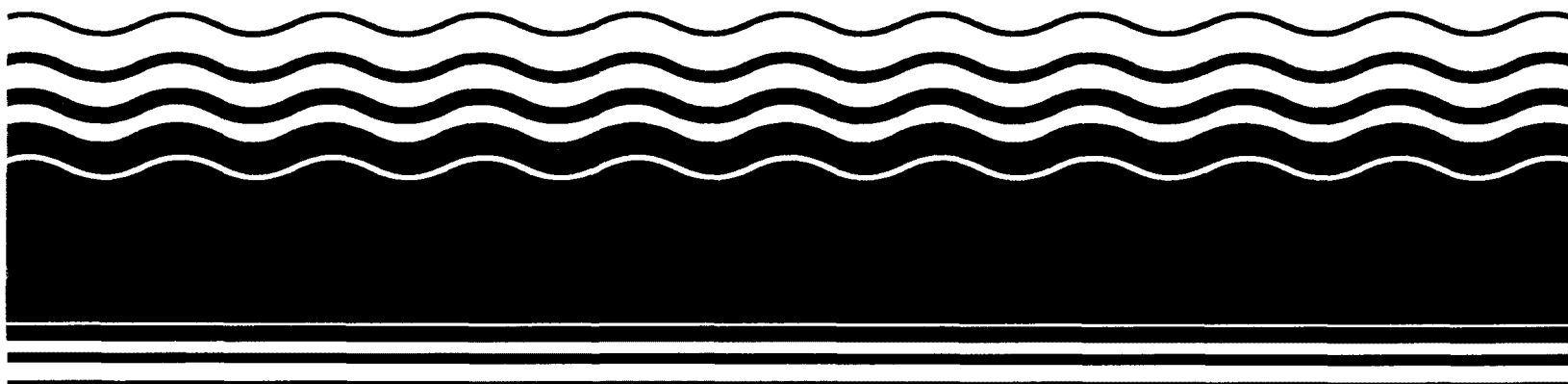


PB98-964016
EPA 541-R98-072
October 1998

EPA Superfund
Record of Decision:

Pensacola Naval Air Station OU 1
Pensacola, FL
9/25/1998





UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 4
ATLANTA FEDERAL CENTER
61 FORSYTH STREET
ATLANTA, GEORGIA 30303-8960

SEP 25 1988

CERTIFIED MAIL
RETURN RECEIPT REQUESTED

4WD-FFB

Commanding Officer
Naval Air Station Pensacola
190 Radford Boulevard
Pensacola, Florida 32508-5217

SUBJ: Record of Decision - Operable Unit 1
NAS Pensacola NPL Site
Pensacola, Florida


Dear Sir:

The U.S. Environmental Protection Agency (EPA) Region 4 has reviewed the above subject decision document and concurs with the selected remedy for the Remedial Action at Operable Unit 1. This remedy is supported by the previously completed Remedial Investigation, Feasibility Study and Baseline Risk Assessment Reports.

The selected remedy consists of: institutional controls to restrict groundwater use of the surficial zone of the sand and gravel aquifer and prohibit intrusive activities within the landfill boundary, an interception system to capture and treat groundwater to reduce iron levels, and natural attenuation of the organic compounds. EPA's concurrence assumes implementation of land use restrictions, through a land use controls assurance and implementation plan via a Memorandum of Agreement between the Navy, State and EPA, will be executed within 90 days. This remedial action is protective of human health and the environment, complies with Federal and State requirements that are legally applicable or relevant and appropriate to the remedial action and is cost effective.

EPA appreciates the coordination efforts of NAS Pensacola and the level of effort that was put forth in the documents leading to this decision. EPA looks forward to continuing the exemplary working relationship with NAS Pensacola and Southern Division Naval Facilities Engineering Command as we move toward final cleanup of the NPL site.

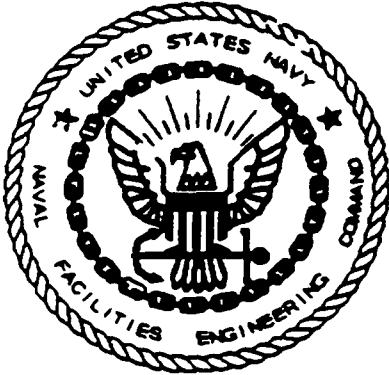
Sincerely,

A handwritten signature in dark ink, appearing to read "Richard D. Green", written over a horizontal line.

Richard D. Green
Director
Waste Management Division

cc: Elsie Munsell, Deputy Assistant Secretary of the Navy
Ron Joyner, NAS Pensacola
Bill Hill, SOUTHDIV
David Grabka, FDEP

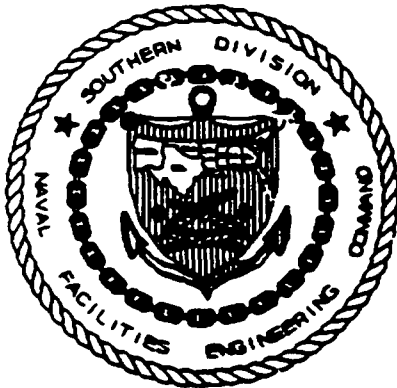
**FINAL RECORD OF DECISION
OPERABLE UNIT 1
NAS PENSACOLA
PENSACOLA, FLORIDA**



**SOUTHNAVFACENGCOM
Contract Number:
N62467-89-D-0318
CTO-083**

Prepared for:

**Comprehensive Long-Term Environmental Action Navy
(CLEAN)
Naval Air Station
Pensacola, Florida**



Prepared by:

**EnSafe Inc.
5724 Summer Trees Drive
Memphis, Tennessee 38134
(901) 372-7962**

August 19, 1998

**Release of this document requires prior notification of the Commanding Officer of the
Naval Air Station, Pensacola, Florida.**

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Appendix B	Responsiveness Summary

List of Abbreviations

The following list contains many of the abbreviations, acronyms and symbols used in this document. A glossary of technical terms is provided in Appendix A.

AOC	Area of Concern
ARAR	Applicable or Relevant and Appropriate Requirement
bls	below land surface
BRA	Baseline Risk Assessment
CDI	Chronic Daily Intake
CEC	Cation exchange capacity
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CG	Cleanup Goal
COC	Chemical of Concern
COPC	Chemical of Potential Concern
CSF	Cancer Slope Factor
CY	Cubic Yard
E&E	Ecology & Environment, Inc.
ED	Exposure Duration
EPC	Exposure Point Concentration
FDER	Florida Department of Environmental Regulation (since renamed Florida Department of Environmental Protection [FDEP])
FFA	Federal Facilities Agreement
FGGC	Florida Groundwater Guidance Concentration
FFS	Focused Feasibility Study
FOTW	Federally Owned Treatment Works
FPDWS	Florida Primary Drinking Water Standard
FS	Feasibility Study
FSDWS	Florida Secondary Drinking Water Standard
G&M	Geraghty & Miller, Inc.
gpm	gallons per minute
HEAST	Health Effects Assessment Summary Tables
HI	Hazard Index
HQ	Hazard Quotient
HRS	Hazard Ranking System

List of Abbreviations (Continued)

IAS	Initial Assessment Study
ILCR	Incremental Lifetime Cancer Risk
IRIS	Integrated Risk Information System
LURA	Land Use Restriction Agreement
lwa	Lifetime Weighted Average
MCL	Maximum Contaminant Level
MCLG	Maximum Contaminant Level Goal
NACIP	Navy Assessment and Control of Installation Pollutants
NAS	Naval Air Station
NCP	National Contingency Plan
NEESA	Naval Energy and Environmental Support Activity
NPDES	National Pollutant Discharge Elimination System
NPL	National Priorities List
O&M	Operation and Maintenance
OU	Operable Unit
PAH	Polyaromatic Hydrocarbon
PCB	Polychlorinated Biphenyl
ppb	part per billion
ppm	part per million
PVC	polyvinyl chloride
PWC	Public Works Center
RAB	Restoration Advisory Board
RCRA	Resource Conservation and Recovery Act
RfD	Reference Dose
RGO	Remedial Goal Option
RME	Reasonable Maximum Exposure
RI	Remedial Investigation
ROD	Record of Decision
SARA	Superfund Amendments and Reauthorization Act of 1986
SDWA	Safe Drinking Water Act
SMCL	Secondary Maximum Contaminant Level
SVOC	Semivolatile Organic Compound
SWMU	Solid Waste Management Unit

List of Abbreviations (Continued)

TBC	To-be-considered
TOC	Total Organic Carbon
TRC	Technical Review Committee
UCL	Upper Confidence Limit
USEPA	U.S. Environmental Protection Agency
VOC	Volatile Organic Compound
WBZ	Water-bearing Zone

DECLARATION OF THE RECORD OF DECISION

Site Name and Location

Operable Unit 1, Site 1, Sanitary Landfill
Naval Air Station Pensacola
Pensacola, Florida

Statement of Purpose

This decision document (Record of Decision), presents the selected remedy for Operable Unit 1 at the Naval Air Station Pensacola, Pensacola, Florida. The remedy was developed in accordance with the Comprehensive Environmental Response, Compensation and Liability Act of 1980 (CERCLA), as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA), 42 U.S.C. § 9601 *et seq.*, and to the extent practicable, the National Contingency Plan (NCP), 40 Code of Federal Regulations Part 300.

This decision is based on the administrative record for Operable Unit 1 at the Naval Air Station Pensacola.

The United States Environmental Protection Agency and the Florida Department of Environmental Protection concur with the selected remedy.

Assessment of the Operable Unit

Actual or threatened releases of hazardous substances from Operable Unit 1, if not addressed by implementing the response action selected in this Record of Decision (ROD), may present an imminent and substantial endangerment to public health or the environment.

Description of the Selected Remedy

This action is the first and final action planned for the operable unit. This alternative calls for the design and implementation of response measures to protect human health and the environment. The action addresses the sources of contamination as well as soil and groundwater contamination.

The major components of the remedy are:


- Institutional controls imposed in accordance with the Land Use Restriction Agreement (LURA) among the Navy, EPA and FDEP to restrict groundwater use of the surficial zone of the Sand-and-Gravel Aquifer within 300 feet of the site

- Institutional controls imposed in accordance with the LURA to restrict intrusive activities within the landfill boundary without prior approval from the NAS Pensacola Environmental office
- Annual review of the institutional controls and certification that the controls should remain in place or be modified to reflect changing site conditions
- Groundwater monitoring program to ensure that natural attenuation processes would be effective
- A review during which the Navy would determine whether groundwater performance standards continue to be appropriate and if natural attenuation processes are effective
- Continued groundwater monitoring at regular sampling intervals after performance standards are attained. The groundwater monitoring program would continue until continued attainment of the performance standards has been achieved and the alternative remains protective of human health and the environment.
- A groundwater interception system to capture the contaminated groundwater upgradient of Wetland 3. The intercepted groundwater will be treated to reduce iron levels to below the applicable water quality standard. The treated groundwater will then be reintroduced into Wetland 3.
- Concentrations of the organic compounds present in the groundwater and surface water will be reduced through natural attenuation resulting from naturally occurring biotic and abiotic processes which take place in the groundwater and surface water systems.

Statutory Determinations

The selected remedy is protective of human health and the environment, complies with federal and state requirements that are legally applicable or relevant and appropriate to the remedial action, and is cost-effective. This remedy utilizes permanent solutions and alternative treatment or resource recovery technologies, to the maximum extent practicable, and satisfies the statutory preference for remedies that employ treatment that reduces toxicity, mobility, or volume as a principal element.

Because this remedy will result in hazardous substances remaining onsite, it will be reviewed within five years after it commences to evaluate that it continues to adequately protect human health and the environment.


CAPT USN

Captain J.M. Denkler, NAS Pensacola

19 AUG 98

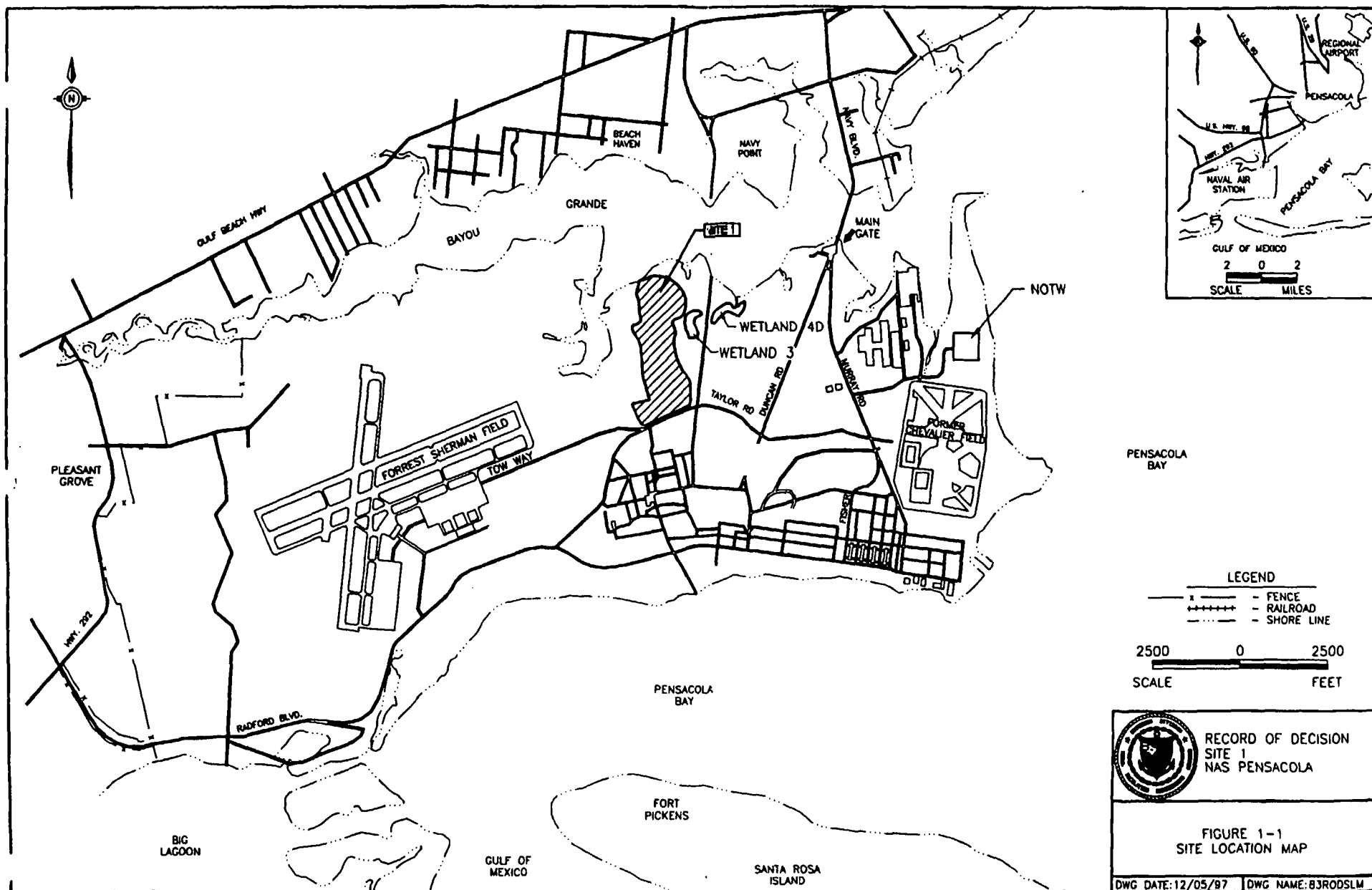
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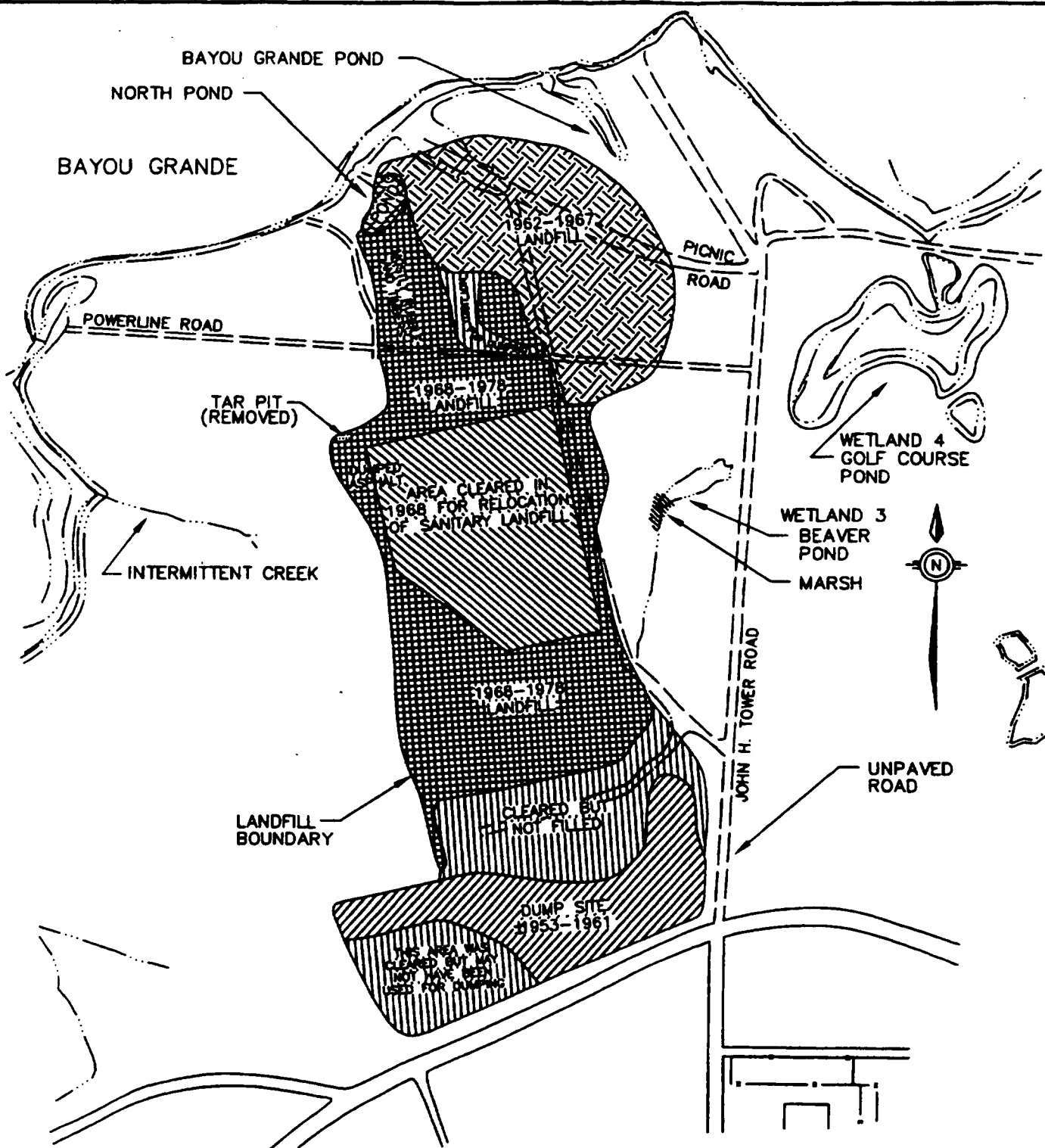
1.0 SITE LOCATION AND DESCRIPTION

Site 1 is an approximately 85-acre inactive sanitary landfill as shown on Figures 1-1 and 1-2. It is from 8 to 20 feet above mean sea level and is densely vegetated with 15- to 25-foot tall planted pines and natural scrub vegetation. Approximately one-half mile east of Forrest Sherman Airfield, the site is within the north central portion of the Naval Air Station (NAS) Pensacola. The landfill is bordered by an inland water body (Bayou Grande) to the north, by the A.C. Read Golf Course to the east, and by areas of natural scrub vegetation to the west and south. Bayou Grande has been classified by the Florida Department of Environmental Protection (FDEP) as a Class III water body, indicating its use for recreation and maintaining a well-balanced fish and wildlife population. Beyond the scrub vegetation, Taylor Road lies approximately 200 feet south of the site.

Developed areas immediately north of the landfill include a Boy Scout camp, a nature trail, an NAS Pensacola picnic area, and recreational Buildings 3553 and 3487. Also in this generally developed area are two tidal-inlet ponds with associated wetlands. Other wetland areas are west and east of the landfill; most are associated with marshy intermittent creeks. The nearest residential area (base housing) is approximately 1,000 feet south of Site 1. Potable water for this residential area and all of NAS Pensacola is supplied from Corry Station, approximately three miles north of NAS Pensacola.

Because soil is highly permeable at the site, the potential for substantial contamination transfer via surface water flow is limited. Two intermittent creeks lie within wetlands outside the landfill, as shown on Figure 1-2. One creek, approximately 50 to 100 feet east of the landfill's central portion (depending upon precipitation amounts), channels flow northeastward to the beaver pond (Wetland 3). The other originates approximately 500 feet west of the landfill's central portion and channels flow northwestward to Bayou Grande. Neither has been observed to receive direct





SOURCE: E&E 1991/NAVFAC DRAWING NUMBER 5205053



RECORD OF DECISION
SITE 1
NAS PENSACOLA

FIGURE 1-2
SITE MAP

DWG DATE: 12/05/97 | DWG NAME: 83RODSTM

surface water runoff from the landfill; it appears that they are fed by groundwater seepage when the water table is high. A dry stream bed is in the site's northern portion, immediately south and leading to Bayou Grande Pond. No surface water was observed in this stream bed during the investigation.

2.0 SITE HISTORY AND ENFORCEMENT ACTIVITIES

2.1 General Site History

In December 1989, the base was placed on the United States Environmental Protection Agency's (USEPA) National Priorities List (NPL). The Federal Facilities Agreement (FFA), signed in October 1990, outlined the regulatory path to be followed at NAS Pensacola. NAS Pensacola must complete, not only the regulatory obligations associated with its NPL listing, but it also must satisfy the ongoing requirements of an environmental permit issued in 1988. A permit is an authorizing document issued by an approved Florida agency or USEPA to implement the requirements of an environmental regulation. That permit addresses the treatment, storage, and disposal of hazardous materials and waste and also the investigation and remediation of any releases of hazardous waste and/or constituents from solid waste management units (SWMUs) at NAS Pensacola. The Resource Conservation and Recovery Act (RCRA) governs ongoing use of hazardous materials and the operating permit rules. RCRA and the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) investigations and actions are coordinated through the FFA, streamlining the cleanup process.

2.2 Site-Specific History

From the early 1950s until 1976, domestic and industrial wastes from NAS Pensacola and other outlying Navy facilities were disposed of at Site 1. The following partial list of wastes and quantities disposed of at the site was taken from the 1983 Naval Energy and Environmental Support Activity (NEESA) Initial Assessment Study (IAS):

- Ketone-soaked rags
- Polychlorinated biphenyl (PCB)- and transformer oil-soaked rags
- Paint chips
- Paint sludge from water wall paint booth
- Paint sludge

- Dry air-filter pads from paint booths
- Compressed air cylinders
- Asbestos from building demolition
- Wood soaked with plating solutions
- Pesticide rinsate
- Garbage
- Wastes from outlying facilities: Corry, Ellison, Saufley, Baron, and Whiting
- Containers of paints, pesticides, oils, strippers, plating chemicals, solvents, thinners, etc.
- Mercury

As shown on Figure 1-2, previous investigation documents and NAS Pensacola Public Works Center (PWC) drawings indicate that disposal activities moved from one portion of the site to another when the landfill was active (NEESA, 1983). The southernmost portion of the site, used during the 1950s, is the landfill's oldest-known section. In the early 1960s, waste disposal was moved approximately 3,000 feet north, to the site's northernmost portion. Additionally, an area along the site's northwestern border is reported to have been filled with construction rubble during the 1950s and 1960s. From the late 1960s until the closure of the landfill, waste was disposed of in its central portion. During the earlier years of disposal, wastes commonly were burned before burial; however, this practice ended in the late 1960s due to residents' concern regarding air pollution in nearby areas. The landfill officially closed on October 1, 1976.

2.3 Chronology of Events and Previous Investigations

The following chronology of events and previous investigations at Site 1 provides a basis for understanding the history and focus of the remedial investigation/feasibility study (RI/FS).

1974 — Discovery of Landfill Leachate Discharge

In 1974, landfill leachate was discharging from an abandoned drainage field into a nearby golf course pond. The leachate discharge resulted from a plugged drainage outlet, which caused the water table to rise and leachate to seep from the surface. The leachate discharge was investigated in 1974 and 1975 by installing and sampling seven galvanized-steel monitoring wells. Groundwater sample analysis detected phenol and several metals (G&M, 1984). This investigation reportedly concluded that shallow groundwater flowed north toward Bayou Grande and was contaminated in the upper portion of the Sand-and-Gravel Aquifer near the landfill (NEESA, 1983).

1983 — Initial Assessment Study

An IAS was performed by NEESA (since renamed) under the Navy Assessment and Control of Installation Pollutants (NACIP) program. As the first phase of the NACIP program, its purpose was to identify and assess sites posing a threat to human health or the environment due to contamination from hazardous materials operations. This study included reviewing facility records and aerial photographs, interviewing facility personnel, and conducting field surveys. During the survey, landfill leachate and sediment from site ponds were sampled. Sample analysis detected cadmium, chromium, mercury, nickel, and lead in sediment, and cadmium and mercury in the leachate (NEESA, 1983). The survey concluded that Site 1 presented a threat to human health and the environment; therefore it was recommended for further investigation to include a confirmation study (verification and characterization studies), Phase II of the NACIP program.

1984 — Verification Study

Part I of the NACIP confirmation study, the verification study, was performed by Geraghty & Miller, Inc. (G&M) to confirm whether groundwater contaminants were present at sites recommended for study in the IAS (G&M, 1984). During this study, eight shallow 2-inch polyvinyl chloride (PVC) monitoring wells were installed and groundwater was sampled for

analysis of volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), pesticides, PCBs, metals, cyanide, and field parameters. Analytical results indicated that shallow groundwater beneath the landfill had been affected by past disposal practices. VOCs were detected in all groundwater samples collected. The highest concentrations of organic compounds, mostly VOCs, were detected in samples from the central portion of the site. Only trace concentrations of SVOCs were detected. No PCBs or pesticides were present at concentrations above method detection limits. All detected metals concentrations were below FDEP 1984 drinking water standards. Water levels measured in the study indicated shallow groundwater flowing north, northwest, and northeast toward surface water bodies, where it discharges to the bayou, site ponds, and tidal inlets.

1986 — Characterization Study

Part II of the NACIP confirmation study, the characterization study, was performed by G&M to determine the nature and extent of contamination at verification study sites requiring additional investigation (G&M, 1986). During this investigation, five additional shallow monitoring wells (GM-38 through GM-42) and three deep wells (GM-43 through GM-45) were installed. Groundwater samples were collected from all new wells and the eight verification study wells. Groundwater samples from the new wells were analyzed for the USEPA's list of organic priority pollutants, including VOCs, SVOCs, pesticides, and PCBs. Samples collected from the previously installed wells were analyzed for VOCs only. No metals analysis was performed for either well group. Samples collected from 12 of the 16 wells contained one or more VOCs. Additionally, two samples collected from deep wells were contaminated with VOCs. However, the presence of certain VOCs during the characterization study was not consistent with the verification study results (e.g., vinyl chloride only detected during characterization, methylene chloride detected only during verification). SVOCs, pesticides, or PCBs were not detected during the characterization study. Water level elevation data again confirmed the generally northward flow

of shallow groundwater toward site surface water bodies. However, deep well water levels indicated a slight gradient to the south (G&M, 1986).

1991 — Contamination Assessment/Remedial Activities Investigation

Phase I of a Contamination Assessment/Remedial Activities Investigation was performed by Ecology and Environment, Inc. (E&E, 1991a), to identify principal areas and primary contaminants of concern at Site 1 and to provide recommendations for subsequent phases of investigation. The following preliminary surveys were performed: site reconnaissance survey, aerial photography analysis, radiation survey, surface emissions survey, and a geophysical survey. Additionally, site surface water, sediment, surface soil, and groundwater were sampled for laboratory analysis. Groundwater samples were collected from 15 G&M monitoring wells, along with 28 temporary shallow monitoring wells. Sediment, surface water, and surface soil samples were analyzed for a suite of screening parameters, including VOCs, polynuclear aromatic hydrocarbons (PAHs), phenols, pesticides, total PCBs, total recoverable petroleum hydrocarbons, and metals (water samples analyzed unfiltered). Samples collected from existing G&M wells were analyzed according to USEPA Contract Laboratory Program protocol for the full Target Analyte List/Target Compound List, plus gross alpha radioactivity. Samples from temporary wells were analyzed for the screening parameters suite. The investigations are detailed in the corresponding 1991 Interim Data Report (E&E, 1991b). The following passage summarizes E&E's investigation result conclusions.

Site Reconnaissance Survey — Numerous disturbed areas indicating fill activities or leachate migration were identified across the site. A collapsed/depression feature with remains of metal containers, an oozing tar-like substance, and elevated organic vapor concentrations was identified in the northwest corner of the 1950s fill area. Exposed medical and industrial waste was identified in the southwestern corner of the 1970s fill area. A linear pit containing a black, tar-like material was also identified in the northwestern corner of the 1970s fill area. This pit measured

approximately 40 feet by 15 feet and contained approximately 1.5 feet of material. A construction rubble field south of North Pond extended south across Powerline Road near well GM-33. Various discolored water/leachate seeps and areas of soil and/or vegetation staining were identified in site wetland areas (intermittent streams, ponds, and tidal inlets).

Aerial Photography Analysis — A review of historical aerial photographs generally confirmed the progression of landfill activities, which began in the site's southern portion during the 1950s, moved to the northern portion in the early 1960s, and ended in the central portion from the late 1960s through 1976. Additionally, numerous areas of disturbance associated with landfill activities were noted from these photographs. Specifically, three dark areas, one corresponding to the tar pit location, were identified on a 1970s photograph along the western extent of the 1970s fill area. An apparently low, linear marshy area also identified on a 1970s photograph corresponds to the construction rubble field. Also, a sizeable dark irregular feature measuring approximately 200 feet by 75 feet was observed in the center of the 1970s fill area on a 1973 photograph (E&E, 1991b).

Surface Emissions and Radiation Surveys — Elevated organic vapor concentrations ranging from 1.0 to 20.0 parts per million above background were detected at five locations. The highest concentration was at the collapse/depression feature in the 1950s fill area. Surface radiation concentrations above reference concentrations were not detected (E&E, 1991b).

Geophysical Survey — An electron magnetometer (EM-31) and metal detector (EM-34) were used to perform the survey. Overall, the results indicated the presence of ferrometallic materials at relatively shallow depths (20 feet below land surface [bls] or less) across most of the landfill, primarily within the landfill boundary as determined by aerial photographs and site reconnaissance. Deeper anomalous EM-34 readings collected north, west, and east of the landfill may be attributable to landfill leachate migration toward the bayou in a lower portion of the

surficial zone of the Sand-and-Gravel Aquifer. However, these deeper anomalies may also reflect saline water intrusion and/or more conductive lithologies present below the surficial zone base (E&E, 1991b).

2.4 Removal Action

The remedial investigation (RI) completed at Site 1 identified a tar pit which posed a physical hazard to site trespassers. There is no PRG established for the material. TCLP samples collected of the tar in 1993 indicated that it was not hazardous waste. A total of 73 tons of this material was excavated in January 1998 and disposed of at a Subtitle D landfill to remove the physical hazard.

3.0 HIGHLIGHTS OF COMMUNITY PARTICIPATION

Throughout the site's history, the community has been kept abreast of activities in accordance with CERCLA Sections 113(k)(2)(B)(i-v) and 117. In January 1989, a Technical Review Committee (TRC) was formed to review recommendations for investigation and remediation efforts at NAS Pensacola and monitor its progress. The TRC was made up of representatives of the Navy, USEPA, FDER (now FDEP), and the local community. In addition, a mailing list of interested community members and organizations was established and maintained by the NAS Pensacola Public Affairs Office. In July 1995, a Restoration Advisory Board (RAB) was established as a forum for communication between the community and decision-makers. The RAB absorbed the existing TRC and added more members from the community and local organizations. The RAB members work together to monitor progress of the investigation and to review remediation activities and recommendations at NAS Pensacola. RAB meetings are held regularly, advertised, and are open to the public.

Site-related documents were made available to the public in the administrative record at information repositories maintained at the NAS Pensacola Library and the John C. Pace Library of the University of West Florida.

Before the removal action occurred at Site 1, a public notice was placed in the *Pensacola News Journal* on January 8, 1998. After finalizing the RI, Focused Feasibility Study (FFS), and FFS addendum reports, the preferred alternative for Site 1 was presented in the Proposed Remedial Action Plan, also called the Proposed Plan. Everyone on the NAS Pensacola mailing list was sent a copy of the Proposed Plan. The notice of availability of the Proposed Plan, RI, and FFS documents was published in the *Pensacola News Journal* on December 4, 1997. A public comment period was held from December 8, 1997, to January 22, 1997, to encourage public participation in the remedy-selection process. In addition, the opportunity for a public meeting was provided. Responses to comments received during the comment period are in Appendix B.

4.0 SCOPE AND ROLE OF THE OPERABLE UNIT

This selected remedy is the first and final remedial action for the site. The function of this remedy is to reduce the risks to human health and environment associated with exposure to contaminated groundwater and soil.

The selected remedial alternative will address conditions which pose a threat to human health and the environment including:

- Contaminated groundwater may potentially impact drinking water supplies or nearby ecological receptors

Pathways of exposure include:

- ingestion and inhalation of contaminated groundwater and
- aquatic exposure to groundwater migrating to surface waters.

The major components of the remedy are:

- Institutional controls imposed in accordance with the LURA to restrict groundwater use of the surficial zone of the Sand-and-Gravel Aquifer within 300 feet of the site.
- Institutional controls imposed in accordance with the LURA to limit intrusive activities within the landfill boundary without prior approval from the NAS Pensacola Environmental Office.

- Annual review of the institutional controls and certification that the controls should remain in place or be modified to reflect changing site conditions.
- Groundwater monitoring to ensure that natural attenuation processes are effective.
- A review during which the Navy would determine whether groundwater performance standards continue to be appropriate and if natural attenuation processes are effective.
- Continued groundwater monitoring at regular sampling intervals after performance standards are attained. The groundwater monitoring program would continue until a five-year review concludes that the alternative has achieved continued attainment of the performance standards and remains protective of human health and the environment.
- A groundwater interception system to capture the contaminated groundwater upgradient of Wetland 3. The intercepted groundwater will be treated to reduce iron levels before being reintroduced into Wetland 3.
- Concentrations of the organic compounds present in the groundwater and surface water will be reduced through natural attenuation resulting from naturally occurring biotic and abiotic processes which take place in the groundwater and surface water systems.

This remedy addresses the first and final cleanup action planned for Operable Unit (OU) 1. The groundwater beneath OU 1 contains concentrations of contaminants similar to those present in OU 1 subsurface soil. Although the water-bearing zone is affected, contamination is not affecting the public drinking water supply. This proposed action is to prevent current or future unacceptable exposure to contaminated soil and groundwater, and to reduce the migration of contaminants to surface water.

This is the only Record of Decision (ROD) contemplated for Site 1. Operable Unit 1, which consists of Site 1, is one of 13 OUs within NAS Pensacola. The purpose of each OU is defined in the *FY 1997 Site Management Plan* (SOUTHNAVFACENGCOM, 1996) for NAS Pensacola, which is in the Administrative Record.

5.0 SITE CHARACTERISTICS

This section of the ROD presents an overview of the nature and extent of contamination at OU 1 with respect to known or suspected sources of contamination, types of contamination, and affected media. Known or potential routes of contaminant migration are also discussed.

5.1 Nature and Extent of Soil Contamination

Based on the Site 1 RI (January 1996), soil inside the landfill boundary has been impacted by past activities there. Buried waste in the landfill has been characterized in the RI as containing detectable concentrations of all analyzed parameter groups (inorganics, volatiles, semivolatiles, pesticides and PCBs). Because the landfill is approximately 20 to 40 years old, minimal concentrations of waste constituents are expected to be leaching to underlying groundwater. Soil quality outside the landfill boundary appears to generally compare to reference soil conditions. However, soil within the boundary appears to have been impacted by landfill activities, resulting in elevated concentrations of inorganic and organic constituents. However, none of the surface soil samples contained any compounds at concentrations above their respective PRG.

5.2 Nature and Extent of Groundwater Contamination

Shallow and Intermediate Groundwater

The affected groundwater in the aquifer beneath OU 1 has been classified by USEPA and FDEP as Class IIA and G-2, a potential source of drinking water. The nature and extent of landfill-impacted groundwater have been evaluated onsite. Inorganic and organic constituents are present in the surficial zone (shallow and intermediate well depths) beneath the site. Groundwater analytical results from 1993 and 1994 indicate that 1993 analytical results were affected (biased) due to sample turbidity. The 1993 samples were collected with Teflon bailers, while 1994 samples were collected with quiescent sampling techniques. Based on 1994 analytical results, the greatest impact from inorganics to shallow and intermediate groundwater quality appears to be limited to the site's center, along the landfill's eastern, western, and northwestern boundaries. Except for

aluminum, iron, and manganese (indicated by reference data to naturally occur at elevated concentrations), inorganic concentrations exceeding applicable or relevant and appropriate requirements (ARARs) are generally limited to areas within and around the landfill perimeter.

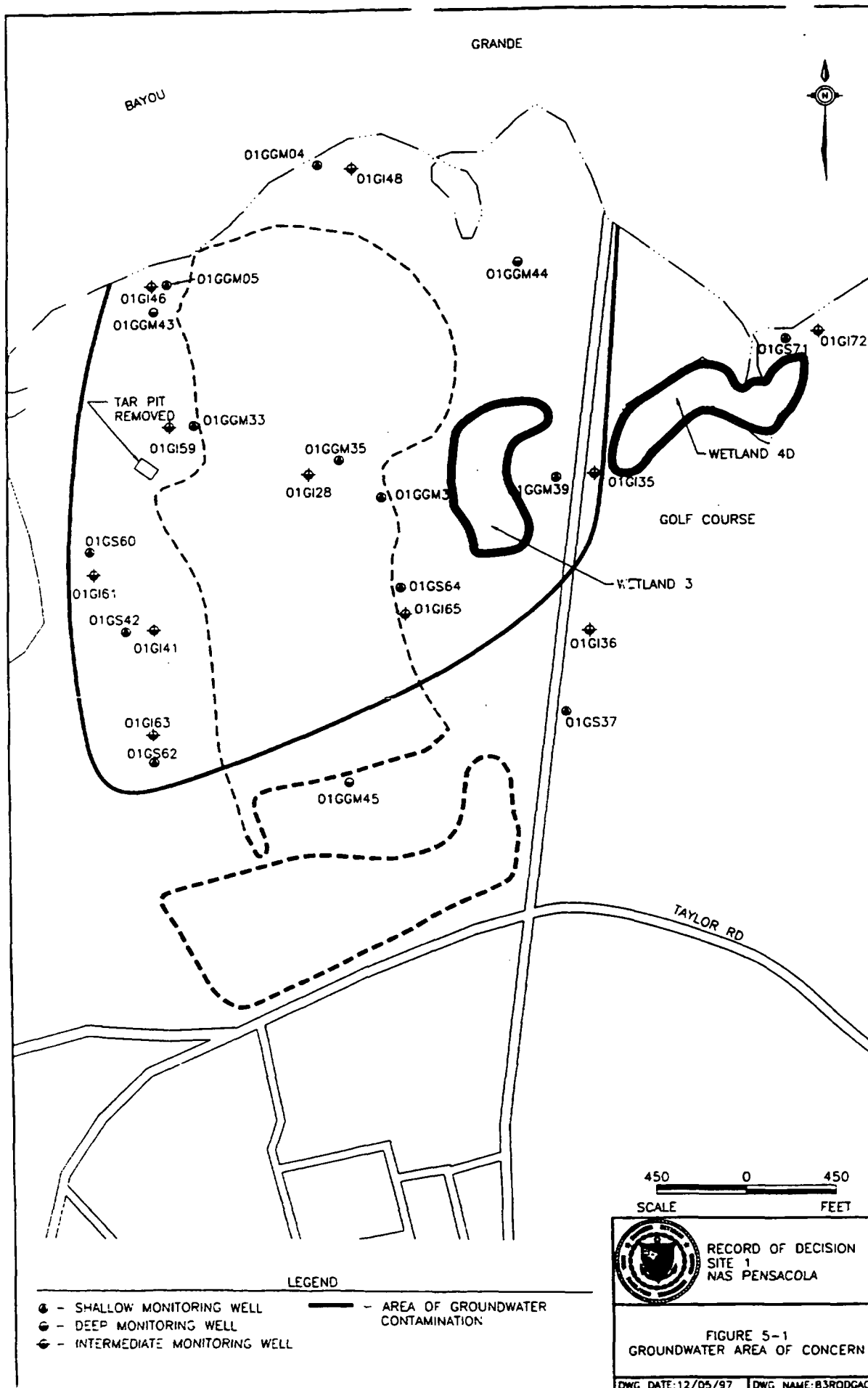
Organic constituents have consistently been detected near Maximum Contaminant Levels/Florida Groundwater Guidance Concentrations [MCL/FGGC] in Site 1 surficial groundwater. Consistent with the distribution of elevated inorganics, the highest organic concentrations were detected in the site's center and along the eastern and western boundaries. Organic concentrations extend downgradient from the landfill to areas along Bayou Grande's coastline, adjacent wetlands, and east-northeast beneath the golf course. However, no elevated inorganic or organic concentrations (except for a single pesticide concentration) were detected in samples collected from the most downgradient monitoring well across the golf course opposite the landfill. This indicates that the extent of organic contaminant-impacted groundwater migrating east-northeast from the landfill is limited to the area beneath the adjacent golf course. As with inorganics, organic concentrations exceeding ARARs are generally limited to areas within and around the landfill's perimeter. The groundwater area of concern is shown on Figure 5-1.

Deep Groundwater

Based on deep well sample results, groundwater quality within the main producing zone beneath the site does not appear to have been affected by site activities.

5.3 Nature and Extent of Sediment and Surface Water Contamination

Wetland 3 is bordered by Site 1 to the north, south, and west, and by John Tower Road and the golf course to the east. A narrow surface water channel in this wetland is approximately 4 inches deep and 1 to 2 feet wide. The wetland's remaining portion is from 3 to 500 feet wide and is saturated sediment overlain by a thin layer of surface water. Sediment in most of the wetland is



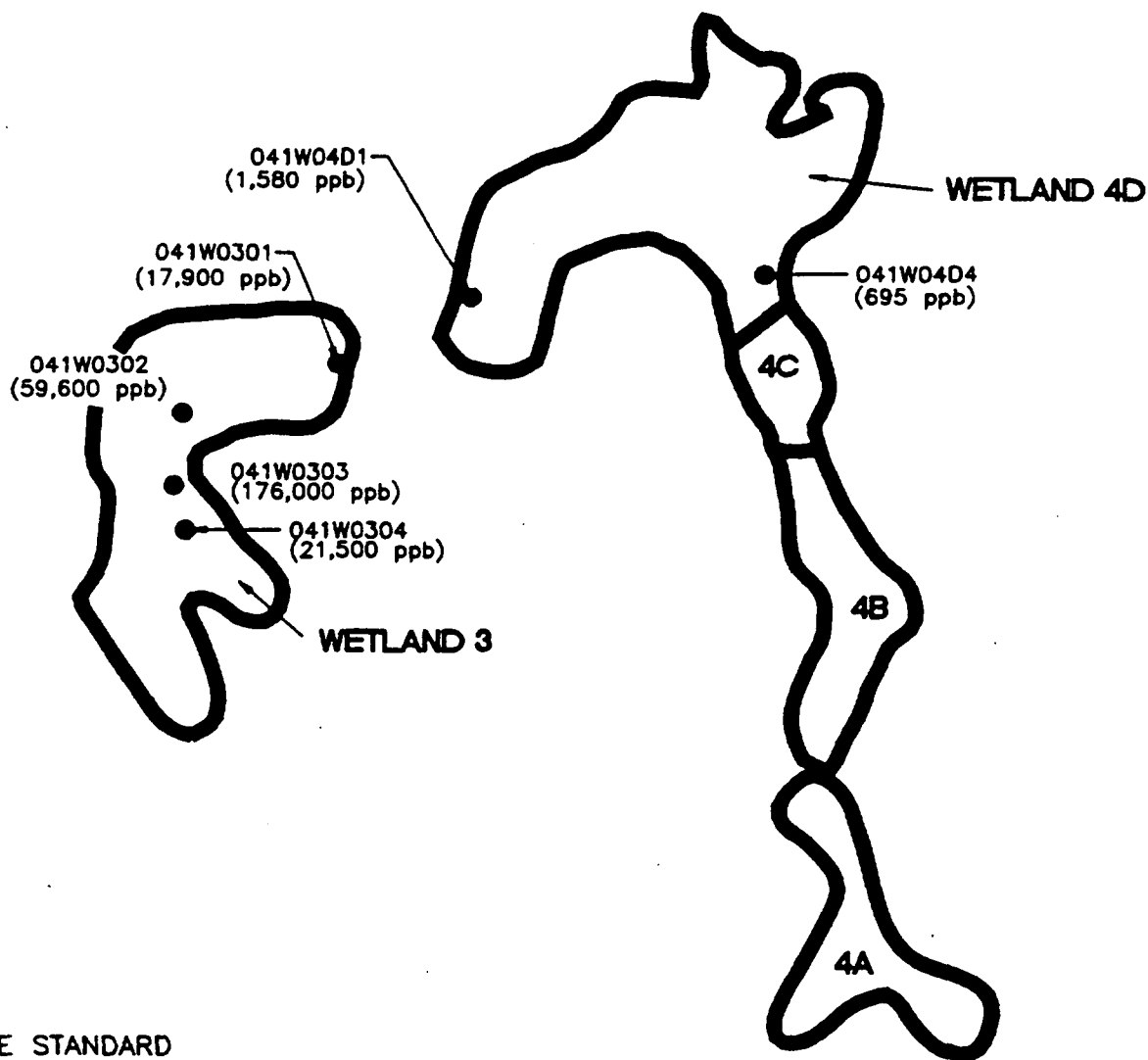
highly organic, with total organic carbon (TOC) detected at up to 24%. The shallow, open water portion contains several freshwater vegetative species such as lizard tail and cattails. The area surrounding the wetland consists of pine trees, with some oaks and other species. These areas could provide habitat and cover for many different species. The lower section of this wetland recently was excavated to clear the drainage culvert that discharges into Wetland 4D. This culvert runs east under John Tower Road and a golf course fairway before discharging into Wetland 4D.

Estuarine Wetland 4D is a pond fed by Wetland 3 from the west, Wetland 4C from the south, and Bayou Grande from the north. Wetland 4D, which flows north into Bayou Grande through a culvert beneath an unnamed dirt road, is surrounded by the golf course. The open water portion of the wetland ranges from 1 foot to approximately 8 feet deep and has a maximum width of approximately 700 feet. Sediment in the wetland is sandy, with TOC detected up to 7%. The steep gradient surrounding the wetland makes the transition from upland to open water obvious. The area surrounding Wetland 4D is mowed grass, with a small stand of pine trees and a small area of spartina at its northwestern corner. The presence of mowed grass around this wetland limits its potential to provide habitat for most species. However, great blue herons have been observed feeding in this wetland.

Wetland 4D discharges into Bayou Grande, which has been classified by the Florida Department of Environmental Protection (FDEP) as a Class III water body, indicating its use for recreation and maintaining a well-balanced fish and wildlife population.

During the Site 41 RI, surface water samples were collected from Wetland 3 and Wetland 4D. The only exceedances were for iron in Wetland 3 surface water and at the outfall of Wetland 3 into Wetland 4D. Figure 5-2 shows where these exceedances occurred.

WETLAND 3 AND WETLAND 4D SURFACE WATER IRON CONCENTRATIONS



FE STANDARD
FLORIDA SALTWATER STANDARD 300 ppb
FLORIDA FRESHWATER STANDARD 1000 ppb



RECORD OF DECISION
SITE 1
NAS PENSACOLA

FIGURE 5-2
SURFACE WATER
AREA OF CONCERN

DWG DATE: 12/11/97

DWG NAME: 83RODAOC

5.4 Fate and Transport

5.4.1 Sources of Contamination

During the RI, contamination was identified within the former landfill boundaries. A limited amount of soil contamination was detected in the 0- to 1-foot surface soil depth interval inside the landfill boundary. Higher concentrations of detected parameters were present within the subsurface landfill waste interval (occurring at depths varying from 2 to 18 feet bls). Surface soil inside the landfill boundary consists of highly permeable silty sand with varying amounts of decaying organic cover (leaves and straw). Landfill wastes include heterogeneous deposits of construction rubble; burned and unburned domestic refuse; industrial refuse including plastic, glass, metal, and crushed drums; clayey-silty sludge; and tar/sludge. Native soil (fine- to medium-grain quartz sand) immediately beneath the waste intervals appears to be only slightly impacted compared to the overlying fill at most sampling locations; however, at one location (trench 6) soil was contaminated down to the water table; at another location (trench 9) landfill waste extended below the shallow water table in this area.

Surface soil samples collected from test trenches in the landfill boundary generally had detections of all analytical parameter groups (inorganics, VOCs, semivolatiles, pesticides, and PCBs) compared to surface soil outside the landfill and background soil samples. These samples should be considered representative of surface conditions across the landfill interior because the surface soil interval sampled at each trench location consisted of the overburden/cover material that was reworked and graded into place during landfill activities. Surface samples from locations 01S8001 and 01S8201 represent discrete sources of surface soil contamination associated with surface features — the mounds of soil and the collapse feature at each locality — in these respective areas.

Concentrations of all analytical parameter groups were identified in landfill waste samples collected during test trenching. Highest concentrations from the trenching samples were detected in waste samples from trench 3, inorganics, VOCs, semivolatiles, pesticides, and PCBs; trench 4,

semivolatiles; trench 6, VOCs and semivolatiles; trench 7, VOCs, semivolatiles, and PCBs; trench 8, PCBs; trench 11, PCBs; and trench 12, inorganics, VOCs, and semivolatiles. These areas would appear to represent the greatest potential threat to groundwater. Notably, efforts were made to sample landfill areas posing the greatest environmental risks based on contaminant source survey findings. However, because of the landfill's size and the sampling location's distribution, these areas are not considered isolated, but may represent parameter concentrations potentially present throughout the heterogeneous waste interval. Therefore, no particular test trench should be considered an isolated, separable source; moreover, broader source areas should be considered when addressing contaminant migration (e.g., the landfill's central portion versus the northern or southern portions).

5.4.2 Contaminant Migration

Leaching from Soil to Groundwater

Parameters detected in Site 1 soil and/or waste samples (solid media) may enter groundwater by two mechanisms. They may leach by downward percolation of precipitation through the solid media toward the water table or from continual groundwater contact with solid media at or near a fluctuating water table. In general, native soil at Site 1 is very permeable, with rapid infiltration and minimal contact time between percolating water and soil above the water table. However, some trench wastes are fine-grained material (sludges, clayey-ash residue, or silty-clayey sand), that have lower permeabilities, resulting in longer contact with percolating water. Most native soil samples from immediately beneath the waste interval yielded very low to nondetect parameter concentrations. This suggests either: (1) the waste material is retaining parameter constituents where present, and minimal leaching is occurring, (2) downward migrating contaminants are not retained by the native soil, but pass directly to groundwater, or (3) leachable fractions have already been flushed to groundwater and current groundwater quality represents reasonable worst-case conditions.

Impacted soil and/or landfill waste material extended into the water table in trenches 6 and 9. At trench 6, petroleum-hydrocarbon stained soil was encountered above and in direct contact with the shallow water table (6 to 8 feet bls). This soil contained concentrations of aromatic and aliphatic volatiles, chlorinated aromatic semivolatiles, and PAHs. At trench 9, waste material extended into the water table. Solid media in these trenches continuously contact shallow groundwater, allowing for maximum contact time for phase partitioning to the aqueous medium. An unfiltered shallow groundwater grab sample collected from trench 9 contained several heavy metals (antimony, cadmium, chromium, lead, mercury, and nickel) and benzene at concentrations exceeding MCLs. However, the high turbidity of the sample likely contributed to the detected concentrations.

The potential for contaminant migration through soil depends on the chemical characteristics of the contaminants and several physical and chemical parameters of the soil, including TOC, cation exchange capacity (CEC), pH, and redox potential. Most semivolatiles, pesticides, and PCBs are considered to have limited potential for migration due to their low solubility and high affinity for soil particles and organic carbon. VOCs are considered more mobile, but also have a moderate affinity for organic carbon. Physical analyses of waste interval material and underlying native soil sampled generally indicate higher TOC content (up to 3,000 mg/kg) in the waste than in the native soil (50 mg/kg to 250 mg/kg). Analyses of most trench waste/native soil pairs show correlations between higher TOC values and high organic concentrations in the waste, and lower TOC values and low to nondetect organic concentrations in the underlying native soil. The mobility and potential for metals migration depends on pH, redox potential, TOC, and CEC of the soil. CEC analyses consistently indicate higher values for the waste interval (up to 14.0 meq/100g) than the underlying native soil (0.2 meq/100g to 5.2 meq/100g). Correspondingly, inorganic analytical results show a higher metals concentration in the waste, and a low to nondetect metals concentration in the underlying native soil. While the waste interval has been determined to be contamination source, its elevated TOC and CEC values may also allow it to retain or bind an appreciable amount of contaminants contained in it. The low to nondetect concentrations in the

underlying native soil may result from minimal downward contaminant migration due to the retention properties of the waste interval, and/or a lower retention capability of the underlying native soil as contaminants pass through it with minimal partitioning to the soil.

Based on the distribution of detected parameters in groundwater, the landfill's most recently filled central portion (early to mid-1970s) appears to be the primary source for organics (VOCs, semivolatiles, and minor amounts of pesticides) currently detected in shallow and intermediate samples. However, the southwestern portion (1950s) also appears to be a source of organics (VOCs and semivolatiles) in both shallow and intermediate samples from the southwestern landfill boundary. The relatively lower concentrations in the landfill's northern portion (1960s) are either associated with relatively lower concentration sources in this area, or are the result of downgradient advective contaminant migration from the site's central portion. This distribution could be due to a higher overall volume of wastes within the central portion, the relative age of that portion compared to the older and perhaps more leached sections, or the monitoring well array spatial positioning.

The actual leachability of waste interval material was evaluated through TCLP analyses of test trench samples. These waste samples consisted of the following materials: sandy soil with domestic and burned waste from trench 2; sandy soil with clayey-ash from trench 3; tar waste and stained sandy soil from trench 4; heavily fuel-stained sandy soil from trenches 6A, 6B, and 6C; sandy soil with industrial and domestic waste from trenches 7, 8, and 9; sandy soil with industrial and burned waste from trench 11; and sandy soil with tar-like sludge material from trench 12. No samples, except those from trench 12 yielded leachable target constituents above TCLP reporting limits. The sample from trench 12 yielded 376 $\mu\text{g/L}$ tetrachloroethane. Based on the TCLP results, it can be inferred that landfill wastes are presently not leaching gross concentrations of contamination above TCLP reporting limits to site groundwater at 10 of the 11 tested locations. However, TCLP reporting limits (parts per million [ppm]) are higher than CLP limits (parts per

billion [ppb]) and the reported list of TCLP analytical parameters is not as comprehensive as the TAL/TCL list. Therefore, lower concentrations of target contaminants or non-TCLP parameters may be leaching from the wastes to site groundwater. Furthermore, landfill portions not investigated by invasive methods may contain more leachable wastes than those encountered during this investigation. However, groundwater quality data do not indicate that the last two items are occurring to any appreciable degree.

Surface Water Transport

The generally high soil permeabilities around Site 1 limit substantial contamination transfer via surface water flow. During the RI, overland flow was not observed within the landfill boundary. Two intermittent creeks lie within wetlands outside the landfill, as shown previously on Figure 1-2. One creek approximately 50 to 100 feet east of the landfill's central portion flows intermittently to the northeast toward Beaver Pond (Wetland 3). The other creek originates approximately 500 feet west of the landfill's central portion and channels flow northwestward to Bayou Grande. Neither creek has been observed to receive direct surface water runoff from the landfill. They appear to be fed by groundwater seepage during periods of high water table. A third dry stream bed in the southern tip of the site's northern portion leads to Bayou Grande Pond. No surface water was observed in this stream bed during the investigation.

Contaminants may be transferred from soil to intermittent stream waters via surface drainage or by the same soil leaching processes discussed above. That is, contaminants would leach from soil to groundwater, then via groundwater to surface water pathways, mediated by groundwater quality characteristics. Because surface waters are fed primarily by groundwater, creek surface water quality may be expected to approximate local shallow groundwater conditions. However, surface water samples collected from site wetlands during 1994 sampling activities indicate that wetland surface water has not been greatly impacted by site groundwater. Additionally, native soil (sample 01S5602) from the dry stream bed south of Bayou Grande Pond yielded no leachable target constituents above TCLP reporting limits. Based on these results, contaminant concentrations are not currently being transported via the surface water pathway.

Groundwater Transport

Groundwater analytical results indicate that organic compounds are leaching or have leached from the landfill and are migrating via the groundwater pathway. Additionally, inorganic concentrations exceeding ARARs were detected in 1994 samples from the site's center, along the landfill's eastern and western boundaries. The highest organic compound concentrations were identified in both shallow and intermediate groundwater samples from the perimeter of the central, 1970s portion of the landfill. Based on piezometric measurements, groundwater contaminants appear to migrate radially north, east, and west from the landfill's central portion toward Bayou Grande. Downward vertical hydraulic gradients between shallow and intermediate groundwater depths, generally equivalent in magnitude to lateral gradients, indicate a strong tendency for downward contaminant migration with lateral movement. Parameter concentrations detected at intermediate depth likely result from this downward flow component. The presence of an 8- to 20-plus-foot thick, low-permeability clay layer between intermediate and deep monitored zones likely inhibits downward contaminant migration into deep groundwater. This likelihood is supported by the absence of organic compounds or elevated inorganics in deep groundwater samples.

The groundwater contaminant migration rate may be conservatively estimated to equal groundwater velocity disregarding retardation effects. Based on groundwater velocities calculated and presented in the RI, the rate of contaminant movement from the landfill's central portion toward the east, north, and west is expected to be approximately 0.17 to 5.01 ft/day in shallow groundwater and approximately 0.08 to 3.38 ft/day in intermediate groundwater. Based on this information, contaminants leaching to shallow groundwater from the landfill's central portion may have migrated across the site's full northwestern, northern, and northeastern extents to Bayou Grande during the approximately 20 years since the landfill was closed.

The high suspended solid and organic content in natural pore water beneath Site 1 may affect contaminant transport due to possible partitioning of organic contaminants onto carbonaceous material and metals onto organic material or clay. The variable pH of site groundwater, ranging from slightly acidic (as low as 4.15) to neutral (as high as 7.25) may also affect the partitioning of organic and metal contaminants. Therefore, contaminant movement may, in part, be retarded by the inability of particulate matter to move with groundwater, resulting in lower migration rates.

Potential Receptors and Impacted Media

The primary medium impacted by site activity has been the surficial zone of the Sand-and-Gravel Aquifer. Samples from this zone's shallow and intermediate monitoring wells have consistently indicated impacted groundwater. Concentrations of several organic compounds in RI samples exceeded drinking water standards and generally compare to those reported in previous studies. Limited elevated inorganic concentrations were also detected in 1994 samples. Impact on groundwater emanating from the landfill's central 1970s portion appears to be the most significant. Both impacted and unimpacted groundwater in the surficial zone is highly turbid (as noted during 1993 sampling) and contains natural iron, manganese, and sodium concentrations exceeding FSDWS. A large portion of this zone yields dark brown, highly organic pore water with an acrid odor. Moreover, background/reference concentrations of regulated metals also exceed drinking water standards. Based on natural groundwater characteristics, the surficial zone does not appear suitable as a drinking water supply either in impacted or unimpacted areas. Groundwater from the surficial zone is not presently used or anticipated to be used for that purpose.

Bayou Grande receives discharge from groundwater flowing west, north, and northeast from the site; therefore, the sediment and surface water are potentially impacted media of Site 1. This bayou has been classified by the FDEP as a Class III water body, indicating its use for maintaining a well-balanced fish and wildlife population. Potential impacts of past landfill activities on Bayou Grande will be addressed in an upcoming RI/FS (Site 40).

Other potentially impacted media include the surface waters and wetlands associated with Beaver Pond (Wetland 3) and Golf Course Pond and the intermittent creek east of the landfill, the intermittent creek west of the landfill, and Bayou Grande Pond and North Pond to the north. These water bodies are potentially threatened by impacted groundwater discharges via direct seepage or intermittent creek flow during wet seasons. However, overland runoff from the landfill into these bodies is unlikely due to the high surface soil permeability. Except for Wetland 3, this investigation's results indicate that current impact to these areas is relatively low with regard to sediment and surface water quality criteria. Surface water samples collected at Wetlands 16 and 18 during the Site 1 investigation had no exceedances of the Florida surface water quality standards for fresh water. In Wetland 1, copper (7.5 ppb), iron (3,540 ppb), and lead (6 ppb) exceeded the surface water quality standards for fresh water which are 6.54 ppb, 1,000 ppb, and 1.32 ppb respectively. Surface water samples collected from Wetland 3 had exceedances of the iron surface water quality standard as shown on Figure 5-2. Potential impacts of past landfill activities on these water bodies will be further addressed in an upcoming RI/FS for the NAS Pensacola wetlands (Site 41).

6.0 SUMMARY OF SITE RISKS

A baseline risk assessment (BRA) has been conducted for OU 1, and the results are presented in Section 10 of the RI report. The BRA, which was based on contaminated environmental site media as identified in the RI, was conducted to assess the resulting impact to human health and environment. Actual or threatened releases of hazardous substances from this site, if not addressed by implementing the response action selected in this ROD, may present an imminent and substantial endangerment to public health or environment.

6.1 Chemicals of Potential Concern

Contaminants detected at OU 1 were screened against available federal and State of Florida cleanup criteria, soil and groundwater standards, and reference concentrations to develop a list or group of chemicals referred to as chemicals of potential concern (COPCs). COPCs are selected after comparison to screening concentrations (risk-based, leachability-based, and reference), intrinsic toxicological properties, persistence, fate and transport characteristics, and cross-media transfer potential. Any COPC is considered a chemical of concern (COC) if it is carried through the risk assessment process and found to contribute to a pathway that exceeds a 10^6 risk or hazard index (HI) greater than 1 for any of the exposure scenarios evaluated in this risk assessment and has an incremental lifetime cancer risk (ILCR) greater than 10^6 or hazard quotient (HQ) greater than 0.1. Table 6-1 summarizes COPCs for these pathways. Surface soil did not produce any risk levels above 10^6 or 1. Bayou Grande and NAS Pensacola wetlands surface water and sediment will be further evaluated during the Sites 40 and 41 RIs.

Essential elements may be screened out of a risk assessment if it is shown that concentrations detected are not associated with adverse health effects. Therefore, the following nutrients were eliminated: calcium, iron, magnesium, potassium, and sodium.

Table 6-1
Chemicals of Potential Concern

Chemicals	Surface Soil (mg/kg)	All Depth Soil (mg/kg)		Shallow and Intermediate (mg/L)	Deep (mg/L)
1,1,2,2-Tetrachloroethane				0.002-0.006	
1,1,2-Trichloroethane				0.001-0.002	
1,2-Dichloroethene (total)				0.001-0.065	
1,4-Dichlorobenzene				0.003-0.017	
4-Chloro-3-methylphenol		0.42-4.3	GWP		
Aluminum	483-13600	141-13600	GWP	0.134-4.78	
Aroclor-1248	0.19				
Aroclor-1254	0.31				
Aroclor-1260	0.0047-0.13				
Arsenic				0.0059-0.0426	
Barium		0.69-1050	GWP	0.0024-0.335	
Benzene				0.001-0.08	
Beryllium	0.61				
bis(2-Ethylhexyl)phthalate				0.011	
Bromoform				0.002-0.004	
Cadmium	5.2-99	1.5-214	GWP	0.0305	
Chlorobenzene				0.001-0.12	
Chloroform				0.004-0.005	
Chromium				0.616	
Copper		3.1-212	GWP	0.147	
Dieldrin		0.00019-0.072	GWP	0.0000076	
Lead	0.9-441				
Manganese	2.3-191	1.9-191	GWP	0.0077-0.6	0.0241- 0.0901
2-Methylnaphthalene		0.22-6.8	GWP	0.003-0.011	
Naphthalene		0.32-16	GWP	0.001-0.038	
Nickel		11.1-55.7	GWP	0.253	
Tetrachloroethene		0.006-26	Air		
Toluene		0.001-2300	Air		
Trichloroethene				0.001-0.002	
Vinyl chloride				0.002-0.012	
Xylene		0.22-49	GWP	0.003-0.11	
Zinc				0.0027-3.02	

Notes:

GWP — The chemical was retained as a COPC based on groundwater protection

AIR — The chemical was retained as a COPC based on potential volatilization and inhalation exposure.

6.2 Exposure Assessment

Whether a chemical is actually a concern to human health depends upon the likelihood of exposure, i.e., whether the exposure pathway is currently complete or could be in the future. A complete exposure pathway (a sequence of events leading to contact with a chemical) is defined by four elements. If all four elements are present, the pathway is considered complete:

- Source and mechanism of release
- Transport medium (e.g., surface water, air) and migration mechanisms through the medium
- Presence or potential presence of a receptor at the exposure point
- Exposure route (ingestion, inhalation, dermal absorption).

All potential exposure pathways that could connect chemical sources at OU 1 with potential receptors were evaluated. All possible pathways were first hypothesized and evaluated for completeness using the above criteria. Current pathways represent exposure pathways that could exist under current conditions, while future pathways represent exposure pathways that could exist in the future, if current exposure conditions change.

6.2.1 Current Exposure

Under current land use conditions at OU 1, access to areas of concern is restricted to authorized personnel only, but the area is not fenced. Potential exposures under present land use are summarized below:

Potential Exposure Scenarios — Current Conditions

Media	Exposure Pathway	Receptor
Soil	Incidental Inhalation	Onsite Worker
	Dermal Contact	Child Trespasser
Surface Water	Incidental Ingestion	Child Trespasser
Sediment	Incidental Ingestion	Child Trespasser
	Dermal Contact	Child Trespasser

6.2.2 Future Exposure

Complete exposure pathways could exist based on an estimate of the reasonable maximum exposure (RME) expected under future conditions. Although unlikely, it is assumed that OU 1 may be developed as residential areas, which could also provide reasonable opportunities for recreational activities. If so, future residents could be exposed to soil via incidental ingestion and dermal contact routes of exposure associated with living in the area. Potential exposures for future land use are summarized below:

Potential Exposure Scenarios — Future Conditions

Media	Pathway	Receptors
Soil	Incidental Ingestion	Site Resident
	Dermal Contact	Site Worker
Groundwater	Ingestion	Site Resident
	Inhalation	Site Worker

Exposure Point Concentration

Exposure point concentrations for each chemical of concern and exposure assumptions for each pathway were used to estimate chronic daily intakes (CDIs) for potentially complete pathways.

CDIs were then used with cancer potency factors and noncarcinogenic reference doses to evaluate risk.

The 95th percentile for reported concentrations of chemicals of concern in each media evaluated were calculated as exposure point concentrations for the RME in each exposure scenario. Exposure point concentrations are summarized in Table 6-2.

Potential future exposure scenarios included all exposures examined under current conditions. The same exposure assumptions used to evaluate future conditions were used for current conditions. Assumptions are listed in Tables 6-3 and 6-4 for current and future land use.

6.3 Toxicity Assessment

A cancer slope factor (CSF) and a reference dose (RfD) are applied to estimate risk of cancer from an exposure and the potential for noncarcinogenic effects from exposure.

CSFs have been developed by USEPA's Carcinogenic Assessment Group to estimate excess lifetime cancer risks associated with exposure to potentially carcinogenic contaminants of concern. CSFs, which are expressed in units of $(\text{mg/kg/day})^{-1}$, are multiplied by a potential carcinogen's estimated intake in mg/kg/day , to provide an upper-bound estimate of the excess lifetime cancer risk associated with exposure at that intake level. The term "upper-bound" reflects the conservative estimate of risks calculated from the CSF. Use of this approach makes underestimation of actual cancer risk highly unlikely. CSFs are derived from the results of human epidemiological studies or chronic animal bioassays to which animal-to-human extrapolation and uncertainty factors have been applied.

This increased cancer risk is expressed by terms such as $1\text{E-}6$. To state that a chemical exposure causes a $1\text{E-}6$ added upper limit risk of cancer means that if 1,000,000 people are exposed, one

additional incident of cancer is expected to occur. The calculations and assumptions yield an upper limit estimate, which assures that no more than one case is expected and, in fact, there may be no additional cases of cancer. USEPA policy has established that an upper limit cancer risk

**Table 6-2
Exposure Point Concentrations**

Exposure Point Concentrations			
Media and Chemical	Frequency of Detection	RME	Background
Soil (mg/kg)			
Aluminum	26/27	4006	3833.8
Beryllium	1/27	0.239	0.41
Cadmium	3/27	2.738	1
Lead	23/27	102.222	7.32
Manganese	19/27	40.5678	21.36
Aroclor 1248	1/27	0.024	NA
Aroclor 1254	1/27	0.0269	NA
Aroclor 1260	3/27	0.00584	NA
Shallow/Intermediate Groundwater (mg/L)			
Vinyl chloride	6/25	0.002462	NA
1,1,2,2-Tetrachloroethane	2/25	0.001371	NA
1,2-Dichloroethene	8/25	0.003035	NA
Benzene	14/25	0.026387	NA
Toluene	3/25	0.001129	NA
Chlorobenzene	17/25	0.12	NA
Ethylbenzene	6/25	0.003317	NA
Xylene	7/25	0.012807	NA
1,4-Dichlorobenzene	14/25	0.007386	NA
1,1,2-Trichloroethane	2/25	0.000637	NA
2-Methylnaphthalene	2/25	0.00214	NA
Naphthalene	9/25	0.00536	NA
Aluminum	14/25	0.449	3.8189
Arsenic	8/25	0.12283	ND

Table 6-2
Exposure Point Concentrations

Exposure Point Concentrations			
Media and Chemical	Frequency of Detection	RME	Background
Barium	18/25	0.11293	ND
Bromoform	2/25	0.001275	NA
Zinc	12/25	0.4614	0.0746
Manganese	22/25	0.042009	0.0215
Cadmium	1/25	0.002865	ND
Chloroform	2/25	0.002373	NA
Chromium (trivalent)	1/25	0.010594	0.0325
Copper	1/25	0.0102	0.0122
Dieldrin	1/25	0.0000041	NA
Nickel	1/25	0.030824	ND
Trichloroethene	2/25	0.000637	NA
bis(2-ethylhexyl)phthalate	1/25	0.000889	NA
Chloroethane	2/25	0.000637	NA
1,1-Dichloroethane	6/25	0.001559	NA
1,2-Dichlorobenzene	8/25	0.001916	NA
Deep Groundwater (mg/L)			
Manganese	3/3	0.0901	0.0498

Notes:

RME — Reasonable Maximum Exposure

All results are in milligrams per kilogram or parts per million (ppm).

Table 6-3
Parameters Used to Estimate Potential Exposures
for Current Land Use Receptors

Trespassing Child

Pathway Parameters	Age 7-16	Units
Incidental Ingestion of Soil		
Ingestion Rate	200 ^a	mg/day
Exposure Frequency	52 ^c	days/year
Exposure Duration	10 ^c	years
Body Weight	45 ^d	kg
Averaging Time-Noncancer	3,650 ^e	days
Averaging Time-Cancer	25,550 ^f	days
Dermal Contact with Soil		
Skin Surface Area	3,950 ^g	cm ²
Adherence Factor	1 ^h	mg/cm ²
Absorption Factor	CSV	unitless
Exposure Frequency	52 ^c	days/year
Exposure Duration	10 ^c	years
Body Weight	45 ^d	kg
Averaging Time-Noncancer	3,650 ^e	days
Averaging Time-Cancer	25,550 ^f	days
Incidental Surface Water Ingestion (while swimming)		
Ingestion Rate	0.13 ^a	liters/hour
Exposure Frequency	52 ^b	days/year
Exposure Duration	10 ^c	years
Body Weight	45 ^a	kg
Averaging Time-Noncancer	3,650 ^d	days
Averaging Time-Cancer	25,550	days
Inhalation of Volatilized Groundwater Constituents (ORD VOC Guidance)		
$CDI_{inhalation} = CDI_{ingestion}$		

Notes:

Trespasser assumptions for soil exposure were used to estimate incidental ingestion and dermal contact with sediment while swimming (i.e., 16 waking hours per day were adjusted to reflect 2.6 hours swimming exposure per day swimming).

- a — USEPA (1989) *Risk Assessment Guidance for Superfund Vol. I, Human Health Evaluation Manual (Part A)*.
- b — USEPA (1991) *Risk Assessment Guidance for Superfund Vol. I, Human Health Evaluation Manual Supplemental Guidance, Standard Default Exposure Factors*, Interim Final, OSWER Directive: 9285.6-03.
- c — Assumes a trespass scenario of an adolescent aged 7-16 with an exposure duration (ED) of 10 years and an exposure frequency of 52 days per year.
- d — Adolescent body weight is the average value for the range of body weights for boys and girls ages 7-16 taken from USEPA (1990) *Exposure Factors Handbook*, USEPA/600/8-89/043.
- e — Calculated as the product of ED (years) x 365 days/year.
- f — Calculated as the product of 70 years (assumed lifetime) x 365 days per year.
- g — Skin surface area (i.e., worker — head, forearms and hands) provided by USEPA Region iv. For trespassing children, skin surface area was computed as 25% of the age group mean total body surface per dermal guidance.
- NA — Not applicable
- CSV — Chemical-specific value

**Table 6-4
Parameters Used to Estimate Potential Exposures
for Future Land Use Receptors**

Pathway Parameters	Onsite Worker	Resident Adult	Resident Child	Units
Incidental Ingestion of Soil				
Ingestion Rate	50 ^b	100 ^a	200 ^a	mg/day
Exposure Frequency	250 ^b	350 ^b	350 ^b	days/year
Exposure Duration	25 ^b	24 ^c	6 ^a	years
Exposure Duration _{LWA}	NA	24 ^c	6 ^a	years
Body Weight	70 ^b	70 ^a	15 ^a	kg
Averaging Time-Noncancer	9125 ^c	8,760 ^d	2,190 ^d	days
Averaging Time-Cancer	25,550 ^f	25,550 ^e	25,550 ^e	days
Dermal Contact with Soil				
Skin Surface Area	4100 ^a	4,100 ^f	2,000 ^f	cm ²
Adherence Factor	1 ^b	1 ^a	1 ^a	mg/cm ²
Absorption Factor	CSV	CSV	CSV	unitless
Exposure Frequency	250 ^b	350 ^b	350 ^b	days/year
Exposure Duration	25 ^b	24 ^c	6 ^a	years
Exposure Duration _{LWA}	NA	24 ^c	6 ^a	years
Body Weight	70 ^b	70 ^a	15 ^a	kg
Averaging Time-Noncancer	9125 ^c	8,760 ^d	2,190 ^d	days
Averaging Time-Cancer	25,550 ^f	25,550 ^e	25,550 ^e	days
Drinking Water Ingestion				
Ingestion Rate	NA	2 ^a	1 ^a	liters/day
Exposure Frequency	NA	350 ^b	350 ^b	days/year
Exposure Duration	NA	24 ^c	6 ^a	years
Exposure Duration _{LWA}	NA	24 ^c	6 ^a	years
Body Weight	NA	70 ^a	15 ^a	kg
Averaging Time-Noncancer	NA	8,760 ^d	2,190 ^d	days
Averaging Time-Cancer	NA	25,550 ^e	25,550 ^e	days

Table 6-4
Parameters Used to Estimate Potential Exposures
for Future Land Use Receptors

Pathway Parameters	Onsite Worker	Resident Adult	Resident Child	Units
Inhalation of Volatilized Groundwater Constituents (ORD VOC Guidance)				
$CDI_{inhalation} = CDI_{ingestion}$				

Notes:

- a — USEPA (1989) *Risk Assessment Guidance for Superfund Vol. I, Human Health Evaluation Manual (Part A)*.
- b — Assumes a residential exposure frequency of 365 days per year with one two-week vacation.
- c — USEPA (1991), *Risk Assessment Guidance for Superfund Vol. I, Human Health Evaluation Manual (Part B, Development of Risk-based Preliminary Remediation Goals)*, OSWER Directive 9285.7-01B.
- d — Calculated as the product of ED (years) x 365 days/year.
- e — Calculated as the product of 70 years (assumed lifetime) x 365 days per year.
- f — Skin surface area (i.e., adult resident — head, forearms and hands; child resident — head, arms, hands, and legs) provided by USEPA Region IV.
- g — Specific guidance from USEPA Region IV (February 11, 1992, New Interim Region IV Guidance).
- NA — Not applicable
- CSV — Chemical-specific value

falling below or within the range of 1E-6 to 1E-4 is acceptable. Florida considers below 1E-6 acceptable.

RfDs have been developed by USEPA to indicate the potential for adverse health effects from exposure to COCs with noncarcinogenic effects. RfDs, which are expressed in units of mg/kg/day, are estimates of lifetime daily exposure levels for humans, including sensitive individuals, who are likely to be without risk of an adverse affect. Estimated intakes of COCs from environmental media (e.g., amount of COCs ingested from contaminated groundwater) can be compared to the RfD. RfDs are derived from results of human epidemiological studies or chronic animal bioassays to which animal-to-human extrapolation and uncertainty factors have been applied (e.g., to account for use of animal data to predict effects on humans). If the estimated exposure to a chemical expressed as mg/kg/day is less than the RfD, exposure is not expected to cause any noncarcinogenic effects, even if exposure is continued for a lifetime. In

other words, if the estimated dose divided by the RfD is less than 1.0, there is no concern for adverse noncarcinogenic effects.

Exposure point concentrations, and toxicity potency factors used to calculate human health risks are summarized in Table 6-5.

Table 6-5
Toxicological Database Information for Chemicals of Potential Concern

Chemical	Oral Reference Dose (mg/kg/day)	Inhalation Reference Dose (mg/kg/day)	Cancer Classification
1,2-Dichloroethene (total)	0.009 b	ND	D
1,4-Dichlorobenzene	ND	0.229	B2
Aluminum	1 c	ND	ND
Arsenic	0.0003 a	ND	A
Benzene	ND	0.00171	A
Barium	0.07 a	0.000143	D
Bromoform	0.02 a	ND	B2
Chloroform	0.01 a	ND	B2
Zinc	0.3 a	ND	D
Beryllium	0.005 a	ND	B2
bis(2-Chloroethyl)ether	ND	ND	ND
bis(2-Ethylhexyl)phthalate	0.02 a	ND	B2
Cadmium (food)	0.001 a	ND	B1
Cadmium (water)	0.0005 a	ND	B1
Chlorobenzene	0.02 a	0.00571	D
Chromium	1 a	ND	D
Copper	0.0371 b	ND	D
Dieldrin	0.00005 a	ND	B2
Lead	ND	ND	B2
Manganese (water)	0.005 a	0.0000143	D
Manganese (food)	0.14 a	ND	D
PCB Aroclor-1248	ND	ND	B2
PCB Aroclor-1254	0.00002 a	ND	B2
PCB Aroclor-1260	ND	ND	B2
Tetrachloroethene	0.01 a	ND	ND
Trichloroethene	0.006 c	ND	B2

Table 6-5
Toxicological Database Information for Chemicals of Potential Concern

Chemical	Oral Reference Dose (mg/kg/day)	Inhalation Reference Dose (mg/kg/day)	Cancer Classification
Vinyl Chloride	ND	ND	A
1,1,2-Trichloroethane	0.004 a	ND	C
1,1,2,2-Tetrachloroethane	ND	ND	ND
Napthalene	ND	ND	D
Nickel	0.02 a	ND	D
4-Chloro-3-methylphenol	ND	ND	D
Toluene	0.2 a	ND	D
Xylene	2 a	ND	D

Notes:

- a — Integrated Risk Information System (IRIS)
- b — Health Effects Assessment Summary Tables (HEAST)
- c — USEPA Environmental Criteria and Assessment Office — Cincinnati
- A — Human toxicological data have shown a proven correlation between exposure and the onset of cancer
- B1 — Some human exposure studies have implicated the compound as a probable carcinogen.
- B2 — Possible human carcinogen based on positive laboratory animal data
- C — Possible human carcinogen
- D — Compound not classifiable with respect to its carcinogenic potential.
- ND — Not determined due to lack of information
- NA — Not applicable or available

Toxicological data for naphthalene were used as surrogates for 2-methylnaphthalene.

6.4 Risk Characterization

For carcinogens, risks are estimated as the incremental probability of an individual developing cancer over a lifetime as a result of exposure to the carcinogen. Excess life time cancer risk is calculated from the following equation:

$$\text{RISK} = \text{CDI} \times \text{CSF}$$

where:

risk = a unitless probability (e.g., 2×10^{-5}) of an individual developing cancer

CDI = chronic daily intake averaged over 70 years (mg/kg-day)

CSF = slope factor, expressed as (mg/kg-day)⁻¹

These risks are probabilities that are generally expressed in scientific notation (e.g., 1×10^{-6} or $1 \text{E} -6$). An excess lifetime cancer risk of 1×10^{-6} indicates that, as a reasonable maximum estimate, an individual has a one in 1,000,000 chance of developing cancer as a result of site-related exposure to a carcinogen over a 70-year lifetime under specific exposure conditions at OU 1.

The potential for noncarcinogenic effects is evaluated by comparing an exposure level over a specified time (e.g., lifetime) with a reference dose derived for a similar exposure period. The ratio of exposure to toxicity is called an HQ. By adding the HQs for all COCs that affect the same target organ within a medium or across all media to which a given population may reasonably be exposed, the HI can be generated.

The HQ is calculated as follows:

$$\text{Noncancer HQ} = \text{CDI/RfD}$$

where:

CDI = Chronic Daily Intake

RfD = Reference Dose

CDI and RfD are expressed in the same units and represent the same exposure period (i.e., chronic, subchronic, or short-term).

To evaluate estimated cancer risks, a risk level lower than 1×10^{-6} is considered a minimal or *de minimis* risk. The risk range of 1×10^{-6} to 1×10^{-4} is an acceptable risk range for USEPA and would not be expected to require a response action. A risk level greater than 1×10^{-4} would be evaluated further, and a remedial action to decrease the estimated risk considered. The State of Florida considers 1×10^{-6} and an HI of 1 acceptable.

An HI of less than unity (1.0) indicates that the exposures are not expected to cause adverse health effects. An HI greater than one (1.0) requires further evaluation. For example, although HQs of several chemicals present are added and exceed 1.0, further evaluation may show that their toxicities are not additive because each chemical affects different target organs. When total effects are evaluated on an effect and target organ basis, the HI of the separate chemicals may be at acceptable levels.

Carcinogenic risks and noncarcinogenic hazards were evaluated for potential exposures to media-specific COCs in surface soil, surface water, surface sediment, and groundwater. Receptor populations were potentially exposed workers, trespassers, and future residents that could, theoretically, use groundwater for a household water source. Risks and hazards for the identified COCs are summarized in Table 6-6.

Estimated potential exposure to COCs in surface water or sediment did not result in unacceptable carcinogenic risk or noncarcinogenic hazard. Current site workers and potential child trespassers did not have an individual pathway or combined single medium pathway with an HI in excess of 0.6 or an ILCR greater than $2E-6$. The cross-pathway HI and cancer risk for these two receptor types were also within the acceptable carcinogenic risk range. These projections indicate that neither group is at significant risk of deleterious health effects resulting from RME to all media. These receptor groups do not warrant further consideration.

6.5 Soil Performance Standards for Groundwater Protection

The potential for groundwater contamination due to site compounds was also assessed by comparing contaminant concentrations in soil with guidance concentrations protective of groundwater (as identified in FDEP's Soil Cleanup Goals). These concentrations are to-be-considered (TBC) criteria for the site. Fourteen compounds were identified as exceeding guidance concentrations when soil concentrations were compared to the leaching criterion.

Table 6-6
Risk and Hazard for Identified COCs and Pathways of Concerns

Chemical	Site Trespasser		Site Worker		Potential Future Land Use		
	HQ	ILCR	HQ	ILCR	Resident Adult HQ	Resident Child HQ	Resident lwa ILCR
Soil Incidental Ingestion Pathway							
Beryllium ^{a,b}	NA	4.600e-08	NA	1.80e-07	NA	NA	1.60e-06
Soil Incidental Ingestion Pathway Total	0.003	7.00e-08	0.004	3.00e-07	0.01	0.1	3.00e-06
Shallow/Intermediate Groundwater Ingestion Pathway							
1,1,2,2-Tetrachloroethane ^b	NA	NA	NA	NA	NA	NA	4.10e-06
1,4-Dichlorobenzene ^b	NA	NA	NA	NA	0.001	0.002	2.60e-06
Arsenic ^{b,c}	NA	NA	NA	NA	1.12	2.62	2.70e-04
Barium ^c	NA	NA	NA	NA	0.04	0.1	NA
Benzene ^{b,c}	NA	NA	NA	NA	0.42	0.99	1.10e-05
Cadmium ^c	NA	NA	NA	NA	0.16	0.37	NA
Chlorobenzene ^c	NA	NA	NA	NA	0.16	0.38	NA
Manganese ^c	NA	NA	NA	NA	0.23	0.54	NA
Vinyl Chloride ^b	NA	NA	NA	NA	NA	NA	7.00e-05
Shallow/Intermediate Groundwater Ingestion Pathway Total	NA	NA	NA	NA	2	5	0.0004
Shallow/Intermediate Groundwater Inhalation Pathway							
1,1,2,2-Tetrachloroethane ^b	NA	NA	NA	NA	NA	NA	4.10e-06
1,4-Dichlorobenzene ^b	NA	NA	NA	NA	0.001	0.002	2.60e-06
Benzene ^{b,c}	NA	NA	NA	NA	0.42	0.99	1.10e-05
Chlorobenzene ^c	NA	NA	NA	NA	0.58	1.34	NA
Chloroform ^b	NA	NA	NA	NA	0.01	0.02	2.80e-06
Vinyl chloride ^b	NA	NA	NA	NA	NA	NA	1.10e-05
Shallow/Intermediate Inhalation Pathway Total	NA	NA	NA	NA	1	2	3.00e-05
Deep Groundwater Ingestion Pathway							
Manganese ^c	NA	NA	NA	NA	0.49	1.2	NA
Deep Groundwater Ingestion Pathway Total	NA	NA	NA	NA	0.5	1	NA

Notes:

- NA — Not applicable
- HQ — Hazard Quotient
- ILCR — Incremental Lifetime Excess Cancer Risk
- a — Beryllium could be considered a COC at only one sample location; beryllium was reported in only one of 27 samples.
- b — Chemical is a COC because of projected future resident lifetime weighted average carcinogenic risk.
- c — Chemical is a COC because of projected child resident noncarcinogenic hazard.

Type A	Type B	Type C
xylene (exceeded the secondary but not the primary MCL)	ethylbenzene toluene 1,4-dichlorobenzene 1,2-dichlorobenzene pentachlorophenol 2,4-dimethylphenol 2-methylphenol dieldrin	tetrachlorethene 2,4-dinitrotoluene 4-methylphenol bis(2-chlorethyl)ether

Type A compounds were defined as contaminants in soil exceeding FDEP cleanup goals (CGs) for leachability in soil and promulgated MCLs, Florida secondary MCLs, or FGGCs in groundwater beneath Site 1 (based on 1994 groundwater samples).

Type B compounds were present in both soil and groundwater. They exceeded FDEP's CGs for leachability in soil, but were below MCLs, Florida secondary MCLs, or FGGCs in groundwater (based on 1994 groundwater samples).

Type C compounds were present in soil, but not detected in groundwater (based on 1994 groundwater samples).

6.6 Risk Uncertainty

The following areas of uncertainty were associated with the estimation of chemical uptake from exposure to groundwater.

The primary source of uncertainty in the groundwater exposure pathway is the potable use assumption, which represents a highly conservative approach to assessing the significance of

groundwater impacts. The combined shallow/intermediate water-bearing zone (WBZ) is not currently used onsite as an industrial or potable water source, nor is it anticipated to be in the future. Assuming that homes were constructed on the landfill and the residents installed unfiltered wells for potable use is an extremely conservative assessment of future aquifer use. The deep WBZ was assessed separately under the same assumptions, but the shallow and intermediate WBZs were combined. If the future-use scenario were to exist, and a future potable well was screened exclusively in the shallow or intermediate WBZ, a change in the estimated risk/hazard could be expected.

Supplemental guidance was presented in draft form in June 1994 by USEPA Region IV to streamline the approach used to address contaminant inhalation via the groundwater exposure pathway. According to the draft supplemental guidance, the CDI for the inhalation pathway is equivalent to that of the ingestion pathway, where 2 liters of groundwater are ingested daily.

According to the draft guidance, the risk/hazard posed by the pathways is cumulative; two times the oral ingestion pathway CDI has been proposed as an equivalent calculation for the cumulative ingestion and inhalation exposure pathways. Previously, these pathways were calculated separately using chemical-specific factors and pathway-specific exposure assumptions. In addition to these factors, this draft method does not consider fugacity (i.e., the propensity for a substance to "break free" from the containing medium) as part of the suggested calculation. This proposed method includes the inhalation reference dose or slope factor, but it is applied to the ingestion formula.

An similar approach for limiting RME uncertainties was taken for groundwater. It would be implausible to expect an individual to be chronically exposed to the maximum concentration of each groundwater chemical. Substitution of the 95% upper confidence limit (UCL) mean concentration (where possible) for each chemical provides a reasonably conservative estimate of

the chronic concentrations to which an individual may be exposed via the groundwater pathway. Spatial analysis shows that inorganic and organic COPCs did not consistently coexist, and detections appeared to be random rather than suggestive of a defined plume.

Many essential nutrients were detected in the shallow, intermediate, and deep WBZs. These essential nutrients would be expected due to possible saltwater intrusion. In addition to these nutrients, arsenic would be expected to be present (as it is in seafood). Arsenic did not exceed its federal MCL or FPDWS at the maximum concentration detected. At the exposure point concentration (EPC), arsenic poses $3.2\text{E-}4$ excess cancer risk, approximately 80% of the total risk.

Groundwater metals concentrations were obtained from unfiltered samples. As mentioned previously, filtration would likely be a part of any system deriving water from the shallow WBZ for potable use. The groundwater in this aquifer has been shown to be highly turbid and to contain natural iron, manganese, and sodium concentrations exceeding FSDWS. A large portion of the aquifer yields dark brown, highly organic pore water with an acrid H_2S odor, which could be the result of reduced manganese and iron. Based on natural qualities, the aquifer does not appear suitable as a drinking water supply either in impacted or unimpacted areas.

As discussed for exposure to surface soil, uniform exposure was assumed for all monitoring well data from Site 1. Percent area affected was not applied to the risk projections, and this is a highly conservative approach, especially in the case of the low frequency of detected COPCs. As discussed above, the likelihood that the aquifer would be used as a drinking water supply is extremely low. Also previously discussed is the Navy's intention for continued operations, which indicates the area will remain a limited access area. Since COCs were identified assuming potable water use by site residents, the conservatism and resulting overestimation of risk projections are substantial. All assumptions regarding the evaluation of shallow and intermediate groundwater and deep groundwater as potential sources of potable water are the same for this risk assessment.

Few COCs are identified for the residential exposure pathways (potential future use) only, and the COPCs identified are based on conservative assumptions for all exposure pathways.

The following are uncertainties associated with estimation of risks:

In hazard and risk evaluations, risks or hazards presented by several chemicals reported for the same exposure have been added to provide a sum of estimated total risk or hazard for that particular exposure. This is a conservative assumption and is scientifically accurate only in those instances where health effects of individual chemicals are directed at the same effect and same target organ. Effects may be additive, synergistic, or antagonistic. Since many chemicals have no similarity as to their noncarcinogenic action or target of their action, this approach may overestimate risk.

Risks calculated from slope factors are derived using a linearized multistage procedure; therefore, they are likely to be conservative upper-bound estimates. Actual risks may be much lower.

6.7 Human Health Risk Summary

Risk and/or hazard associated with exposure to all environmental media (and combinations) was within USEPA's and FDEP's generally acceptable ranges for both current site workers and potential current child trespassers.

For an unlikely hypothetical future site resident, exposure media were shown to exceed acceptable residential goals. These media included shallow/intermediate and deep groundwater.

Shallow/Intermediate Groundwater RGOs

Table 6-7 provides remedial goal options (RGOs) for the combined shallow/intermediate groundwater pathways (ingestion/inhalation exposures). The EPCs for 1,4-dichlorobenzene,

Table 6-7
 Remedial Goal Options for Shallow/Intermediate Groundwater

Chemical	Carcinogenic Risk-based RGOs			Hazard-based RGOs Hazard Goal			EPC (mg/L)	Reference Concentration (mg/L)	ARAR (mg/L)	Source
	1.00e-04	1.00e-05	1.00e-06	10	1	0.1				
1,1,2,2-Tetrachloroethane	1.70e-02	1.70e-03	1.70e-04	NA	NA	NA	0.0014	NA	0.0002	FDWS-C
"1,4-Dichlorobenzene	1.40e-01	1.40e-02	1.40e-03	17.9	1.79	0.179	0.0074	NA	0.075	FPDWS
"Arsenic"	4.50e-03	4.50e-04	4.50e-05	0.047	0.0047	0.00047	0.012	ND	0.05	FPDWS
"Barium"	NA	NA	NA	11.0	1.10	0.110	0.113	ND	2	FPDWS
Benzene	1.90e-01	1.90e-02	1.90e-03	0.27	0.027	0.00267	0.026	NA	0.001	FPDWS
"Cadmium"	NA	NA	NA	0.078	0.0078	0.00078	0.0029	ND	0.005	FPDWS
"Nickel"	NA	NA	NA	3.1	0.31	0.031	0.0308	ND	0.1	FPDWS
"Chlorobenzene	NA	NA	NA	3.1	0.31	0.031	0.12	NA	0.1	MCL — monochlorobenzene
"Manganese"	NA	NA	NA	0.78	0.078	0.0078	0.042	0.0215	0.05	FSDWS
Vinyl Chloride	3.50e-03	3.50e-04	3.50e-05	NA	NA	NA	0.0025	NA	0.001	FPDWS
"Chloroform	7.20e-03	7.20e-04	7.20e-05	1.6	0.16	0.016	0.0024	NA	0.006	FDWS-C

Notes:

- NA — Indicates an RGO was not applicable for this chemical under risk and/or hazard-based conditions.
- ND — Indicates the chemical was not detected in reference (background) wells.
- FPDWS — Means Florida Primary Drinking Water Standard.
- FDWS-C — Indicates Florida guidance concentration based on carcinogenicity.
- * — Indicates the inhalation pathway was not considered in establishing RGOs.
- ** — Indicates the ARAR is greater than the EPC.
- EPC — Exposure Point Concentration
- mg/L — milligrams per liter

Noncarcinogenic hazard-based RGOs were computed based on the future child site resident scenario with combined ingestion and inhalation exposure (where applicable).

Carcinogenic risk-based RGOs were computed based on the future site resident lifetime weighted average scenario with combined ingestion and inhalation exposure (where applicable).

arsenic, barium, cadmium, nickel, chlorobenzene, manganese, and chloroform are below corresponding ARARs, which may influence remediation levels deemed necessary.

Deep Groundwater RGOs

The RGOs for the deep groundwater pathway are provided in Table 6-8. The COC is potentially related to saltwater intrusion and/or natural ambient groundwater concentrations.

6.8 Ecological Considerations

Ecological risks at Site 1 were determined to be inconsequential for flora and fauna from contaminated soil. Based on a review of the factors that may affect availability of chemicals, and a critical assessment of the concentrations observed during the 1994 sampling activity, no appreciable ecological effects are expected from groundwater discharge to wetlands, other than Wetland 3, near Site 1. The risk to ecological receptors at Wetland 3 has been evaluated by comparing sediment and surface water concentrations to established screening values from FDEP and USEPA Region 4. Contaminants of concern are primarily metals and pesticides. Benthic community species and fish in downgradient sections of the wetland are potentially exposed to excess risk. Methods proposed to assess risk to receptors for Phase IIB of the Site 41 RI are bioassays for benthic and fish species. All contaminants will be studied further during the Bayou Grande (Site 40) and NAS Pensacola wetlands remedial investigations (Site 41).

Table 6-8
 Remedial Goal Objectives for Deep Groundwater

Chemical	Carcinogenic Risk-Based RGOs Risk Goal			Noncarcinogenic Hazard-Based RGOs (mg/L) Hazard Index Goal			Exposure Point Concentration (mg/L)	Reference Concentration (mg/L)	ARAR (mg/L)	Source
	1.00e-04	1E-05	1E-06	10	1	0.1				
Manganese	NA	NA	NA	0.00	0.000	0.0000	0.090	0.0215	0.05	FSDWS

Notes:

- NA — Indicates an RGO was not applicable for this chemical under risk and/or hazard-based conditions.
 FSDWS — Means Florida Secondary Drinking Water Standard, SMCL means Secondary Maximum Contaminant Levels

7.0 DESCRIPTION OF THE REMEDIAL ALTERNATIVES

The OU 1 FFS report and addendum presented the detailed analysis results on four potential remedial action alternatives. These alternatives were developed to provide a range of remedial actions for the site. This section of the ROD summarizes the four alternatives described in the FFS report and addendum, which include:

- No Action
- Natural Attenuation

In addition, three natural attenuation options have been developed addressing Wetland 3 and the outfall for Wetland 3 into Wetland 4D.

- a) Natural attenuation with monitoring only of the water entering and leaving Wetland 3
- b) *Natural attenuation for the landfill and enhancement of Wetland 3 to improve its effectiveness*
- c) *Natural attenuation for the landfill with interception and treatment of groundwater before reaching Wetland 3*

- Capping
- Groundwater Extraction and Treatment

These four remedial action alternatives were developed to address contaminated groundwater and soil and various OU 1 areas of concern (AOCs). The AOCs were identified by comparing media-

specific contaminant concentrations detected at OU 1 to media-specific remediation goals developed in the FFS and the FFS addendum. The AOCs identified for OU 1 are:

- Contaminated soil above FDEP leachability guidance (TBCs)
- Contaminated groundwater above performance standards
- Contaminated surface water above performance standards

Figure 7-1 shows the general location of the AOCs for soil, groundwater, and surface water. Table 7-1 summarizes the remedial objectives. Performance standards are defined in Section 9. A concise description of how each alternative will address contamination at OU 1 as well as estimated cost follows.

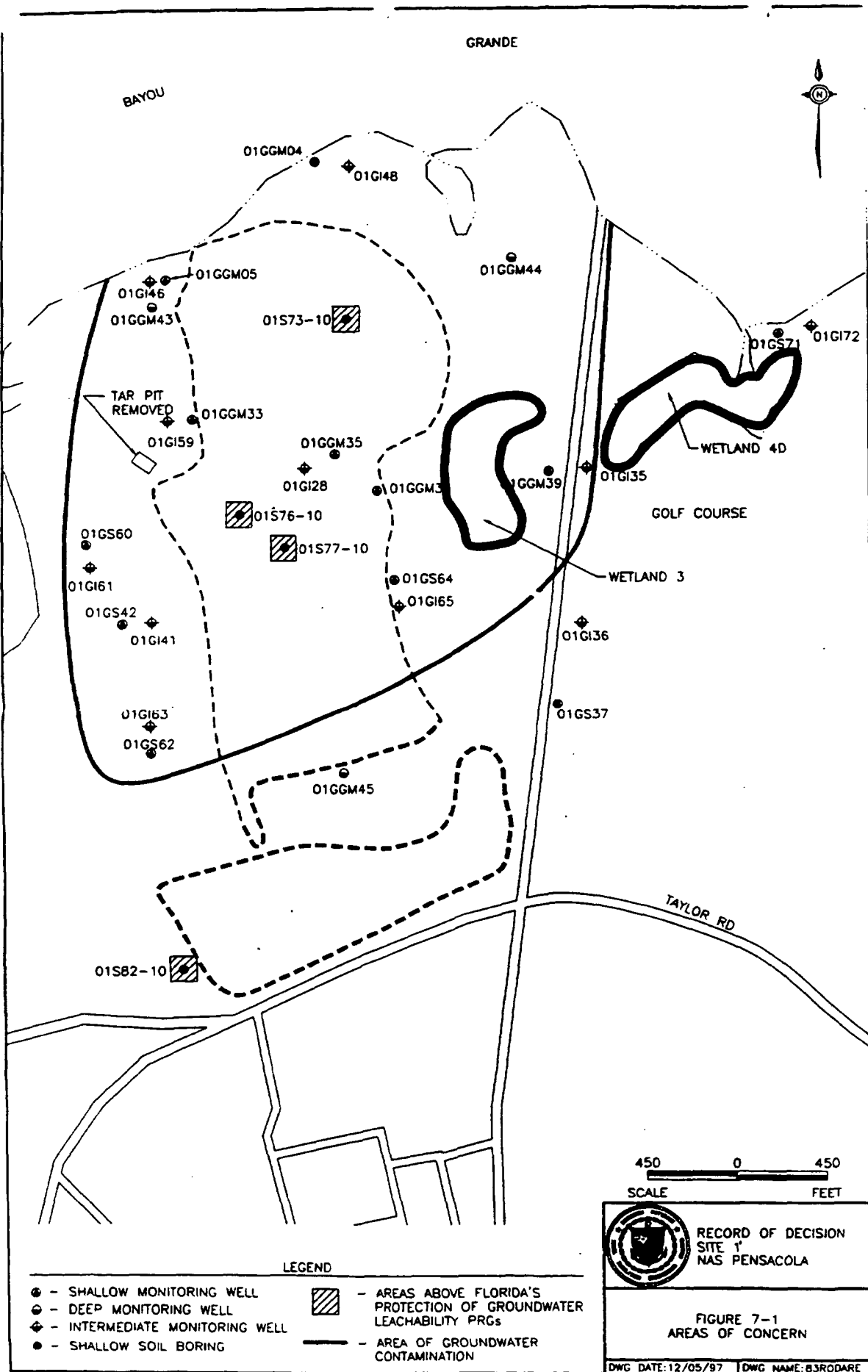
**Table 7-1
Site 1 – Remedial Objectives**

Media	Objective	Location	Volume	Rationale
Waste	Protect groundwater from leachable compounds	Entire landfill	± 700,000 yd ³	Entire waste component may be leaching contaminants to groundwater (TBC).
Groundwater	Restore site groundwater to MCLs and prevent further contamination of shallow/intermediate groundwater	Central, northern, western, and eastern portions of Site 1	210 million gallons	Groundwater exceeding MCLs (ARARs).
Surface Water	Prevent further contamination of surface water in Wetland 3	eastern portion of Site 1	1,156 million gallons	Surface water exceeding SWQS (ARARs).

Note:
yd³ — Cubic yards

7.1 Alternative 1: No Action

Capital Cost:	\$0.00
Annual Operation and Maintenance (O&M) Costs:	\$0.00
Net Present Worth	\$0.00



The NCP requires consideration of a no-action alternative as a baseline against which other alternatives are compared. In the no-action alternative, no further action will be taken to contain, remove, or treat soil and groundwater contaminated above performance standards.

Health risks for the future resident will remain and no chemical-specific ARARs will be met. This alternative does not meet the effectiveness criterion because it does not reduce future exposures for the unlikely future child resident through exposure to groundwater. Contaminated waste/soil may threaten site groundwater.

7.2 Alternative 2: Natural Attenuation

This alternative would include:

- Institutional controls imposed in accordance with the LURA to restrict groundwater use of the surficial zone of the Sand-and-Gravel Aquifer within 300 feet of the site.
- Institutional controls imposed in accordance with the LURA to limit intrusive activities within the landfill boundary without prior approval from the NAS Pensacola Environmental Office.
- Annual review of the institutional controls and certification that the controls should remain in place or be modified to reflect changing site conditions
- Groundwater monitoring to ensure that natural attenuation processes would be effective and that contaminants would not migrate.
- A review during which the Navy would determine whether groundwater performance standards continue to be appropriate and if natural attenuation processes are effective.

- Continued groundwater monitoring at sampling intervals to be established by the Navy with FDEP and USEPA concurrence. The groundwater monitoring program would continue until the alternative has achieved continued attainment of the performance standards and remains protective of human health and the environment.

Groundwater samples would be collected in accordance with the monitoring plan to be completed during remedial design. Proper well construction and development techniques, along with a low flow sampling method, would be used during the monitoring. The Navy may revise the groundwater monitoring program sampling intervals with USEPA and FDEP concurrence.

In addition, three natural attenuation options have been developed to address Wetland 3 and the outfall for Wetland 3 into Wetland 4D. Natural attenuation costs for the landfill are included in each subalternative.

7.2.1 Alternative 2a: Contaminated Groundwater Discharge into Wetland 3 with Monitoring Only

Capital Cost:	\$211,500.00
Annual Operation and Maintenance (O&M) Costs:	\$358,700.00
Net Present Worth	\$3,258,600.00

Under this alternative, no active remedial steps are taken and the wetland is included in the monitoring plan presented for the landfill in the original FFS. Natural processes that decrease contamination of the water discharging into the wetland are monitored to ensure that they are proceeding as expected. It is expected that surface water standards would continue to be exceeded for some time.

7.2.2 Alternative 2b: Enhancement of Wetland 3

Capital Costs:	\$816,400.00
Annual Operation and Maintenance (O&M) Costs:	\$179,900.00
Net Present Worth	\$4,278,500.00

Wetlands improve water quality through independent and interactive physical, chemical, and biological processes. Wetlands physically remove suspended solids from water in two ways. First, suspended solids settle to the bottom; increased retention times and contact with plant materials enhance this process. Secondly, absorption of suspended solids to sediment and plant material results in removal of suspended material. Chemical removal occurs when chemical constituents attach or sorb onto solids. Increased water surface area for gas exchange improves dissolved oxygen content for decomposition of organic compounds and oxidation of many metal ions. However, the most important attenuation processes are biological and similar to those occurring in conventional treatment plants. Like conventional treatment plants, wetlands provide a suitable environment for abundant microbial populations. Wetlands require larger treatment areas than conventional treatment plants to establish stable, low maintenance environments for similar microbes, but may support additional types of microorganisms because of the diverse mixture of microenvironments. Having a more diverse microenvironment and a larger treatment area than conventional treatment plants produces lower discharge concentrations of water-borne pollutants.

The principal function of vegetation in wetlands systems is to create additional environments for microbial populations. Not only do the stems and leaves in the water column obstruct flow and facilitate sedimentation, they provide substantial amounts of surface area for attachment of microbes (reactive surfaces). Plants also increase the amount of aerobic microbial environment incidental to the unique adaption that allows wetland plants to thrive in saturated sediments. Most plants are unable to survive in water-logged soil because their roots cannot obtain oxygen in the

anaerobic conditions created after inundation. However, hydrophilic plants have specialized structures in their leaves, stems, and roots similar to a mass of breathing tubes that conduct atmospheric gases, including oxygen, down into the roots. Because the root hair outer covering is not a perfect seal, oxygen leaks out, creating a thin aerobic region around each root hair. In addition, the ability of vascular plants to absorb and concentrate heavy metals is well-documented. Plants would limit the growth of algae in the system by restricting the penetration of sunlight and competing for available nutrients.

7.2.3 Alternative 2c: Groundwater Interception, Treatment and Reintroduction to Wetland 3

Capital Cost:	\$559,000.00
Annual Operation and Maintenance (O&M) Costs:	\$209,800.00
Net Present Worth	\$4,542,600.00

In this alternative, a groundwater interception system would be installed to capture the contaminated groundwater upgradient of Wetland 3. This extracted groundwater would be treated to reduce iron levels and then reintroduced into Wetland 3. This alternative addresses Wetland 3 surface water exceedances by preventing water with high iron content from entering the wetland, while at the same time having a minimal effect on the wetland's water level.

Based on areal extent of apparent contamination in the surficial aquifer, and specific characteristics of the aquifer (hydraulic conductivity, aquifer thickness) and subject to the detailed Remedial Design, an eight-well recovery system was conceptualized for the purpose of developing costs for the Feasibility Study. The actual method of groundwater interception will be determined during Remedial Design and may involve alternatives to wellpoint extraction (e.g., trenching, walls, etc.). The hydrogeological basis for the current conceptual design is the groundwater model prepared for and presented in the Final Focused Feasibility Study which may be consulted for details.

Due to the high concentration of iron in the groundwater stream, iron removal will be required before the intercepted groundwater is reintroduced to Wetland 3. The various physical and chemical processes (e.g., pH adjustment, flocculation, coagulation, oxidation, etc.) by which iron may effectively be removed to concentrations below the RGOs will be evaluated during Remedial Design. For the purpose of developing costs for use in the Feasibility Study, the conceptual treatment scheme was based on an oxidation process. An aeration/pH adjustment tank would enhance removal of the dissolved iron prior to filtration, while air would promote the oxidation of iron from the soluble ferrous state to the insoluble ferric state. The iron removal filter removes suspended particulates and iron bacterial residue from the groundwater. Particulates are removed by a combination of gravity settling and filtration on a series of nonwoven fabric filter plates.

The system design was based on the following assumptions:

- The groundwater flow is 110 gpm.
- The facility would be manually controlled.
- The system's design life is 20 years.
- The iron concentration in groundwater is 73 ppm.
- The desired effluent concentration is 1,000 ppb maximum.

A more complete description of the conceptual design used to develop the cost of this alternative may be found in the Focused Feasibility Study Addendum. Again, this conceptual design was intended to be used for FFS purposes only. Details on the groundwater interception system and iron removal system will be developed during Remedial Design.

Under this alternative, the iron removal system may also provide some incidental treatment of the other contaminants (primarily organics) present in the extracted groundwater. However, the

primary reduction of remaining contaminant concentrations would be through natural attenuation after the water is reintroduced to Wetland 3. These naturally occurring biotic and abiotic processes are described fully under Alternative 2b, above.

7.3 Alternative 3: Capping

Capital Cost:	\$10,813,200.00
Annual Operation and Maintenance (O&M) Costs (for 30 years):	\$140,400.00
Net Present Worth	\$13,450,400.00

This alternative includes:

- Institutional controls imposed in accordance with the LURA to restrict groundwater use of the surficial zone of the Sand-and-Gravel Aquifer within 300 feet of the site.
- Institutional controls imposed in accordance with the LURA to limit intrusive activities within the landfill boundary.
- Construction and maintenance of a clay cap for 30 years.
- A review during which the Navy would determine whether groundwater performance standards continue to be appropriate and if natural attenuation processes are effective.
- Continued groundwater monitoring at sampling intervals to be established by the Navy with Florida and USEPA concurrence. The groundwater monitoring program would continue until the alternative has achieved continued attainment of the performance standards and remains protective of human health and the environment.

Capping reduces the risk of contact with contaminated soil and reduces the quantity of leachate generated when rainwater filters through contaminated waste/soil. With the capping alternative, approximately 85 acres will be capped with clay. The entire site is cleared, grubbed, and graded before cap installation. Storm water runoff is controlled by perimeter ditches that collect and direct it away from the site. Under this alternative, groundwater is monitored and with little additional contamination, is expected to meet remedial goals through natural attenuation over time. Regular maintenance is required, such as inspecting, mowing, and repairing the cap. The present cost of this alternative is estimated at \$13,450,400, assuming 30 years of maintenance.

7.4 Alternative 4: Groundwater Extraction with Treatment for the Entire Landfill

Groundwater Extraction

Capital Cost:	\$753,300.00
Annual Operation and Maintenance (O&M) Costs:	\$132,200.00
Net Present Worth	\$3,198,500.00

Air Stripping

Capital Cost:	\$149,500.00
Annual Operation and Maintenance (O&M) Costs:	\$82,300.00
Net Present Worth	\$2,000,000.00

Constructed Wetlands

Capital Cost:	\$866,800.00
Annual Operation and Maintenance (O&M) Costs:	\$54,000.00
Net Present Worth	\$2,431,100.00

This alternative would include:

- Institutional controls imposed in accordance with the LURA to restrict groundwater use of the surficial zone of the Sand-and-Gravel Aquifer within 300 feet of the site.
- Institutional controls imposed in accordance with the LURA to limit intrusive activities within the landfill boundary without prior approval from the NAS Pensacola Environmental Office.
- A groundwater monitoring program to ensure that the groundwater treatment system would be effective and that contaminants would not migrate.
- Active remediation of groundwater. Groundwater extraction and treatment would continue until all performance standards are met for two consecutive sampling events.
- Continued groundwater monitoring upon attainment of the performance standards at sampling intervals established during remedial design. The groundwater monitoring program would continue until a five-year review concludes that the alternative has achieved continued attainment of the performance standards and remains protective of human health and the environment.

If implemented, the groundwater extraction system shall consist of a group of wells within the estimated plume area. The pumping system shall be designed to provide a capture zone sufficient to intercept the delineated plume targeted for extraction. The effectiveness of the groundwater extraction system depends on the aquifer characteristics, transmissivity, and storativity. Typically, these design criteria are developed by aquifer testing based on constant discharge pumping and/or recovery tests. Pumping tests and modeling shall be required before extraction. The number of

wells, estimated at 20, and system extraction rate, estimated at a combined 80 gallons per minute, will be determined during remedial design. The two treatment processes considered under this alternative are constructed wetlands and air stripping, which are described below.

Air Stripping

Air stripping is an established technology by which volatile organics are partitioned from groundwater by greatly increasing the surface area of the contaminated water exposed to air. Types of aeration methods include packed towers, diffused aeration, tray aeration, and spray aeration. In this FFS, tray aeration was chosen for implementation at Site 1. The following variables may limit the applicability and effectiveness of the process:

- Equipment may be fouled by inorganic or biological constituents. Ferrous iron precipitates as insoluble ferrous hydroxide species upon aeration. Air strippers must be taken out of service and packing materials acid-washed.
- Consideration should be given to the Henry's Law constant of the VOCs in the water stream.
- Compounds with low volatility at ambient temperature may require pre-heating the groundwater.

A pretreatment process using sodium hydroxide to raise the pH and precipitate metals from the water will be included in the treatment train for air stripping. The water will then be treated with air stripping and the waste residuals will be disposed of offsite at a licensed treatment, storage, and disposal facility.

This established technology can be implemented with a minimum of testing. Treated water must be discharged to surface water, reinjected into the underlying aquifer, or discharged to a federally owned treatment works (FOTW). The process of extracting groundwater eliminates contaminant migration.

Contaminated groundwater would be extracted, treated, and discharged in accordance with National Pollution Discharge Elimination System (NPDES) permit requirements. If an NPDES is not viable, other discharge alternatives such as discharge to the Navy-owned wastewater treatment plant would be considered. Onsite treatment would likely be required so that the treated water would meet permit requirements for discharge to a nearby surface water body. The number of extraction wells and pumping rates will be determined during remedial design.

Constructed Wetlands

Constructed wetlands are man-made systems that are designed, built, and operated to perform the functions of natural wetlands for treatment of contaminated water. Wetlands improve water quality through physical, chemical, and biological processes operating independently and also interactively. The removal mechanisms for suspended solids in the wetlands treatment system essentially fall under two processes. The first is sedimentation in which the suspended solids ultimately settle to the bottom. Retention times and contact with plant materials enhance this process. Absorption of suspended solids also aids in this reduction process. Many chemical constituents tend to attach or sorb onto solids. Absorption, combined with solids settling, removes constituents from the water column that otherwise could remain. Increased water surface area for gas exchange improves dissolved oxygen content for decomposition of organic compounds and oxidation of many metallic ions. But the most important processes are similar to transformations occurring in conventional treatment plants. Wetlands, like conventional treatment systems, simply provide suitable environments for abundant microbial populations. Wetland systems use larger treatment areas to establish stable, low maintenance systems providing environments for similar

microbes, but may support additional types of microorganisms because of the diverse mixture of microenvironments. The latter, along with a larger treatment area, frequently provides more complete reduction and lower discharge concentrations of water-borne pollutants.

The principal function of vegetation in wetlands systems is to create additional environments for microbial populations. Not only do the stems and leaves in the water column obstruct flow and facilitate sedimentation, they also provide substantial amounts of surface area for attachment of microbes — reactive surfaces. Plants also increase the amount of aerobic microbial environment in the substrate incidental to the unique adaptation that allows wetlands plants to thrive in saturated soil. Most plants are unable to survive in water-logged soil because their roots cannot obtain oxygen in the anaerobic conditions rapidly created after inundation. However, hydrophytic or wet-growing plants have specialized structures in their leaves, stems, and roots somewhat analogous to a mass of breathing tubes that conduct atmospheric gases, including oxygen, down into the roots. Because the root hair outer covering is not a perfect seal, oxygen leaks out, creating a thin aerobic region around each root hair. In addition, the ability of vascular plants to absorb and concentrate heavy metals is well-documented.

Constructed wetlands provide an onsite treatment that requires little maintenance or power after a landfill is closed. They provide several characteristics that are beneficial for leachate treatment including large vegetative bio-mass, large adsorptive surfaces on sediments and plant material, aerobic/anaerobic interfaces, and diverse, active microbial populations. Plants also provide a more rapid decrease in leachate volume through transpiration than lagoons without plants.

Although constructed wetlands is an emerging technology, it is based on well-established processes and can be implemented, but requires substantial testing and planning. Also, treated water must be discharged to surface water or reinjected into the underlying aquifer. The process of collecting leachate from the groundwater eliminates contaminant migration.

The present worth cost of this alternative ranges from \$5,216,500 (air stripping) to \$5,629,500 (constructed wetlands) for 30 years O&M for an 80-gallon per minute (gpm) treatment system.

7.5 Applicable or Relevant and Appropriate Requirements

The remedial action for OU 1, under CERCLA Section 121(d), must comply with federal and state environmental laws that are either applicable or relevant and appropriate. Applicable requirements are standards, criteria, or limitations promulgated under federal or state law that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site. Relevant and appropriate requirements are those that, while not applicable, still address problems or situations sufficiently similar to those encountered onsite that their use is well-suited to the particular site. TBC criteria are nonpromulgated advisories and guidance that are not legally binding, but should be considered in determining the necessary level of cleanup for protection of health or the environment.

The affected groundwater in the aquifer beneath OU 1 has been classified by USEPA and FDEP as Class IIA and G-1, a potential source of drinking water. It is Florida and USEPA's policy that groundwater resources be protected and restored to their beneficial uses. A complete definition for USEPA's groundwater classification is provided in the *Guidelines for Groundwater Classification under the EPA Groundwater Protection Strategy*, Final Draft, December 1986. Florida groundwater classification is defined in Chapter 62-520, Groundwater Classes, Standards, and Exemptions.

While TBCs do not have the status of ARARS, the approach to determining if a remedial action is protective of human health and the environment involves consideration of TBCs, along with ARARs. Potential ARARs for all of the alternatives are presented in the feasibility study completed for OU 1.

Location-specific ARARs are restrictions placed on the concentration of hazardous substances or the conduct of activities solely on the basis of location. Examples of location-specific ARARs include state and federal requirements to protect floodplains, critical habitats, and wetlands, and solid and hazardous waste facility siting criteria. Table 7-2 summarizes the location-specific ARARs for OU 1 for the selected remedy.

Action-specific ARARs are technology- or activity-based requirements or limitations on actions taken with respect to hazardous wastes. These requirements are triggered by the particular remedial activities that are selected to accomplish a remedy. Table 7-3 lists action-specific ARARs and TBCs for the OU 1 selected remedy.

Chemical-specific ARARs are specific numerical quantity restrictions on individually listed chemicals in specific media. An example of a chemical-specific ARAR is the MCLs specified under the Safe Drinking Water Act. Since there are usually numerous chemicals of concern for any remedial site, various numerical quantity requirements can be ARARs. Table 7-4 lists chemical-specific ARARs for OU 1 for the selected remedy.

Table 7-2

Potential Location-Specific ARARs for the Selected Remedy

Requirements	Status	Requirement Synopsis	Application to the RI/FS
Federal Requirements			
Executive Order 11990 Wetlands Protection Policy	Applicable	Sets forth policy for the protection of wetlands	Several wetlands on Site 1 fit the definition under the Executive Order.
State Requirements			
None			

Table 7-3
Potential Action-Specific ARARs for the Selected Remedy

Requirements	Status	Requirement Synopsis	Application to the RI/FS
Federal Requirements			
RCRA Groundwater Monitoring Requirements 40 CFR 264 Subpart F	Relevant and Appropriate	Establishes minimum requirements for groundwater monitoring and protection standards for RCRA facilities.	Onsite treatment, storage, and/or disposal of RCRA wastes may be included in the remediation of Site 1.
Clean Water Act Discharge Limitations NPDES Permit 40 CFR 122, 125, 129, 136 Pretreatment Standards 40 CFR 403.5	Applicable	Prohibits unpermitted discharge of any pollutant or combination of pollutants to waters of the U.S. from any point source. Standards and limitations are established for these discharges	Remedial actions may include the discharge of treated groundwater, runoff, or other flows to a surface water.
Safe Drinking Water Act Underground Injection Control Program 40 CFR 144	Applicable	Regulates the use of five classes of underground injection wells for the purpose of disposal of hazardous substances.	Would be applicable if injection well technology is used as a part of site remediation.
State Requirements			
Florida Rules on Permits Title 62 Chapter 62-4	Applicable	Establishes antidegradation requirements.	Requirements may be applicable to site depending upon remedial actions and discharge options selected.
Florida Underground Injection Control Regulations Title 62 Chapter 62-28	Applicable	Establishes construction standards, permitting procedures, and operating requirements for underground injection wells.	Remedial actions may include underground injection as a disposal option for treated effluent.
RCRA Solid Waste Groundwater Monitoring Requirements	Applicable	Establishes monitoring requirements	Remedial action will require monitoring

Table 7-4
 Potential Chemical-Specific ARARs for the Selected Remedy

Requirements	Status	Requirement Synopsis	Application to the RI/FS
Federal Requirements			
RCRA Maximum Concentration Limits 40 CFR 264 Subpart F	Applicable	Maximum Concentration Levels have been established for 14 toxic compounds under RCRA groundwater protection standards. A compliance monitoring program is included for RCRA facilities.	Applicable to Site 1 with current groundwater monitoring program; also applicable where identified hazardous wastes are treated, stored, or disposed onsite.
Safe Drinking Water Act MCLs 40 CFR 141.11 - 141.16	Applicable	MCLs have been set for toxic compounds as enforceable standards for public drinking water systems. SMCLs are unenforceable goals regulating the aesthetic quality of drinking water.	The Sand- and-Gravel Aquifer is a potential source of drinking water. Some contaminants in the plume below Site 1 are above MCLs and SMCLs.
Safe Drinking Water Act MCLGs 40 CFR 141.50-141.51	Relevant and Appropriate	MCLGs are unenforceable goals under the SDWA.	The Sand-and-Gravel Aquifer is a potential source of drinking water. Some contaminants is plume below Site 1 are above non-zero MCLGs.
State Requirements			
Florida Water Quality Standards Title 62 Chapter 62-3	Applicable	Establishes minimum water quality criteria for groundwater.	Remedial objectives require remediation of Sand-and-Gravel Aquifer.
Florida Surface Water Standards Title 62 Chapter 62-301 and 62-302	Applicable	Establishes water quality standards for all waters of the state.	Remedial objectives require protection of surficial water. Remedial actions may impact surficial water bodies.
Florida Drinking Water Standards Title 62 Chapter 62-550	Applicable	Establishes MCLs for drinking water. Establishes secondary requirements for drinking water.	Remedial objectives require restoration of Sand- and-Gravel Aquifer to drinking water standards.

8.0 COMPARATIVE ANALYSIS OF ALTERNATIVES

This section of the ROD provides the basis for determining which alternative provides the best balance with respect to the statutory balancing criteria in Section 121 of CERCLA, 42 U.S.C. Section 9621, and in the NCP, 40 CFR, Section 300.430. The major objective of the FFS and addendum was to develop, screen, and evaluate alternatives for remediating OU 1. Alternatives and technologies were identified as potential candidates to remediate the contamination at OU 1. These were screened based on their feasibility with respect to the contaminants present and site characteristics. After the initial screening, the remaining alternatives/technologies were combined into potential remedial alternatives and evaluated in detail. The remedial alternative was selected from the screening process using the following nine evaluation criteria:

- Overall protection of human health and the environment.
- Compliance with applicable and/or relevant federal or state public health or environmental standards.
- Long-term effectiveness and permanence.
- Reduction of toxicity, mobility, or volume of hazardous substances or contaminants.
- Short-term effectiveness or the impacts a remedy might have on the community, workers, or the environment during implementation.
- Implementability, that is, the administrative or technical capacity to carry out the alternative.

- Cost-effectiveness, considering costs for construction, operation, and maintenance of the alternative over the life of the project, including additional costs should it fail.
- Acceptance by the state.
- Acceptance by the community.

The NCP categorizes the nine criteria into three groups:

- *Threshold Criteria* — Overall protection of human health and the environment and compliance with ARARs (or invoking a waiver) are threshold criteria that must be satisfied for an alternative to be eligible for selection.
- *Primary Balancing Criteria* — Long-term effectiveness and permanence; reduction of toxicity, mobility or volume; short-term effectiveness; implementability and cost are primary balancing factors used to weigh major trade-offs among alternative hazardous waste management strategies.
- *Modifying Criteria* — State and community acceptance are modifying criteria that are formally taken into account after public comments are received on the proposed plan and incorporated into ROD.

The selected alternative must meet the threshold criteria and comply with all ARARs or be granted a waiver for compliance with ARARs. Any alternative that does not satisfy both of these requirements is not eligible for selection. The Primary Balancing Criteria are the technical criteria upon which the detailed analysis of alternatives is primarily based. The final two criteria, known as Modifying Criteria, assess the acceptance of the alternative.

The following analysis summarizes the evaluation of alternatives for remediating OU 1 under each of the criteria. Each alternative is compared for achievement of a specific criterion.

8.1 Threshold Criteria

All alternatives considered for selection must comply with the threshold criteria, overall protection of human health and the environment, and compliance with ARARs.

8.1.1 Overall Protection of Human Health and the Environment

This criterion evaluates the degree of overall protectiveness afforded to human health and the environment. It assesses the overall adequacy of each alternative.

The no-action alternative will not mitigate the risks associated with contamination at or originating from OU 1. Therefore, this alternative is not protective of human health and the environment and will no longer be considered in this discussion.

Alternatives 2 and 3 would use groundwater monitoring and apply natural attenuation processes to meet groundwater performance standards. Since there is no current direct exposure route to groundwater, natural attenuation of groundwater contamination is protective. In addition, risk and/or hazard associated with exposure to surface water and sediment within Wetland 3 did not exceed USEPA or FDEP risk and hazard thresholds for recreational use by swimmers or waders. No excess threat to human health is caused by discharging groundwater to the surface water of Wetland 3; therefore, all alternatives are protective of human health.

Institutional controls restricting unapproved intrusive activities within the landfill boundary and restricting use of the surficial zone of the Sand-and-Gravel Aquifer within 300 feet of the site afford additional protection of potential human receptors under Alternatives 2, 3, and 4.

The iron detected in Wetland 3 surface water does exceed Florida Surface Water Quality Standards (1,000 ppb). High iron concentrations are a physical threat to fish and other biota because the oxidation products of iron can affect inhalation and ingestion processes. Wetland 3 is currently not a suitable fish habitat because the water is too shallow, and during dry periods of the year, it recedes below ground level. Because no adverse effects have yet been conclusively linked to the iron at the site, it is difficult to differentiate between the three alternatives. Assuming iron is causing environmental impacts to the wetland, Alternative 2c would be more protective than Alternatives 2a or 2b.

Alternative 4 would treat the groundwater contamination, thereby allowing the groundwater to attain the COC's MCL through extraction and treatment. Alternative 4 would actively restore groundwater and would protect human health and the environment best and most quickly.

These alternatives protect human health and the environment by restoring the aquifer and preventing potential migration of contaminated groundwater to available receptors.

8.1.2 Compliance with ARARs

The iron detected in Wetland 3 surface water does exceed Florida Surface Water Quality Standards (1,000 ppb). Alternative 2c would be more protective than Alternatives 2a or 2b as it provides for the interception and treatment of the groundwater before it enters Wetland 3.

Groundwater ARARs include MCLs that establish chemical-specific limits on certain contaminants in community water systems. Long-term monitoring is included in Alternatives 2, 3 and 4. Additional statistical analysis of data will further substantiate the presence or absence of a groundwater plume. This long-term monitoring will provide the data necessary for a statistical determination of constituent concentrations in groundwater.

For Alternatives 2 and 3, remedial action would include further sampling and analysis of groundwater to assure that groundwater beneath the site will meet ARARs through attenuation in a reasonable time-frame. Alternative 4 also has further sampling and analysis to assure that groundwater will meet ARARs through treatment. Bayou Grande and NAS Pensacola wetlands will be further evaluated during the Sites 40 and 41 RIs.

Alternatives 2, 3, and 4 would meet all federal and state standards for contaminants and proposed actions.

8.2 Primary Balancing Criteria

8.2.1 Long-term Effectiveness and Permanence

Alternatives 2, 3, and 4 would provide long-term effectiveness and permanence.

All of the Alternative 2 subalternatives and Alternatives 3 and 4 would use institutional controls, which would be re-evaluated after implementation of the monitoring program and again at the five-year review. Although this alternative would require additional time to meet the performance standards, it would likely be as effective long-term.

As stated earlier, no excess risk to human health is posed under current use scenarios by any alternative, including the no action alternative. Alternative 2a depends on Wetland 3's capacity to retain iron and how much of this capacity has already been used. Therefore, Alternative 2a's permanence is difficult to predict. With harvesting of plants and removal of decayed matter, Alternative 2b should be effective for the 30-year life of the project. Alternative 2c's long-term effectiveness depends upon maintenance of the system for the project's 30-year life. With proper operation, Alternative 2c should effectively remove iron from the groundwater. None of the alternatives eliminates the iron's source, and under alternatives 2a, 2b, and 2c, conditions would return to their present state when the systems are shut down or maintenance terminated.

Alternative 2c provides more reliable controls than Alternatives 2a or 2b. The technology involved in groundwater interception and removal of iron is well developed and has been used for many years in other applications. Wetlands have been used to aid in the removal of inorganics from water, as proposed in Alternatives 2a and 2b, but this practice is an innovative technology. Its successful implementation often depends upon trial and error because of the many variables involved.

Alternative 3 would use a clay cap, which would limit leachate generation, and long-term monitoring to meet the performance standards. Although this alternative would require additional time to meet the performance standards, it would likely be as effective long-term. Alternative 4 would use treatment technologies to reduce hazards posed by the contaminants in the OU 1 groundwater.

Alternative 3 would require long-term cover maintenance. Alternatives 2, 3 and 4 would require monitoring after performance standards were met to ensure continued effectiveness. Five-year reviews would be needed to verify that the cleanup remained protective for all three alternatives.

8.2.2 Reduction of Toxicity, Mobility, or Volume Through Treatment

Alternative 4 would actively remediate and treat groundwater. Alternative 3 would not treat groundwater, but would reduce contaminants over time. Toxicity, volume, and mobility of groundwater would be reduced through active restoration in Alternative 4. Alternatives 2a and 2b address reduction of the iron's mobility at Wetland 3 and do not significantly reduce the volume or toxicity. With physical removal of the iron by filtration, Alternative 2c addresses toxicity, mobility, and volume.

Therefore, Alternatives 2c and 4 would best satisfy CERCLA's statutory preference for treatment and use of treatment to reduce toxicity, mobility, and volume of contaminants.

8.2.3 Short-term Effectiveness

No short-term effectiveness issues are associated with Alternative 2a. The only short-term effectiveness issues for Alternative 2b are obtaining permits, and testing and planning required during the remedial design phase. Short-term issues associated with Alternative 2c include worker and community safety during interception and treatment system installation. However, these are easily controlled with proper personal protective equipment and engineering controls. The duration of the construction activities under Alternative 2c is short, estimated to be less than 6 months.

Alternative 3 would also be effective short-term. The installation of the cap may impose risks by disturbing the soil contamination; however, it is not expected to pose unacceptable short-term environmental or health hazards that could not be controlled. Adverse impacts to the surrounding environment are not anticipated during cap construction; engineering controls can be applied to manage storm water runoff and siltation, if necessary.

Alternative 4 would also be effective short-term. Alternative 4 (groundwater treatment) would require additional studies to determine groundwater treatment design specifications. However, Alternative 4 would more quickly remediate groundwater contamination through extraction and treatment. The installation of groundwater wells may impose risks by disturbing the contamination in the soil or groundwater; however, it is not expected to pose unacceptable short-term environmental or health hazards that could not be controlled.

8.2.4 Implementability

Alternative 2a would be the most easily implemented alternative. Alternative 2b would require more planning, and testing during remedial design. Alternatives 2b and 2c would either require permits for discharges or that the permit's intent be met. In addition, Alternative 2b would require a permit for wetlands alterations.

Alternative 3 would also be simple to implement. Materials, services, capabilities, and specialists would be readily available for cover maintenance. Periodic maintenance of the cover would provide reliability in the future. The groundwater monitoring program would determine the effectiveness of contaminated groundwater attenuation.

Alternative 4 would be the most technically difficult to implement and would require treatability studies and testing to define the design parameters for these processes.

8.2.5 Cost

Cost details are provided in the FFS and the addendum and are summarized below in Table 8-1. Alternative 2, institutional controls/monitoring, has the lowest present worth cost and Alternative 3, capping and monitoring, has the highest. Alternative 3 is significantly more expensive to construct and operate because of the 85 acres requiring capping. Alternative 4 is more expensive than Alternative 2 because of the groundwater extraction and treatment component for the entire landfill. Alternative 2 provides for the best ratio of costs to benefit received through the permanent reduction of risks to human health and the environment.

8.3 Modifying Criteria

8.3.1 State Acceptance

The State of Florida has concurred with the selection of Alternative 2c to remediate OU 1.

8.3.2 Community Acceptance

Based on comments expressed during the comment period, it appears that the Pensacola community generally agreed with the selected remedy. No comments were received during the public comment period.

Table 8-1
Cost Comparison for Alternatives

Alternative	Direct and Indirect Costs	Annual O&M Costs	Total Net Present Worth
Alternative 1	None	None	None
Alternative 2			
2a. Monitoring at Wetland 3	\$211,500	\$358,700	\$3,258,600
2b. Enhancement of Wetland 3	\$816,400	\$180,000	\$4,278,500
2c. Groundwater Interception with Treatment at Wetland 3	\$559,100	\$209,800	\$4,542,600
Alternative 3	\$10,728,100	\$140,400	\$13,450,400
Alternative 4			
4a. Extraction with Air Stripping	1,230,400	214,700	5,216,500
4b. Extraction with Constructed Wetlands	1,343,900	186,300	5,629,500

Notes:

Net present worth costs, where appropriate, were calculated using a 6% discount rate over 30 years.

All of the alternatives include cost estimates of engineering services/report preparation supplied by Bechtel Environmental Inc.

9.0 THE SELECTED REMEDY

Based upon consideration of the requirements of CERCLA, the NCP, the detailed analysis of alternatives and public and state comments, the Navy has selected Alternative 2c, institutional controls, natural attenuation, groundwater monitoring, and interception and treatment of groundwater in the Wetland 3 area as the remedial action for OU 1. At the completion of this remedy, the risk associated with this site will be protective of human health and the environment.

The selected alternative for OU 1 is consistent with the requirements of Section 121 of CERCLA and the NCP. The selected alternative will reduce the mobility, toxicity, and volume of contaminated groundwater onsite. In addition, the selected alternative is protective of human health and the environment, will attain all federal and state ARARs, is cost-effective, and uses permanent solutions to the maximum extent practicable.

Based on the information available at this time, the selected alternative represents the best balance among the criteria used to evaluate remedies. Alternative 2c is thought to be protective of human health and the environment, will attain ARARs, will be cost-effective, and will use permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable.

9.1 Source Control

Since the Baseline Risk Assessment indicates no unacceptable risk to exposure to soil, source control remediation will address restricting exposure to contaminated wastes and subsurface soil at the site and intercepting groundwater before discharge to Wetland 3. Source control shall include institutional controls to be placed in accordance with the LURA as agreed by the USEPA, FDEP, and the Navy.

The major components of source control to be implemented include:

- Institutional controls imposed in accordance with the LURA to restrict groundwater use of the surficial zone of the Sand-and-Gravel Aquifer within 300 feet of the site.
- Institutional controls imposed in accordance with the LURA to limit intrusive activities within the landfill boundary without prior approval from the NAS Pensacola Environmental Office.
- Groundwater interception and treatment before reintroduction into Wetland 3.

9.2 Monitoring

Groundwater monitoring will be implemented at OU 1 to record contaminant movement to nearby surface water bodies. The major components of groundwater monitoring to be implemented are:

- Placement of institutional controls to preclude usage of groundwater in the surficial zone of the Sand-and-Gravel Aquifer within 300 feet of the site
- Implementation of a groundwater monitoring program to monitor compliance with the performance standards listed in Table 9-1.

9.3 Compliance Testing

Groundwater and surface water will be monitored at this site in accordance with the monitoring plan to be completed during the remedial design. After demonstration of compliance with performance standards for two consecutive sampling events and continued attainment through the five-year review at the designated compliance points, sampling and monitoring may be discontinued. If sampling or monitoring indicates that the performance standards set forth in Section 9.2 are being exceeded at any time after monitoring has been discontinued, groundwater sampling may recommence until the performance standards are once again achieved.

**Table 9-1
Performance Standards for Groundwater**

Contaminant	Performance Standards
Nickel	100
Benzene	1
Chlorobenzene	100
Vinyl Chloride	1

Note:

Florida Primary Drinking Water Standard or USEPA MCL, whichever is lower.

10.0 STATUTORY DETERMINATIONS

Under CERCLA Section 121, 42 U.S.C. § 9621, the Navy must select remedies that are protective of human health and the environment, comply with ARARs (unless a statutory waiver is justified), are cost-effective, and use permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable. In addition, CERCLA includes a preference for remedies that employ treatment that permanently and significantly reduces the volume, toxicity, or mobility of hazardous wastes as their principal element. The following sections discuss how the selected remedy at OU 1 meets these statutory requirements.

10.1 Protection of Human Health and the Environment

The selected remedy protects human health and the environment by eliminating, reducing, and controlling risk through institutional controls and monitoring through performance standards described in Section 9. Contaminated groundwater will be monitored to meet the performance standards described in Section 9. Institutional controls will prevent exposure to contaminants in groundwater. The review will ensure that the performance standards are being met. Groundwater interception and treatment will prohibit further contamination of the surface water in Wetland 3.

10.2 Attainment of the ARARs

Remedial actions performed under CERCLA, Section 121, 42 U.S.C. § 9621 must comply with all ARARs. All alternatives considered for OU 1 were evaluated based on the degree to which they complied with these requirements. The selected remedial action was found to meet or exceed identified ARARs.

The selected remedy was found to meet or exceed ARARs identified in Tables 7-2, 7-3, and 7-4. The following is a short narrative in support of attainment of the pertinent ARARs.

Chemical-Specific ARARs

Groundwater restoration performance standards identified as MCLs are the groundwater protection standards set out in this ROD as performance standards for remedial action.

Action-Specific ARARs

Performance standards are consistent with ARARs identified in Tables 7-2 and 7-3; these regulations will be incorporated into the design and implementation of this remedy.

Location-Specific ARARs

Performance standards are consistent with ARARs identified in Table 7-1.

Waivers

Section 121 (d)(4)(C) of CERCLA, 42 U.S.C. § 9621(d)(4)(c) provides that an ARAR may be waived when compliance with an ARAR is technically impracticable from an engineering perspective.

Other Guidance To Be Considered

Other guidance TBCs include health-based advisories and guidance. TBCs have been used in estimating incremental cancer risk numbers for remedial activities at the sites and in determining RCRA applications to contaminated media. TBCs for OU 1 include *Guidelines for Groundwater Classification under the EPA Groundwater Protection Strategy*, Draft Final, December 1986.

10.3 Cost-Effectiveness

The Navy believes the selected remedy, Alternative 2c, will eliminate risks to human health at an estimated cost of \$4,542,000. Alternative 2c is expected to achieve a comparable effectiveness at a substantially lower cost than the other alternatives (although over a longer time).

Alternative 2c provides an overall effectiveness proportionate to its costs, such that it represents a reasonable value achieved for the investment.

10.4 Use of Permanent Solutions to the Maximum Extent Practicable

The Navy, with USEPA and FDEP concurrence, has determined that the selected remedy represents the maximum extent to which permanent solutions and treatment technologies can be used cost-effectively for final remediation at OU 1 at NAS Pensacola. Of those alternatives that protect human health and the environment and comply with ARARs, the Navy, with USEPA and FDEP concurrence, has determined that this selected remedy provides the best balance of trade-offs in long-term effectiveness and permanence; reduction in toxicity, mobility, or volume achieved through treatment, short-term effectiveness; implementability; and cost, while also considering the statutory preference for treatment as a principal element and consideration of state and community acceptance. The selected remedy provides for long-term effectiveness and permanence; is easily implemented; reduces toxicity, mobility, or volume, and is cost-effective.

10.5 Preference for Treatment as a Principal Element

Because groundwater treatment is practicable, the statutory preference for remedies that employ treatment as a principal element is satisfied.

11.0 DOCUMENTATION OF NO SIGNIFICANT CHANGES

There have been no significant changes in the selected remedy, Alternative 2c, from the preferred remedy described in the proposed plan. No comments were received during the public comment period.

12.0 REFERENCES

- Ecology & Environment, Inc. (1991a). *Data Evaluation Summaries and Proposed Samples Location Changes, Phase I Site Groups A through E, Contamination Assessment/ Remedial Activities Investigations, Naval Air Station (NAS) Pensacola, Florida*, Ecology & Environment, Inc.: Pensacola, Florida.
- Ecology & Environment, Inc. (1991b). *Contamination Assessment/Remedial Activities Investigation, Sanitary Landfill (Site 1), Naval Air Station Pensacola, Pensacola, Florida, Interim Data Report*, Ecology & Environment, Inc.: Pensacola, Florida.
- Ecology & Environment, Inc. (1992). *Contamination Assessment/Remedial Activities Investigation, Naval Air Station, Pensacola, Pensacola, Florida, Data Summary and Preliminary Scoping Report for Ecological Risk Assessment Work Plans*, Ecology & Environment, Inc.: Pensacola, Florida.
- Geraghty & Miller, Inc. (1984). *Verification Study, Assessment of Potential Ground-water Pollution at Naval Air Station, Pensacola, Florida*. Geraghty & Miller, Inc.: Tampa, Florida.
- Geraghty & Miller, Inc. (1986). *Characterization Study, Assessment of Potential Ground-water Pollution at Naval Air Station, Pensacola, Florida*. Geraghty & Miller, Inc.: Tampa, Florida.
- Naval Energy and Environmental Support Activity. (1983). *Initial Assessment Study of Naval Air Station, Pensacola, Pensacola, Florida, NEESA 13-015*, Naval Energy and Environmental Support Activity: Port Hueneme, California.

Southern Division Naval Facilities Engineering Command. (1996). 1977 Site Management Plan for the Naval Air Station Pensacola, Pensacola, Florida. Southern Division Naval Facilities Engineering Command: Charleston, South Carolina

U.S. Environmental Protection Agency. (1989). *Risk Assessment Guidance for Superfund, Volume 1, Human Health Evaluation Manual Part A, Interim Final*. EPA/540/1-89/002. December 1989.

U.S. Environmental Protection Agency. (1990). *National Oil and Hazardous Substances Pollution Contingency Plan; Final Rule*. EPA/540/1-89/002. December 1989. Federal Register V55:46 pg 8666-8865, March 8, 1990.

U.S. Environmental Protection Agency. (1990). *Exposure Factors Handbook*.

U.S. Environmental Protection Agency. (1991a). *Risk Assessment Guidance for Superfund, Volume I-Human Health Evaluation Manual, (Part B, Development of Risk-based Preliminary Remediation Goals)*. USEPA/OERR, USEPA/540/R92/003, December 1991 (Interim). (RAGS Part B).

U.S. Environmental Protection Agency. (1991b). *Risk Assessment Guidance for Superfund, Volume I-Human Health Evaluation Manual, Supplemental Guidance-Standard Default Exposure Factors-Interim Final*. USEPA/OERR, OSWER Directive: 9285.6-03, March 25, 1991. (RAGS Supplement).

Appendix A
Glossary

This glossary defines terms used in this record of decision describing CERCLA activities. The definitions apply specifically to this record of decision and may have other meanings when used in different circumstances.

ADMINISTRATIVE RECORD: A file that contains all information used by the lead agency to make its decision in selecting a response action under CERCLA. This file is to be available for public review and a copy is to be established at or near the site, usually at one of the information repositories. Also a duplicate is filed in a central location, such as a regional or state office.

AQUIFER: An underground formation of materials such as sand, soil, or gravel that can store and supply groundwater to wells and springs. Most aquifers used in the United States are within a thousand feet of the earth's surface.

BASELINE RISK ASSESSMENT: A study conducted as a supplement to a remedial investigation to determine the nature and extent of contamination at a Superfund site and the risks posed to public health and/or the environment.

CARCINOGEN: A substance that can cause cancer.

CLEANUP: Actions taken to deal with a release or threatened release of hazardous substances that could affect public health and/or the environment. The noun "cleanup" is often used broadly to describe various response actions or phases of remedial responses such as Remedial Investigation/Feasibility Study.

COMMENT PERIOD: A time during which the public can review and comment on various documents and actions taken, either by the Department of Defense installation or the USEPA. For example, a comment period is provided when USEPA proposes to add sites to the National Priorities List.

COMMUNITY RELATIONS: USEPA's, and subsequently Naval Air Station Pensacola's, program to inform and involve the public in the Superfund process and respond to community concerns.

COMPREHENSIVE ENVIRONMENTAL RESPONSE, COMPENSATION, AND LIABILITY ACT (CERCLA): A federal law passed in 1980 and modified in 1986 by the Superfund Amendments and Reauthorization Act (SARA). The act created a special tax that goes into a trust fund, commonly known as "Superfund," to investigate and clean up abandoned or uncontrolled hazardous waste sites.

Under the program the USEPA can either:

- Pay for site cleanup when parties responsible for the contamination cannot be located or are unwilling or unable to perform the work.
- Take legal action to force parties responsible for site contamination to clean up the site or pay back the federal government for the cost of the cleanup.

DEFENSE ENVIRONMENTAL RESTORATION ACCOUNT (DERA): An account established by Congress to fund Department of Defense hazardous waste site cleanups, building demolition, and hazardous waste minimization. The account was established under the Superfund Amendments and Reauthorization Act.

DRINKING WATER STANDARDS: Standards for quality of drinking water that are set by both the USEPA and the FDEP.

EXPLANATION OF DIFFERENCES: After adoption of final remedial action plan, if any remedial or enforcement action is taken, or if any settlement or consent decree is entered into, and if the settlement or decree differs significantly from the final plan, the lead agency is required to publish an explanation of any significant differences and why they were made.

FEASIBILITY STUDY: See Remedial Investigation/Feasibility Study.

GROUNDWATER: Water beneath the earth's surface that fills pores between materials such as sand, soil or gravel. In aquifers, groundwater occurs in sufficient quantities that it can be used for drinking water, irrigation, and other purposes.

HAZARD RANKING SYSTEM (HRS): A scoring system used to evaluate relative risks to public health and the environment from releases or threatened releases of hazardous substances. USEPA and states use the HRS to calculate a site score, from 0 to 100, based on the actual or potential release of hazardous substances from a site through air, surface water, or groundwater to affect people. This score is the primary factor used to decide if a hazardous site should be placed on the NPL.

HAZARDOUS SUBSTANCES: Any material that poses a threat to public health and/or the environment. Typical hazardous substances are materials that are toxic, corrosive, ignitable, explosive, or chemically reactive.

INFORMATION REPOSITORY: A file containing information, technical reports, and reference documents regarding a Superfund site. Information repositories for Naval Air Station Pensacola are at The John C. Pace Library at the University of West Florida and the NAS Pensacola Library in Building 633 on the Naval Air Station, Pensacola, Florida.

MAXIMUM CONTAMINANT LEVEL: National standards for acceptable concentrations of contaminants in drinking water. These standards are legally enforceable standards set by the USEPA under the Safe Drinking Water Act.

MONITORING WELLS: Wells drilled at specific locations on or off a hazardous waste site where groundwater can be sampled at selected depths and studied to assess the groundwater flow direction and the types and amounts of contaminants present, etc.

NATIONAL PRIORITIES LIST (NPL): The USEPA's list of the most serious uncontrolled or abandoned hazardous waste sites identified for possible long-term remedial response using money from the trust fund. The list is based primarily on the score a site receives on the Hazard Ranking System. USEPA is required to update the NPL at least once a year.

PARTS PER BILLION (ppb)/PARTS PER MILLION (ppm): Units commonly used to express low concentrations of contaminants. For example, 1 ounce of trichloroethylene in a million ounces of water is 1 ppm; 1 ounce of trichloroethylene in a billion ounces of water is 1 ppb. If one drop of trichloroethylene is mixed in a competition-size swimming pool, the water will contain about 1 ppb of trichloroethylene.

PRELIMINARY REMEDIATION GOALS: Screening concentrations that are provided by the USEPA and the FDEP and are used in the assessment of the site for comparative purposes before remedial goals being set during the baseline risk assessment.

PROPOSED PLAN: A public participation requirement of SARA in which the lead agency summarizes for the public the preferred cleanup strategy, and the rationale for the preference, reviews the alternatives presented in the detailed analysis of the remedial investigation/feasibility study, and presents any waivers to cleanup standards of Section 121(d)(4) that may be proposed. This may be prepared either as a fact sheet or as a separate document. In either case, it must actively solicit public review and comment on all alternatives under agency consideration.

RECORD OF DECISION (ROD): A public document that explains which cleanup alternative(s) will be used at NPL sites. The Record of Decision is based on information and technical analysis generated during the remedial investigation/feasibility study and consideration of public comments and community concerns.

REMEDIAL ACTION (RA): The actual construction or implementation phase that follows the remedial design and the selected cleanup alternative at a site on the NPL.

REMEDIAL INVESTIGATION/FEASIBILITY STUDY (RI/FS): Investigation and analytical studies usually performed at the same time in an interactive process, and together referred to as the "RI/FS." They are intended to: (1) gather the data necessary to determine the type and extent of contamination at a Superfund site; (2) establish criteria for cleaning up the site; (3) identify and screen cleanup alternatives for remedial action; and (4) analyze in detail the technology, and costs of the alternatives.

REMEDIAL RESPONSE: A long-term action that stops or substantially reduces a release or threatened release of hazardous substances that is serious, but does not pose an immediate threat to public health and/or the environment.

REMOVAL ACTION: An immediate action performed quickly to address a release or threatened release of hazardous substances.

RESOURCE CONSERVATION AND RECOVERY ACT (RCRA): A federal law that established a regulatory system to track hazardous substances from the time of generation to disposal. The law requires safe and secure procedures to be used in treating, transporting, storing, and disposing of hazardous substances. RCRA is designed to prevent new, uncontrolled hazardous waste sites.

RESPONSE ACTION: As defined by Section 101(25) of CERCLA, means remove, removal, remedy, or remedial action, including enforcement activities related thereto.

RESPONSIVENESS SUMMARY: A summary of oral and written public comments received by the lead agency during a comment period on key documents, and the response to these comments prepared by the lead agency. The responsiveness summary is a key part of the ROD, highlighting community concerns for USEPA decision-makers.

SECONDARY DRINKING WATER STANDARDS: Secondary drinking water regulations are set by the USEPA and the FDEP. These guidelines are not designed to protect public health,

instead they are intended to protect "public welfare" by providing guidelines regarding the taste, odor, color, and other aesthetic aspects of drinking water which do not present a health risk.

SUPERFUND: The trust fund established by CERCLA which can be drawn upon to plan and conduct clean ups of past hazardous waste disposal sites, and current releases or threats of releases of nonpetroleum products. Superfund is often divided into removal, remedial, and enforcement components.

SUPERFUND AMENDMENTS AND REAUTHORIZATION ACT (SARA): The public law enacted on October 17, 1986, to reauthorize the funding provisions, and to amend the authorities and requirements of CERCLA and associated laws. Section 120 of SARA requires that all federal facilities "be subject to and comply with, this act in the same manner and to the same extent as any non-governmental entity."

SURFACE WATER: Bodies of water that are aboveground, such as rivers, lakes, and streams.

VOLATILE ORGANIC COMPOUND: An organic (carbon-containing) compound that evaporates (volatilizes) readily at room temperature.

Appendix B
Responsiveness Summary

RESPONSIVENESS SUMMARY

Overview

During the public comment period, the U.S. Navy proposed a preferred remedy to address groundwater contamination at OU 1 on NAS Pensacola. This preferred remedy was selected in coordination with the USEPA and the FDEP. The NAS Pensacola Restoration Advisory Board, a group of community volunteers, reviewed the technical details of the selected remedy. The sections below describe the background of community involvement on the project and comments received during the public comment period.

Background of Community Involvement

Throughout the site's history, the community has been kept abreast of site activities through press releases to the local newspaper and television stations that reported on site activities. Site related documents were made available to the public in the administrative record at information repositories maintained at the NAS Pensacola Library and The John C. Pace Library of the University of West Florida.

On December 4, 1997, newspaper announcements were placed to announce the public comment period (December 8, 1997, through January 22, 1998) and included a short description of the proposed plan. The announcement appeared in the *Pensacola News Journal*. In conjunction with the newspaper announcement, copies of the proposed plan were mailed to addresses on the Installation Restoration Program mailing list. The opportunity for a public meeting was provided.

Summary of Comments Received During the Public Comment Period

No comments were received during the public comment period.