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FEASIBILITY STUDY OPERABLE UNIT 19 (OU19) SITE 44 FORMER UNDERGROUND STORAGE TANK (UST) SITE 3221 SW NAS PENSACOLA FL

4/1/2010

TETRA TECH

Comprehensive Long-term Environmental Action Navy

CONTRACT NUMBER N62467-04-D-0055

Rev. 2
04/06/10

Feasibility Study
for
Operable Unit 19
Site 44 - Former UST Site 3221 SW

Naval Air Station Pensacola
Pensacola, Florida

Contract Task Order 0079

April 2010

NAVFAC
Naval Facilities Engineering Command
NAVFAC SOUTHEAST

NAS Jacksonville
Jacksonville, Florida 32212-0030

TETRA TECH NUS, Inc.

Rev. 2
04/06/10

FEASIBILITY STUDY
FOR
OPERABLE UNIT 19
SITE 44 - FORMER UST SITE 3221 SW

NAVAL AIR STATION PENSACOLA
PENSACOLA, FLORIDA

COMPREHENSIVE LONG-TERM
ENVIRONMENTAL ACTION NAVY (CLEAN) CONTRACT

Submitted to:
Naval Facilities Engineering Command Southeast
NAS Jacksonville
Jacksonville, Florida 32212-0030

Submitted by:
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CONTRACT NUMBER N62467-04-D-0055
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APRIL 2010

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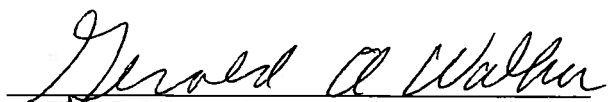

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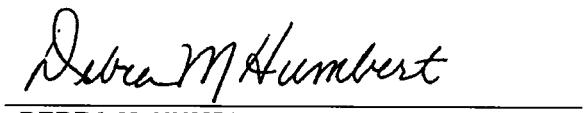

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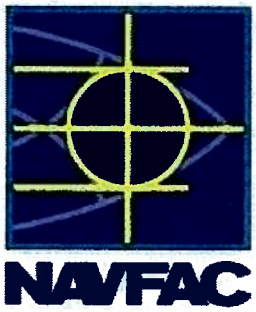

CERTIFICATION OF TECHNICAL
DATA CONFORMITY

The Contractor, Tetra Tech NUS, Inc., hereby certifies that, to the best of its knowledge and belief, the technical data delivered herewith under Contract No. N62467-04-D-0055 are complete and accurate and comply with all requirements of this contract.

DATE: April 6, 2010

COMPANY CERTIFICATION AUTHORIZATION NUMBER: 7988
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NAME AND TITLE OF CERTIFYING OFFICIAL

Gerald Walker

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Task Order Manager

This document which describes the Feasibility Study for Operable Unit 19 Site 44 – Former UST Site 3221 SW Naval Air Station Pensacola, located in Pensacola, Florida, has been prepared under the direction of a Florida registered professional engineer. The work and professional opinions rendered in this report were conducted or developed in accordance with commonly accepted procedures consistent with applicable standards of practice. This document was prepared for Naval Air Station Pensacola, Pensacola, Florida and should not be construed to apply to any other site.

Tetra Tech NUS, Inc.
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ACRONYMS

ABB-ES	ABB Environmental Services, Inc.
ARAR	Applicable or Relevant and Appropriate Requirement
AS	Air sparging
AWQC	Ambient Water Quality Criteria
BHC	Hexachlorocyclohexane
bls	Below land surface
CAR	Contamination Assessment Report
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
cfm	Cubic feet per minute
CLEAN	Comprehensive Long-Term Environmental Action Navy
COC	Chemicals of concern
cPAH	Carcinogenic polynuclear aromatic hydrocarbon
CSF	Cancer Slope Factor
CTL	Cleanup Target Levels
CTO	Contract Task Order
CVOC	Chlorinated volatile organic compound
CWA	Clean Water Act
DO	Dissolved oxygen
DPT	Direct-push technology
F.A.C.	Florida Administrative Code
FDEP	Florida Department of Environmental Protection
FS	Feasibility Study
ft^2	Square foot (feet)
GAC	Granular activated carbon
GCTL	Groundwater Cleanup Target Level
GRA	General Response Action
HI	Hazard Index
HQ	Hazard Quotient
IR	Installation Restoration
IWTP	Industrial Wastewater Treatment Plant
LUC	Land use control
µg/L	Microgram(s) per liter
µg/kg	Microgram(s) per kilogram

ACRONYMS (CONTINUED)

mg/kg	Milligram(s) per kilogram
MCL	Maximum Contaminant Level
msl	Mean Sea Level
NADSC	Natural Attenuation Default Source Concentration
NARF	Naval Air Rework Facility
NAS	Naval Air Station
NAVFAC SE	Naval Facilities Engineering Command Southeast
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NFA	No Further Action
NPW	Net present worth
O&M	Operation and maintenance
ORP	Oxidation/reduction potential
OSHA	Occupational Safety and Health Administration
PCB	Polychlorinated biphenyl
PCE	Tetrachloroethene
PPE	Personal protective equipment
PRG	Preliminary Remediation Goal
RAO	Remedial Action Objective
RCRA	Resource Conservation and Recovery Act
RD	Remedial Design
RfD	Reference Dose
RI	Remedial Investigation
RMO	Risk Management Option
SAR	Site Assessment Report
SCTL	Soil Cleanup Target Level
SPLP	Synthetic Precipitation Leaching Procedure
SVE	Soil vapor extraction
SVOC	Semi volatile organic compound
TAL	Target Analyte List
TBC	To Be Considered
TCE	Trichloroethene
TCL	Target Compound List
TOC	Total organic carbon
TtNUS	Tetra Tech NUS, Inc.
UCL	Upper Confidence Level of the Mean

ACRONYMS (CONTINUED)

USEPA	United States Environmental Protection Agency
UST	Underground storage tank
VOC	Volatile organic compound

EXECUTIVE SUMMARY

E.1 INTRODUCTION AND PURPOSE

This Feasibility Study (FS) for Operable Unit (OU) 19 Site 44 – Former Underground Storage Tank (UST) Site 3221 SW at Naval Air Station (NAS) Pensacola, Florida, has been prepared by Tetra Tech NUS, Inc. (TtNUS) for Naval Facilities Engineering Command Southeast (NAVFAC SE) under the Comprehensive Long-Term Environmental Action Navy (CLEAN) Program, Contract Number N62467-04-D-0055, Contract Task Order (CTO) 0079. This FS describes the development and evaluation of remedial alternatives for contaminated soil and groundwater at Site 44.

The FS is being conducted to establish Remedial Action Objectives (RAOs) and cleanup goals, to screen remedial technologies, and to assemble, evaluate, and compare remedial alternatives.

The development of remedial alternatives for Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) sites consists of developing Preliminary Remediation Goals (PRGs) and areas and volumes of contamination and then identifying applicable technologies and developing those technologies into remedial alternatives to meet the PRGs.

Remedial alternatives are then described and analyzed in detail using the CERCLA evaluation criteria described in the National Oil and Hazardous Substances Pollution Contingency Plan (NCP), including:

Threshold Criteria

- Overall protection of human health and the environment
- Compliance with Applicable or Relevant and Appropriate Requirements (ARARs)

Balancing Criteria

- Long-term effectiveness and permanence
- Reduction of toxicity, mobility, or volume of contaminants through treatment
- Short-term effectiveness
- Implementability
- Cost

Alternatives are evaluated against two additional factors (Modifying Criteria) after state participation:

Modifying Criteria

- State acceptance
- Community acceptance

The results of the detailed analyses are summarized and compared in a comparative analysis. The alternatives are compared against each other using the CERCLA evaluation criteria.

The entire FS process provides the technical information and analyses forming the basis for a proposed remedy, and the subsequent Record of Decision (ROD) documents the identification and selection of the remedy.

The following criteria are considered in identifying appropriate remedial action for Site 44:

- RAOs: RAOs are developed to specify the contaminants, media of interest, exposure pathways, and remedial action goals.
- Applicable Technologies: Technologies applicable for addressing contaminated media are identified and screened. Technologies are eliminated if they cannot be implemented.
- Remedial Alternatives: Technologies passing the screening phase are assembled into remedial alternatives.
- Detailed Analysis: Selected remedial alternatives are described and evaluated using seven of the nine criteria outlined in the NCP.
- Comparative Analysis: Remedial alternatives are compared against each other using threshold and primary balancing criteria.

E.2 SITE DESCRIPTION AND HISTORY

Site 44 is located at the southwestern end of Building 3221, which is adjacent to Forrest Sherman Field. Building 3221 is a large hangar currently used to refurbish aircraft used for museum display. The hangar and adjacent paved areas were part of the Naval Air Rework Facility (NARF), and according to historical records, were most likely used for aircraft maintenance before the current National Museum of Naval Aviation opened in 1975.

The surface of the site is a mixture of grass, asphalt, concrete, and tree cover. The north-central portion of the site is covered with concrete; the northwestern portion is an asphalt-covered storage area for various aircraft parts and is bounded to the west by a wooded area; the northeastern portion abutting

Building 3221 is an asphalt parking area; and the southern portion is grass covered with an unpaved access road trending southwest-northeast through it.

E.3 SUMMARY OF ENVIRONMENTAL INVESTIGATIONS AND RESTORATION ACTIVITIES

Two USTs have been removed from Site 44. A site assessment was completed in 2003. These removal and investigative activities are summarized below.

1992 – UST Removal: Site 44 was first investigated as UST Site 3221 SW following the removal of a 1,000-gallon UST located at the southwestern corner of Building 3221. The former tank was installed in 1967 and reportedly used to store PD-680 (a petroleum distillate cleaning solvent). A Contamination Assessment Report (CAR) was prepared as part of the UST investigation [ABB Environmental Services, Inc. (ABB-ES), 1993]. Tetrachloroethene (PCE) was detected at concentrations slightly exceeding the Florida Department of Environmental Protection (FDEP) Groundwater Cleanup Target Levels (GCTLs) in four monitoring wells located hydraulically downgradient of the UST. PCE was not detected in groundwater samples collected from the monitoring wells located in the area near the former UST, but was present in a groundwater sample collected from a single monitoring well located approximately 100 feet hydraulically downgradient of the former UST. Trichloroethene (TCE) was not detected at monitoring well locations near the former UST, but was present in three hydraulic downgradient monitoring wells (approximately 75 feet downgradient of the former UST).

1994 – Fuel Oil UST Removal: UST Site 3241 is located east of Site 44. A fuel oil UST of unknown capacity was closed by removal in 1994. Soil collected from the excavation indicated the presence of total xylenes and PCE in excess of its FDEP Soil Cleanup Target Levels (SCTLs). A single monitoring well installed in the tank excavation area had a benzene concentration greater than the FDEP GCTL.

2003 – Site Assessment Report: TtNUS completed a Site Assessment Report (SAR) for UST Site 3241 (adjacent to UST Site 3221 SW, now Site 44). As part of the investigation, 19 direct-push technology (DPT) soil borings were completed, and five additional monitoring wells were installed and sampled. The results of the investigation indicated that benzene concentrations remained in excess of its GCTL in the old tank excavation area. Following implementation of a natural attenuation monitoring plan under the Florida UST program, the site was approved for No Further Action (NFA) and is not part of Site 44.

E.4 SUMMARY OF INVESTIGATION FINDINGS

The nature and extent of contamination at Site 44 described below is based on exceedances of United States Environmental Protection Agency (USEPA) Region 9 PRGs and Maximum Contaminant Levels

(MCLs) and FDEP SCTLs and GCTLs, as defined by Chapter 62-777, Florida Administrative Code (F.A.C.), Tables I and II.

In addition to these screening criteria, sample results were compared to the NAS Pensacola background or reference values for inorganic constituents.

Soil

Volatile Organic Compounds

Soil screening for Volatile Organic Compounds (VOCs) with a mobile laboratory identified one soil boring location with a detectable concentration of PCE less than its screening levels. Concentrations of VOCs detected in soil samples did not exceed their SCTLs.

Metals

Arsenic delineation sampling indicated that arsenic exceedances were limited to one soil boring location. Arsenic was detected in two soil samples at concentrations greater than its residential PRG and SCTL. These arsenic concentrations were within the background range determined by statistical analysis of arsenic and iron distribution at NAS Pensacola.

Lead and cadmium were detected at concentrations exceeding their GCTLs in several Synthetic Precipitation Leaching Procedure (SPLP) samples. Total lead concentrations detected in the samples were less than its NAS Pensacola reference concentration. Total cadmium concentrations detected in the samples were less than its PRGs and SCTLs.

Pesticides

Eleven pesticides were detected in one surface soil sample. Concentrations of these pesticides were less than its residential and industrial direct exposure SCTLs. Alpha- hexachlorocyclohexane (BHC) (estimated at 1.1 micrograms per kilogram [µg/kg]) and beta-BHC (estimated at 1.6 µg/kg) were detected in the field duplicate sample at concentrations greater than their leachability-to-groundwater SCTLs of 0.3 µg/kg and 1 µg/kg, respectively.

Detections of pesticides were limited to this soil boring location. Detected concentrations of pesticides and polychlorinated biphenyls (PCBs) were less than standard laboratory detection limits in the other soil characterization samples collected at Site 44.

Carcinogenic Polynuclear Aromatic Hydrocarbons

Carcinogenic polynuclear aromatic hydrocarbon (cPAH) delineation sampling identified an area of exceedances around the foundation of former Building 3629. Soil samples collected from five soil boring

locations had benzo(a)pyrene equivalent concentrations exceeding the residential direct exposure PRG and SCTL. One of the five soil borings had benzo(a)pyrene equivalent concentrations exceeding the industrial direct exposure PRG and SCTL. The maximum concentration detected for benzo(a)pyrene in soil at Site 44 was 1,200 µg/kg.

Groundwater

VOCs

TCE was detected at concentrations exceeding its GCTL in samples collected from six shallow monitoring wells. In addition, four other VOCs, including chloroform, chloromethane, 1,1-DCA, and cis 1,2-DCE, were detected in groundwater samples at concentrations less than their GCTLs. The detection of cis 1,2-DCE indicates that natural attenuation of TCE is likely occurring.

One TCE plume was identified in the vicinity of well PEN-3221-09 (52 micrograms per liter [µg/L]), which was installed as part of the UST investigation and previously had TCE exceedances. The second, larger TCE plume (maximum concentration of 34 µg/L) extends north from the northwestern corner of Building 3221 and includes wells PEN-44-11, PEN-44-14, PEN-44-15, PEN-44-21, PEN-44-22 and PEN-44-24.

Semi Volatile Organic Compounds (SVOCs)

Bis(2-ethylhexyl)phthalate was detected in two groundwater samples at concentrations greater than its GCTL of 6 µg/L. These two monitoring wells were resampled on May 9, 2006.

Metals

Sixteen metals were detected in groundwater samples collected at Site 44. Three of the metals (aluminum, iron, and manganese) were detected at concentrations exceeding their FDEP GCTLs. The metals barium, chromium, copper, lead, nickel, selenium, silver, sodium, vanadium, and zinc were detected at concentrations less than their FDEP GCTLs. Calcium, magnesium, and potassium were detected at concentrations below their maximum criteria as an essential nutrient, GCTLs and MCLs have not been developed for these inorganics.

Aluminum was detected at concentrations below its NAS Pensacola background concentration and therefore was not retained as a chemical of concern (COC) for evaluation in the FS. The monitoring wells were re-sampled and analyzed for iron, and manganese. The new groundwater samples contained iron below its NAS Pensacola background concentration and manganese below its FDEP GCTL. Therefore, iron and manganese are not retained as COCs for evaluation in the FS.

The following table summarizes the estimated surface areas, volumes, and quantities of COCs for the contaminant plumes.

Designation	Depth (feet bls)	Surface Area (ft^2)	Volume to be Addressed
Contaminant Plumes			
Benzo(a)pyrene Equivalents in soil (Industrial Direct Exposure CTL)	0 to 1 foot	314	12 cubic yards
TCE Plume in Groundwater	7 to 15 feet	43,673	785,000 gallons

Notes:
CTL = Cleanup Target Level
bls = below land surface
ft^2 = square feet

The results of the Remedial Investigation (RI) for Site 44 indicate that an NFA determination can be made using Risk Management Option (RMO) Level III in accordance with Chapter 62-780, F.A.C. RMO Level III involves NFA with institutional and/or engineering controls.

E.5 REMEDIAL ACTION OBJECTIVES AND CLEANUP GOALS

Site-specific RAOs specify COCs, media of interest, exposure pathways, and cleanup goals or acceptable contaminant concentrations. To protect the public from potential current and future health risks, as well as to protect the environment, the following site-specific RAOs have been developed:

- **RAO 1:** Prevent unacceptable human health risk associated with exposure to soil containing cPAHs with concentrations exceeding the industrial direct exposure PRG and SCTL.

- **RAO 2:** Prevent unacceptable human health risk associated with exposure to groundwater containing TCE with concentrations exceeding the USEPA MCL and FDEP GCTL.

A cleanup goal is the target concentration to which a COC must be reduced within a particular medium of concern to achieve RAOs. According to the NCP, the cleanup goals are developed based on readily available information such as chemical-specific ARARs. The following provides a discussion of the cleanup goals for Site 44:

Soil Cleanup Goals

The current land use at Site 44 is industrial and will not change for the foreseeable future. Under this scenario, the cleanup goals for soil are to meet the FDEP industrial direct exposure SCTLs:

- cPAHs (benzo(a)pyrene equivalents): 700 µg/kg

The maximum detected arsenic concentration (2.5 mg/kg) does not exceed the industrial direct exposure SCTL (12 mg/kg), and the concentration is within the NAS Pensacola background or reference concentration range (0.1 to 17.5 mg/kg). Therefore, arsenic is not retained as a COC under this land use scenario.

Groundwater Cleanup Goals

The FDEP GCTL for TCE (3 µg/L) has been selected because it is more stringent than the USEPA MCL (5 µg/L).

- TCE: 3 µg/L

E.6 SCREENING OF GENERAL RESPONSE ACTIONS, REMEDIATION TECHNOLOGIES, AND PROCESS OPTIONS

General Response Actions (GRAs), remediation technologies, and process options associated with these GRAs were screened for effectiveness, implementability, and cost. Remediation technologies that were determined to be ineffective or too difficult to implement were eliminated from further consideration.
The following GRAs, remedial technologies, and process options were retained for Site 44 soil.

General Response Action	Remedial Technology	Process Option
No Action	None	Not applicable
Limited Action	Land Use Controls (LUCs)	Administrative controls: prohibition of future residential land use

The following GRAs, remedial technologies, and process options were retained for Site 44 groundwater.

General Response Action	Remedial Technology	Process Option
No Action	None	Not applicable
Limited Action	LUCs	Prohibiting use of groundwater as a drinking water source
	Monitoring	Periodic sampling and analysis of groundwater to track the fate of contamination
	Natural Attenuation	Monitoring groundwater to assess the reduction in concentrations of COCs through natural processes
In-Situ Treatment	Air Sparging (AS)/Soil Vapor Extraction (SVE)	Supplying of air and extraction of volatilized organic compounds

E.7 DEVELOPMENT OF REMEDIAL ALTERNATIVES

Based on the results of the screening of remediation technologies, the following remedial alternatives were developed for Site 44 soil:

- **Alternative 1: No Action**. No action would be taken. This alternative is retained as a baseline for comparison with other alternatives.

- **Alternative 2: LUCs**. LUCs would be developed to prevent unacceptable risks from exposure to contaminated soil by prohibiting residential use of the site. Periodic site inspections would be performed to verify implementation of the LUCs.

Based on the results of the screening of remediation technologies, the following remedial alternatives were developed for Site 44 groundwater:

- **Alternative 1: No Action**. No action would be taken. This alternative is retained as a baseline for comparison with other alternatives.

- **Alternative 2: Natural Attenuation, LUCs, and Monitoring**. Natural attenuation would consist of allowing TCE concentrations in groundwater to decrease through naturally occurring processes such as biodegradation, dilution, and dispersion. LUCs would be developed to prevent unacceptable risks from exposure to contaminated groundwater. Periodic site inspections would be performed to verify implementation of the LUCs. Monitoring would consist of regularly measuring the water levels in existing and new monitoring wells and collecting and analyzing groundwater samples from some of the 28 existing and two new shallow monitoring wells located within and surrounding the TCE plume to assess the performance of natural attenuation in accordance with FDEP natural attenuation monitoring requirements. Also, a vertical extent monitoring well will be installed. The vertical extent monitoring well will be screened between the depth of the existing water table and deep monitoring wells and would be more likely to adequately assess the vertical extent of the TCE plume and provide adequate compliance monitoring. For the first 5 years, the performance monitoring samples would also be analyzed for natural attenuation parameters. Sampling frequency would be quarterly for the first year, semi-annually for the next 2 years, and annually thereafter.

- **Alternative 3: In-Situ AS/SVE of the TCE Plume, Natural Attenuation, LUCs, and Monitoring**. This alternative would consist of installing and operating an AS/SVE system consisting of 31 air sparge wells and 19 SVE wells. Air would be delivered to the sparge wells at a rate of 10 to 15 cubic feet per minute (cfm) per well. The SVE wells would extract air from the

vadose zone at an approximate rate of 25 cfm per well. The air sparge and SVE wells would be connected to an equipment building via an underground piping network. It is anticipated that TCE concentrations would reach the RAOs within 2 years of system start-up. Natural Attenuation, LUCs and monitoring would be the same as described for Alternative 2.

E.8 DETAILED ANALYSIS OF REMEDIAL ALTERNATIVES

The remedial alternatives were analyzed in detail using seven of the nine criteria provided in the NCP and the CERCLA. These seven criteria are as follows:

Threshold Criteria:

- Overall Protection of Human Health and the Environment
- Compliance with ARARs

Balancing Criteria:

- Long-Term Effectiveness and Permanence
- Reduction of Contaminant Toxicity, Mobility, or Volume through Treatment
- Short-Term Effectiveness
- Implementability
- Cost

Modifying Criteria:

Two other criteria, State and Community Acceptance, were not evaluated in this report. They will be evaluated after regulatory and public comments are available.

E.9 COMPARATIVE ANALYSIS OF REMEDIAL ALTERNATIVES

The remedial alternatives were compared to each other using the same criteria used for the detailed analysis. The following is a summary of the comparisons.

Threshold Criteria:

Overall Protection of Human Health and Environment

Soil

Alternative 1 would not protect human health and the environment because nothing would prevent exposure to contaminated soil that could result in unacceptable risk to human receptors.

Alternative 2 would restrict the use of surficial and subsurface soil and would be protective of human health by preventing unacceptable risks from exposure to contaminated soil.

Groundwater

Alternative 1 would not protect human health and the environment because nothing would prevent exposure to contaminated groundwater that could result in unacceptable risk to human receptors.

The natural attenuation component of Alternative 2 would be protective because it would eventually reduce the concentrations of TCE to the cleanup goal over a reasonable time frame. The LUC component of Alternative 2 would be protective because it would prevent exposure to contaminated groundwater until the cleanup goal is met. The monitoring component of Alternative 2 would be protective because it would assess the progress of natural attenuation and warn of potential future migration of TCE.

Alternative 3 would be more protective than Alternative 2, because, in addition to the same natural attenuation, LUC, and monitoring components, this alternative would include an active treatment component that would accelerate the removal of TCE.

Compliance with ARARs

Remedial actions selected under CERCLA Section 121(d) must attain a degree of cleanup that assures protection of human health and the environment and meets applicable or relevant and appropriate standards. FDEP GCTLs and SCTLs are deemed relevant and appropriate for restoration of groundwater and soil, respectively, at NAS Pensacola.

Soil

Alternative 1 would not comply with chemical- and location-specific ARARs. Action-specific ARARs would not apply.

Alternative 2 would not immediately comply with chemical-specific ARARs, but this alternative would eventually achieve compliance for cPAHs as the cleanup goal is attained through natural attenuation. Exposure to soil with contaminant concentrations greater than chemical-specific ARARs would be prevented by the LUCs.

Groundwater

Alternative 1 would not comply with chemical- and location-specific ARARs. Action-specific ARARs would not apply.

Alternatives 2 and 3 would not immediately comply with chemical-specific ARARs, but this alternative would eventually achieve compliance as cleanup goals are attained either through active remediation and/or natural attenuation.

Balancing Criteria:

Long-Term Effectiveness and Permanence

Soil

Alternative 1 would not have long-term effectiveness and permanence. Because there would not be a restriction of land use and/or site development, human receptors could be exposed to contaminated soil. Because there would not be monitoring, the progress of natural attenuation would not be assessed, and there would not be warning of potential future migration of the COC or cPAHs or benzo (a) pyrene equivalents.

The LUC component of Alternative 2 would effectively prevent exposure to contaminated soil through implementation of restrictions and site inspections.

Groundwater

Alternative 1 would not have long-term effectiveness and permanence. Because there would not be a restriction of groundwater use and/or site development, human receptors could be exposed to contaminated groundwater. Because there would not be monitoring, the progress of natural attenuation would not be assessed, and there would not be warning of potential future migration of TCE.

Over time, the natural attenuation component of Alternative 2 would effectively and permanently reduce the concentration of TCE to the cleanup goal. The LUC component of Alternative 2 would effectively prevent exposure to contaminated groundwater until the cleanup goal has been achieved. The monitoring component of Alternative 2 would effectively assess the progress of natural attenuation and determine if TCE migration is occurring.

Alternative 3 would be more effective than Alternative 2, because, in addition to the natural attenuation, LUC, and monitoring components, this alternative would also include an active treatment component that would effectively treat the areas of greater groundwater contamination and thus accelerate the removal of remaining TCE.

Reduction of Contaminant Toxicity, Mobility, or Volume through Treatment

Soil

Alternatives 1 and 2 would not achieve reduction of toxicity, mobility, or volume of COCs through treatment. Both alternatives would achieve reduction of cPAH toxicity and volume through natural attenuation; however, this reduction would neither be verified nor quantified.

Groundwater

Alternative 1 would not achieve any reduction of toxicity, mobility, or volume of COCs through treatment. This alternative would achieve reduction of contaminant toxicity and volume through natural attenuation; however, this reduction would neither be verified nor quantified.

Alternative 2 would eventually achieve reduction of the toxicity and volume of COCs through natural attenuation.

Alternative 3 would achieve reductions in TCE toxicity and volume through treatment. Alternative 3 would permanently and irreversibly remove an estimated 0.00013 pounds of TCE from the groundwater through AS/SVE. Alternative 3 would not generate treatment residues.

Short-Term Effectiveness

Soil

Implementation of Alternative 1 would not result in risks to site workers or adversely impact the surrounding community or environment because no remedial activities would be performed. Alternative 1 would not achieve the RAO, and although the cleanup goal might eventually be attained through natural processes, this would not be verified.

Alternative 2 would have minimal short-term effectiveness concerns. Exposure of workers to contamination during ground keeping activities would be minimized by the wearing of appropriate Personal protective equipment (PPE) and complying with site-specific health and safety procedures. Alternative 2 would also not adversely impact the surrounding community or the environment.

Groundwater

Implementation of Alternative 1 would not result in risks to site workers or adversely impact the surrounding community or environment because remedial activities would not be performed. Alternative 1 would not achieve the RAO, and although the cleanup goal might eventually be attained through natural processes, this would not be verified.

Implementation of Alternative 2 would result in a slight possibility of exposing site workers to contaminated groundwater during the installation, maintenance, and sampling of new and existing monitoring wells. However, these risks of exposure would be effectively controlled by wearing appropriate PPE and compliance with proper site-specific health and safety procedures. Following four quarters of groundwater monitoring for natural attenuation parameters, data would be available to estimate the time required to achieve the RAO or reach the cleanup goal. It is estimated that natural attenuation may achieve the RAO in 5 to 10 years.

Implementation of Alternative 3 would result in a significant possibility of exposing construction workers to contaminated groundwater during the construction of in-situ groundwater treatment systems, installation of new monitoring wells, and sampling of new and existing wells. However, as for Alternative 2, these risks of exposure would be effectively controlled by wearing appropriate PPE and compliance with proper site-specific health and safety procedures. Alternative 3 would achieve the RAO and remove the TCE plumes through active remediation within approximately 2 years followed by natural attenuation within approximately 3 years.

Implementability

Soil

Alternative 1 would be easiest to implement because there would not be any activities to implement.

Technical implementation of Alternative 2 would not be difficult. The resources required for the activities associated with this alternative are readily available.

Administrative implementation of the LUC component of Alternative 2 would be relatively simple because, as part of any transfer in ownership of the site from military to public, appropriate provisions would be incorporated into the property transfer documents to ensure continued enforcement of LUCs.

Groundwater

Alternative 1 would be easiest to implement because there would not be any activities to implement.

Technical implementation of the various components of Alternatives 2 and 3 would be relatively simple. Technical implementation of the natural attenuation, LUC, and monitoring components of Alternative 2 would not be difficult. The resources, equipment, and material required for the activities associated with these components are readily available. A number of qualified contractors are available locally, and the resources, equipment, and material necessary to implement these alternatives are also readily available. Technical implementation of Alternative 3 would be somewhat more difficult than that of Alternative 2.

Administrative implementation of the LUC and monitoring components of Alternative 2 would be relatively simple. The administrative implementation of Alternative 3 would be slightly more difficult than that of Alternative 2. In addition to the same requirements as Alternative 2, the construction and operation of the remediation system for Alternative 3 would have to comply with the requirements of any identified ARARs.

Cost

The capital and operation and maintenance (O&M) costs and net present worth (NPW) of the soil alternatives are as follows.

Alternative	Capital	NPW of O&M	NPW
1	$0	$0	$0
2	$15,000	$71,000 (30 years)	$86,000 (30 years)

The capital and O&M costs and NPW of the groundwater alternatives are as follows.

Alternative	Capital	NPW of O&M	NPW
1	$0	$0	$0
2	$44,000	$227,000 (<10 years)	$271,000 (<10 years)
3	$631,000	$282,000 (5 years)	$913,000 (5 years)

TABLE ES-1

SUMMARY OF COMPARATIVE ANALYSIS OF REMEDIAL ALTERNATIVES - SOIL
SITE 44 FEASIBILITY STUDY
PENSACOLA, FLORIDA
PAGE 1 OF 2

Evaluation Criterion	Alternative S1: No Action	Alternative S2: LUCs
Overall Protection of Human Health and Environment	Would not provide protection of human health and the environment. Because no monitoring would be performed, potential migration of COCs would not be detected.	Would be protective of human health and the environment. Restricting access to surficial and subsurface soil would be protective of human health by preventing unacceptable risks from exposure to contaminated soil.
Compliance with ARARs: Chemical-Specific Location-Specific Action-Specific	 Would not comply Would not comply Not applicable	 Would eventually comply Would comply Would comply
Long-Term Effectiveness and Permanence	Would have no long-term effectiveness and permanence. Contaminant reduction or migration would not be detected because monitoring would not occur.	Would provide long-term effectiveness and permanence. Although no active treatment of contaminated soil would occur, risks to human health and the environment would be controlled.
Reduction of Contaminant Toxicity, Mobility, or Volume through Treatment	Would not reduce toxicity, mobility, or volume of contaminants through treatment because no treatment would occur. Some reduction of the toxicity and volume of COCs might occur through natural dispersion, dilution, or other attenuation processes, but no monitoring would be performed to verify.	The volume and toxicity of cPAHs would eventually be reduced over time through natural attenuation processes. This alternative would not reduce the mobility of COCs because containment, removal, or treatment would not be provided. Treatment residues would not be generated by this alternative.
Short-Term Effectiveness	Would not pose any risks to on-site workers or result in short-term adverse impact to the local community and the environment. Would never achieve the RAOs and, although the cleanup goal might eventually be achieved through natural attenuation, this would not be verified through monitoring.	Would have minimal short-term effectiveness concerns. Exposure of workers to contamination would be minimized by the wearing of appropriate PPE and complying with site-specific health and safety procedures. Would also not adversely impact the surrounding community or the environment.

TABLE ES-1

SUMMARY OF COMPARATIVE ANALYSIS OF REMEDIAL ALTERNATIVES - SOIL
SITE 44 FEASIBILITY STUDY
PENSACOLA, FLORIDA
PAGE 2 OF 2

Evaluation Criterion	Alternative S1: No Action	Alternative S2: LUCs
Implementability	Because no action would occur, Alternative 1 would be readily implementable.	Would be readily implementable.
Costs: Capital NPW of O&M NPW	 $0 $0 $0	 $15,000 $71,000 $86,000
State Acceptance	FDEP reviewed and commented on the Draft FS for Site 44. The response to FDEP comments on the Draft FS were addressed in the Final FS for Site 44 and are included in Appendix B.	
Community Acceptance	The information concerning community acceptance will be addressed following the public comment period for the Proposed Plan for Site 44.	

Notes:

ARARs = Applicable or Relevant and Appropriate Requirements
COCs = Chemicals of concern
cPAH = Carcinogenic Polynuclear Aromatic Hydrocarbons
FDEP = Florida Department of Environmental Protection
FS = Feasibility Study
LUCs = Land use controls
NPW = Net present worth
O&M = Operation and maintenance
PPE = Personal protective equipment
RAOs = Remedial Action Objectives

TABLE ES-2

SUMMARY OF COMPARATIVE ANALYSIS OF REMEDIAL ALTERNATIVES - GROUNDWATER
SITE 44 FEASIBILITY STUDY
PENSACOLA, FLORIDA
PAGE 1 OF 2

Evaluation Criterion	Alternative G1: No Action	Alternative G2: Natural Attenuation, LUCs, and Monitoring	Alternative G3: In-Situ AS/SVE, Natural Attenuation, LUCs, and Monitoring
Overall Protection of Human Health and Environment	Would not provide protection of human health and the environment. Under the current commercial/industrial land use, there could be unacceptable risks to human health from exposure to contaminated groundwater, and this potential for unacceptable risk would increase if Site 44 is further developed. Because monitoring would not be performed, potential migration of TCE would not be detected.	Would be protective of human health and the environment. Although the TCE plumes could expand, natural attenuation would eventually reduce the concentrations of TCE to less than the GCTL. LUCs would be protective of human health and the environment. Restricting the use of surficial aquifer groundwater would be protective of human health by preventing unacceptable risks from exposure to contaminated groundwater. Monitoring would be protective of the environment by evaluating the progress of natural attenuation and detecting potential migration of contaminated groundwater.	Would be protective of human health and the environment. By actively removing the majority of groundwater contamination, AS/SVE would prevent the expansion of the TCE plumes. This would ultimately eliminate risk from exposure to contaminated groundwater and provide protection to future human receptors. LUCs would be protective of human health and the environment during the remedial period until cleanup goals are met. Restricting the use of surficial aquifer groundwater would be protective of human health and the environment by avoiding unacceptable risks of exposure to contaminated soil and groundwater. Monitoring would be protective by evaluating the effectiveness of the in-situ treatment.
Compliance with ARARs:			
Chemical-Specific	Would not comply	Would eventually comply	Would eventually comply
Location-Specific	Would not comply	Would comply	Would comply
Action-Specific	Not applicable	Would comply	Would comply
Long-Term Effectiveness and Permanence	Would have no long-term effectiveness and permanence because contaminated groundwater would remain on site. Because there would not be LUCs to restrict the use of surficial aquifer groundwater, the potential would also exist for unacceptable risk to human receptors. Because there would not be groundwater monitoring, potential off-site migration of TCE would not be detected. Although TCE concentrations might eventually decrease to the cleanup goal through natural attenuation, monitoring would not be conducted to verify this.	Would provide long-term effectiveness and permanence. Naturally occurring processes such as biodegradation would reduce concentrations of TCE to its cleanup goal over the long term. Long-term monitoring would be an effective means to evaluate the progress of natural attenuation and to warn of potential future migration of contaminated groundwater.	Would provide long-term effectiveness and permanence. AS/SVE of the TCE plumes is expected to effectively remove the majority of groundwater contamination. LUCs would effectively prevent the use of surficial aquifer groundwater until the cleanup goal is met. Long-term monitoring would be an effective means to evaluate the progress of remediation and verify that no migration of TCE is occurring.

TABLE ES-2

SUMMARY OF COMPARATIVE ANALYSIS OF REMEDIAL ALTERNATIVES - GROUNDWATER
SITE 44 FEASIBILITY STUDY
PENSACOLA, FLORIDA

Evaluation Criterion	Alternative G1: No Action	Alternative G2: Natural Attenuation, LUCs, and Monitoring	Alternative G3: In-Situ AS/SVE, Natural Attenuation, LUCs, and Monitoring
Reduction of Contaminant Toxicity, Mobility, or Volume through Treatment	Would not reduce toxicity, mobility, or volume of contaminants through treatment because treatment would not occur. Some reduction of the toxicity and volume of TCE might occur through natural dispersion, dilution, or other attenuation processes, but monitoring would not be performed to verify this.	The volume and toxicity of TCE would eventually be reduced over time through natural attenuation processes. This alternative would not reduce the mobility of TCE because no containment, removal, or treatment would be provided. Treatment residues would not be generated by this alternative.	Would reduce the toxicity, mobility and volume of contaminated groundwater. AS/SVE could permanently and irreversibly remove an estimated 0.00013 pound of TCE from groundwater. Treatment residues would not be generated by this alternative.
Short-Term Effectiveness	Would not pose any risks to on-site workers or result in short-term adverse impact to the local community and the environment. The No Action alternative would not achieve the RAOs and, although the cleanup goal might eventually be achieved through natural attenuation, this would not be verified through monitoring.	Would have minimal short-term effectiveness concerns. Exposure of workers to contamination during the maintenance and sampling of monitoring wells would be minimized by the wearing of appropriate PPE and complying with site-specific health and safety procedures. This alternative would not adversely impact the surrounding community or the environment.	Would reduce human health risks in the short term because LUCs would be implemented to prohibit groundwater use. Exposure of workers to contamination during installation of SVE and AS wells, construction and operation of the groundwater treatment systems, and groundwater sampling would be minimized by compliance with health and safety requirements including wearing of appropriate PPE and adherence to site-specific health and safety procedures. Implementation of LUCs and monitoring would not adversely impact the surrounding community or the environment.
Implementability	Because no action would occur, Alternative 1 would be readily implementable.	Would be readily implementable. Maintenance of existing monitoring wells, sampling and analysis of groundwater, and performance of regular site inspections and 5-year reviews could readily be accomplished. The resources, equipment, and materials required to implement these activities are readily available.	Would be implementable. However, trenching and pipe placement may prove challenging in the area behind Building 3221 due to thick concrete and aircraft traffic.
Costs: Capital NPW of O&M NPW	$0 $0 $0	$44,000 $227,000 $271,000	$631,000 $282,000 $913,000
State Acceptance	The state regulatory agency, FDEP, will review and comment on the Draft FS for Site 44 prior to final approval and subsequent acceptance. The FDEP comments will be addressed in the Final FS for Site 44.		
Community Acceptance	**The information concerning community acceptance will be addressed following the public comment period for the Proposed Plan for Site 44.**		

Notes:
ARARs = Applicable or Relevant and Appropriate Requirements
AS/SVE= Air sparging/soil vapor extraction
COCs = Chemicals of concern
cPAH = Carcinogenic polynuclear aromatic hydrocarbons
LUCs = Land use controls
NPW = Net present worth
O&M = Operation and maintenance
PPE = Personal Protective Equipment
RAOs = Remedial Action Objectives
TCE = Trichloroethene

1.0 INTRODUCTION

This Feasibility Study (FS) for Operable Unit (OU) 19 Site 44 – Former Underground Storage Tank (UST) Site 3221 SW at Naval Air Station (NAS) Pensacola, Florida, has been prepared by Tetra Tech NUS, Inc. (TtNUS) for Naval Facilities Engineering Command Southeast (NAVFAC SE) under the Comprehensive Long-Term Environmental Action Navy (CLEAN) Program, Contract Number N62467-04-D-0055, Contract Task Order (CTO) 0079. This FS describes the development and evaluation of remedial alternatives for contaminated soil and groundwater at Site 44.

The FS is being conducted to establish Remedial Action Objectives (RAOs) and cleanup goals; to screen remedial technologies; and to assemble, evaluate, and compare remedial alternatives.

THE CERCLA FS PROCESS

The development of remedial alternatives for Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) sites consists of developing Preliminary Remediation Goals (PRGs) and areas and volumes of contamination and then identifying applicable technologies and developing those technologies into remedial alternatives to meet the PRGs.

The first step in the FS process is to develop RAOs specifying the contaminants, media of interest, and exposure pathways leading to development of the PRGs. The PRGs are developed based on chemical-specific Applicable or Relevant and Appropriate Requirements (ARARs), when available; site-specific risk-based factors; or other available information. Chemicals of concern (COCs), as identified in the Remedial Investigation (RI), are those chemicals with average concentrations exceeding the PRGs and background. Once the PRGs and COCs have been determined, the areas and volumes of contamination requiring remedial action are determined.

Once RAOs and PRGs are identified, General Response Actions (GRAs) for each medium of interest are developed. GRAs typically fall into the following categories: natural attenuation (NA), containment, excavation, extraction, treatment, disposal, or other actions, singular or in combination, taken to satisfy the RAOs for the site.

The next step in the FS process is to identify and screen alternatives. This step considers applicable technologies for each GRA. This step eliminates technologies not technically feasible. Those technologies passing the screening phase are then assembled into remedial alternatives. The National Oil and Hazardous Substances Pollution Contingency Plan (NCP) requires a range of alternatives be presented in the FS to the maximum practicable extent. Remedial alternatives are then described and analyzed in detail using the CERCLA evaluation criteria (see Table 1-1) described in the NCP, including:

TABLE 1-1

CRITERIA FOR DETAILED ANALYSIS OF ALTERNATIVES
SITE 44 FEASIBILITY STUDY
PENSACOLA, FLORIDA

THRESHOLD CRITERIA

OVERALL PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT

- How Alternative Provides Human Health and Environmental Protection

COMPLIANCE WITH ARARs

- Compliance with Chemical-Specific ARARs
- Compliance with Action-Specific ARARs
- Compliance with Location-Specific ARARs
- Compliance with Other Criteria, Advisories, and Guidances

BALANCING CRITERIA

LONG-TERM EFFECTIVENESS AND PERMANENCE

- Magnitude of Residual Risk
- Adequacy and Reliability of Controls

REDUCTION OF TOXICITY, MOBILITY, AND VOLUME THROUGH TREATMENT

- Treatment Process Used and Materials Treated
- Amount of Hazardous Materials Destroyed or Treated
- Degree to Expected Reductions in Toxicity, Mobility, and Volume
- Degree to Which Treatment is Irreversible
- Type and Quantity of Residuals Remaining After Treatment

SHORT-TERM EFFECTIVENESS

- Protection of Community During Remedial Actions
- Protection of Workers During Remedial Actions
- Environmental Impacts
- Time Until Remedial Action Objectives Are Achieved

IMPLEMENTABILITY

- Ability to Construct and Operate the Technology
- Reliability of the Technology
- Ease of Undertaking Additional Remedial Actions, If Necessary
- Ability to Monitor Effectiveness of Remedy
- Ability to Obtain Approvals From Other Agencies
- Coordination With Other Agencies
- Availability of Offsite Treatment, Storage, and Disposal Services and Capacity
- Availability of Necessary Equipment, Materials, and Specialists
- Availability of Prospective Technologies

COST

- Capital Costs
- Operating and Maintenance Costs
- Present Worth Costs

MODIFYING CRITERIA

STATE ACCEPTANCE [1]

COMMUNITY ACCEPTANCE [1]

1 These criteria are assessed following regulatory and public comment on the RI/FS report and the proposed plan.
Source: Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA (USEPA, 1988).

Threshold Criteria

- Overall protection of human health and the environment
- Compliance with ARARs

Balancing Criteria

- Long-term effectiveness and permanence
- Reduction of toxicity, mobility, or volume of contaminants through treatment
- Short-term effectiveness
- Implementability
- Cost

Alternatives are evaluated against two additional factors (Modifying Criteria) after state participation:

Modifying Criteria

- State acceptance
- Community acceptance

The results of the detailed analyses are summarized and compared in a comparative analysis. The alternatives are compared against each other using the CERCLA evaluation criteria.

These criteria are used to comply with the Superfund Amendments and Reauthorization Act which requires them to be considered during remedy selection. Modifying criteria, including state and community acceptance, are also evaluated. State acceptance is evaluated when the state reviews and comments on the draft FS report, and a proposed plan is then prepared in consideration of the State's comments. Community acceptance is evaluated based on comments received on the proposed plan during a public comment period. This evaluation is described in a responsiveness summary and will be included in the ROD.

Upon completion of the FS report, the Proposed Plan will be developed. The Proposed Plan will identify the preferred remedial alternative for Site 44. This document will be written in community-friendly language and will be made available for public comment. Following receipt of all public comments, responses to these comments will be developed in a responsiveness summary within the ROD. The ROD will document the chosen alternative for the site and will include the responsiveness summary as an appendix. Once the ROD is signed, the chosen remedial alternative will be implemented.

The entire FS process provides the technical information and analyses forming the basis for the proposed remedy, and the subsequent ROD documents the identification and selection of the remedy.

PURPOSE

The purpose of the FS report for Site 44 at NAS Pensacola is to develop remedial alternatives to address threats to human health and the environment resulting from contaminated soil. RAOs are used to develop, screen, and evaluate potential remedial alternatives to meet the objectives.

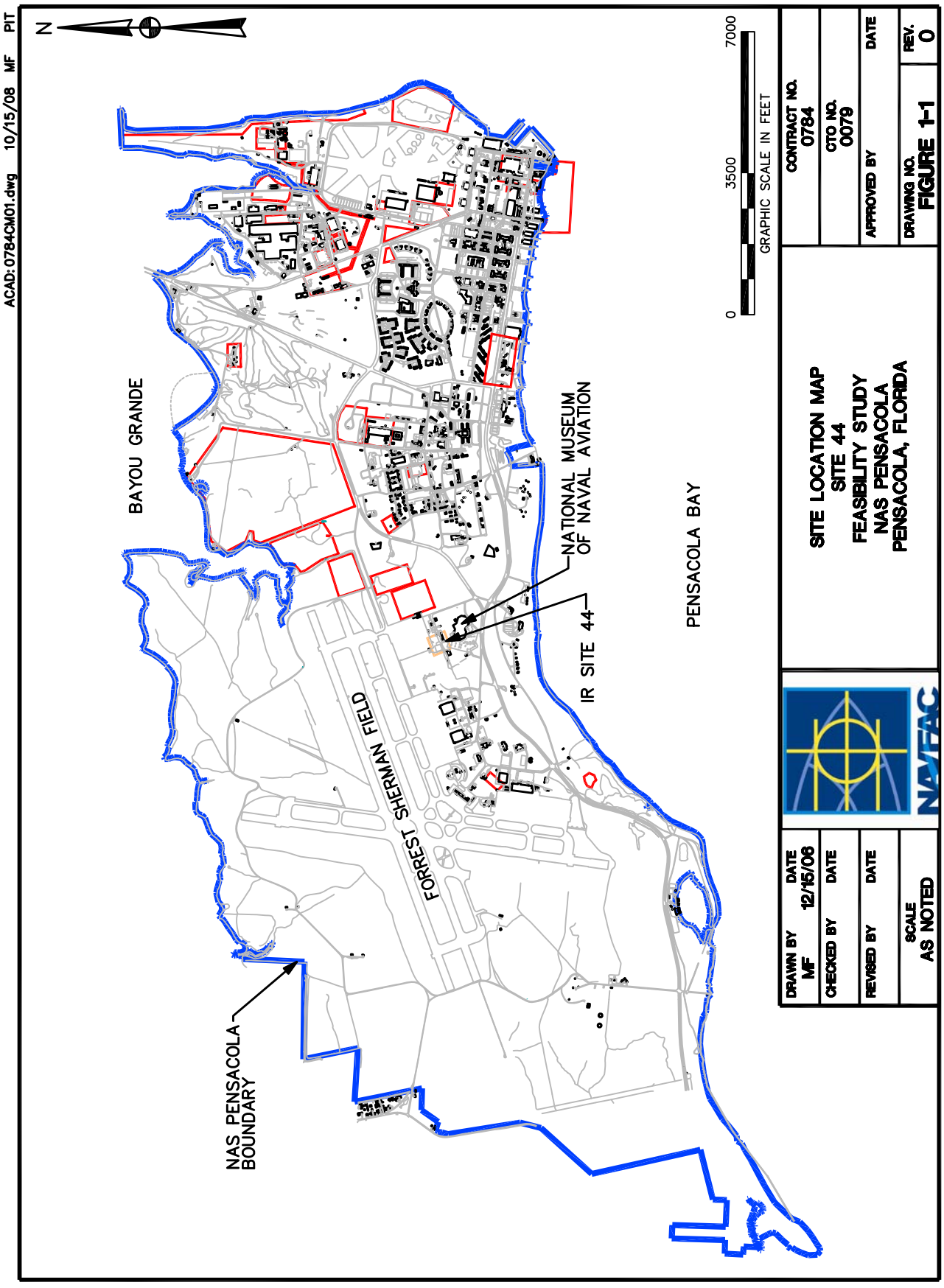
The FS report was developed in accordance with the NCP, providing guidance for identifying applicable remedial action technologies. The FS report does not present all the possible variations and combinations of remedial actions possible, but presents distinctly different alternatives representing a range of opportunities for meeting the RAOs. It is expected these different alternatives can be adjusted during the proposed plan and decision process, and to a lesser extent during detailed design, to accomplish the RAOs in a manner similar to the initially proposed alternative. Also, the FS report does not present information on alternatives failing to meet the RAOs.

The following criteria are considered in identifying appropriate remedial action for Site 44:

- RAOs: RAOs are developed to specify the contaminants, media of interest, exposure pathways, and remedial action goals.
- Applicable Technologies: Technologies applicable for addressing contaminated media are identified and screened. Technologies are eliminated if they cannot be implemented.
- Remedial Alternatives: Technologies passing the screening phase are assembled into remedial alternatives.
- Detailed Analysis: Selected remedial alternatives are described and evaluated using seven of the nine criteria outlined in the NCP.
- Comparative Analysis: Remedial alternatives are compared against each other using threshold and primary balancing criteria.

1.1 SITE BACKGROUND

The following paragraphs provide background information about Site 44. Figure 1-1 provides the site location, and Figure 1-2 shows the main site features.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BAYOU GRANDE
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GRAPHIC SCALE IN FEET
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SITE 44
FEASIBILITY STUDY
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1.1.1 Site Description and History

Site 44 is located at the southwestern end of Building 3221, as shown in Figure 1-1. Building 3221, located adjacent to Forrest Sherman Field, is a large hangar currently used to refurbish aircraft used for museum display. The hangar and adjacent paved areas were part of the Naval Air Rework Facility (NARF), and according to historical records were most likely used for aircraft maintenance before the current National Museum of Naval Aviation opened in 1975.

The paved area located adjacent to the southwestern corner of Building 3221 is currently used as a wash rack for cleaning aircraft and aircraft parts. Surface drainage in this area flows to a small concrete-lined ditch located on the southeastern edge of the pavement. When aircraft parts-washing activities are being conducted, a diverter system is used to direct the runoff to the sanitary sewer system for treatment at the NAS Pensacola Industrial Wastewater Treatment Plant (IWTP).

The surface of the site is a mixture of grass, asphalt, concrete, and tree cover. The north-central portion of the site is covered with concrete; the northwestern portion is an asphalt-covered storage area for various aircraft parts and is bounded to the west by a wooded area; the northeastern portion abutting Building 3221 is an asphalt parking area; and the southern portion is grass covered with an unpaved access road trending southwest-northeast through it. An overhead power line runs through the northern portion of the site, trending southwest-northeast parallel to the southeastern face of Building 3221. An underground water line enters the site from the north, terminating in a fire hydrant connection.

1.1.2 Site Investigations

The section summarizes relevant events and investigations at Site 44.

1992 – UST Removal: Site 44 was first investigated as UST Site 3221 SW following the removal of a 1,000-gallon UST located at the southwestern corner of Building 3221 (Figure 1-2). The former tank had been installed in 1967 and was reportedly used to store PD-680 (a petroleum distillate cleaning solvent). A Contamination Assessment Report (CAR) was prepared as part of the UST investigation [ABB Environmental Services, Inc. (ABB-ES), 1993]. Tetrachloroethene (PCE) was detected at concentrations slightly exceeding the then-current state guidance concentrations in four monitoring wells located hydraulically downgradient of the UST. Additional monitoring wells and soil borings were installed at the site and sampled. PCE was not detected in groundwater samples located in the area near the former UST but was present in a single monitoring well located approximately 100 feet hydraulically downgradient of the former UST. Trichloroethene (TCE) was not detected at locations near the former UST but was present in three hydraulic downgradient monitoring wells (beginning at approximately 75 feet downgradient of the former UST).

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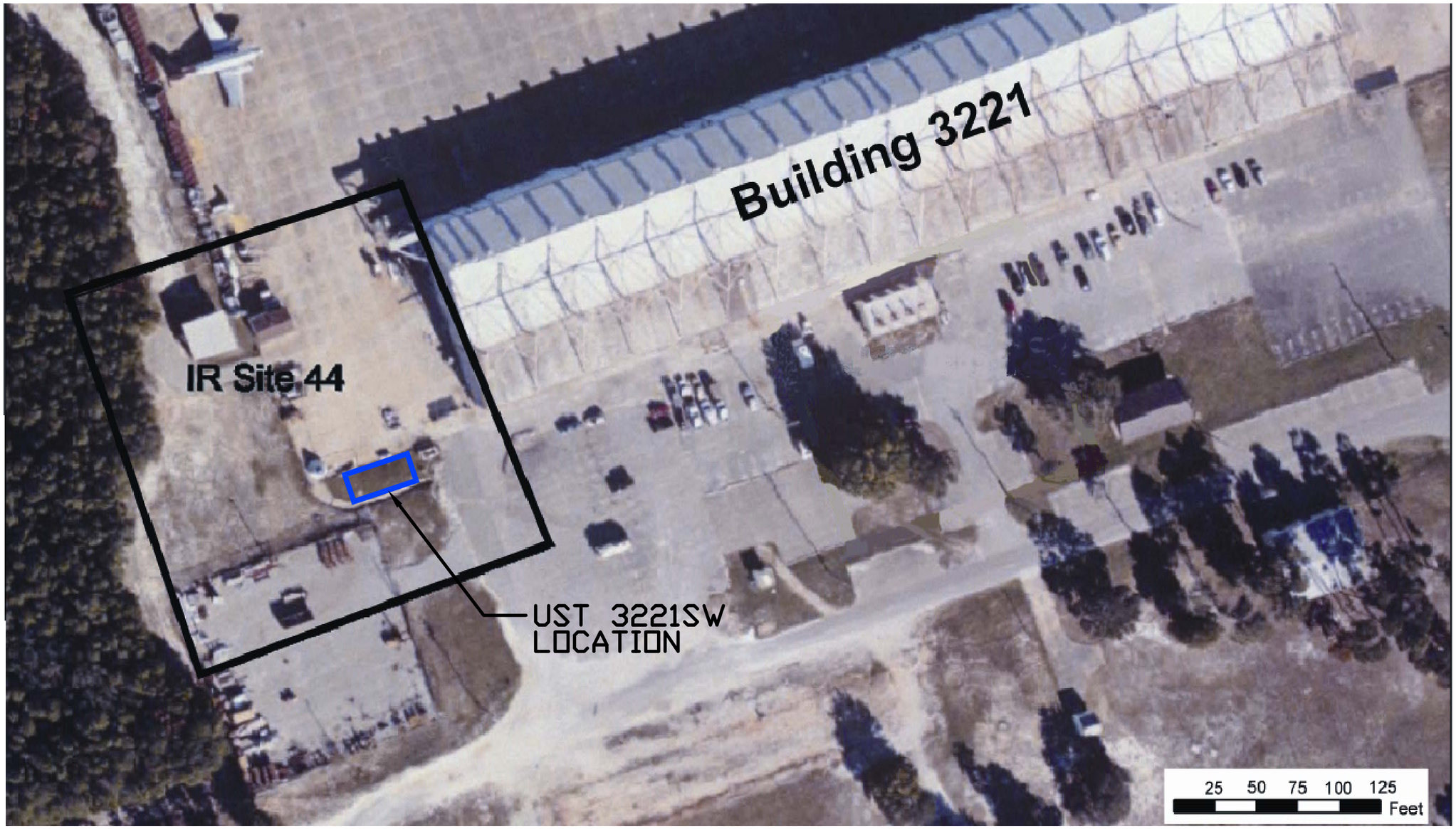

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DRAWN BY MF DATE 10/15/08		SITE AREA SITE 44 FEAASIBILITY STUDY NAS PENSACOLA PENSACOLA, FLORIDA	CONTRACT NO. 0784
CHECKED BY DATE			CTO NO. 0079
REVISED BY DATE			APPROVED BY DATE
SCALE AS NOTED	NAVFAC		DRAWING NO. FIGURE 1-2 / REV. 0

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Due to the detection of chlorinated solvents in groundwater, the Navy transferred this site (as Site 44) to the Installation Restoration (IR) Program for further assessment. The site soil and groundwater did not exceed state UST program guideline concentrations for petroleum constituents; therefore a No Further Action (NFA) was required by the UST program.

1994 – Fuel Oil UST Removal: In addition to UST Site 3221 SW, UST Site 3241 is located approximately 250 feet east of Site 44 (Figure 1-3). A fuel oil UST of unknown capacity was closed by removal in 1994. Soil collected from the excavation indicated the presence of total xylenes and PCE in excess of its Florida Department of Environmental Protection (FDEP) Soil Cleanup Target Levels (SCTLs). A single monitoring well installed in the tank excavation area had benzene at a concentration exceeding the FDEP Groundwater Cleanup Target Level (GCTL).

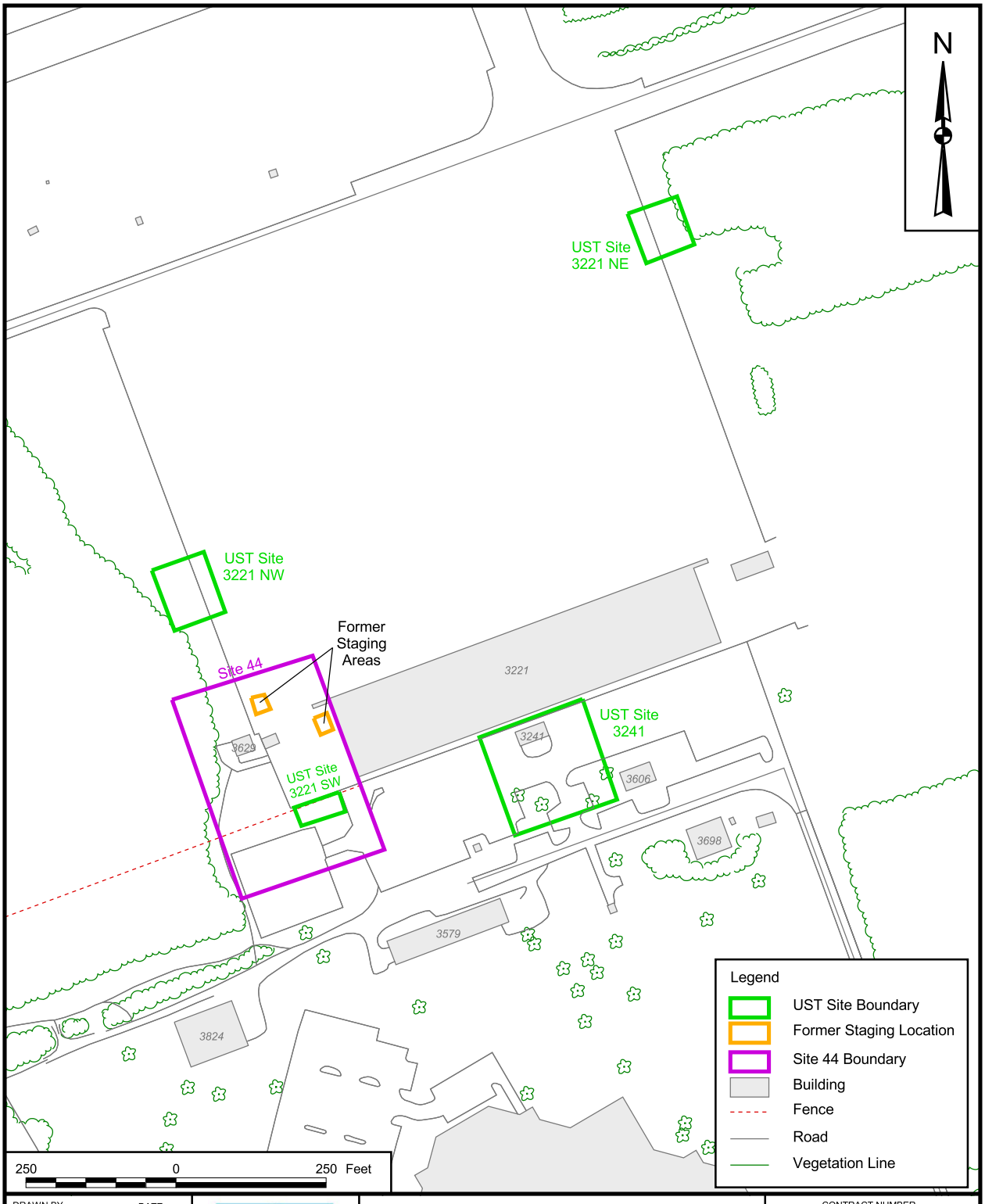
2003 – Site Assessment Report: TtNUS completed a Site Assessment Report (SAR) for UST Site 3241. As part of the investigation, 19 direct-push technology (DPT) soil borings were completed, and five additional monitoring wells installed and sampled. The results of the investigation indicated that concentrations of petroleum constituents in soil were less than their SCTLs, free product was not present in soil or groundwater, and benzene concentrations remained in excess of its GCTL in the old tank excavation area. Following implementation of a natural attenuation monitoring plan under the Florida UST program, the site was approved for NFA and is not considered part of Site 44.

1.1.3 Summary of Site 44 RI Findings

This section summarizes the subsurface physical characteristics, nature and extent of contamination, and contaminant fate and transport at the site based on the findings provided in the RI Report (TtNUS, 2007). Current surface features of the site and the site layout are discussed in Section 1.1.1. The regional geology and hydrogeology are described in the RI. The following is a summary of geology and hydrogeology information at Site 44 relevant to the FS.

1.1.3.1 Site Geology and Hydrogeology

The lithologies observed during drilling of Site 44 monitoring wells are typical of undifferentiated Pleistocene marine deposits. The ground surface to 2-foot interval at most of the sampling locations showed signs of disturbance by either grading and filling or pavement construction. Below 2 feet, typical lithologies included sand ranging from white or tan to dark brown in color. Significant clay or gravel horizons were not encountered. At some monitoring well locations, a dark brown, well-indurated, peat layer was encountered at a depth of approximately 14 feet. The thickness of this peat horizon was approximately 1 foot. Most of the shallow monitoring wells were installed above this interval.



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CHECKED BY M. JAYNES	DATE 1/20/09	ADJACENT UST SITES SITE 44 FEASIBILITY STUDY NAS PENSACOLA PENSACOLA, FLORIDA	APPROVED BY — DATE —
COST/SCHEDULE-AREA			APPROVED BY — DATE —
SCALE AS NOTED			DRAWING NO. FIGURE 1 - 3 REV 0

P:\GIS\PENSACOLA_NAS\MAPDOCS\APR\SITE44_45_46.APR SITE 44 BLDG 3221 AREA LAYOUT 1/20/09 KM

Groundwater in Escambia county occurs in three major aquifers: a shallow aquifer which is both artesian and nonartesian (the sand and gravel aquifer), and two deep artesian aquifers (the upper and lower limestones of the Floridan Aquifer). In the southern half of the area, the sand and gravel aquifer and the upper limestone of the Floridan Aquifer are separated by a thick section of relatively impermeable clay; however, in the northern half the sand and gravel aquifer and the upper limestone of the Floridan Aquifer are in contact with one another. The upper limestone of the Floridan Aquifer is separated from the lower limestone by a thick clay bed.

Monitoring wells installed at Site 44 are grouped by well screen interval as follows:

- Shallow aquifer monitoring wells are screened to 15 feet below land surface (bls)
- Deep aquifer monitoring wells are screened from 65 to 75 feet bls

Groundwater elevations above mean sea level (msl) in shallow monitoring wells have shown significant seasonal variation as follows:

- December 6, 2005 - 18.14 to 18.95 feet
- December 20, 2005 - 18.29 to 19.11 feet
- May 12, 2006 - 16.56 to 17.13 feet
- August 14, 2006 - 15.29 to 15.64 feet

The overall groundwater flow direction is to the northeast, and the horizontal gradient ranges from 0.001 to 0.003 for shallow monitoring wells. The flow direction of the deep aquifer is also estimated to be northeast, but this has not been confirmed because there are only two deep monitoring wells for this site. The vertical hydraulic gradient is determined from the difference in groundwater elevation in adjacent shallow and deep monitoring wells and the vertical separation of the screened intervals of the monitoring wells determined by the midpoint of the water column in shallow wells that bracket the water table and the midpoint of the well screen in deep wells screened below the water table. Vertical hydraulic gradients were downward at Site 44 and ranged from -0.05 to -0.07.

The geometric mean of the hydraulic conductivity values reported for shallow wells at Site 44 is approximately 0.05 feet per minute or 72 feet per day. The geometric mean of the hydraulic conductivity values reported for deep wells at Site 44 is approximately 0.003 feet per minute or 4.3 feet per day, which is an order of magnitude less than the shallow wells.

1.1.3.2 Nature and Extent of Contamination

In September 2005, soil screening samples were collected at 29 locations at Site 44 for on-site analysis for selected volatile organic compounds (VOCs). Based on the screening results, soil samples were collected at three locations, 44SB02, 44SB11, and 44SB25. Three soil samples were collected from each of the three boring locations at depths of 0 to 6 inches, 6 inches to 2 feet, and 2 feet to 4 feet. The samples were analyzed for Target Analyte List (TAL) metals, Target Compound List (TCL) VOCs, TCL semi volatile organic compounds (SVOCs), TCL pesticides and polychlorinated biphenyls (PCBs), and petroleum hydrocarbons. The samples were also submitted for Synthetic Precipitation Leaching Procedure (SPLP) extraction and analysis for TAL metals and TCL VOCs.

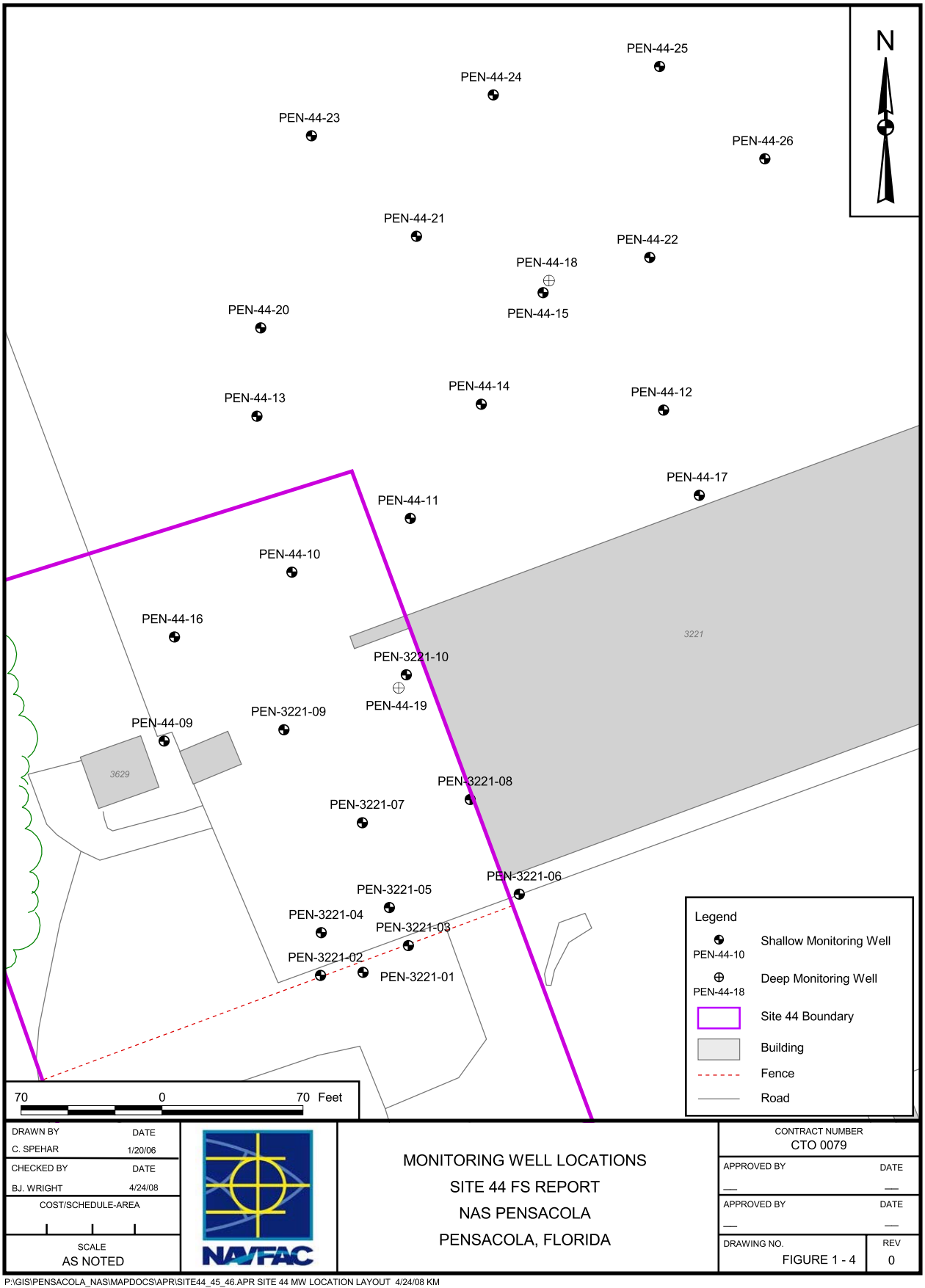
The groundwater samples were collected from 19 monitoring wells including 17 shallow wells screened at the water table and two deep wells screened at 65 to 75 feet bls. During previous groundwater sampling events at the site, samples were analyzed for petroleum constituents required by the FDEP's UST program; therefore, the groundwater samples collected during the RI were analyzed for the full list of TCL and TAL analytes, as well as petroleum hydrocarbons. The chlorinated volatile organic compound (CVOC) delineation groundwater samples were analyzed for a select list of CVOCs. Sampling events were conducted in May, August, and December 2005.

The locations of the groundwater monitoring wells and soil screening borings are shown on Figures 1-4 and 1-5, respectively.

As defined by Chapter 62-777, Florida Administrative Code (F.A.C.), Tables I and II, the soil and groundwater sample analytical results were compared to the following Cleanup Target Levels (CTLs) to define the nature and extent of contamination:

- Soil samples were compared to residential and industrial direct exposure SCTLs and leachability-to-groundwater SCTLs.
- Groundwater samples were compared to GCTLs based on ingestion (lifetime excess cancer risk of 1×10^{-6}) and freshwater and/or marine surface water criteria, as appropriate.

In addition to these screening criteria, all media samples were compared to the NAS Pensacola reference or background values for inorganic constituents. The results, depicting parameter-specific exceedances for each of the main parameter groups, are described below and depicted on Figures 1-6 and 1-7. Only contaminants retained as COCs during the RI are included.



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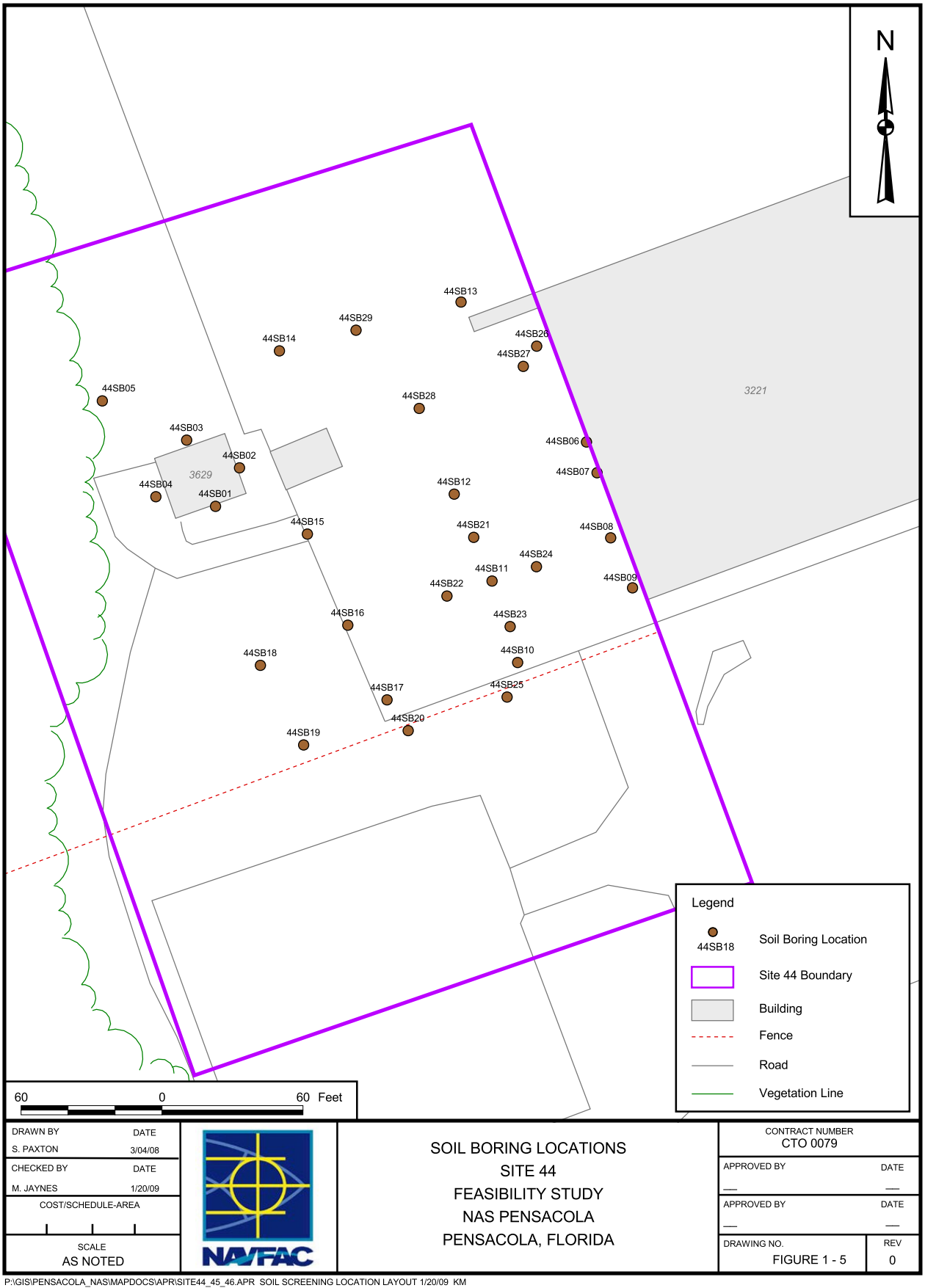
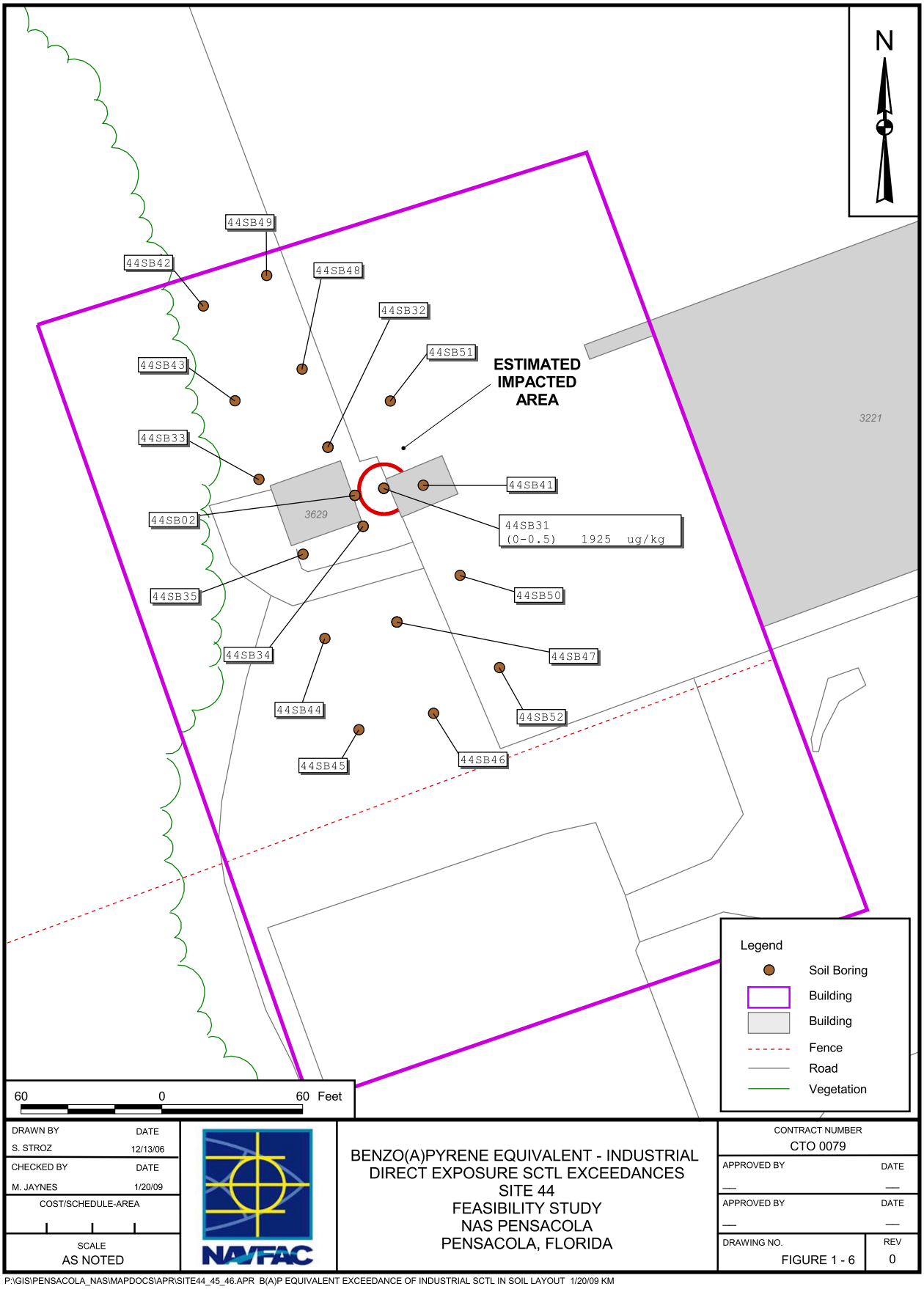


P:\GIS\PENSACOLA_NAS\MAPDOCS\APR\SITE44_45_46.APR SOIL SCREENING LOCATION LAYOUT 1/20/09 KM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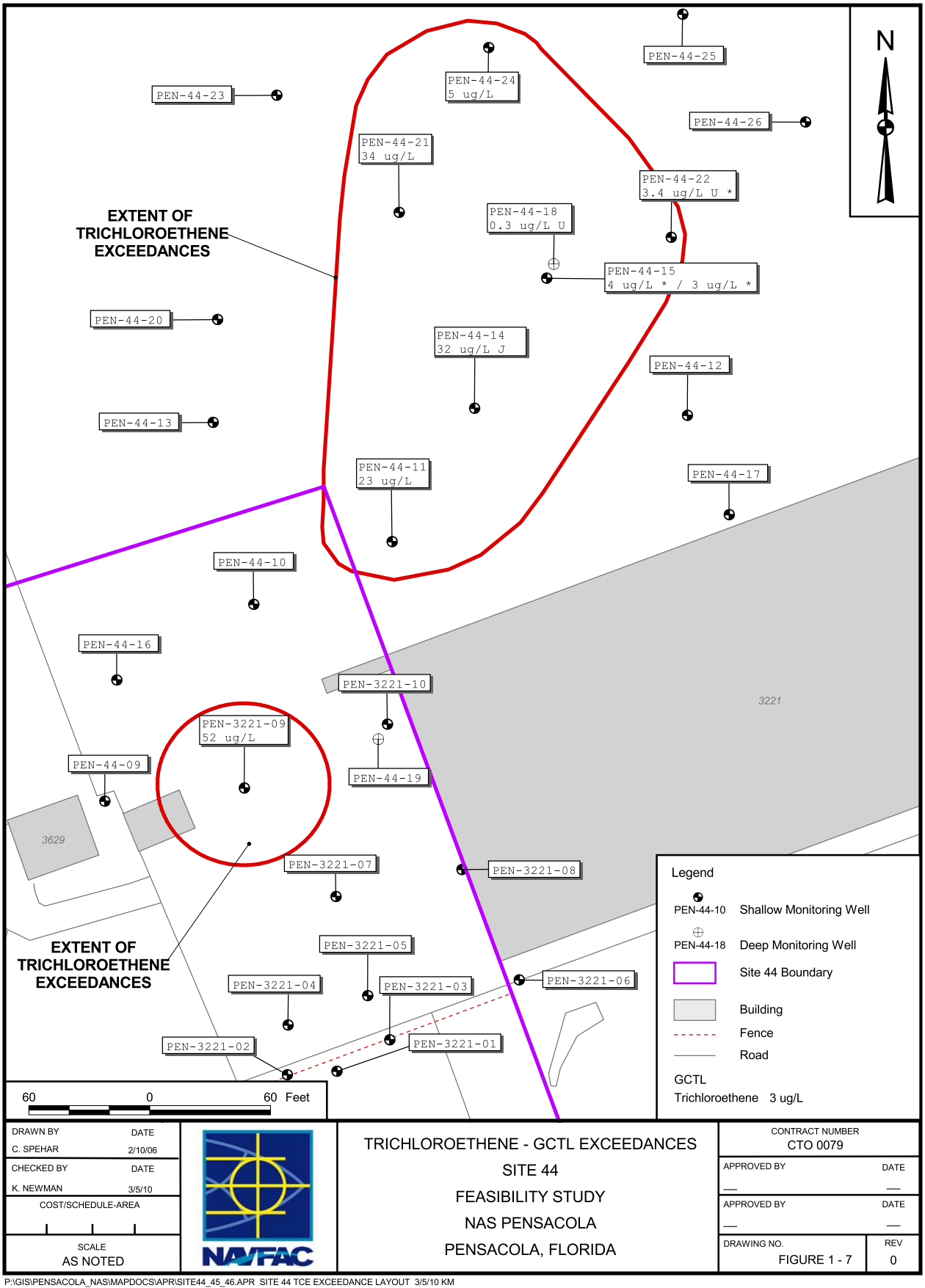
44SB49
44SB42
44SB48
44SB32
44SB51
44SB43
ESTIMATED IMPACTED AREA
44SB33
3221
44SB41
3629
44SB02
44SB31
(0-0.5) 1925 ug/kg
44SB35
44SB50
44SB34
44SB47
44SB44
44SB52
44SB45
44SB46
Legend
Soil Boring
Building
Building
Fence
Road
Vegetation
60 0 60 Feet
DRAWN BY
S. STROZ
DATE
12/13/06
CHECKED BY
M. JAYNES
DATE
1/20/09
COST/SCHEDULE-AREA
SCALE
AS NOTED
NAVFAC
BENZO(A)PYRENE EQUIVALENT - INDUSTRIAL
DIRECT EXPOSURE SCTL EXCEEDANCES
SITE 44
FEASIBILITY STUDY
NAS PENSACOLA
PENSACOLA, FLORIDA
CONTRACT NUMBER
CTO 0079
APPROVED BY
DATE
APPROVED BY
DATE
DRAWING NO.
FIGURE 1 - 6
REV
0
P:\GIS\PENSACOLA_NAS\MAPDOCS\APR\SITE44_45_46.APR B(A)P EQUIVALENT EXCEEDANCE OF INDUSTRIAL SCTL IN SOIL LAYOUT 1/20/09 KM



DRAWN BY C. SPEHAR	DATE 2/10/06	TRICHLOROETHENE - GCTL EXCEEDANCES SITE 44 FEASIBILITY STUDY NAS PENSACOLA PENSACOLA, FLORIDA	CONTRACT NUMBER CTO 0079
CHECKED BY K. NEWMAN	DATE 3/5/10		APPROVED BY — DATE —
COST/SCHEDULE-AREA			APPROVED BY — DATE —
SCALE AS NOTED			DRAWING NO. FIGURE 1 - 7 REV 0

P:\GIS\PENSACOLA_NAS\MAPDOCS\APR\SITE44_45_46.APR SITE 44 TCE EXCEEDANCE LAYOUT 3/5/10 KM

Soil

Soil COCs for Site 44 were established in the RI based on the human health risk assessment, which used both United States Environmental Protection Agency (USEPA) guidelines and State of Florida methodology for risk characterization. The State of Florida methodology is based on guidance provided in Chapter 62-780 F.A.C., which makes use of a phased risk-based corrective action process that is iterative and tailors site rehabilitation to site-specific conditions and risks. Chapter 62-780, F.A.C. is used in conjunction with Chapter 62-777 F.A.C., which provides the methodology used to establish the FDEP CTLs for the residential (level I), commercial/industrial (level II), or alternate land use (level III) scenarios. COCs were identified based on a comparison of maximum detected concentrations to USEPA PRGs and FDEP SCTLs.

Arsenic was detected in samples collected from 0 to 2 feet and 2 to 4 feet depths at soil boring 44SB25, at a concentration of 2.5 milligram per kilogram (mg/kg). This arsenic concentration, which is slightly above the residential (level I) SCTL of 2.1 mg/kg and PRG of 0.39 mg/kg, is within the background range determined by statistical analysis of arsenic distribution at NAS Pensacola, and is therefore not retained as a COC.

Carcinogenic polynuclear aromatic hydrocarbon (cPAH) concentrations exceed the level I and level II SCTLs. An area of cPAH exceedances was identified around the foundation of former Building 3629. Five soil boring locations, 44SB02, 44SB31, 44SB32, 44SB34, and 44SB47, had benzo(a)pyrene equivalent concentrations exceeding the residential direct exposure SCTL of 100 micrograms per kilogram (µg/kg). One of the five soil borings, 44SB31 (at 1,925 µg/kg), had benzo(a)pyrene equivalent concentrations exceeding the industrial direct exposure SCTL (700 µg/kg) and the PRG (210 µg/kg).

Groundwater

Groundwater COCs for Site 44 were established based on the human health risk assessment that employs both USEPA guidelines and the State of Florida methodology for risk characterization. The RI identified TCE as the main COC in groundwater at Site 44. Concentrations of TCE exceed the USEPA Maximum Contaminant Level (MCL) and FDEP GCTL.

TCE was detected at concentrations exceeding its GCTL [3 micrograms per liter (µg/L)] in groundwater samples collected from six shallow monitoring wells. One plume was identified in the vicinity of PEN-3221-09 (52 µg/L), which was installed as part of the UST investigation and previously had TCE exceedances. The second, larger plume extends north from the northwestern corner of Building 3221 and includes monitoring wells PEN-44-11, PEN-44-14, PEN-44-15, PEN-44-21, PEN-44-22 and PEN-44-24. The concentrations in these monitoring wells ranged from 5 to 34 µg/L.

The human health risk assessment in the RI also identified iron and manganese as potential COCs because their maximum concentrations exceeded USEPA Secondary MCLs. However, the aquifer is not used as a water supply source in the Pensacola area because of high mineralization. In addition, the Hazard Quotients (HQs) for iron and manganese calculated in the USEPA evaluation were less than the USEPA and FDEP goal of 1.0 for non-carcinogenic health effects. The maximum detected concentrations of the two metals were also less than the NAS Pensacola reference concentrations. Therefore, iron and manganese are not retained as COCs.

1.1.3.3 Potential Receptors

Site 44 has been an industrial area supporting aircraft maintenance and refurbishing for more than 30 years. The contaminants at Site 44 appear to be limited to surface soil, subsurface soil, and groundwater. Migration pathways may include the following:

- Leaching of soil contaminants into groundwater
- Migration of groundwater contaminants in a downgradient direction
- Volatilization of TCE from soil or groundwater

The mobility of chemicals at Site 44 is influenced by the relatively shallow water table, potentially high rates of precipitation, and sandy soil in the area, which may allow a higher rate of infiltration than less permeable soil. The contaminants identified in soil at Site 44 (arsenic and cPAHs) generally have physical and chemical properties that result in a low mobility and a high persistence in the environment.

The groundwater data at Site 44 do not provide evidence of immiscible contaminants at concentrations exceeding water solubility levels. Therefore, the migration of contaminants in groundwater, for the most part, is likely governed by factors such as advection, dilution, dispersion and sorption (retardation) that govern the movement of dissolved contaminants.

Most of the contaminants detected in soil at Site 44 (metals and cPAHs) are not especially volatile and are not expected to vaporize into the air. The TCE concentrations in groundwater are relatively low, and volatilization is not likely to occur. Air monitoring was conducted during the soil investigation due to the potential for dust/particulate exposure. Because of the sandy soil at the site, little dust is generated under normal conditions. However, there is a potential for particulate exposure in areas without grass if the soil is significantly disturbed (e.g., during excavation).

Current and potential receptors at Site 44 include the following:

- Adult and adolescent trespassers
- Maintenance workers

- Construction workers
- Occupational workers
- Future residents

1.2 RISK MANAGEMENT OPTION DETERMINATION

The results of the RI for Site 44 indicate that an NFA with conditions determination can be made using Risk Management Option (RMO) Level III in accordance with Chapter 62-780, F.A.C. As such, this section has been prepared to support an NFA proposal for soil at Site 44.

RMO Level III involves NFA with Land Use Controls (LUCs) (institutional and/or engineering controls). This section will use soil and groundwater data in conjunction with risk assessment results to describe how RMO Level III is attained and why RMO Levels I and II were not suitable for this site.

1.2.1 Risk Assessment Results

USEPA Guidance Risk Assessment

The USEPA risk assessment considered five receptors, the hypothetical future resident, the typical industrial worker, the construction worker, the maintenance worker, and the trespasser/recreational user, assuming exposure via the ingestion, dermal contact, and inhalation route of exposures. However, maintenance workers and trespassers/recreational users are considered to be the most likely receptors at Site 44 under current land use. Noncarcinogenic risks for exposure to surface soil, subsurface soil, and groundwater are less than the USEPA and FEDP target Hazard Index (HI) of 1.0 for all receptors. Carcinogenic risks exceeded 1×10^{-4} for exposure to groundwater by the hypothetical future resident due the presence of TCE. This exceeds USEPA's target risk range of 1×10^{-4} to 1×10^{-6}.

Florida Guidance Risk Assessment

The risk assessment conducted per State of Florida regulations and guidelines evaluated risks to a hypothetical future resident and a typical industrial worker using SCTLs for the residential and industrial land use scenario, respectively. Risks to a hypothetical future recreational user were evaluated using SCTLs specifically developed for this risk assessment as stipulated in the State of Florida regulations and guidelines.

Carcinogenic risks associated with exposure to surface soil exceed FDEP's target risk level for the hypothetical future resident and industrial worker due to the concentrations of cPAHs. Carcinogenic risks associated with exposure to subsurface soil exceed FDEP's target risk level for the hypothetical future resident due to cPAHs and arsenic above their SCTLs.

Carcinogenic risks exceeded 1 x 10^{-4} for exposure to groundwater by the hypothetical future resident due to the presence of TCE. This exceeds FDEP's target risk level of 1 x 10^{-6}.

Iron and manganese were identified as potential COCs for groundwater because their maximum detected concentrations exceeded their GCTLs, which are, in effect, USEPA Secondary MCLs. Secondary MCLs are criteria based not on health effects but on aesthetic effects such as taste and odor. Also, HQs for iron and manganese calculated in the USEPA evaluation were less than the USEPA and Florida goal of unity for noncarcinogenic health effects.

Ecological Risk Assessment

Actual or potential exposures of ecological receptors are determined by identifying the most likely pathways of contaminant release and transport. Complete exposure pathways and routes of entry into biota at Site 44 consisted of direct contact with surface soil by invertebrates and plants, and ingestion of surface soil by invertebrates. The risk analysis for Site 44 determined that a number of the contaminants detected in Site 44 surface soil were at concentrations that exceeded their conservative screening levels that are associated with potential risk to ecological receptors. However, the risk characterization reevaluated the conservative assumptions and determined that the overall level of ecological risk associated with the detected contaminants was considered to be minimal.

1.2.2 RMO Level I Evaluation

The requirements for FDEP's RMO Level I, NFA without institutional controls or without institutional and engineering controls, are presented in Chapter 62-780.680, F.A.C., and are summarized below.

Free Product

> **62-780.680(1)(a)** Free product is not present, and no fire or explosive hazard exists as a result of a release of non-aqueous phase liquids.

Free product is not present at Site 44. There is no source material at the site that will continue to leach high concentrations of dissolved chemicals to groundwater.

Soil - Direct Contact

> **62-780.680(1)(b)1.a.** Contaminated soil is not present in the unsaturated zone, as demonstrated by the analyses of soil samples collected from representative sampling locations that show that soil contaminant concentrations do not exceed the less stringent of the following:

(I) The residential direct exposure SCTLs specified in Chapter 62-777, F.A.C., Table II

(II) Background concentrations

(III) Best achievable detection limits

Maximum detected concentrations of benzo(a)pyrene equivalents exceed its residential direct exposure SCTL. The soil contaminant concentrations do not meet these requirements; therefore, RMO Level I cannot be attained under current conditions.

Groundwater

62-780.680(1)(c)1. Contaminated groundwater is not present, as demonstrated by the analyses of groundwater samples collected from representative sampling locations that show that criteria 1 and 2 are met:

1. Groundwater contaminant concentrations do not exceed the less stringent of:
    a. The groundwater CTLs specified in Chapter 62-777, F.A.C., Table I groundwater criteria column,
    b. Background concentrations; or
    c. Best achievable detection limits; and
2. Groundwater contaminant concentrations do not exceed the surface water CTLs specified in Chapter 62-777, F.A.C., Table I freshwater surface water criteria column "… if the sites groundwater contamination is affecting or may potentially affect a surface water body based on monitoring well data, groundwater flow rate and direction, or fate and transport modeling."

Groundwater monitoring data at Site 44 indicate that TCE is present at concentrations greater than its FDEP GCTL. The groundwater contaminant concentrations for TCE do not meet these requirements; therefore, RMO Level I cannot be attained under current conditions.

1.2.3 RMO Level II Evaluation

The requirements for FDEP's RMO Level II, NFA with institutional and engineering controls, are presented in Chapter 62-780.680, F.A.C., and are summarized below.

Free Product

62-780.680(2)(a) Free product is not present, and no fire or explosive hazard exists as a result of a release of non-aqueous phase liquids.

Free product is not present at Site 44. There is no source material at the site that will continue to leach high concentrations of dissolved chemicals to groundwater.

Soil - Direct Contact and Leachability

62.780.680(2)(b)1.a. Soil contaminant concentrations or average soil contaminant concentrations do not exceed the commercial/industrial SCTLs as specified in Chapter 62-777, Table II, F.A.C.

62.780.680(2)(b)2.a. Soil contaminant concentrations do not exceed the alternative leachability-based SCTLs established on using the equations and default assumptions specified in Chapter 62-777 Table II.

62.780.680(2)(b)2.a. It has been demonstrated to the Department by a minimum of 1 year of groundwater monitoring data and, if applicable, fate and transport modeling results that, based on the site-specific conditions, contaminants will not leach into the groundwater at concentrations that exceed the appropriate groundwater CTLs established pursuant to paragraph 62-780.680(1)(c), F.A.C., "… and if applicable, the appropriate surface water CTLs pursuant to paragraph 62-780.680(1)(d), F.A.C."

A review of the soil data indicates that the 95 percent Upper Confidence Level of the Mean (UCL) of benzo(a)pyrene equivalent concentrations and the maximum detected concentrations of all other COCs are less than their respective FDEP commercial/industrial SCTLs. Also, the maximum detected benzo(a)pyrene equivalent concentration is less than three times the industrial direct exposure SCTL. Therefore, "hot spots" are not considered to be present. All COCs have maximum detected concentrations less than the alternate leachability to groundwater based SCTLs, which in this case are the default leachability to groundwater SCTLs identified in Chapter 62-777, F.A.C., Table II. The soil data at Site 44 meet the requirements for RMO Level II.

Moreover, the cumulative risks associated with these contaminants must be less than FDEP's target risk of 1×10^{-6} and less than or within USEPA's target cancer risk range of 1×10^{-4} to 1×10^{-6} and less than a non-cancer HI of 1. The cancer risk is less than USEPA's target risk range and less than FDEP's target risk level of 1×10^{-6}, and the HI is less than the USEPA and FDEP target value of 1.

Groundwater

62-780.680(2)(c)4 Groundwater contamination must be contained within the property boundaries and be limited to the immediate vicinity of the source area. The area of

groundwater contamination must be less than one quarter of an acre, where it has been demonstrated to FDEP by a minimum of 1 year of groundwater monitoring data that the groundwater contamination is not migrating away from the localized source area, that the plume is stable and shrinking, and the plume has not affected, and will not affect, a freshwater or marine surface water boundary.

It is evident that the groundwater contamination at Site 44 is contained within the property boundary; however, the area of contamination is greater than one quarter of an acre. The data do not meet these requirements; therefore, RMO Level II cannot be attained under current conditions.

1.2.4 RMO Level III Evaluation

Free Product

62-780.680(3)(a) Free product is not present, and no fire or explosive hazard exists as a result of a release of non-aqueous phase liquids.

Free product is not present at Site 44. There is no source material at the site that will continue to leach high concentrations of dissolved chemicals to groundwater.

Soil

The soil concentrations satisfy RMO Level II criteria; therefore, it follows that the soil concentrations satisfy RMO Level III criteria.

Groundwater

62-780.680(3)(c)1 Groundwater contaminant concentrations do not exceed the alternative GCTLs established pursuant to paragraph 62-780.650(1)(d), F.A.C. "… and the plume has not affected, and will not affect, a freshwater or marine surface water body pursuant to subparagraph 62-780.680(1)(c)2., F.A.C."

62-780.680(3)(c)2 It has been demonstrated to the Department by a minimum of 1 year of groundwater monitoring data and, if applicable, fate and transport modeling results, that the plume is stable or shrinking, and groundwater contaminant concentrations at the institutional control boundary do not, and will not, exceed the appropriate GCTLs pursuant to paragraph 62-780.680(1)(c), F.A.C., and, if applicable, the appropriate surface water CTLs pursuant to paragraph 62-780.680(1)(d), F.A.C.

It is evident that the groundwater contamination at Site 44 is contained within the property boundary; however, the area of contamination is greater than one quarter of an acre.

Because the size of the plume is greater than one quarter of an acre, alternative GCTLs can be established depending on the current and projected use of groundwater in the vicinity of the site. Meeting certain criteria renders these alternative GCTLs acceptable and suitable for qualifying for RMO Level III.

The present and projected restrictions on the affected aquifer preclude exposure to groundwater. Therefore, current concentrations in the aquifer would be considered acceptable because there is no exposure to the aquifer.

Moreover, the nearest downgradient surface water body is the Bayou Grande, which is approximately 3,500 feet from the source. Based on the groundwater monitoring data, it appears that the plume is not migrating and not impacting any surface water body. The data indicate that the requirements set forth for alternative GCTLs under RMO Level III are met.

1.2.5 Conclusion

The Navy concludes from the data and technical evaluation presented in this document that the site conditions at Site 44 meet all USEPA requirements and FDEP requirements for RMO Level III, NFA with Institutional Controls, as follows:

- All soil COCs are less than commercial/industrial PRGs, SCTLs, and leachability SCTLs.
- Current and future restrictions on the aquifer mitigate direct exposure to groundwater. Therefore, the absence of exposure results in no significant risks associated with groundwater.
- Although groundwater concentrations of TCE at a localized plume exceed its PRG and GCTL, it is evident based on groundwater monitoring data that the plume is stable and not migrating.
- Contaminated surface water and sediment are not present at the site.
- The nearest surface water body, the Bayou Grande, is approximately 3,500 feet from the site and would not be significantly impacted by Site 44.

1.3 DOCUMENT ORGANIZATION

This FS has been organized with the intent of meeting the general format requirements specified in the RI/FS Guidance Document (USEPA, 1988). This report contains the following five sections:

- Section 1.0, Introduction, summarizes the purpose of the report, provides site background information, summarizes findings of the RI, and provides the report outline.

- Section 2.0, RAOs and GRAs, presents the RAOs, identifies ARARs criteria, develops cleanup goals and associated GRAs, and provides an estimate of the matrix volumes to be remediated.

- Section 3.0, Screening of Remediation Technologies and Process Options, provides a two-tiered screening of potentially applicable remediation technologies and identifies the technologies that will be assembled into remedial alternatives.

- Section 4.0, Assembly and Detailed Analysis of Remedial Alternatives, assembles the remedial technologies retained from the Section 3.0 screening process into multiple remedial alternatives, describes these alternatives, and performs a detailed analysis of these alternatives in accordance with seven CERCLA criteria.

- Section 5.0, Comparative Analysis of Remedial Alternatives, compares the remedial alternatives on a criterion-by-criterion basis, for each of the seven CERCLA analysis criteria used in Section 4.0.

Appendix A contains remedial alternative cost estimates.

2.0 REMEDIAL ACTION OBJECTIVES AND GENERAL RESPONSE ACTIONS

This section develops RAOs and presents cleanup goals. The regulatory requirements and guidances (e.g., ARARs) that may potentially govern remedial activities are presented in this section. In addition, this section presents the COCs identified in Section 1.0 and the conceptual pathways through which these chemicals may affect human health and the environment, and thus derives the environmental media of concern. The cleanup goals for contaminated media are developed in this section, and GRAs that may be suitable to achieve the cleanup goals are presented. Finally, this section presents estimates of the volumes of contaminated media.

2.1 REMEDIAL ACTION OBJECTIVES

The purpose of this section is to develop RAOs for Site 44 at NAS Pensacola. Development of RAOs is an important step in the FS process. The RAOs are medium-specific goals that define the objective of conducting remedial actions to protect human health and the environment. The RAOs specify the COCs, potential exposure routes and receptors, and acceptable concentrations (i.e., cleanup goals) for the site.

The development of cleanup goals takes into consideration chemical-specific ARARs and to be considered (TBC) criteria, if any. Section 2.1.2 identifies the ARARs and TBCs, Section 2.1.3 identifies the media of concern, and Section 2.1.4 identifies the COCs retained for remediation at Site 44.

2.1.1 Statement of Remedial Action Objectives

RAOs are developed to permit consideration of a range of treatment and containment alternatives. Site-specific RAOs specify COCs, media of interest, exposure pathways, and cleanup goals or acceptable contaminant concentrations. This FS addresses soil and groundwater contamination at Site 44. To protect the public from potential current and future health risks, as well as to protect the environment, the following site-specific RAOs have been developed:

- **RAO 1:** Prevent unacceptable human health risk associated with exposure to soil containing cPAHs, evaluated collectively as benzo(a)pyrene equivalents, with concentrations exceeding the industrial direct exposure SCTL.

- **RAO 2:** Prevent unacceptable human health risk associated with exposure to groundwater containing TCE with concentrations exceeding the FDEP GCTL.

2.1.2 Applicable or Relevant and Appropriate Requirements (ARARs) and To Be Considered (TBC) Criteria

ARARs consist of the following:

- Any standard, requirement, criterion, or limitation under federal environmental law.

- Any promulgated standard, requirement, criterion, or limitation under a state environmental or facility-siting law that is more stringent than the associated federal standard, requirement, criterion, or limitation.

Per 40 Code of Federal Regulations (CFR) 300.400(g)(3), TBCs are nonpromulgated, nonenforceable guidelines or criteria that may be useful for developing a remedial action or are necessary for determining what is protective to human health and/or the environment. Examples of TBCs include USEPA Drinking Water Health Advisories, Reference Doses (RfDs) and Cancer Slope Factors (CSFs).

In addition, according to 40 CFR 300.430(f)(1)(i)(A), overall protection of human health and the environment and compliance with ARARs are threshold requirements that each alternative must meet to be eligible for selection.

2.1.2.1 Definitions

The NCP at 40 CFR 300.5 provides the following definitions for ARARs:

- Applicable Requirements are those cleanup standards, standards of control, and other substantive environmental protection requirements, 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 cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal or state law, although not "applicable" to a hazardous substance, pollutant, contaminant, or remedial action, location, or other circumstance at a CERCLA site, address problems or situations sufficiently similar to those encountered at the CERCLA site that their use is well suited to the particular site.

Per 40 CFR 300.400(g)(3), other advisories, criteria, or guidance are to be considered for a particular release. The TBC category consists of advisories, criteria, or guidance that were developed by USEPA, other federal agencies, or states that may be useful in developing CERCLA remedies.

Under CERCLA Section 121(d)(4), USEPA may waive compliance with an ARAR if one of the following conditions can be demonstrated:

- The remedial action selected is only part of a total remedial action that will attain the ARAR level or standard of control upon completion.

- Compliance with the requirement will result in greater risk to human health and the environment than other alternatives.

- Compliance with the requirement is technically impracticable from an engineering perspective.

- The remedial action selected will attain a standard of performance equivalent to that required by the ARAR through the use of another method or approach.

- With respect to a state requirement, the state has not consistently applied the ARAR in similar circumstances at other remedial actions in the state.

- Compliance with the ARAR will not provide a balance between protecting public health, welfare, and the environment at the facility with the availability of Superfund money for response at other facilities (fund-balancing). This condition only applies to Superfund-financed actions.

USEPA and the NCP have divided ARARs into three categories to facilitate identification. Chemical-specific and location-specific ARARs are identified early in the process, generally during the RI, and action-specific are normally identified during the FS in the detailed analysis of alternatives. The categories of ARARs are defined as follows:

- Chemical-Specific: Health- or risk-based numerical values or methodologies that establish concentration or discharge limits for particular contaminants. Examples include MCLs and Clean Water Act (CWA) Ambient Water Quality Criteria (AWQC).

- Location-Specific: Restrict actions or contaminant concentrations in certain environmentally sensitive areas. Examples of areas regulated under various federal laws include floodplains, wetlands, and locations where endangered species or historically significant cultural resources are present.

- Action-Specific: Technology- or activity-based requirements, limitations on actions, or conditions involving special substances. Examples of action-specific ARARs include Resource

Conservation and Recovery Act (RCRA) regulations for generation, characterization, and management of hazardous wastes and CWA effluent limitations and pre-treatment standards for wastewater discharges.

The following section discusses chemical- and location-specific ARARs and TBCs. Action-specific ARARs and TBCs are presented in Section 2.3 along with the discussion of GRAs.

2.1.2.2 Chemical-Specific ARARs and TBCs

Tables 2-1 and 2-2 present federal and State of Florida chemical-specific ARARs and TBCs, respectively, for this FS. These ARARs and TBCs provide medium-specific guidance on "acceptable" or "permissible" concentrations of contaminants.

2.1.2.3 Location-Specific ARARs and TBCs

Table 2-3 presents the federal location-specific ARARs and TBCs, respectively, for this FS. These ARARs and TBCs place restrictions on concentrations of contaminants or the conduct of activities based on the site's particular characteristics or location. There are not any State of Florida location-specific ARARs for Site 44.

2.1.3 Media of Concern

Based on the discussion in Section 1.0 involving toxicity and risk assessment for human receptors, the media of concern at Site 44 was determined to be surface soil, subsurface soil, and groundwater. The subsurface soil of concern is less than 4 feet in depth, and most of the COCs are contained in surface soil to a depth of 0.5 feet. Ecological receptors of concern were not identified at Site 44 for exposure to soil or groundwater.

2.1.4 Chemicals of Concern for Remediation

The COCs at Site 44 are cPAHs, evaluated collectively as benzo(a)pyrene equivalents, with concentrations in soil exceeding the industrial direct exposure SCTL, and TCE in groundwater with concentrations exceeding the USEPA MCL and Florida GCTL.

2.2 CLEANUP GOALS

A cleanup goal is the target concentration to which a COC must be reduced within a particular medium of concern to achieve RAOs. According to the NCP, cleanup goals are developed based on readily available information such as chemical-specific ARARs.

TABLE 2-1

FEDERAL CHEMICAL-SPECIFIC ARARs AND TBCs
SITE 44 FEASIBILITY STUDY
NAVAL AIR STATION PENSACOLA
PENSACOLA, FLORIDA

Requirement	Citation	Status	Synopsis	Evaluation/Action to be Taken
Applicable or Relevant and Appropriate Requirements (ARARs)				
SDWA Regulations, MCLs	40 CFR Part 141	Relevant and Appropriate	Establishes enforceable standards for potable water for specific contaminants that have been determined to adversely affect human health.	Would be used as protective levels for groundwater that is a potential drinking water source.
To Be Considered (TBCs)				
SDWA Regulations, National Secondary Drinking Water Standards (MCLs)	40 CFR Part 143	To Be Considered	Establishes welfare-based standards for public water systems for specific contaminants or water characteristics that may affect the aesthetic qualities of drinking water.	Would be used as protective levels for groundwater that is a potential drinking water source.

CFR = Code of Federal Regulations
MCLs = Maximum Contaminant Levels
SDWA = Safe Drinking Water Act

TABLE 2-2

STATE CHEMICAL-SPECIFIC ARARs
SITE 44 FEASIBILITY STUDY
NAVAL AIR STATION PENSACOLA
PENSACOLA, FLORIDA

Requirement	Citation	Status	Synopsis	Evaluation/Action to be Taken
Applicable or Relevant and Appropriate Requirements (ARARs)				
Florida Groundwater Classes, Standards, and Exemptions	Chapter 62-520 and 62-520.420, Florida Administrative Code (F.A.C.)	Applicable	This rule designates the groundwater of the State into five classes and establishes minimum criteria. This rule also specifies that Classes I and II must meet primary drinking water standards listed in Chapter 62-550 F.A.C.	This rule was used to classify groundwater and establish cleanup goals for groundwater. Groundwater at this site is considered a potential source of drinking water (Class II).
Florida Drinking Water Standards, Monitoring and Reporting	Chapter 62-550.310, F.A.C.	Relevant and Appropriate	This rule provides primary drinking water standards and maximum contaminant levels (MCLs) for public water supply systems.	Cleanup goals for some of the chemicals of concern (COCs) in groundwater are based upon USEPA MCLs listed in the Tables of this rule.
Florida Contaminant Cleanup Target Levels (CTLs)	Chapter 62-777.170, F.A.C.	Relevant and Appropriate	This rule provides guidance for soil, groundwater, and surface water cleanup levels that can be developed on a site-by-site basis.	These guidelines would be used in determining cleanup goals for soil and groundwater.
Florida Contaminated Site Cleanup Criteria	Chapter 62-780.650, F.A.C.	Relevant and Appropriate	This rule provides a phased risk-based corrective action process that is iterative and that tailors site rehabilitation tasks based on site-specific conditions and risk assessment.	These guidelines would be used in determining cleanup goals for soil and groundwater. A lifetime excess cancer risk level of 1.0E-6 and a hazard index of 1 or less considered in developing apportioned CTLs.

TABLE 2-3

FEDERAL LOCATION-SPECIFIC ARARs
SITE 44 FEASIBILITY STUDY REPORT
NAVAL AIR STATION PENSACOLA
PENSACOLA, FLORIDA

Requirement	Citation	Status	Synopsis	Evaluation/Action to be Taken
Historic Sites Act Regulations	36 Code of Federal Regulations (CFR) Part 62	NA	Requires federal agencies to consider the existence and location of landmarks on the National Registry of Natural Landmarks to avoid undesirable impacts on such landmarks.	The existence of Natural Landmarks would be identified prior to remedial activities on site.
Clean Water Act (CWA) Regulations, Guidelines for Specification of Disposal Sites for Dredged or Filled Materials	40 CFR Part 230	NA	These regulations apply to all existing, proposed, or potential disposal sites for discharges of dredged or fill material into U.S. waters, including wetlands.	If remediation involves the discharge of dredged or fill material into U.S. waters, it must be demonstrated that such a discharge will not have an unacceptable effect.

NA – Not applicable

2.2.1 Soil Cleanup Goals

Current land use at NAS Pensacola consists of aviation-related activities at Forrest Sherman Field, various military housing, training, and support activities, and historical facilities open to the public, including the National Museum of Naval Aviation. The current land use scenario at Site 44 will remain industrial for the foreseeable future at NAS Pensacola. Under this scenario, the cleanup goals for soil are to meet the FDEP industrial direct exposure SCTLs:

- cPAHs (benzo(a)pyrene equivalents): 700 µg/kg

2.2.2 Groundwater Cleanup Goals

The FDEP GCTL (3 µg/L) has been selected because it is more stringent than the USEPA MCL (5 µg/L).

- TCE: 3 µg/L

2.3 GENERAL RESPONSE ACTIONS AND ACTION-SPECIFIC ARARs

GRAs are broadly defined remedial approaches that may be used (by themselves or in combination with one or more of the others) to attain the RAOs. Action-specific ARARs and TBCs are those regulations, criteria, and guidances that must be complied with or taken into consideration during remedial activities on site.

2.3.1 General Response Actions

GRAs describe categories of actions that could be implemented to satisfy or address a component of the RAOs for the site. Remedial action alternatives are formed using GRAs individually or in combination to meet the RAOs.

Because current and future land use will involve industrial activities falling under the RMO Level III category, the following GRAs will be considered for soil and groundwater at Site 44:

- No Action
- Limited Action (Natural Attenuation, LUCs, and Monitoring)

2.3.2 Action-Specific ARARs

Action-specific ARARs and TBCs are technology- or activity-based regulatory requirements or guidance that would control or restrict remedial action. Tables 2-4 and 2-5 present lists of federal and state action-specific ARARs and TBCs, respectively, for this FS.

TABLE 2-4

FEDERAL ACTION-SPECIFIC ARARs and TBCs
SITE 44 FEASIBILITY STUDY
NAVAL AIR STATION PENSACOLA
PENSACOLA, FLORIDA
PAGE 1 OF 2

Requirement	Citation	Status	Synopsis	Evaluation/Action to be Taken
Applicable or Relevant and Appropriate Requirements (ARARs)				
Resource Conservation and Recovery Act (RCRA) Regulations, Identification and Listing of Hazardous Wastes	40 Code of Federal Regulation (CFR) Part 261	Applicable	Defines the listed and characteristic hazardous wastes subject to RCRA.	These regulations would apply when determining whether or not a solid waste is hazardous, either by being listed or by exhibiting a hazardous characteristic, as described in the regulations.
RCRA Regulations, General Facility Standards	40 CFR Subpart B, 264.10-264.18	Relevant and Appropriate	Sets general facility requirements including general waste analysis, security measures, inspections, and training requirements. Section 264.18 establishes that a facility located in a 100-year floodplain must be designed, constructed, and maintained to prevent washout of any hazardous wastes by a 100-year flood.	If the remedial action involves construction of an on-site treatment facility, the substantive requirements of this rule would be applicable. A permitted treatment facility must be selected for off-site treatment.
RCRA Regulations, Miscellaneous Units	40 CFR Part 264, Subpart X	Potentially Relevant and Appropriate	These standards are applicable to miscellaneous units not previously defined under existing RCRA regulations. Subpart X outlines performance requirements that miscellaneous units be designed, constructed, operated, and maintained to prevent releases to the subsurface, groundwater, and wetland that may have adverse effects on human health and the environment.	The design of proposed treatment alternatives, not specifically regulated under other subparts of RCRA, must prevent the release of hazardous constituents and future impacts on the environment. This subpart would apply to on-site construction of any treatment facility that is not previously defined under the RCRA regulation.

TABLE 2-4

FEDERAL ACTION-SPECIFIC ARARs and TBCs
SITE 44 FEASIBILITY STUDY
NAVAL AIR STATION PENSACOLA
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Requirement	Citation	Status	Synopsis	Evaluation/Action to be Taken
RCRA Regulations, Standards for Owners and Operators of Hazardous Waste TSDFs.	40 CFR Part 264	Potentially Relevant and Appropriate	Establishes minimum national standards defining the acceptable management of hazardous wastes for owners and operators of facilities that treat, store, or dispose of hazardous wastes.	If remedial actions involve management of RCRA wastes at an off-site TSDF or if RCRA wastes are managed on site, the requirements of this rule would be followed.
RCRA Regulations, Use and Management of Containers	40 CFR Part 264, Subpart I	Potentially Relevant and Appropriate	Sets standards for the storage of containers of hazardous waste.	This requirement would apply if a remedial alternative involves the storage of a hazardous waste (i.e., contaminated soil) in containers prior to treatment or disposal.
To Be Considered (TBCs)				
Air/Superfund National Technical Guidance	USEPA Guidance: EPA/450/1-89/001-EPA/450/1-89/004	To Be Considered	This guidance describes methodologies for predicting risks due to air releases at a Superfund site.	This guidance would be considered when risks due to air releases from fugitive dust are being evaluated.

Notes:

CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act
CFR = Code of Federal Regulations
RCRA = Resource Conservation and Recovery Act
TSDF = Treatment, storage, and disposal facilities
USC = United States Code

TABLE 2-5

STATE ACTION-SPECIFIC ARARs
SITE 44 FEASIBILITY STUDY
NAVAL AIR STATION PENSACOLA
PENSACOLA, FLORIDA
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Requirement	Citation	Status	Synopsis	Evaluation/Action to be Taken
Applicable or Relevant and Appropriate Requirements (ARARs)				
Florida Water Well Permitting and Construction Requirements	Chapter 62-532.500, Florida Administrative Code (F.A.C.)	Applicable	Establishes minimum standards for location, construction, repair, and abandonment of water wells.	These requirements for construction, repair, and abandonment of monitoring and/or extraction, wells will be met.
Florida Natural Attenuation with Monitoring Regulations	Chapter 62-780.690, F.A.C.	Relevant and Appropriate	Specifies minimum number of wells and sampling frequency for groundwater monitoring as part of a Monitored Natural Attenuation (MNA) remedy.	These requirements for implementation of groundwater monitoring as part of an MNA remedy will be met.
Florida Active Remediation Regulation for Groundwater	Chapter 62-780.700, F.A.C.	Potentially Relevant and Appropriate	Specifies that water-level data be collected from monitoring well locations at the time they are sampled.	The requirements of data collection and monitoring during implementation of groundwater remedy will be met.
Florida Post-Active Remediation Monitoring Regulation	Chapter 62-780.750, F.A.C.	Potentially Relevant and Appropriate	Specifies minimum number of wells and sampling frequency for groundwater monitoring as part of post-active remediation monitoring.	The requirements of post-active remediation monitoring following implementation of the groundwater remedy will be met.
Florida Solid Waste Management Facilities	Chapter 62-701, F.A.C.	Potentially Applicable	Sets the facility standards for construction, operation, and closure of SWMUs.	These requirements would apply if on-site waste was deemed a nonhazardous solid waste and needed to be stored, transported, or disposed properly.

TABLE 2-5

STATE ACTION-SPECIFIC ARARs
SITE 44 FEASIBILITY STUDY
NAVAL AIR STATION PENSACOLA
PENSACOLA, FLORIDA
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Requirement	Citation	Status	Synopsis	Evaluation/Action to be Taken
Florida Air Pollution Control Rules – Feb. 2008	Chapter 62-204, F.A.C.	Potentially Relevant and Appropriate	Establishes permitting requirements for owners or operators of any source that emits any air pollutant. These rules also establish ambient air quality standards for sulfur dioxide, carbon monoxide, lead, and ozone.	Although this rule is directly applicable to industrial polluters, these requirements are relevant and appropriate for a remedial action that could result in release of regulated contaminants to the atmosphere.
Florida Regulation of Stormwater Discharge – May 1993	Chapter 62-25, F.A.C.	Potentially Applicable	Establishes requirements for discharges of untreated stormwater to ensure protection of the surface water of the state.	Remedial actions would consider the impact of the discharge of untreated stormwater from the site.

F.A.C. = Florida Administrative Code
SWMU = Solid Waste Management Unit

2.4 ESTIMATED VOLUMES OF CONTAMINATED MEDIA

The chemical-specific volumes of soil and groundwater requiring remediation were estimated using the following medium-specific decision criteria:

Soil

- The volume of soil contaminated by benzo(a)pyrene equivanents was determined based on industrial direct exposure SCTL as the soil cleanup goal (Section 2.2.1).

- The soil area was assumed to extend 10 feet radially from sampling point 44SB31 (Figure 1-6) to a depth of 1 foot bls.

Groundwater

- Volumetric determinations were based on data from monitoring wells with MCL and GCTL exceedance.

- Groundwater contaminant distributions were estimated using the observed groundwater flow direction.

- To account for dispersion, the affected groundwater was assumed to extend to the midway point between the observed GCTL exceedance and the nearest well with a TCE concentration below the GCTL.

- The thickness of the saturated volume of aquifer matrix used in the calculations was 8 feet based on the lithology of the shallow aquifer.

- The estimated porosity of the aquifer matrix was 30 percent based on typical values for the site lithology.

2.4.1 Estimated Chemical-Specific Volume of Contaminated Soil

The benzo(a)pyrene equivalent concentration reported for the field duplicate of one surface soil sample collected at the 44SB02 soil boring location exceeded the residential SCTL. To delineate the extent of cPAHs in this area, 17 additional soil borings (44SB31 to 44SB35 and 44SB41 to 44SB52) were sampled around the 44SB02 location. Only one soil sample collected at a depth of 0.5 foot, the 44SB31 soil boring location, had a benzo(a)pyrene equivalent concentration that exceeded the industrial SCTL. Based on

the proximity of surrounding soil borings, the impacted soil area is assumed to extend 10 feet radially from 44SB31 to a depth of 1 foot bls. It is estimated that approximately 12 cubic yards (yd^3) of soil exceed the industrial direct exposure SCTL for benzo(a)pyrene equivalent (Figure 1-6).

2.4.2 Estimated Chemical-Specific Volume of Contaminated Groundwater

TCE was detected in six shallow monitoring wells at concentrations greater than the FDEP GCTL of 3 µg/L. Based on the results of the groundwater characterization and CVOC delineation sampling, two TCE plumes have been identified (Figure 1-7). The first plume is located in the vicinity of PEN-3221-09 and is estimated to have a radius of approximately 50 feet. The second plume includes monitoring wells PEN-44-11, PEN-44-14, PEN-44-15, PEN-44-21, and PEN-44-24 extends north from the western end of Building 3221, and is approximately 275 feet long and 170 feet wide. These plumes are considered separate because of the distance between PEN-3221-10 and PEN-44-10 is approximately 90 feet, and because the TCE concentration in PEN-3221-10, which previously exceeded the GCTL, is now less than the laboratory detection limit. Based on an aquifer thickness of 8 feet, the estimated volume of water impacted by TCE is approximately 785,000 gallons in total for the two plumes.

3.0 SCREENING OF TECHNOLOGIES AND PROCESS OPTIONS

This section identifies, screens, and evaluates the potential technologies and process options that may be applicable to develop remedial alternatives for Site 44 at NAS Pensacola. The primary objective of this phase of the FS is to develop an appropriate range of remedial technologies and process options that will be used for developing the remedial alternatives.

The basis for technology identification and screening began in Section 2.0 with a series of discussions that included the following:

- Development of RAOs
- Identification of ARARs
- Identification of COCs
- Development of cleanup goals
- Identification of GRAs
- Estimation of volumes and areas of the media of concern

Technology screening evaluation is performed in this section with the completion of the following analytical steps:

- Identification and screening of remedial technologies and process options
- Evaluation and selection of representative process options

A variety of technologies and process options are identified under each GRA (discussed in Section 2.3.1) and screened. The selection of technologies and process options for initial screening is based on the Guidance for Conducting Remedial Investigations/Feasibility Studies under CERCLA (USEPA, 1988). The screening is first conducted at a preliminary level to focus on relevant technologies and process options, then the screening is conducted at a more detailed level based on certain evaluation criteria. Finally, process options are selected to represent the technologies that have passed the detailed evaluation and screening.

The evaluation criteria for detailed screening of technologies and process options that have been retained after the preliminary screening are effectiveness, implementability, and cost. The following are descriptions of these evaluation criteria:

- Effectiveness
  - Protection of human health and environment; reduction in toxicity, mobility, or volume; and permanence of the solution.
  - Ability of the technology to address the estimated areas or volumes of contaminated media.
  - Ability of the technology to meet the cleanup goals identified in the RAOs.
  - Technical reliability (innovative versus proven) with respect to contaminants and site conditions.

- Implementability
  - Overall technical feasibility at the site.
  - Availability of vendors, mobile units, storage and disposal services, etc.
  - Administrative feasibility.
  - Special long-term O&M requirements.

- Cost (Qualitative)
  - Capital cost.
  - O&M costs.

Technologies and process options will be identified for Site 44 in the following sections.

3.1 PRELIMINARY SCREENING OF TECHNOLOGIES AND PROCESS OPTIONS

This section identifies and screens technologies and process options at a preliminary stage based on implementation with respect to site conditions and COCs. Tables 3-1 and 3-2 summarize the preliminary screening of technologies and process options for soil and groundwater at Site 44, respectively. The tables present the GRAs, identify the technologies and process options, and provide a brief description of each process option followed by comments regarding the results of the screening process. The technologies and process options that passed the initial screening step were retained for detailed screening in Section 3.2 and 3.4.

3.2 DETAILED SCREENING OF TREATMENT TECHNOLOGIES AND PROCESS OPTIONS FOR SOIL

This section identifies and develops the representative process options for the soil at Site 44, through a detailed screening procedure, that will be used in the formulation of remedial alternatives to accomplish the RAOs and meet the cleanup goals identified in Section 2. The retained technologies are summarized in Table 3-3.

TABLE 3-1

PRELIMINARY SCREENING OF TECHNOLOGIES AND PROCESS OPTIONS FOR SOIL
SITE 44 FEASIBILITY STUDY
NAVAL AIR STATION PENSACOLA
PENSACOLA, FLORIDA
PAGE 1 OF 4

General Response Action	Technology	Process Option	Description	Screening Comment
No Action	None	Not applicable	No activities would be conducted at the site to address contamination.	Retain. No action is retained as baseline comparison with other technologies.
Limited Action	LUC's (i.e. Institutional and Engineering Controls)	Active controls: Physical barriers/ security guards	Fencing, markers, and warning signs to restrict site access.	Retain. This option could be used to restrict access to the area of concern.
		Passive controls: Restrictions on land use type	Administrative action such as restricting future land use to industrial activities.	Retain. Prohibiting future residential land use (current land use is industrial) will prevent unacceptable risks from exposure to contaminated soil using Risk Management Option Level II.
Containment	Surface capping	Soil cover	Use of soil cover or low-permeability barriers to minimize exposure to contaminants and migration of contaminants.	Eliminate. Application of soil layer(s) over contaminated areas to reduce exposure of human and animal receptors to site contaminants, and to prevent infiltration and provide a physical barrier. Not required under current land use scenario as industrial facility.
Removal	Excavation	Excavation	Means for removal of contaminated soil by backhoe, bulldozer, loader, etc.	Eliminate. Excavation is not considered necessary under current site use scenario as industrial facility.
In-Situ Treatment	Thermal	Vitrification	Use of high-temperature melting to fuse inorganic contaminants into a glass matrix within vadose zone or the use of moderate temperature heating to volatilize and remove contaminants from the vadose zone.	Eliminated because of implementability concerns associated with the shallow groundwater table. Typically used for highly contaminated or radioactive materials.

TABLE 3-1

PRELIMINARY SCREENING OF TECHNOLOGIES AND PROCESS OPTIONS FOR SOIL
SITE 44 FEASIBILITY STUDY
NAVAL AIR STATION PENSACOLA
PENSACOLA, FLORIDA
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General Response Action	Technology	Process Option	Description	Screening Comment
In-Situ Treatment (Continued)	Thermal (Continued)	Radiofrequency heating	Use of radio-frequency energy to heat soil and cause volatilization of contaminants.	Eliminate. Limited thickness and shallow depth of contaminated soil renders this technology difficult to implement with limited, commercially available equipment.
		Electrical heating	Use of an electrical blanket or electrical heating elements within slotted pipes to volatilize contaminants.	Eliminate. The shallow depth to groundwater renders this technology difficult to implement at the site.
	Physical/ Chemical	Soil flushing/ Chemical extraction	Use of water/solvents to remove contaminants from the vadose zone by flushing and collecting the contaminated wastewater in the saturated zone followed by above-ground pumping and treatment.	Eliminated because of concern about migration of contaminants from soil to groundwater.
		Dynamic underground stripping	Steam injection at the periphery of the contaminated area resulting in the vaporization of volatile compounds bound to soil and the movement of contaminants to a centrally located extraction well.	Eliminated because of impracticability in regard to cost verses mass removal.
		Soil vapor extraction	Use of vacuum and possibly air sparging to volatilize contaminants.	Eliminated as a soil remedial technology. cPAHs are not highly volatile and the effectiveness of SVE would be limited.
		Chemical fixation/ Solidification	Mixing of chemical agents in the vadose zone to chemically bind, solidify, and reduce contaminant mobility.	Eliminate. Mobility of soil COCs is not a concern at this site. Moreover the treated material would not be suitable for revegetation.

TABLE 3-1

PRELIMINARY SCREENING OF TECHNOLOGIES AND PROCESS OPTIONS FOR SOIL
SITE 44 FEASIBILITY STUDY
NAVAL AIR STATION PENSACOLA
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General Response Action	Technology	Process Option	Description	Screening Comment
In-Situ Treatment (Continued)	Biological	Biodegradation	Nutrients and amendments are added to surface soil to promote biodegradation.	Eliminated because of the low solubility of the detected PAHs, the strong tendency of PAHs to bind to soil organic matter, and the slow degradation rate for multi-ringed PAHs.
Ex-Situ Treatment	Physical/ Chemical	Soil washing/ Solvent extraction	Use of solubilization and chemical (oxidation/reduction/neutralization) processes to remove contaminants from the solid phase and convert them into more concentrated forms or less toxic forms in the liquid phase.	Eliminated because of the cost associated with low treatment volumes. This technology is more cost effective for larger contaminant plumes than that which is present at Site 44.
		Stabilization/ Solidification	Physically binds or encloses contaminants within a stabilized mass and chemically reduces the hazard potential of a waste by converting the contaminants into less soluble, mobile, or toxic forms.	Eliminated because of its limited effectiveness for the immobilization of SVOCs in contaminated soil.
	Biological	On-site landfarming	Tilling of contaminated soil and waste in layers to remove VOCs and biodegrade organics.	Eliminated because of limited effectiveness for the detected PAHs.

TABLE 3-1

PRELIMINARY SCREENING OF TECHNOLOGIES AND PROCESS OPTIONS FOR SOIL
SITE 44 FEASIBILITY STUDY
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General Response Action	Technology	Process Option	Description	Screening Comment
Ex-Situ Treatment (Continued)	Thermal	Off-site incineration	Use of high temperature to destroy organic contaminants.	Eliminated because of the cost associated with low volumes. This technology is more cost effective for larger contaminant plumes than that which is present at Site 44.
		Low-temperature thermal desorption	Use of low to moderate temperature to volatilize contaminants and remove them from the solid phase into the gaseous phase.	Eliminated because of the cost associated with low volumes. This technology is more cost effective for larger contaminant plumes than that which is present at Site 44.
Disposal	Landfill	Hazardous or non-hazardous waste landfill	Disposal of excavated material at a permitted on-site or off-site landfill. Recycling can be incorporated if scrap metal is present.	Eliminated. Excavation has been eliminated as an option.
		Consolidation	Excavation and placement in one location to minimize space and closure requirements.	Eliminated. Excavation has been eliminated as an option.

Notes:
COCs = Chemicals of concern
cPAH = Carcinogenic polynuclear aromatic hydrocarbon
LUC = Land Use Controls
PAH = Polynuclear hydrocarbon
SVE = Soil Vapor Extraction
SVOC = Semivolatile organic compound
VOC = Volatile organic compound

TABLE 3-2

PRELIMINARY SCREENING OF TECHNOLOGIES AND PROCESS OPTIONS FOR GROUNDWATER
SITE 44 FEASIBILITY STUDY
NAVAL AIR STATION PENSACOLA
PENSACOLA, FLORIDA
PAGE 1 OF 5

General Response Action	Technology	Process Option	Description	Screening Comment
No Action	None	Not applicable	No activities would be conducted at the site to address contamination.	Retain. No action is retained as baseline comparison with other technologies.
Limited Action	LUCs (i.e. Institutional and Engineering Controls)	Active controls: Physical barriers/ security guards	Fencing, markers, and warning signs to restrict site access.	Retained. Restricted access would reduce risk of exposure.
		Passive controls: Restrictions on groundwater use	Administrative action such as restricting the use of groundwater as a source of drinking water.	Retain. Groundwater is currently not used as a drinking water source at Pensacola. This technology will limit all future uses of groundwater and thus limit human exposure to groundwater.
	Monitoring	Sampling and analysis	Periodic sampling and analysis of groundwater to track the spread of contamination.	Retain. This technology could effectively assess natural attenuation and/or migration of contaminants from site and evaluate the progress of active remediation.
	Natural Attenuation	Naturally occurring biodegradation and dilution	Monitoring groundwater to assess the reduction in concentrations of COCs through natural processes.	Retain. This technology might decrease concentrations of TCE over time.
Containment	Vertical Barriers	Slurry wall	Use of a low-permeability wall to restrict horizontal migration of groundwater or to redirect groundwater flow.	Eliminate. This technology would not restore groundwater quality and is used for containment only.
		Grout curtain	Pressure injection of grout to form a low-permeability perimeter wall to restrict horizontal migration of groundwater.	Eliminate. This technology would not restore groundwater quality and is used for containment only.

TABLE 3-2

PRELIMINARY SCREENING OF TECHNOLOGIES AND PROCESS OPTIONS FOR GROUNDWATER
SITE 44 FEASIBILITY STUDY
NAVAL AIR STATION PENSACOLA
PENSACOLA, FLORIDA
PAGE 2 OF 5

General Response Action	Technology	Process Option	Description	Screening Comment
Containment (continued)	Vertical Barriers (continued)	Sheet piling	Metal sheet piling driven into the ground to restrict horizontal migration of groundwater or to redirect groundwater flow.	Eliminate. This technology would not restore groundwater quality and would interfere with continued use of the site as an active Naval air station that has historical facilities open to the public.
	Hydraulic Barriers	Extraction wells	Use of extraction wells and/or collection trenches to restrict horizontal migration of groundwater.	Eliminate. This technology would not restore groundwater quality.
	Horizontal Barriers	Physical barrier	Injection of bottom-sealing slurry beneath source to minimize vertical migration of groundwater.	Eliminate. The source is not migrating vertically.
Removal	Groundwater Extraction	Extraction wells	Series of conventional pumping wells used to remove contaminated groundwater.	Eliminate. This technology is considered effective for containment only.
		Collection trench	A permeable trench used to intercept and collect groundwater.	Eliminate. This technology is considered effective for containment only.
In-Situ Treatment	Biological	Aerobic	Enhancement of biodegradation of organics by addition of nutrients and oxidizers.	Eliminate. The COC is a chlorinated VOC that degrades more favorably under anaerobic conditions.
		Anaerobic	Enhancement of biodegradation of organics in an anaerobic (oxygen-deficient) environment by injection of electron-donor compounds	Eliminate, the concentrations of TCE in groundwater are too low to effectively stimulate or enhance bioremediation.
	Physical/ Chemical	Air sparging/ Soil vapor extraction	Volatilization of organics by supply of air and extraction of organic compounds.	Retain. This technology is potentially effective because the aquifer predominantly consists of fine sand.

TABLE 3-2

PRELIMINARY SCREENING OF TECHNOLOGIES AND PROCESS OPTIONS FOR GROUNDWATER
SITE 44 FEASIBILITY STUDY
NAVAL AIR STATION PENSACOLA
PENSACOLA, FLORIDA
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General Response Action	Technology	Process Option	Description	Screening Comment
Ex-Situ Treatment	Physical	Filtration	Separation of suspended solids from water via entrapment in a bed of granular media or membrane.	Eliminate. All extraction technologies have been eliminated from consideration.
		Reverse osmosis	Use of high pressure and membranes to separate dissolved materials from water.	Eliminate. All extraction technologies have been eliminated from consideration.
		Air stripping	Contact of water with air to remove volatile organics.	Eliminate. All extraction technologies have been eliminated from consideration.
		Gas-phase granular activated carbon	Separation of volatilized contaminants from a gas stream via adsorption onto activated carbon.	Eliminate. All extraction technologies have been eliminated from consideration.
		Solvent extraction	Separation of contaminants from a solution by contact with an immiscible liquid with a higher affinity for the COCs.	Eliminate. All extraction technologies have been eliminated from consideration.
		Sedimentation	Separation of solids from water via gravity settling.	Eliminate. All extraction technologies have been eliminated from consideration.
	Chemical	Ion exchange	Process in which ions, held by electrostatic forces to charged functional groups on a resin surface, are exchanged for ions of similar charge in a water stream.	Eliminate. All extraction technologies have been eliminated from consideration.

TABLE 3-2

PRELIMINARY SCREENING OF TECHNOLOGIES AND PROCESS OPTIONS FOR GROUNDWATER
SITE 44 FEASIBILITY STUDY
NAVAL AIR STATION PENSACOLA
PENSACOLA, FLORIDA
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General Response Action	Technology	Process Option	Description	Screening Comment
Ex-Situ Treatment (continued)	Chemical (continued)	Electrolytic recovery	Passage of an electric current through a solution with resultant ion recovery on positive and negative electrodes.	Eliminate. All extraction technologies have been eliminated from consideration.
		Chemical precipitation	Use of reagents to convert soluble constituents into insoluble constituents.	Eliminate. All extraction technologies have been eliminated from consideration.
		Enhanced oxidation	Use of oxidizers such as ozone, hydrogen peroxide, or potassium permanganate to break down certain organic compounds.	Eliminate. All extraction technologies have been eliminated from consideration.
		Neutralization/pH adjustment	Use of acids or bases to counteract excess pH.	Eliminate. All extraction technologies have been eliminated from consideration.
Discharge/ Disposal	Surface discharge	Direct discharge (NPDES)	Discharge of treated water to surface water.	Eliminate. All extraction technologies have been eliminated from consideration.
		Indirect discharge (IWTP/STP)	Discharge of collected/treated water to a Sewage Treatment Plant (STP).	Eliminate. All extraction technologies have been eliminated from consideration.
		Offsite treatment Facility	Treatment and disposal of water at an offsite treatment works.	Eliminate. All extraction technologies have been eliminated from consideration.
	Subsurface discharge	Re-injection	Use of injection wells, spray irrigation, or infiltration to discharge collected/treated groundwater underground.	Eliminate. All extraction technologies have been eliminated from consideration.

TABLE 3-2

PRELIMINARY SCREENING OF TECHNOLOGIES AND PROCESS OPTIONS FOR GROUNDWATER
SITE 44 FEASIBILITY STUDY
NAVAL AIR STATION PENSACOLA
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Notes:
LUC = Land Use Controls
COCs = Chemicals of concern
IWTP = Industrial Wastewater Treatment Plant
NPDES = National Pollutant Discharge Elimination System
TCE = Trichloroethene
VOC = Volatile organic compound
STP = Sewage Treatment plant

TABLE 3-3

TECHNOLOGIES AND PROCESS OPTIONS RETAINED FOR DETAILED SCREENING FOR SOIL
SITE 44 FEASIBILITY STUDY
NAVAL AIR STATION PENSACOLA
PENSACOLA, FLORIDA

General Response Action	Remedial Technology	Process Option
No Action	None	Not applicable
Limited Action	LUCs	Administrative Controls: Prohibition of future residential land use

Note:

LUC = Land Use Controls

3.2.1 No Action

The No Action alternative consists of maintaining the current status of the site, i.e., no remedial action is taken under this response. As required under CERCLA regulations, the No Action alternative is carried through the FS to provide a baseline for comparison with other alternatives and their effectiveness in mitigating risks posed by site contaminants.

Effectiveness

A No Action alternative would not be effective in meeting the RAOs. The contaminated media are left as is without the implementation of any monitoring, LUCs, containment, removal, treatment, or other mitigation actions. Thus, No Action would not actively reduce the toxicity, mobility, or volume of contaminants in the soil.

Implementability

There would be no implementability concerns because no action would be implemented.

Cost

There would be no costs associated with the No Action alternative.

Conclusion

No action is retained because of NCP requirements, although it would not be effective.

3.2.2 Limited Action

3.2.2.1 Institutional Controls

LUCs would be developed to prevent unacceptable risks from exposure to soil at the site. LUCs would permit Site 44 to be managed using RMO Level III, pursuant to Chapter 62 780-680(2), F.A.C.

LUC performance objectives for Site 44 would be as follows:

- Prohibit residential or residential-like use of the site unless prior written approval is obtained from the Navy, USEPA, and FDEP. Prohibited residential or residential-like uses shall include, but are not limited to, any form of housing, any kind of school (including pre-schools, elementary schools,

and secondary schools), child care facilities, playgrounds, and adult convalescent and nursing care facilities.

- Prohibit the excavation of surface and subsurface soil from the site unless prior written approval is obtained from the Navy, USEPA, and FDEP.

- Restrict access to the area of concern to limit exposure by workers to surface soil. The area of concern is considered a 10 feet radius surrounding sample location 44SB31.

- Maintain access restrictions unless prior written approval is obtained from the Navy, USEPA, and FDEP.

A LUC Remedial Design (RD) would be prepared. Periodic inspections of the site would be conducted to confirm compliance with LUC objectives, and an annual compliance certificate would be prepared and provided to USEPA and FDEP. Prior to any property conveyance, USEPA and FDEP would be notified.

Effectiveness

LUCs would not reduce the toxicity, mobility, or volume of COCs in soil. cPAH contamination may degrade through natural processes over time. Prohibiting future residential or residential-like development and restricting worker access to the site would effectively prevent the occurrence of unacceptable risks to human receptors from direct exposure to contaminated surface and subsurface soil. Groundwater monitoring would verify that contaminant migration from soil to groundwater is not occurring.

Implementability

LUCs would be readily implementable. The implementability of these controls would be more of a concern if the site is transferred to private owners. Provisions would be incorporated into property transfer documents to insure the continued implementation of LUCs. Resources are readily available for the preparation of a LUC RD.

Cost

Costs for LUCs would be low.

Conclusion

LUCs are retained for the development of remedial alternatives.

3.3 SELECTION OF REPRESENTATIVE PROCESS OPTIONS FOR SOIL

The following GRAs, technologies, and process options, under the GRAs as noted, were retained for the development of soil remedial alternatives:

- No Action
- Limited Action: LUCs

All process options listed in Table 3-3 were retained for the formulation of alternatives. The list of options is limited because of the industrial land use classification and the site meeting the requirements of RMO Level III.

3.4 DETAILED SCREENING OF TECHNOLOGIES AND PROCESS OPTIONS FOR GROUNDWATER

This section identifies and develops the representative process options for groundwater at Site 44, through a detailed screening procedure, that will be used in the formulation of remedial alternatives to accomplish the RAOs and meet the cleanup goals identified in Section 2. The retained technologies are summarized in Table 3-4.

3.4.1 No Action

The No Action alternative consists of maintaining the current status of the site, i.e., remedial action is not taken under this response. As required under CERCLA regulations, the No Action alternative is carried through the FS to provide a baseline for comparison with other alternatives and their effectiveness in mitigating risks posed by the COCs at the site.

Effectiveness

A No Action alternative would not be effective in meeting the RAOs. The contaminated media are left as is without the implementation of any monitoring, LUCs, containment, removal, treatment, or other mitigation actions. Thus, No Action would not actively reduce the toxicity, mobility, or volume of contaminants in the groundwater.

Implementability

There would be no implementability concerns because no action would be implemented.

TABLE 3-4

**TECHNOLOGIES AND PROCESS OPTIONS
RETAINED FOR DETAILED SCREENING FOR GROUNDWATER
SITE 44 FEASIBILITY STUDY
NAVAL AIR STATION PENSACOLA
PENSACOLA, FLORIDA**

General Response Action	Remedial Technology	Process Option
No Action	None	Not applicable
Limited Action	LUCs	Restriction on all uses of groundwater
	Monitoring	Periodic sampling and analysis of groundwater to track natural attenuation
	Natural attenuation	Monitoring groundwater to assess the reduction in concentrations of COCs through natural processes
In-Situ Treatment	Air Sparging/ Soil Vapor Extraction	Supply of air and extraction of volatilized organic compounds

Note:

COC = Chemical of concern

LUC = Land Use Controls

Cost

There would be no costs associated with the No Action alternative.

Conclusion

No Action is retained for comparison to other options per NCP requirements.

3.4.2 Limited Action

3.4.2.1 Land Use Controls

LUCs would be developed to prevent unacceptable risks from exposure to contaminated groundwater. These LUCs would be formulated and implemented to prevent the extraction of surficial aquifer groundwater at Site 44. The following performance objectives would be incorporated into the LUC RD:

- Prohibit all uses of groundwater from the surficial aquifer underlying the site (including, but not limited to, human consumption, dewatering, irrigation, heating/cooling purposes, and industrial processes) unless prior written approval is obtained from the Navy, USEPA, and FDEP.

- Maintain the integrity of any existing or future monitoring or remediation system(s) unless prior written approval is obtained from the Navy, USEPA, and FDEP.

Periodic inspections of the site would be conducted to confirm compliance with LUC objectives, and an annual compliance certificate would be prepared and provided to USEPA and FDEP. Prior to any property conveyance, USEPA and FDEP would be notified.

Effectiveness

Groundwater use restrictions would be effective in combination with plume remediation activities. These controls would minimize potential human health risks associated with exposure to contaminated groundwater.

Implementability

LUCs would be readily implementable. NAS Pensacola will remain an active military facility in the foreseeable future. Groundwater is currently not used as a drinking water source at NAS Pensacola because of high mineralization. LUCs would assure prohibition of future use of groundwater and thus limit human exposure to groundwater at the site.

Cost

Costs for LUCs would be low.

Conclusion

LUCs are retained in combination with other process options for the development of groundwater remedial alternatives.

3.4.2.2 Monitoring

Sampling and analysis of groundwater throughout the area of groundwater contamination could be used to evaluate migration of COCs and the potential for contamination of possible future on-site drinking water supplies. Monitoring could also be used to monitor potential natural attenuation or the progress of active groundwater remediation. Monitoring would consist of regularly measuring the water levels in existing and new monitoring wells and collecting and analyzing groundwater samples from some of the 28 existing and two new shallow monitoring wells located within and surrounding the TCE plume to assess the performance of natural attenuation in accordance with FDEP natural attenuation monitoring requirements. Also, a vertical extent monitoring well will be installed. The vertical extent monitoring well will be screened between the depth of the existing water table and deep monitoring wells and would be more likely to adequately assess the vertical extent of the TCE plume and provide adequate compliance monitoring.

Effectiveness

Monitoring would not of itself reduce the toxicity, mobility, or volume of COCs in the groundwater, but it would allow the evaluation of potential off-site migration of contaminants and the expected reduction in contaminant concentrations through natural attenuation. Periodic groundwater monitoring would serve as a warning mechanism for contaminant migration. Monitoring would also be helpful in measuring and evaluating the effectiveness of natural attenuation and/or active remediation technologies.

For the first 5 years, the performance monitoring samples would also be analyzed for natural attenuation parameters. Sampling frequency would be quarterly for the first year, semi-annually for the next 2 years, and annually thereafter. Site reviews would be performed every 5 years to evaluate the continued effectiveness of natural attenuation.

Implementability

A groundwater monitoring program could be readily implemented at Site 44. Local and state permits would be required for monitoring well installation.

Cost

Capital and O&M costs for monitoring would be low.

Conclusion

Monitoring is retained in combination with other process options for the development of groundwater remedial alternatives.

3.4.2.3 Natural Attenuation

Natural attenuation would consist of monitoring groundwater quality to determine the extent to which naturally occurring processes such as biodegradation, abiotic transformation, dispersion, and dilution would reduce concentrations of TCE in the two plumes. For this purpose, new monitoring wells would be installed as required, and samples from these new wells and existing wells would be regularly collected and analyzed for natural attenuation parameters such as oxidation/reduction potential (ORP), dissolved oxygen (DO), pH, alkalinity, temperature, conductivity, total organic carbon (TOC), ferrous and total iron, sulfur compounds (sulfides, sulfates), nitrogen compounds (nitrites, nitrates), orthophosphates, chloride, and metabolic gases (methane, ethane, ethene, and carbon dioxide).

Effectiveness

The detected TCE concentrations are relatively low, varying from 5 to 52 µg/l. Limited historical information suggests that natural attenuation may be occurring at Site 44. Cis 1,2-DCE an anerobic degradation product of the natural attenuation of TCE was detected in a groundwater sample collected from the site. Also, several studies have been conducted to obtain MNA data and to evaluate treatability of petroleum related constituents using oxygen enriching technologies at various sites across NAS Pensacola that meet the intent of the above tiered approach. The preponderance of evidence for MNA from these studies suggest that the shallow groundwater across NAS Pensacola is typically under reducing (anaerobic) conditions that range from limited to strongly favorable for reductive dechlorination of chlorinated solvents and reducing conditions that potentially result in the sorption and immobilization of some inorganics (Appendix B). In the UST investigation in 1992, four wells had TCE concentrations greater than the GCTL. Currently, only one of these four wells, PEN-3221-09, which previously had a TCE concentration of 5 µg/L (ABB-ES, 1993), continues to exceed the GCTL. The TCE concentrations

detected in groundwater samples collected from monitoring wells PEN-3221-09, PEN-44-11, PEN-44-14, PEN-44-15, PEN-44-21, PEN-44-22 and PEN-44-24 were below its FDEP natural attenuation default screening criteria.

Natural attenuation mechanisms other than reductive de-chlorination and biodegradation could still be effective for the removal of TCE through advection, dispersion and dilution. However, such natural attenuation mechanisms are typically slower in reducing concentrations of TCE.

Groundwater monitoring would provide an effective means of evaluating the concentrations of TCE in groundwater and of assessing the rate of decrease of the concentrations. Monitoring of indicator parameters would help to evaluate the potential effectiveness of the reductive dechlorination process.

Implementability

Natural attenuation would be easy to implement. Monitoring groundwater quality and periodically reviewing site conditions could readily be performed, and the necessary resources are available to provide these services.

Cost

Capital and O&M costs for natural attenuation would be low to moderate.

Conclusion

Natural attenuation is retained for the development of remedial alternatives because this technology could be effective in the long term and for the relatively low TCE concentrations at the site.

3.4.3 In-Situ Treatment - Air Sparging/Soil Vapor Extraction

Air sparging (AS) consists of injecting air into a contaminant plume to induce an air current through the groundwater that promotes short-term stripping of VOCs and long-term biodegradation of residual VOCs. Air is injected through a network of vertical wells screened at various depths within the contaminant plume. If capture and treatment of vaporized groundwater COCs or treatment of overlying soil (vadose zone) is required, a soil vapor extraction (SVE) system is added. In this case, a vacuum is applied through a network of vertical wells screened in the vadose zone above the contaminant plume, and the extracted vapors are collected and treated either through vapor-phase granular activated carbon (GAC) adsorption or another acceptable technology such as catalytic oxidation. Groundwater samples are regularly collected and analyzed to monitor the progress of the remedial action and, if an SVE system is used, off-gas samples are collected and analyzed to evaluate its performance and to verify compliance

with regulatory emission requirements. Natural Attenuation, LUCs and monitoring would be the same as described in Section 3.4.2 Limited Action.

Effectiveness

AS and AS/SVE are well-established technologies that could be effective for the removal of TCE from the two TCE plumes at Site 44. Because of the low concentrations of TCE in Site 44 groundwater, it is anticipated that an SVE off-gas treatment system, such as activated carbon, would not be required. TCE would be removed primarily through volatilization.

The use of AS results in highly aerobic subsurface conditions, and a significant lag time (possibly up to 6 months) is required following application for the subsurface to readjust to anaerobic conditions if anoxic/anaerobic reductive natural attenuation is required to complete the remediation process.

Implementability

AS/SVE could be implemented at Site 44. Many qualified contractors would be available for the implementation of this technology. Installation of AS and SVE wells through concrete or asphalt surfaces at the site would have to be followed by repair with like material to match the existing conditions. Load-rated well vaults may be required in paved areas.

Cost

Capital and O&M costs for AS/SVE would be moderate.

Conclusion

AS/SVE is retained for further consideration.

3.5 SELECTION OF REPRESENTATIVE TECHNOLOGIES AND PROCESS OPTIONS FOR GROUNDWATER

The following GRAs, technologies, and process options, under the GRAs as noted, were retained for the development of groundwater remedial alternatives:

- No Action
- Limited Action: LUCs, monitoring, and natural attenuation
- In-Situ Treatment: air sparging with soil vapor extraction

The next step is to select representative process options from each technology to assemble an adequate variety of alternatives and evaluate the alternatives in sufficient detail to aid in the final selection process. All process options listed in Table 3-4 were retained for the development of alternatives.

4.0 ASSEMBLY AND DETAILED ANALYSIS OF REMEDIAL ALTERNATIVES

4.1 INTRODUCTION

This section presents an evaluation of each remedial alternative with respect to the criteria of the NCP (40 CFR Part 300). These criteria and the relative importance of these criteria are described in the following subsections.

4.1.1 Evaluation Criteria

In accordance with the NCP (40 CFR Part 300.430), the following nine criteria are used for the evaluation of remedial alternatives:

Threshold Criteria:

- Overall Protection of Human Health and the Environment
- Compliance with ARARs

Primary Balancing Criteria:

- Long-Term Effectiveness and Permanence
- Reduction of Toxicity, Mobility, or Volume through Treatment
- Short-Term Effectiveness
- Implementability
- Cost

Modifying Criteria:

- State Acceptance
- Community Acceptance

4.1.1.1 Overall Protection of Human Health and the Environment

Alternatives must be assessed for adequate protection of human health and the environment, in both the short and long term, from unacceptable risks posed by hazardous substances or contaminants present at the site by eliminating, reducing, or controlling exposure to levels exceeding cleanup goals. Overall protection draws on the assessments of other evaluation criteria, especially long-term effectiveness and permanence, short-term effectiveness, and compliance with ARARs.

4.1.1.2 Compliance with ARARs

Alternatives must be assessed to determine whether they attain ARARs under federal environmental laws and state environmental or facility siting laws. CERCLA Section 121(d) specifies in part that remedial actions for cleanup of hazardous substances must comply with requirements and standards under federal or more stringent state environmental laws and regulations that are applicable or relevant and appropriate (i.e., ARARs) to the hazardous substances or particular circumstances at a site or a waiver must be obtained [see also 40 CFR 300.430(f)(1)(ii)(B)]. ARARs include only federal and state environmental or facility siting laws/regulations and do not include occupational safety or worker protection requirements. In addition, per 40 CFR 300.405(g)(3), other advisories, criteria, or guidance may be considered in determining remedies (TBC guidance category).

4.1.1.3 Long-Term Effectiveness and Permanence

Alternatives must be assessed for the long-term effectiveness and permanence they offer, along with the degree of certainty that the alternative will prove successful. Factors that will be considered as appropriate include the following:

- Magnitude of Residual Risk - Risk posed by untreated waste or treatment residuals at the conclusion of remedial activities. The characteristics of residuals should be considered to the degree that they remain hazardous, taking into account their volume, toxicity, mobility, and propensity to bioaccumulate.

- Adequacy and Reliability of Controls - Controls such as containment systems and LUCs that are necessary to manage treatment residuals and untreated waste must be shown to be reliable. In particular, the uncertainties associated with land disposal for providing long-term protection from residuals; the assessment of the potential need to replace technical components of the alternative such as a cap, slurry wall, or treatment system; and the potential exposure pathways and risks posed if the remedial action needs replacement.

4.1.1.4 Reduction of Toxicity, Mobility, or Volume through Treatment

The degree to which the alternative employs recycling or treatment that reduces the toxicity, mobility, or volume will be assessed, including how treatment is used to address the principal threats posed by the site. Factors that will be considered, as appropriate, include the following:

- The treatment or recycling processes the alternative employs and the materials that they will treat.

- The amount of hazardous substances, pollutants, or contaminants that will be destroyed, treated, or recycled.

- The degree of expected reduction in toxicity, mobility, or volume of waste due to treatment or recycling and the specification of which reduction(s) is occurring.

- The degree to which the treatment is irreversible.

- The type and quantity of residuals that will remain following treatment, considering the persistence, toxicity, mobility, and propensity to bioaccumulate of such hazardous substances and their constituents.

- The degree to which treatment reduces the inherent hazards posed by principal threats at the site.

4.1.1.5 Short-Term Effectiveness

The short-term impacts of the alternative will be assessed considering the following:

- Short-term risks that might be posed to the community during implementation.

- Potential impacts on workers during remedial action and the effectiveness and reliability of protective measures.

- Potential environmental impacts of the remedial action and the effectiveness and reliability of mitigative measures during implementation.

- Time until protection is achieved.

4.1.1.6 Implementability

The ease or difficulty of implementing the alternatives will be assessed by considering the following types of factors, as appropriate:

- Technical feasibility, including technical difficulties and unknowns associated with the construction and operation of a technology, the reliability of the technology, ease of undertaking additional remedial actions, and the ability to monitor the effectiveness of the remedy.

- Administrative feasibility, including activities needed to coordinate with other offices and agencies, and the ability and time required to obtain any necessary approvals and permits from other agencies (for off-site actions).

- Availability of services and materials, including the availability of adequate off-site treatment capacity, storage capacity, and disposal capacity and services; the availability of necessary equipment and specialists, and provisions to ensure necessary additional resources; the availability of services and materials; and the availability of prospective technologies.

4.1.1.7 Cost

Capital costs will include both direct and indirect costs. Annual O&M costs will be provided, and a net present value of the capital and O&M costs will also be provided. Typically, the cost estimate accuracy range is plus 50 percent to minus 30 percent.

4.1.1.8 State Acceptance

The state's concerns that must be assessed include the following:

- The state's position and key concerns related to the preferred alternative and other alternatives
- State comments on ARARs or the proposed use of waivers

These concerns cannot be evaluated until the State has reviewed and commented on the FS. These concerns will be discussed, to the extent possible, in the Proposed Plan to be issued for public comment.

4.1.1.9 Community Acceptance

This assessment consists of responses of the community to the Proposed Plan and includes determining which components of the alternatives interested persons in the community support, have reservations about, or oppose. This assessment can be conducted after comments on the Proposed Plan are received from the public.

4.1.2 Relative Importance of Criteria

Among the nine criteria, the threshold criteria are considered to be:

- Overall Protection of Human Health and the Environment
- Compliance with ARARs (excluding those that may be waived)

The threshold criteria must be satisfied for an alternative to be eligible for selection.

Among the remaining criteria, the following five criteria are considered to be the primary balancing criteria:

- Long-Term Effectiveness and Permanence
- Reduction of Contaminant Toxicity, Mobility, or Volume through Treatment
- Short-Term Effectiveness
- Implementability
- Cost

The balancing criteria are used to weigh the relative merits of the alternatives.

The remaining two of the nine criteria: State Acceptance and Community Acceptance are considered to be modifying criteria that must be considered during remedy selection. These last two criteria can be evaluated after the FS has been reviewed by the State of Florida and the Proposed Plan has been discussed at a public meeting, if required and requested, and opened to public comment. Therefore, this document addresses only seven of the nine evaluation criteria.

4.1.3 Selection of Remedy

The selection of a remedy is a two-step process. The first step consists of identification of a preferred alternative and presentation of the alternative in a Proposed Plan to the community for review and comment. The preferred alternative must meet the following criteria:

- Protection of human health and the environment.
- Compliance with ARARs unless a waiver is justified.
- Cost effectiveness in protecting human health and environment and in complying with ARARs.
- Utilization of permanent solutions and alternate treatment technologies or resource recovery technologies to the maximum extent practicable.

The second step consists of the review of public comments and determination by the Navy and USEPA, in consultation with FDEP as to whether the preferred alternative continues to be the most appropriate remedial action for the site.

4.2 ASSEMBLY AND DETAILED ANALYSIS OF REMEDIAL ALTERNATIVES FOR SOIL

Based on the detailed screening of technologies and process options presented in Sections 3.2 and 3.3, the following two remedial alternatives were developed for soil at Site 44:

- Alternative S1: No Action
- Alternative S2: LUCs

Alternative S1 was developed and analyzed to serve as a baseline for other alternatives, as required by CERCLA and the NCP. Alternative S2 was formulated and analyzed to evaluate the adequacy of minimal action. A description and detailed analysis of these alternatives are presented in the following sections.

4.2.1 Alternative S1: No Action

4.2.1.1 Description

The No Action alternative maintains the site as is. This alternative does not address the soil contamination and is retained to provide a baseline for comparison to other alternatives. There would not be a reduction in toxicity, mobility, or volume of the contaminants other than what would result from natural dispersion, dilution, biodegradation, and other attenuating factors. The site would be available for unrestricted use.

4.2.1.2 Detailed Analysis

Threshold Criteria:

Overall Protection of Human Health and the Environment

Alternative S1 would not provide protection of human health and the environment. Under the current commercial/industrial land use, there could be unacceptable risks to human health from direct exposure to contaminated soil, and this potential for unacceptable risk would increase if Site 44 is further developed. Because monitoring would not be performed, potential migration of COCs from soil to groundwater would not be detected.

Compliance with ARARs

Alternative S1 would not comply with chemical-specific ARARs because no action would be taken to reduce contaminant concentrations. Compliance with location-specific ARARs would be possible, but not actively pursued. Action-specific ARARs are not applicable to this alternative.

Primary Balancing Criteria:

Long-Term Effectiveness and Permanence

Alternative S1 would have no long-term effectiveness and permanence because contaminated soil would remain on site. Because there would not be LUCs to restrict the disturbance of soil within the site boundaries, the potential would also exist for unacceptable risk to develop for human receptors. Because there would not be monitoring, potential off-site migration of COCs would not be detected. Although COC concentrations might eventually decrease to cleanup goals through natural attenuation, monitoring not be performed to verify this.

Reduction of Toxicity, Mobility, or Volume through Treatment

Alternative S1 would not reduce the toxicity, mobility, or volume of contaminants through treatment because treatment would not occur. Some reduction of the toxicity and volume of COCs might occur through natural dispersion, dilution, or other attenuation processes, but monitoring would not be performed to verify this.

Short-Term Effectiveness

Because no action would occur, implementation of Alternative S1 would not pose any risks to on-site workers or result in short-term adverse impact to the local community and the environment. Alternative S1 would never achieve the RAOs and, although the cleanup goal might eventually be achieved through natural attenuation, this would not be verified through monitoring.

Implementability

Because no action would occur, Alternative S1 would be readily implementable. The technical feasibility criteria, including constructability, operability, and reliability, are not applicable. Implementability of administrative measures is not applicable because no such measures would be taken.

Cost

There would be no costs associated with the No Action alternative.

4.2.2 Alternative S2: LUCs

4.2.2.1 Description

Alternative S2 would consist of the implementation of LUCs to limit the exposure of industrial workers to contaminated soil via direct exposure. The LUCs would have the following performance objectives:

- Prohibit residential or residential-like use of the site unless prior written approval is obtained from the Navy, USEPA, and FDEP. Prohibited residential or residential-like uses include, but are not limited to, any form of housing, any kind of school (including pre-schools, elementary schools, and secondary schools), child care facilities, playgrounds, and adult convalescent and nursing care facilities.

- Prohibit the excavation of surface and subsurface soil from the site unless prior written approval is obtained from the Navy, USEPA, and FDEP.

- Restrict access to the area of concern to limit exposure of workers to surface soil. The area of concern is considered to be the 10 feet radius surrounding sample point 44SB31 to a depth of 1 foot bls.

- Maintain access restrictions unless prior written approval is obtained from the Navy, U.S EPA, and FDEP.

Annual inspections of the site would be conducted to confirm compliance with LUC objectives, and an annual compliance certificate would be prepared and provided to USEPA and FDEP. Prior to any property conveyance, USEPA and FDEP would be notified. The LUCs would be implemented through a LUC RD that would be prepared as a component of the overall RD.

LUCs would be developed in accordance with the Principles and Procedures for Specifying, Monitoring, and Enforcement of Land Use Controls and Other Post-ROD Actions, per a letter dated October 2, 2003, from Raymond F. DuBois, Deputy Under Secretary of Defense (Installations and Environment), to Hon. Marianne Lamont Horinko, Acting Administrator, USEPA. Implementation of this alternative would therefore require a survey of the site, annual visual inspections, and five-year review report preparation.

The LUCs would be maintained for as long as concentrations of hazardous substances remain in excess of levels that allow for unlimited use and unrestricted exposure.

4.2.2.2 Detailed Analysis

Threshold Criteria:

Overall Protection of Human Health and the Environment

Alternative S2 would be protective of human health and the environment.

Because cPAHs have relatively low mobility values, the cPAHs in soil are not likely to migrate. Natural attenuation would eventually reduce the concentrations of cPAHs to less than the benzo(a)pyrene equivalent cleanup goal (FDEP industrial direct exposure SCTL).

LUCs would be protective of human health and the environment. Restricting surficial and subsurface soil exposure would be protective of human health by preventing unacceptable risks from exposure to contaminated soil.

Some short-term risks to workers from exposure to contamination during implementation of this alternative are possible. However, the potential for such exposure would be minimized by the wearing of appropriate personal protective equipment (PPE) and compliance with site-specific health and safety procedures.

Adverse short-term or cross-media effects are not anticipated as a result of implementing this alternative.

Compliance with ARARs

Alternative S2 would comply with location- and action-specific ARARs. In the short-term, this alternative would not comply with chemical-specific ARARs such as the FDEP SCTL, but eventually, compliance would be achieved as natural processes in the soil reduce concentrations of cPAHs to the benzo(a)pyrene equivalent cleanup goal.

Primary Balancing Criteria:

Long-Term Effectiveness and Permanence

Alternative S2 would provide long-term effectiveness and permanence. Although active treatment of contaminated soil would not occur, risks to human health and the environment would be controlled.

Naturally occurring processes such as biodegradation, dispersion, and dilution would reduce concentrations of cPAHs to the cleanup goal over the long term. However, it would be some time before

these processes achieve the cleanup goal, and risk from exposure to contaminated soil would be addressed through LUCs, which would effectively prevent unacceptable risk from exposure until the cleanup goals have been met.

Reduction of Toxicity, Mobility, or Volume through Treatment

Although active treatment is not included in Alternative S2, the volume and toxicity of cPAHs would eventually be reduced over time through natural attenuation processes. This alternative would not reduce the mobility of cPAHs because no containment, removal, or treatment would be provided. Treatment residues would not be generated by this alternative.

Short-Term Effectiveness

Alternative S2 would have minimal short-term effectiveness concerns. Exposure of workers to contamination would be minimized by the wearing of appropriate PPE and complying with site-specific health and safety procedures. Alternative S2 would also not adversely impact the surrounding community or the environment.

Implementability

Alternative S2 would be readily implementable. The resources, equipment, and materials required to implement these activities are readily available.

The administrative aspects of Alternative S2 would be relatively simple to implement. Construction permits would not be required for this alternative.

Cost

The estimated costs for Alternative S2 are as follows:

Capital:	$15,000
30-Year Inspection and Site Review:	$71,000
30-Year net present worth (NPW):	$86,000

The above cost figures have been rounded to the nearest $1,000 to reflect the preliminary nature of these estimates. A detailed breakdown of estimated costs for this alternative is provided in Appendix A.

4.3 ASSEMBLY AND DETAILED ANALYSIS OF REMEDIAL ALTERNATIVES FOR GROUNDWATER

Based on the detailed screening of technologies and process options presented in Sections 3.2 and 3.3, the following four remedial alternatives were developed:

- Alternative G1: No Action
- Alternative G2: Natural Attenuation, LUCs, and Monitoring
- Alternative G3: AS/SVE of TCE, Natural Attenuation, LUCs, and Monitoring

Alternative G1 was developed and analyzed to serve as a baseline for other alternatives, as required by CERCLA and the NCP. Alternative G2 was formulated and analyzed to evaluate the adequacy of minimal action. Alternative G3 was formulated and analyzed to evaluate active remediation of the areas with the most contaminated groundwater. A description and detailed analysis of these alternatives are presented in the following sections.

4.3.1 Alternative G1: No Action

4.3.1.1 Description

The No Action alternative maintains the site as is. This alternative does not address the groundwater contamination and is retained to provide a baseline for comparison to other alternatives. There would not be a reduction in toxicity, mobility, or volume of the contaminants other than what would result from natural dispersion, dilution, biodegradation, and other attenuating factors. The site would be available for unrestricted use.

4.3.1.2 Detailed Analysis

Threshold Criteria:

Overall Protection of Human Health and the Environment

Alternative G1 would not provide protection of human health and the environment. Under the current commercial/industrial land use, there could be unacceptable risks to human health from exposure to contaminated groundwater, and this potential for unacceptable risk would increase if Site 44 is further developed. Groundwater contamination might migrate off site and, although this migration would not have an immediate negative impact because Site 44 is located far from any surface water body, such a negative impact could eventually develop. Because monitoring would not be performed, potential migration of TCE would not be detected.

Compliance with ARARs

Alternative G1 would not comply with chemical-specific ARARs (MCLs, CSFs, RfDs, and GCTLs) because no action would be taken to reduce contaminant concentrations. Compliance with location-specific ARARs would be possible, but not actively pursued. Action-specific ARARs are not applicable to the alternative.

Primary Balancing Criteria:

Long-Term Effectiveness and Permanence

Alternative G1 would have no long-term effectiveness and permanence because contaminated groundwater would remain on site. Because there would not be LUCs to restrict the use of surficial aquifer groundwater, the potential would exist for unacceptable risk to develop for human receptors. Because there would not be groundwater monitoring, potential off-site migration of TCE would not be detected. Although TCE concentrations might eventually decrease to the cleanup goal through natural attenuation, monitoring would not be conducted to verify this.

Reduction of Toxicity, Mobility, or Volume through Treatment

Alternative G1 would not reduce toxicity, mobility, or volume of contaminants through treatment because treatment would not occur. Some reduction of the toxicity and volume of TCE might occur through natural dispersion, dilution, or other attenuation processes, but monitoring would not be performed to verify this.

Short-Term Effectiveness

Because no action would occur, implementation of Alternative G1 would not pose any risks to on-site workers or result in short-term adverse impact to the local community and the environment. Alternative G1 would never achieve the RAOs and, although the cleanup goal might eventually be achieved through natural attenuation, this would not be verified through monitoring.

Implementability

Because no action would occur, Alternative G1 would be readily implementable. The technical feasibility criteria, including constructability, operability, and reliability, are not applicable. Implementability of administrative measures is not applicable because no such measures would be taken.

Cost

There would be no costs associated with the No Action alternative.

4.3.2 Alternative G2: Natural Attenuation, LUCs, and Monitoring

4.3.2.1 Description

Alternative G2 would consist of three major components: (1) natural attenuation, (2) LUCs, and (3) monitoring.

Component 1: Natural Attenuation

Natural attenuation would rely on naturally occurring processes within the aquifer to reduce the concentrations of TCE. Aquifer conditions (geochemical parameters) would be continually monitored to ensure that concentrations are being adequately reduced through natural processes.

Component 2: LUCs

LUCs would be developed to prevent unacceptable risks from exposure to contaminated groundwater. These LUCs would have the following performance objectives:

- Prohibit all uses of groundwater from the surficial aquifer underlying Site 44 (including, but not limited to, human consumption, dewatering, irrigation, heating/cooling purposes, and industrial processes) unless prior written approval is obtained from the Navy, USEPA, and FDEP.

- Maintain the integrity of any existing or future monitoring or remediation system(s) unless prior written approval is obtained from the Navy, USEPA, and FDEP.

Annual inspections of the site would be conducted to confirm compliance with LUC objectives, and an annual compliance certificate would be prepared and provided to USEPA and FDEP. Prior to any property conveyance, USEPA and FDEP would be notified.

The LUCs would be implemented through a LUC RD that would be prepared as a component of the overall RD. The LUCs would be maintained for as long as they are required to prevent unacceptable exposure to contaminated groundwater.

Component 3: Monitoring

Monitoring would consist of regularly collecting water level measurement from the 28 existing and new monitoring wells and analyzing groundwater samples from some of the 28 existing and two new shallow monitoring wells located within and surrounding the TCE plumes to assess the performance of natural attenuation in accordance with FDEP natural attenuation monitoring guidance. Also, a vertical extent monitoring well will be installed. The vertical extent monitoring well will be screened between the depth of the eisting water table and deep monir=toringe wells and would be more likely to adequately assess the vertical extent of the TCE plume and provide adequate compliance monitoring. For the first 5 years, the performance monitoring samples would also be analyzed for natural attenuation parameters. Sampling frequency would be quarterly for the first year, semi-annually for the next 2 years, and annually thereafter.

Based on the current plume footprint (Figure 1-7), two new monitoring wells would be installed north-northeast of PEN-44-24 (Figure 4-1) and designated as “sentinel” wells. If analysis of the groundwater collected from these sentinel wells indicated that the cleanup goal had been exceeded, the following step-by-step actions would be taken:

1. The sentinel well(s) where the exceedance(s) was detected would be resampled to verify the exceedance(s).

2. If the exceedance(s) is verified, hydrogeological modeling would be performed to determine a predicted expansion of the contaminant plume(s) based on the new monitoring data.

3. If the expansion of the contaminant plume(s) predicted by the additional modeling is such that it would be of concern, contingency remedies would be developed.

Site reviews would be conducted every 5 years to evaluate the continued adequacy of the remedy.

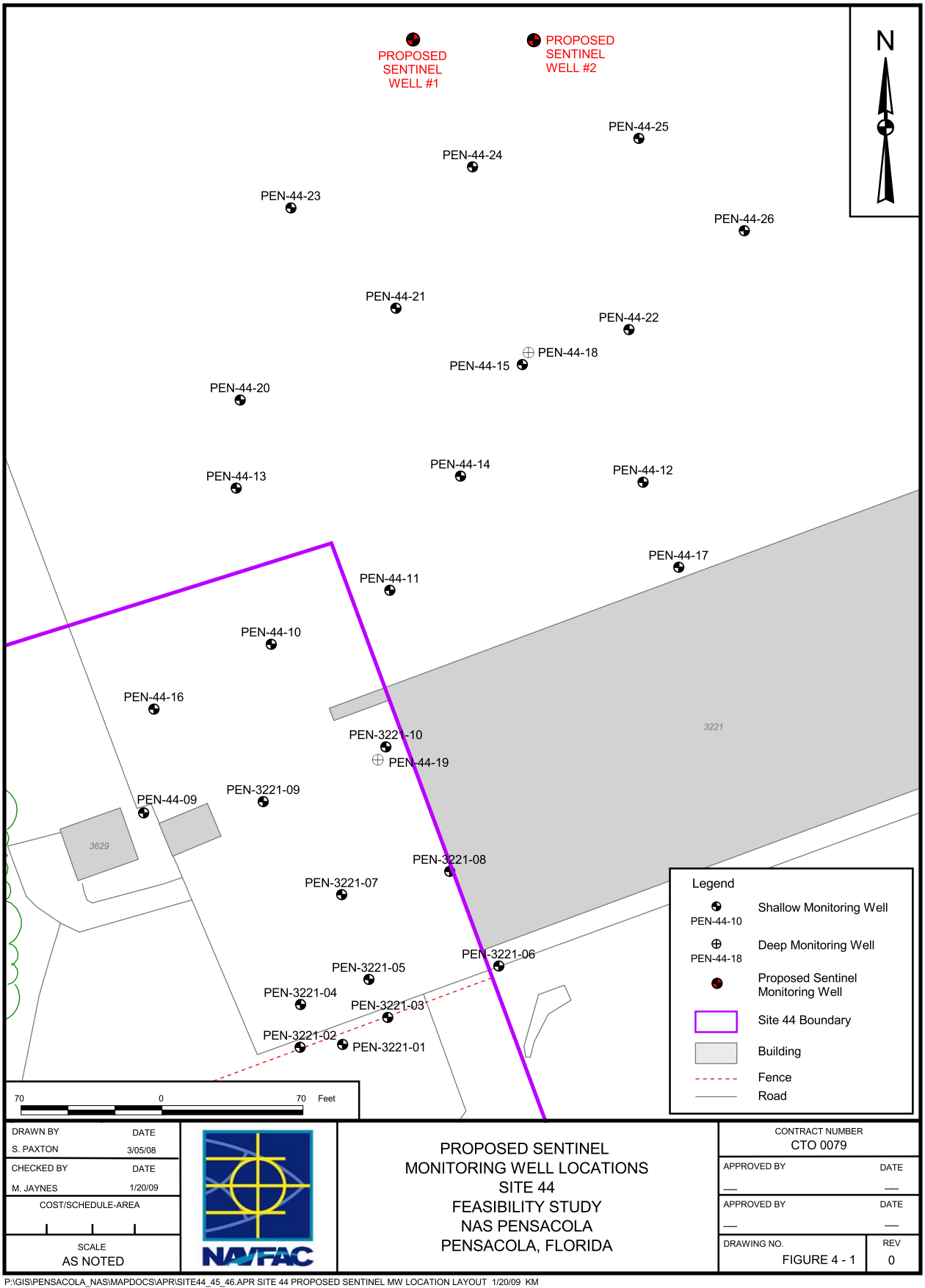
4.3.2.2 Detailed Analysis

Threshold Criteria:

Overall Protection of Human Health and the Environment

Alternative G2 would be protective of human health and the environment.

Although the TCE plumes could expand, natural attenuation would be expected to eventually reduce the concentrations of TCE to less than its GCTL. If the results of monitoring conducted as part of this



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alternative indicate otherwise and that expansion of the TCE plumes could have a negative environmental impact, contingency remedies would be implemented to prevent such an occurrence.

LUCs would be protective of human health and the environment. Restricting the use of surficial aquifer groundwater would be protective of human health by preventing unacceptable risks from exposure to contaminated groundwater.

Monitoring would be protective of the environment by evaluating the progress of natural attenuation and detecting potential migration of contaminated groundwater so that appropriate contingency measures could be taken, if required.

Some short-term risks would not be incurred by workers during groundwater sampling. However, any potential for exposure would be minimized by the wearing of appropriate PPE and compliance with site-specific health and safety procedures.

Adverse short-term or cross-media effects are not anticipated as a result of implementing this alternative.

Compliance with ARARs

Alternative G2 would comply with location- and action-specific ARARs. In the short-term, this alternative would not comply with chemical-specific ARARs such as the FDEP GCTL, but eventually, compliance would be achieved as natural processes in the aquifer reduce concentrations of TCE to its cleanup goal, and this would be verified through monitoring.

Primary Balancing Criteria:

Long-Term Effectiveness and Permanence

Alternative G2 would provide long-term effectiveness and permanence. Although active treatment of contaminated groundwater would not occur and the TCE plumes may expand, risks to human health and the environment would be monitored and controlled.

Naturally occurring processes such as biodegradation would reduce concentrations of TCE to its cleanup goal over the long term. However, it would be some time before these processes achieve the cleanup goal, and risk from exposure to contaminated groundwater would be addressed through LUCs, which would effectively prevent unacceptable risk from exposure until the cleanup goal has been met.

Long-term monitoring would be an effective means to evaluate the progress of natural attenuation and to warn of potential future migration of contaminated groundwater. Supporting trend data are not available for the preparation of a model to predict attenuation rates for TCE and its daughter products. However, an attenuation model could be prepared after 1 year of natural attenuation sampling.

Reduction of Toxicity, Mobility, or Volume through Treatment

Although active treatment is not included in Alternative G2, the volume and toxicity of TCE would eventually be reduced over time through natural attenuation processes. This alternative would not reduce the mobility of TCE because no containment, removal, or treatment would be provided. Treatment residues would not be generated by this alternative.

Short-Term Effectiveness

Alternative G2 would have minimal short-term effectiveness concerns. Exposure of workers to contamination during the maintenance and sampling of monitoring wells would be minimized by the wearing of appropriate PPE and complying with site-specific health and safety procedures. Alternative G2 would also not adversely impact the surrounding community or the environment.

The time frame required to reach RAOs is estimated to be 5 to 10 years due to the limited amount of laboratory analytical data. Data would be available to more accurately estimate the time required to reach the RAOs after obtaining four quarters of groundwater monitoring for natural attenuation parameters, TCE and degradation product concentrations..

Implementability

Alternative G2 would be readily implementable.

Maintenance of existing monitoring wells, sampling and analysis of groundwater, and performance of regular site inspections and 5-year reviews could readily be accomplished. The resources, equipment, and materials required to implement these activities are readily available.

The administrative aspects of Alternative G2 would be relatively simple to implement. Construction permits would not be required for this alternative. Establishment of LUCs would require negotiation and agreement on the specifics of the procedures between the Navy, USEPA, FDEP, and potential future site owners who might be affected by deed restrictions.

Cost

The estimated costs for Alternative G2 are as follows:

Capital Cost:	$44,000
30-Year NPW of Monitoring Costs:	$227,000
30-Year NPW:	$271,000

The above cost figures have been rounded to the nearest $1,000 to reflect the preliminary nature of these estimates. A detailed breakdown of estimated costs for this alternative is provided in Appendix A.

4.3.3 Alternative G3: In-Situ AS/SVE, Natural Attenuation, LUCs, and Monitoring

4.3.3.1 Description

Alternative G3 would consist of four major components: (1) in-situ treatment of the TCE plumes via AS/SVE, (2) natural attenuation of remaining areas within the TCE plumes, (3) LUCs and (4) monitoring.

Component 1: AS/SVE of the TCE Plumes

This component would consist of installing and operating an AS/SVE system consisting of 31 AS wells and 19 SVE wells (Figure 4-2). Air would be delivered to the sparge wells at a rate of 10 to 15 cubic feet per minute (cfm) per well. The SVE wells would extract air from the vadose zone at an approximate rate of 25 cfm per well. The AS and SVE wells would be connected to the equipment building via an underground piping network. Based on experience with AS/SVE systems and plumes with similar size and concentrations, it is anticipated that the AS/SVE system would operate for 2 years.

Component 2: Natural Attenuation

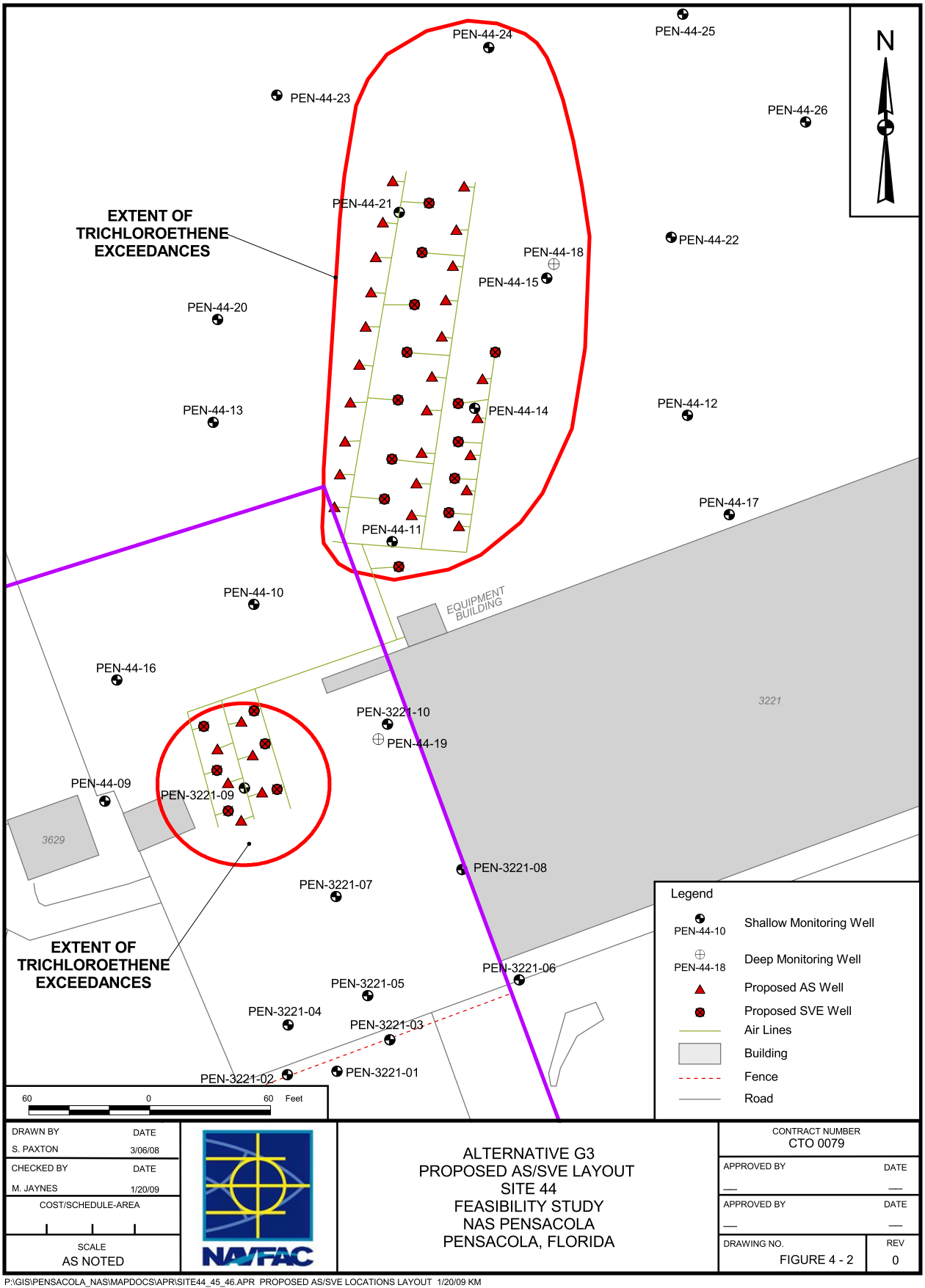
This component, to be initiated following active remediation, would be the same as Component 2 of Alternative G2.

Component 3: LUCs

This component would be identical to Component 2 of Alternative G2.

Component 4: Monitoring

This component would be to the same as Component 3 of Alternative G2. However, aerobic parameters, such as DO would be added to the geochemistry parameters. Additional monitoring would



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be required for the AS/SVE system, including, but not limited to flow rates, pressure, vacuum, influent vapor concentrations, and treated effluent concentrations to evaluate system performance.

4.3.3.2 Detailed Analysis

Threshold Criteria:

Overall Protection of Human Health and the Environment

Alternative G3 would be protective of human health and the environment. By actively removing the majority of groundwater contamination, AS/SVE would reduce risk from exposure to contaminated groundwater and provide protection to future human receptors.
LUCs would be protective of human health and the environment during the remedial period until cleanup goals are met. Restricting the use of surficial aquifer groundwater would be protective of human health and the environment by avoiding unacceptable risks of exposure to contaminated groundwater.

Monitoring would be protective by evaluating the effectiveness of the in-situ treatment, measuring natural attenuation, and detecting potential migration of groundwater COCs.

Some short-term risks could be incurred by workers from exposure to contamination during the installation of AS/SVE system piping. However, the potential for this exposure would be minimized by the wearing of appropriate PPE and compliance with site-specific health and safety procedures.

Adverse short-term or cross-media effects are not anticipated as a result of implementing this alternative.

Compliance with ARARs and TBCs

Alternative G3 would eventually comply with chemical-specific ARARs and TBCs through active remediation followed by monitored natural attenuation. Alternative G3 would also comply with location- and action-specific ARARs and TBCs.

Primary Balancing Criteria:

Long-Term Effectiveness and Permanence

Alternative G3 would provide long-term effectiveness and permanence. AS/SVE of the TCE plumes would be expected to effectively remove the majority of groundwater contamination. Although AS/SVE is a well-established technology, its effectiveness for the treatment of the Site 44 TCE plumes could be limited due to the relatively low concentrations of TCE within the plume. The current TCE concentrations

are less than the FDEP Natural Attenuation Default Source Concentrations (NADSCs), indicating that active remediation may not be necessary.

Groundwater use restrictions would effectively prevent the use of surficial aquifer groundwater until the TCE cleanup goal is met. Long-term monitoring would be an effective means to evaluate the progress of remediation and verify that no migration of COCs is occurring. The controls proposed in this alternative are considered reliable.

Reduction of Toxicity, Mobility, or Volume through Treatment

Alternative G3 would reduce the toxicity, mobility and volume of TCE in groundwater. AS/SVE could permanently and irreversibly remove an estimated 0.22 pound of TCE from groundwater. No treatment residues would be generated by this alternative.

Short-Term Effectiveness

Alternative G3 would reduce human health risks in the short term because groundwater use restrictions would be implemented. Exposure of workers to contamination during installation of SVE and AS wells, construction and operation of the groundwater treatment system, and groundwater monitoring would be minimized by compliance with Occupational Safety and Health Administration (OSHA) requirements including wearing of appropriate PPE and adherence to site-specific health and safety procedures. Implementation of AS/SVE system, LUCs and monitoring would not adversely impact the surrounding community or the environment.

Based on experience, it is anticipated that the life cycle of the AS/SVE system will be 2 years. It is estimated that an additional 3 years of monitored natural attenuation will be required to reach the RAO.

Implementability

Alternative G3 would be implementable. However, trenching and pipe placement may prove challenging in the area behind Building 3221 due to thick concrete and aircraft traffic.

Cost

The estimated costs for Alternative G3 are as follows:

Capital Cost:	$631,000
5-Year NPW of O&M Costs:	$282,000
5-Year NPW:	$913,000

A detailed breakdown of the estimated costs for this alternative is provided in Appendix A.

5.0 COMPARATIVE ANALYSIS OF ALTERNATIVES

This section compares the analyses for each of the remedial alternatives presented in Section 4.0 of this FS. The criteria for comparison are identical to those used for the detailed analysis of individual alternatives.

5.1 COMPARISON OF REMEDIAL ALTERNATIVES BY CRITERIA

The following remedial alternatives for Site 44 are being compared in this section:

Soil

- Alternative S1: No Action
- Alternative S2: LUCs

Groundwater

- Alternative G1: No Action
- Alternative G2: Natural Attenuation, LUCs, and Monitoring
- Alternative G3: In-Situ AS/SVE, Natural Attenuation, LUCs, and Monitoring

The alternatives above are being compared using the following criteria:

Threshold Criteria

- Overall Protection of Human Health and the Environment
- Compliance with ARARs

Primary Balancing Criteria

- Long-Term Effectiveness and Permanence
- Reduction of Toxicity, Mobility, or Volume through Treatment
- Short-Term Effectiveness
- Implementability
- Cost

Modifying Criteria

- State Acceptance
- Community Acceptance

5.1.1 Overall Protection of Health and Environment

Soil

Alternative S1 would not protect human health and the environment because nothing would prevent exposure to contaminated soil that could result in unacceptable risk to human receptors. Also under this alternative, knowledge of the potential future migration of cPAHs would not be known because monitoring would not be performed.

Alternative S2 would be protective of human health and the environment by restricting the use of surficial and subsurface soil and would prevent unacceptable risks from exposure to contaminated soil.

Groundwater

Alternative G1 would not protect human health and the environment because nothing would prevent exposure to contaminated groundwater that could result in unacceptable risk to human receptors. Also under this alternative, knowledge of the potential future migration of TCE would not be known because monitoring would not be performed.

Alternatives G2 and G3 would be protective of human health and the environment. The natural attenuation component of Alternative G2 would be protective because it would eventually reduce the concentrations of TCE to its cleanup goal over a reasonable time frame (estimated to be 5 to 10 years). The LUC component of Alternative G2 would be protective because it would prevent exposure to contaminated groundwater until the cleanup goal is met. The monitoring component of Alternative G2 would be protective because it would assess the progress of natural attenuation and warn of potential future migration of TCE.

Alternative G3 would be more protective than Alternative G2, because, in addition to the same natural attenuation, LUCs, and monitoring components, this alternative would also include an active treatment component that would accelerate the removal of TCE. The time frame is estimated to be 2 years for active remediation and 3 years for natural attenuation.

5.1.2 Compliance with ARARs

Soil

Alternative S1 would not comply with chemical- and location-specific ARARs. Action-specific ARARs would not apply to this alternative.

Alternative S2 would comply with location- and action-specific ARARs.

Alternative S2 would not immediately comply with chemical-specific ARARs, but this alternative would eventually achieve compliance for cPAHs as the benzo(a)pyrene equivalent cleanup goal is achieved through natural attenuation. Exposure to soil with contaminant concentrations greater than chemical-specific ARARs would be prevented by LUCs.

Groundwater

Alternative G1 would not comply with chemical- and location-specific ARARs. Action-specific ARARs would not apply to this alternative.

Alternatives G2 and G3 would comply with location- and action-specific ARARs.

Alternatives G2 and G3 would not immediately comply with chemical-specific ARARs, but these alternatives would eventually achieve compliance as they the TCE attain cleanup goal through active remediation and/or natural attenuation.

5.1.3 Long-Term Effectiveness and Permanence

Soil

Alternative S1 would not have long-term effectiveness and permanence. Because there would be not be a restriction of land use and/or site development, human receptors could be exposed to contaminated soil. Because there would not be any monitoring, the progress of natural attenuation would not be assessed, and there would be knowledge of potential future migration of the cPAHs.

Alternative S2 would provide long-term effectiveness and permanence. The LUC component of Alternative S2 would effectively prevent exposure to contaminated surface soil and subsurface through implementation of restrictions and site inspections.

Groundwater

Alternative G1 would not have long-term effectiveness and permanence. Because there would not be a restriction of groundwater use and/or site development, human receptors could be exposed to contaminated groundwater. Because there would not be monitoring, the progress of natural attenuation would not be known, and there would not be any knowledge of potential future migration of TCE.

Alternatives G2 and G3 would provide long-term effectiveness and permanence.

Over time, the natural attenuation component of Alternative G2 would effectively and permanently reduce the concentration of TCE to the cleanup goal. The LUC component of Alternative G2 would effectively prevent exposure to contaminated groundwater until the cleanup goal is achieved. The monitoring

component of Alternative G2 would effectively assess the progress of natural attenuation and could verify that TCE migration is not occurring.

Alternative G3 would be more effective than Alternative G2, because, in addition to the natural attenuation, LUC, and monitoring components, this alternative would also include an active treatment component that would effectively treat the areas of groundwater contamination and thus accelerate the removal of TCE followed by natural attenuation.

5.1.4 Reduction of Toxicity, Mobility, or Volume through Treatment

Soil

Alternatives S1 and S2 would not achieve reduction of toxicity, mobility, or volume of cPAHs through treatment. Both alternatives would achieve reduction of cPAH toxicity and volume through natural attenuation; however, this reduction would neither be verified nor quantified.

Groundwater

Alternative G1 would not achieve any reduction of toxicity, mobility, or volume of TCE through treatment. This alternative would achieve reduction of contaminant toxicity and volume through natural attenuation; however, this reduction would neither be verified nor quantified.

Alternative G2 would eventually achieve reduction of toxicity and volume of TCE through natural attenuation.

Alternative G3 would achieve reductions in TCE toxicity and volume through treatment. Alternative G3 would permanently and irreversibly remove an estimated 0.00013 pounds of TCE from the groundwater AS/SVE. Alternative G3 would not generate treatment residues.

5.1.5 Short-Term Effectiveness

Soil

Implementation of Alternative S1 would not result in risks to site workers or adversely impact the surrounding community or environment because no remedial activities would be performed. Alternative S1 would not achieve the RAOs, and although the cleanup goal might eventually be attained through natural processes, this would not be verified.

Alternative S2 would have minimal short-term effectiveness concerns. Exposure of workers to contamination would be minimized by the wearing of appropriate PPE and complying with site-specific

health and safety procedures. Alternative S2 would also not adversely impact the surrounding community or the environment.

Groundwater

Implementation of Alternative G1 would not result in risks to site workers or adversely impact the surrounding community or environment because remedial activities would not be performed. Alternative G1 would not achieve the RAOs, and although the cleanup goal might eventually be attained through natural processes, this would not be verified.

Implementation of Alternative G2 would result in a slight possibility of exposing site workers to contaminated groundwater during the installation, maintenance, and sampling of new and existing monitoring wells. However, these risks of exposure would be effectively controlled by wearing appropriate PPE and compliance with proper site-specific health and safety procedures. Implementation of Alternative G2 would not adversely impact the surrounding community or environment. The time frame required to reach the RAO is estimated to be 5 to 10 years. Following four quarters of groundwater monitoring for natural attenuation parameters, data would be available to estimate the time required to reach the RAO.

Implementation of Alternative G3 would result in a significant possibility of exposing construction workers to contaminated groundwater during the construction of in-situ groundwater treatment systems, installation of new monitoring wells, and sampling of new and existing wells. However, as for Alternative G2, these risks of exposure would be effectively controlled by wearing appropriate PPE and compliance with proper site-specific health and safety procedures. Implementation of Alternative G3 would not adversely impact the surrounding community or the environment. It is estimated that Alternative G3 would remove the TCE plumes through active remediation and natural attenuation within approximately 5 years (2 years active remediation and 3 years natural attenuation).

5.1.6 Implementability

Soil

Alternative S1 would be easiest to implement because there would be no activities to implement.

Technical implementation of the LUCs of Alternative S2 would not be difficult. The resources required for the activities associated with this component are readily available.

Administrative implementation of the various components of Alternative S2 would be relatively simple. As part of any future transfer in ownership of the site from military to public, appropriate provisions would be incorporated into the property transfer documents to ensure continued enforcement of LUCs.

Groundwater

Alternative G1 would be easiest to implement because there would be no activities to implement.

Technical implementation of Alternative G2 would be relatively simple. The technical implementation of the natural attenuation, LUC, and monitoring components of Alternative G2 would not be difficult. The resources, equipment, and material required for the activities associated with these components are readily available.

The technical implementation of Alternative G3 would be somewhat more difficult than that of Alternative G2 because this alternative would require the installation and operation and maintenance (O&M) of a groundwater remediation system. A number of qualified contractors are available locally, and the resources, equipment, and material necessary to implement either of these alternatives are also readily available.

Administrative implementation of the LUC and monitoring components of Alternative G2 would be relatively simple. The administrative implementation of Alternative G3 would be slightly more difficult than that of Alternative G2. In addition to the same requirements as Alternative G2, the construction and operation of the remediation systems for Alternative G3 would have to comply with the substantive requirements of any identified ARARs.

5.1.7 Cost

The capital and O&M costs and NPW of the soil alternatives are as follows.

Alternative	Capital	NPW of O&M	NPW
S1	$0	$0	$0
S2	$15,000	$71,000 (30 years)	$86,000 (30 years)

The capital and O&M costs and NPW of the groundwater alternatives are as follows.

Alternative	Capital	NPW of O&M	NPW
G1	$0	$0	$0
G2	$44,000	$227,000 (<10 years)	$271,000 (<10 years)
G3	$631,000	$282,000 (5 years)	$913,000 (5 years)

Detailed cost estimates for all alternatives are provided in Appendix A.

5.2 SUMMARY OF COMPARATIVE ANALYSIS OF REMEDIAL ALTERNATIVES

Tables 5-1 and 5-2 summarize the comparative analysis of the soil and groundwater remedial alternatives, respectively.

TABLE 5-1

SUMMARY OF COMPARATIVE ANALYSIS OF REMEDIAL ALTERNATIVES - SOIL
SITE 44 FEASIBILITY STUDY
NAS PENSACOLA
PENSACOLA, FLORIDA
PAGE 1 OF 2

Evaluation Criterion	Alternative S1: No Action	Alternative S2: LUCs
Overall Protection of Human Health and Environment	Would not provide protection of human health and the environment. Because no monitoring would be performed, potential migration of COCs would not be detected.	Would be protective of human health and the environment. Restricting access to surficial and subsurface soil would be protective of human health by preventing unacceptable risks from exposure to contaminated soil.
Compliance with ARARs: Chemical-Specific Location-Specific Action-Specific	 Would not comply Would not comply Not applicable	 Would eventually comply Would comply Would comply
Long-Term Effectiveness and Permanence	Would have no long-term effectiveness and permanence. Contaminant reduction or migration would not be detected because monitoring would not occur.	Would provide long-term effectiveness and permanence. Although no active treatment of contaminated soil would occur, risks to human health and the environment would be controlled.
Reduction of Contaminant Toxicity, Mobility, or Volume through Treatment	Would not reduce toxicity, mobility, or volume of contaminants through treatment because no treatment would occur. Some reduction of the toxicity and volume of COCs might occur through natural dispersion, dilution, or other attenuation processes, but no monitoring would be performed to verify.	The volume and toxicity of cPAHs would eventually be reduced over time through natural attenuation processes. This alternative would not reduce the mobility of COCs because no containment, removal, or treatment would be provided. No treatment residues would be generated by this alternative.

TABLE 5-1

SUMMARY OF COMPARATIVE ANALYSIS OF REMEDIAL ALTERNATIVES - SOIL
SITE 44 FEASIBILITY STUDY
NAS PENSACOLA
PENSACOLA, FLORIDA
PAGE 2 OF 2

Evaluation Criterion	Alternative S1: No Action	Alternative S2: LUCs
Short-Term Effectiveness	Would not pose any risks to on-site workers or result in short-term adverse impact to the local community and the environment. Would never achieve the RAOs and, although the cleanup goal might eventually be achieved through natural attenuation, this would not be verified through monitoring.	Would have minimal short-term effectiveness concerns. Exposure of workers to contamination would be minimized by the wearing of appropriate PPE and complying with site-specific health and safety procedures. Would also not adversely impact the surrounding community or the environment.
Implementability	Because no action would occur, Alternative 1 would be readily implementable.	Would be readily implementable.
Costs: Capital NPW of O&M NPW	 $0 $0 	 $15,000 $71,000 $86,000

ARARs = Applicable or Relevant and Appropriate Requirements
COCs = Chemicals of concern
cPAH = Carcinogenic Polynuclear Aromatic Hydrocarbons
LUCs = Land use controls
NPW = Net present worth
O&M = Operation and maintenance
PPE = Personal protective equipment
RAOs = Remedial Action Objectives
SCTLs = Soil Cleanup Target Levels
TSDF = Treatment Storage and Disposal Facility

TABLE 5-2

SUMMARY OF COMPARATIVE ANALYSIS OF REMEDIAL ALTERNATIVES - GROUNDWATER
SITE 44 FEASIBILITY STUDY
NAS PENSACOLA
PENSACOLA, FLORIDA

Evaluation Criterion	Alternative G1: No Action	Alternative G2: Natural Attenuation, LUCs, and Monitoring	Alternative G3: In-Situ AS/SVE, Natural Attenuation, LUCs, and Monitoring
Overall Protection of Human Health and Environment	Would not provide protection of human health and the environment. Under the current commercial/industrial land use, there could be unacceptable risks to human health from exposure to contaminated groundwater, and this potential for unacceptable risk would increase if Site 44 is further developed. Because no monitoring would be performed, potential migration of TCE would not be detected.	Would be protective of human health and the environment. Although the TCE plumes could expand, natural attenuation would eventually reduce the concentrations of TCE to less than the GCTL. LUCs would be protective of human health and the environment. Restricting the use of surficial aquifer groundwater would be protective of human health by preventing unacceptable risks from exposure to contaminated groundwater. Monitoring would be protective of the environment by evaluating the progress of natural attenuation and detecting potential migration of contaminated groundwater so that appropriate contingency measures could be taken, if required.	Would be protective of human health and the environment. By actively removing the majority of groundwater contamination, AS/SVE would prevent the expansion of the TCE plumes. This would ultimately eliminate risk from exposure to contaminated groundwater and provide protection to future human receptors that may use this aquifer as a potable water source. LUCs would be protective of human health and the environment during the remedial period until cleanup goal is met. Restricting the use of surficial aquifer groundwater would be protective of human health and the environment by avoiding unacceptable risks of exposure to contaminated soil and groundwater. Monitoring would be protective by evaluating the effectiveness of the in-situ treatment, measuring natural attenuation and detecting potential migration of TCE.
Compliance with ARARs: Chemical-Specific Location-Specific Action-Specific	 Would not comply Would not comply Not applicable	 Would eventually comply Would comply Would comply	 Would eventually comply Would comply Would comply
Long-Term Effectiveness and Permanence	Would have no long-term effectiveness and permanence because contaminated groundwater would remain on site. Because there would be no LUCs to restrict the use of surficial aquifer groundwater, the potential would also exist for unacceptable risk to human receptors. Because there would be no groundwater monitoring, potential off-site migration of TCE would not be detected. Although TCE concentrations might eventually decrease to the cleanup goal through natural attenuation, no monitoring would verify this.	Would provide long-term effectiveness and permanence. Naturally occurring processes such as biodegradation would reduce concentrations of TCE to its cleanup goal over the long term. Long-term monitoring would be an effective means to evaluate the progress of natural attenuation and to warn of potential future migration of contaminated groundwater.	Would provide long-term effectiveness and permanence. AS/SVE of the TCE plumes is expected to effectively remove the majority of groundwater contamination. LUCs would effectively prevent the use of surficial aquifer groundwater until the cleanup goal is met. Long-term monitoring would be an effective means to evaluate the progress of remediation and verify that no migration of TCE is occurring.
Reduction of Contaminant Toxicity, Mobility, or Volume through Treatment	Would not reduce toxicity, mobility, or volume of contaminants through treatment because no treatment would occur. Some reduction of the toxicity and volume of TCE might occur through natural dispersion, dilution, or other attenuation processes, but no monitoring would be performed to verify.	The volume and toxicity of TCE would eventually be reduced over time through natural attenuation processes. This alternative would not reduce the mobility of TCE because no containment, removal, or treatment would be provided. No treatment residues would be generated by this alternative.	Would reduce the toxicity, mobility and volume of contaminated groundwater. AS/SVE could permanently and irreversibly remove an estimated 0.22 pound of TCE from groundwater. No treatment residues would be generated by this alternative.

TABLE 5-2

SUMMARY OF COMPARATIVE ANALYSIS OF REMEDIAL ALTERNATIVES - GROUNDWATER
SITE 44 FEASIBILITY STUDY
NAS PENSACOLA
PENSACOLA, FLORIDA
PAGE 2 OF 2

Evaluation Criterion	Alternative G1: No Action	Alternative G2: Natural Attenuation, LUCs, and Monitoring	Alternative G3: In-Situ AS/SVE, Natural Attenuation, LUCs, and Monitoring
Short-Term Effectiveness	Would not pose any risks to on-site workers or result in short-term adverse impact to the local community and the environment. No Action would not achieve the RAOs and, although the cleanup goal might eventually be achieved through natural attenuation, this would not be verified through monitoring.	Would have minimal short-term effectiveness concerns. Exposure of workers to contamination during the maintenance and sampling of monitoring wells would be minimized by the wearing of appropriate PPE and complying with site-specific health and safety procedures. This alternative would not adversely impact the surrounding community or the environment.	Would reduce human health risks in the short term because LUCs would be implemented to prohibit groundwater use. Exposure of workers to contamination during installation of SVE and AS wells, construction and operation of the groundwater treatment systems, and groundwater sampling would be minimized by compliance with health and safety requirements including wearing of appropriate PPE and adherence to site-specific health and safety procedures. Implementation of LUCs and monitoring would not adversely impact the surrounding community or the environment.
Implementability	Because no action would occur, Alternative 1 would be readily implementable.	Would be readily implementable. Maintenance of existing monitoring wells, sampling and analysis of groundwater, and performance of regular site inspections and 5-year reviews could readily be accomplished. The resources, equipment, and materials required to implement these activities are readily available. The administrative aspects would be relatively simple to implement.	Would be implementable. However, trenching and pipe placement may prove challenging in the area behind Building 3221 due to thick concrete and aircraft traffic.
Costs:			
Capital	$0	$44,000	$631,000
NPW of O&M	$0	$227,000	$282,000
NPW	$0	$271,000	$913,000

Notes:

ARARs = Applicable or Relevant and Appropriate Requirements
AS/SVE = Air sparge/soil vapor extraction
COCs = Chemicals of concern
cPAH = Carcinogenic polynuclear aromatic hydrocarbons
GCTL = Groundwater Cleanup Target Level
LUCs = Land use controls
NPW = Net present worth
O&M = Operation and Maintenance
PPE = Personal Protective Equipment
RAOs = Remedial Action Objectives
TCE = Trichloroethene

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APPENDIX A

REMEDIAL ALTERNATIVE COST ESTIMATES

NAS Pensacola, Site 44
Pensacola, Florida
Site 44
Soil Alternative 2: LUCs
Capital Cost

Item	Quantity	Unit	Unit Cost				Extended Cost				Subtotal
			Subcontract	Materia	Labor	Equipment	Subcontract	Materia	Labor	Equipment	
1 PROJECT PLANNING & DOCUMENTS											
1.1 Prepare LUC RD Documents	250	hr			$35.00		$0	$0	$8,750	$0	$8,750
. **Subtotal**							$0	$0	$8,750	$0	$8,750
Overhead on Labor Cost @ 30%									$2,625		$2,625
G & A on Labor Cost @ 10%									$875		$875
G & A on Material Cost @ 10%								$0			$0
G & A on Equipment Cost @ 10%										$0	$0
G & A on Subcontract Cost @ 10%							$0				$0
Tax on Materials and Equipment Cost @ 6%								$0		$0	$0
Total Direct Cost							$0	$0	$12,250	$0	$12,250
Indirects on Total Direct Cost @ 0%											$0
Profit on Total Direct Cost @ 10%											$1,225
Subtotal											$13,475
Health & Safety Monitoring @ 0%											$0
Total Field Cost											$13,475
Contingency on Total Field Costs @ 10%											$1,348
Engineering on Total Field Cost @ 0%											$0
TOTAL CAPITAL COST											**$14,823**

NAS Pensacola, Site 44
Pensacola, Florida
Site 44
Soil Alternative 2: LUCs
Annual Cost

Item	Item Cost year 1	Item Cost years 2 to 30	Item Cost years 5, 15, 30	Item Cost every 5 years	Notes
Site Inspection: Visit	$1,482	$1,482			One-day visit to verify LUC RD
Site Inspection: Repor	$800	$800			
Sampling	$0	$0			
Analysis/Water	$0	$0			
Analysis/Water			$0		
Report	$0	$0			
Site Review				$17,000	Five Year Site Reviews
Subtotal	$2,282	$2,282	$0	$17,000	
Contingency @ 10%	$228	$228	$0	$1,700	
TOTAL	**$2,510**	**$2,510**	**$0**	**$18,700**	

NAS Pensacola, Site 44
Pensacola, Florida
Site 44
Soil Alternative 2: LUCs
Present Worth Analysis

Year	Capital Cost	Annual Cost	Total Year Cost	Annual Discount Rate at 7%	Present Worth
0	$14,823		$14,823	1.000	$14,823
1		$2,510	$2,510	0.935	$2,347
2		$2,510	$2,510	0.873	$2,191
3		$2,510	$2,510	0.816	$2,048
4		$2,510	$2,510	0.763	$1,915
5		$21,210	$21,210	0.713	$15,123
6		$2,510	$2,510	0.666	$1,672
7		$2,510	$2,510	0.623	$1,564
8		$2,510	$2,510	0.582	$1,461
9		$2,510	$2,510	0.544	$1,366
10		$21,210	$21,210	0.508	$10,775
11		$2,510	$2,510	0.475	$1,192
12		$2,510	$2,510	0.444	$1,115
13		$2,510	$2,510	0.415	$1,042
14		$2,510	$2,510	0.388	$974
15		$21,210	$21,210	0.362	$7,678
16		$2,510	$2,510	0.339	$851
17		$2,510	$2,510	0.317	$796
18		$2,510	$2,510	0.296	$743
19		$2,510	$2,510	0.277	$695
20		$21,210	$21,210	0.258	$5,472
21		$2,510	$2,510	0.242	$607
22		$2,510	$2,510	0.226	$567
23		$2,510	$2,510	0.211	$530
24		$2,510	$2,510	0.197	$495
25		$21,210	$21,210	0.184	$3,903
26		$2,510	$2,510	0.172	$432
27		$2,510	$2,510	0.161	$404
28		$2,510	$2,510	0.150	$377
29		$2,510	$2,510	0.141	$354
30		$21,210	$21,210	0.131	$2,779
				TOTAL PRESENT WORTH	**$86,289**

NAS Pensacola
Pensacola, Florida
Site 44
Groundwater Alternative 2: National Attenuation, Institutional Controls, and Groundwater Monitorin
Capital Cost

Item	Quantity	Unit	Unit Cost				Extended Cost				Subtotal
			Subcontract	Material	Labor	Equipment	Subcontract	Material	Labor	Equipment	
PROJECT PLANNING & DOCUMENTS											
Prepare LUC RD Documents	250	hr			$35.00		$0	$0	$8,750	$0	$8,750
Groundwater Monitoring Plar	200	hr			$35.00		$0	$0	$7,000	$0	$7,000
MOBILIZATION/DEMOBILIZATION AND FIELD SUPPOR											
Drill Rig Mob/Demob	1	ls	$2,000.00				$2,000	$0	$0	$0	$2,000
Supervision & Oversight (2p * 5 days/week	1	wk			$2,500.00		$0	$0	$2,500	$0	$2,500
DECONTAMINATION											
Decontamination Trailer	1	wk				$720.00	$0	$0	$0	$720	$720
Pressure Washer	1	wk				$400.00	$0	$0	$0	$400	$400
Equipment Decon Pad	1	ls		$500.00	$450.00	$155.00	$0	$500	$450	$155	$1,105
Decon Water Storage Tank, 1,000 gallor	1	mo				$450.00	$0	$0	$0	$450	$450
Clean Water Storage Tank, 500 gallor	0	mo				$250.00	$0	$0	$0	$0	$0
Disposal of Decon Waste (liquid & solid)	1	ls	$900.00				$900	$0	$0	$0	$900
Monitoring Wells											
Install Monitoring Wells	60	vlf	$27.00				$1,620	$0	$0	$0	$1,620
Well Vaults, 18" round	4	ea		$70.00	$380.00	$70.00	$0	$280	$1,520	$280	$2,080
. **Subtotal**							$4,520	$780	$20,220	$2,005	$27,525
Overhead on Labor Cost @ 30%									$6,066		$6,066
G & A on Labor Cost @ 10%									$2,022		$2,022
G & A on Material Cost @ 10%								$78			$78
G & A on Equipment Cost @ 10%										$201	$201
G & A on Subcontract Cost @ 10%							$452				$452
Tax on Materials and Equipment Cost @ 6%								$47		$120	$167
Total Direct Cost							$4,972	$905	$28,308	$2,326	$36,511
Indirects on Total Direct Cost @ 0%											$0
Profit on Total Direct Cost @ 10%											$3,651
Subtotal											$40,162
Health & Safety Monitoring @ 0%											$0
Total Field Cost											$40,162
Contingency on Total Field Costs @ 10%											$4,016
Engineering on Total Field Cost @ 0%											$0
TOTAL CAPITAL COST											**$44,178**

NAS Pensacola
Pensacola, Florida
Site 44
Groundwater Alternative 2: National Attenuation, Institutional Controls, and Groundwater Monitorin
Annual Cost

Item	Item Cost year 1	Item Cost years 2 to 3	Item Cost years 4 to 5	Item Cost years 6 to 10	Notes
Site Inspection: Visit	$1,482	$1,482	$1,482	$1,482	One-day visit to verify LUC RD
Site Inspection: Report	$800	$800	$800	$800	
Sampling	$30,000	$15,000	$7,500	$6,000	Labor and supplies to collect samples from wells using a crew of two.
Analysis/Water	$24,000	$12,000	$6,000	$4,500	Analyze groundwater samples from 28 wells for TCE & natural attenuation parameters in years 1 through 10. Collect samples quarterly in year 1, twice in years 2 &3, and once a year for years 4 through 10. Natural Attenuation samplin discintinues after year 5.
Report	$16,000	$8,000	$4,000	$3,000	Document sampling events and results
Subtotal	$72,282	$37,282	$19,782	$15,782	
Contingency @ 10%	$7,228	$3,728	$1,978	$1,578	
TOTAL	**$79,510**	**$41,010**	**$21,760**	**$17,360**	

NAS Pensacola
Pensacola, Florida
Site 44
Groundwater Alternative 2: National Attenuation, Institutional Controls, and Groundwater Monitorin
Present Worth Analysis

Year	Capital Cost	Annual Cost	Total Year Cost	Annual Discount Rate at 7%	Present Worth
0	$44,178		$44,178	1.000	$44,178
1		$79,510	$79,510	0.935	$74,342
2		$41,010	$41,010	0.873	$35,802
3		$41,010	$41,010	0.816	$33,464
4		$21,760	$21,760	0.763	$16,603
5		$21,760	$21,760	0.713	$15,515
6		$17,360	$17,360	0.666	$11,562
7		$17,360	$17,360	0.623	$10,815
8		$17,360	$17,360	0.582	$10,104
9		$17,360	$17,360	0.544	$9,444
10		$17,360	$17,360	0.508	$8,819
11				0.475	$0
12				0.444	$0
13				0.415	$0
14				0.388	$0
15				0.362	$0
16				0.339	$0
17				0.317	$0
18				0.296	$0
19				0.277	$0
20				0.258	$0
21				0.242	$0
22				0.226	$0
23				0.211	$0
24				0.197	$0
25				0.184	$0
26				0.172	$0
27				0.161	$0
28				0.150	$0
29				0.141	$0
30				0.131	$0
			TOTAL PRESENT WORTH		**$270,648**

NAS Pensacola
Pensacola, Florida
Site 44
Groundwater Alternative 3 - Air Sparge/SVE
Capital Cost

Item	Quantity	Unit	Unit Cost Subcontract	Unit Cost Material	Unit Cost Labor	Unit Cost Equipment	Total Cost Subcontract	Total Cost Material	Total Cost Labor	Total Cost Equipment	Total Direct Cost
PROJECT DOCUMENTS/INSTITUTIONAL CONTROLS											
Prepare Documents & Plans including Permits	200	hr			$30.00		$0	$0	$6,000	$0	$6,000
AS/SVE Pilot Study	370	hr			$30.00		$0	$0	$11,100	$0	$11,100
AS/SVE Pilot Study Subcontractor Cost	1	ls	$25,000.00				$25,000	$0	$0	$0	$25,000
MOBILIZATION/DEMOBILIZATION AND FIELD SUPPORT											
Office Trailer	3	mo				$374.00	$0	$0	$0	$1,122	$1,122
Field Office Support	3	mo		$153.00			$0	$459	$0	$0	$459
Utility Connection/Disconnection (phone/electric)	1	ls	$500.00				$500	$0	$0	$0	$500
Construction Survey	1	ls	$1,500.00				$1,500	$0	$0	$0	$1,500
Drill Rig Mob/Demob	1	ls	$2,000.00				$2,000	$0	$0	$0	$2,000
Site Utilities	3	mo		$1,000.00			$0	$3,000	$0	$0	$3,000
Supervision & Oversight (2p * 5 days/week)	3	mwk			$2,500.00		$0	$0	$7,500	$0	$7,500
DECONTAMINATION											
Decontamination Trailer	1	mo				$2,883.00	$0	$0	$0	$2,883	$2,883
Pressure Washer	1	mo				$1,282.00	$0	$0	$0	$1,282	$1,282
Equipment Decon Pad	1	ls		$500.00	$450.00	$155.00	$0	$500	$450	$155	$1,105
Decon Water Storage Tank, 1,000 gallon	1	mo				$450.00	$0	$0	$0	$450	$450
Clean Water Storage Tank, 500 gallon	1	mo				$250.00	$0	$0	$0	$250	$250
Disposal of Decon Waste (liquid & solid)	1	mo	$900.00				$900	$0	$0	$0	$900
IN-SITU SOIL TREATMENT - SVE											
Install Soil Vapor Extraction Wells	180	vlf	$27.00				$4,860	$0	$0	$0	$4,860
Install ASWells	800	vlf	$27.00				$21,600	$0	$0	$0	$21,600
AS/SVE Vaults, 2" by 2' concrete	50	ea		$271.00	$380.00	$70.00	$0	$13,550	$19,000	$3,500	$36,050
2" PVC Pipe, including trenching	900	ft		$5.00	$4.54	$7.32	$0	$4,500	$4,086	$6,588	$15,174
2" True Union Ball Valve	55	ea		$92.40	$23.10		$0	$5,082	$1,271	$0	$6,353
Vacuum/pressure Gauge, 2 1/2" dia	55	ea		$14.85	$21.50		$0	$817	$1,183	$0	$1,999
AS/SVE Blower, 100 scfm	4	ea		$7,500.00	$180.00		$0	$30,000	$720	$0	$30,720
Control Panel	1	ea		$5,000.00	$500.00		$0	$5,000	$500	$0	$5,500
SVE Moisture Separator, 50 gal	2	ea		$1,000.00	$180.00		$0	$2,000	$360	$0	$2,360
MISCELLANEOUS EQUIPMENT & MATERIALS											
Pre-Engineered Building, 20' by 20'	400	sf	$112.20				$44,880	$0	$0	$0	$44,880
Pavement Repair, asphalt, 4" thick, 900 ft by 2 ft	190	sy	$32.92				$6,255	$0	$0	$0	$6,255
Transport/Dispose IDW Drums Off Site	45	drum	$150.00				$6,750	$0	$0	$0	$6,750
ELECTRICAL											
Electrical	1	ls		$5,418.28	$3,026.80		$0	$5,418	$3,027	$0	$8,445
START-UP											
Start-up Cost	1	ls		$4,000.00	$4,000.00		$0	$4,000	$4,000	$0	$8,000
Subtotal							$114,245	$74,326	$59,196	$16,230	$263,997
Shipping cost on materials 15%								$11,149			$11,149
Taxes on materials, equipment, & subcontracts 6.25%							$7,140	$4,645		$1,014	$12,800
Subtotal							$121,385	$90,120	$59,196	$17,244	$287,946

NAS Pensacola
Pensacola, Florida
Site 44
Groundwater Alternative 3 - Air Sparge/SVE
Capital Cost

Item	Quantity	Unit	Unit Cost Subcontract	Unit Cost Material	Unit Cost Labor	Unit Cost Equipment	Total Cost Subcontract	Total Cost Material	Total Cost Labor	Total Cost Equipment	Total Direct Cost
Overhead on Labor Cost @ 30%									$17,759		$17,759
G & A on Labor Cost @ 10%									$5,920		$5,920
G & A on Material Cost @ 10%								$9,012			$9,012
G & A on Subcontract Cost @ 10%							$12,139				$12,139
G & A on Equipment Cost @ 10%										$1,724	$1,724
Total Direct Cost							$133,524	$99,132	$82,874	$18,969	$334,499
Indirects on Total Direct Cost @ 25%											$83,625
Profit on Total Direct Cost @ 10%											$33,450
Total Field Cost											$451,573
Contingency on Total Field Cost @ 20%											$90,315
Engineering on Total Field Cost @ 10%											$45,157
TOTAL COST											**$587,046**

NAS Pensacola
Pensacola, Florida
Site 44
Groundwater Alternative 2: National Attenuation, Institutional Controls, and Groundwater Monitoring
Capital Cost

Item	Quantity	Unit	Unit Cost				Extended Cost				Subtotal
			Subcontract	Material	Labor	Equipment	Subcontract	Material	Labor	Equipment	
PROJECT PLANNING & DOCUMENTS											
Prepare LUC RD Documents	250	hr			$35.00		$0	$0	$8,750	$0	$8,750
Groundwater Monitoring Plan	200	hr			$35.00		$0	$0	$7,000	$0	$7,000
MOBILIZATION/DEMOBILIZATION AND FIELD SUPPORT											
Drill Rig Mob/Demob	1	ls	$2,000.00				$2,000	$0	$0	$0	$2,000
Supervision & Oversight (2p * 5 days/w	1	wk			$2,500.00		$0	$0	$2,500	$0	$2,500
DECONTAMINATION											
Decontamination Trailer	1	wk				$720.00	$0	$0	$0	$720	$720
Pressure Washer	1	wk				$400.00	$0	$0	$0	$400	$400
Equipment Decon Pad	1	ls		$500.00	$450.00	$155.00	$0	$500	$450	$155	$1,105
Decon Water Storage Tank, 1,000 gall	1	mo				$450.00	$0	$0	$0	$450	$450
Clean Water Storage Tank, 500 gallon	0	mo				$250.00	$0	$0	$0	$0	$0
Disposal of Decon Waste (liquid & solic	1	ls	$900.00				$900	$0	$0	$0	$900
Monitoring Wells											
Install Monitoring Wells	60	vlf	$27.00				$1,620	$0	$0	$0	$1,620
Well Vaults, 18" round	4	ea		$70.00	$380.00	$70.00	$0	$280	$1,520	$280	$2,080
Subtotal							$4,520	$780	$20,220	$2,005	$27,525
Overhead on Labor Cost @ 30%									$6,066		$6,066
G & A on Labor Cost @ 10%									$2,022		$2,022
G & A on Material Cost @ 10%								$78			$78
G & A on Equipment Cost @ 10%										$201	$201
G & A on Subcontract Cost @ 10%							$452				$452
Tax on Materials and Equipment Cost @ 6%								$47		$120	$167
Total Direct Cost							$4,972	$905	$28,308	$2,326	$36,511
Indirects on Total Direct Cost @ 0%											$0
Profit on Total Direct Cost @ 10%											$3,651
Subtotal											$40,162
Health & Safety Monitoring @ 0%											$0
Total Field Cost											$40,162
Contingency on Total Field Costs @ 10%											$4,016
Engineering on Total Field Cost @ 0%											$0
TOTAL CAPITAL COST											**$44,178**

NAS Pensacola
Pensacola, Florida
Operation and Maintenance Costs per Year

Item	Qty	Unit	Unit Cost	Subtotal Cost	Notes
Energy - Electric	120,000	kWh	$0.08	$9,600	
Equipment Maintenance	1	ls	$6,230.79	$6,231	5% of Installation Cost
GAC - (Service Based) - Unit	0	ea	$6,000.00	$0	Assume GAC not required
GAC - (Service Based) - Monthly Fee	0	ea	$750.00	$0	
Labor, Mobilization/Demobilization, Per Diem, Supplies	52	wk	$800.00	$41,600	1 visit per week - 1 day
Quarterly Reports	4	ea	$4,000.00	$16,000	
			COST	$73,431	

NAS Pensacola
Pensacola, Florida
Annual Sampling Cost

Item	Cost Year 1	Cost Year 2	Cost Year 3-5	Notes
Site Inspection	$3.650	$3.650		
Sampling & Analysis Air [(1)(2)]	$1,700	$3,400		SVE off gas
GW Sampling - MNA	$30,000	$15,000	$7,500	Labor and supplies to collect samples from wells using a crew of two.
MNA Sampling Analysis/Water	$24,000	$12,000	$6,000	Analyze groundwater samples from 28 wells for TCE & natural attenuation parameters in years 1 through 5. Collect samples quarterly in year 1, twice in years 2 &3, and once a year for years 4 and 5.
Reporting	$8,000	$8,000	$8,000	Reports: Presentation and evaluation of results, conclusions and recommendations.
TOTALS	$67,350	$42,050	$21,500	

(1) Year 1 = 3 months weekly, 3 months monthly, 6 months quarterly

(2) Year 2 - Quarterly before and after GAC

APPENDIX B

RESPONSE TO REGULATORY COMMENTS

NAVAL AIR STATION PENSACOLA
PENSACOLA, FLORIDA
FEASIBILITY STUUDY FOR SITE 44
(FORMER UST SITE 3221 SW)

RESPONSE TO FDEP COMMENTS DATED FEBRUARY 8, 2010

COMMENT:

I have one small comment on the FS and a condition I would propose on the implementation of either groundwater remedy G-2 or G-3. My comment is that the delineation line for groundwater contamination depicted on Figure 1-7 does not encompass monitoring well PEN-44-22 which is shown to have a trichloroethene (TCE) concentration slightly above its groundwater cleanup target level. This figure should be corrected.

The condition I propose to be implemented with either groundwater remedy G-2 or G-3 is that shallower deep compliance wells would be required for approval of natural attenuation monitoring of the TCE plume as well as for air sparging / soil vapor extraction with natural attenuation monitoring. Because of the relatively low concentrations of TCE detected in water table monitoring wells, I feel somewhat confident that vertical extent wells much shallower than the current deep wells located at Site 44 can be emplaced to provide better vertical delineation of the TCE plume and provide locations for compliance monitoring. The installation of these vertical extent wells should be a condition of the two remedies being selected; the proposed wells should be added to the remedial design and / or natural attenuation monitoring plan reports.

Otherwise, the Feasibility Study appears acceptable to the Department and may be finalized.

RESPONSE:

Figure 1-7 will be revised as requested in the final version of the FS. Also, we concur with your opinion that a vertical extent monitoring well screened between the depth of the existing water table and deep monitoring wells would be more likely to adequately assess the vertical extent of the TCE plume and provide adequate compliance monitoring. This will be addressed in the final FS for remedial options G-2 and G-3 as well as in the Proposed Plan.

NAVAL AIR STATION PENSACOLA
PENSACOLA, FLORIDA
FEASIBILITY STUUDY FOR SITE 44
(FORMER UST SITE 3221 SW)

RESPONSE TO EPA COMMENTS DATED FEBRUARY 24, 2010

COMMENT:

We would like to see an explanation of why you expect natural attenuation to be a plausible remedial alternative. Natural attenuation is mentioned in G-2 and G-3 as a reasonable cleanup alternative. I am attaching a memo that you can use as a guide to help you explain your choice of natural attenuation as a remedial alternative. Once this question of the use of natural attenuation is resolved we will approve the document.

RESPONSE:

We agree with the U.S. Environmental Protection Agency and Florida Department of Environmental Protection (FDEP) that monitored natural attenuation (MNA) is not considered a "presumptive" or "default" remedy but is one of the options that should be evaluated with other applicable remedies. However, it should be noted that cis 1,2-dichloroethene (DCE) was detected in the groundwater samples collected from Site 44. The detection of cis 1,2-DCE indicates that natural attenuation of TCE is likely occurring at this site.

As such, MNA was considered an appropriate alternative to be included in the FS for Site 44 as it has been approved in Record of Decisions (RODs) for Sites 11, 12, 25, 26, 27 and 30. Contamination is present at these sites in groundwater at concentrations greater than FDEP groundwater cleanup target levels (GCTLs) and like Site 44, the detected concentrations were relatively low and do not present an unacceptable threat to human health or the environment under the groundwater use restrictions that will be implemented as part of the selected remedy. Also, like Site 44 the contaminant plumes are relatively small.

Additionally, in December, 1999, EnSafe, Inc. prepared a Final Technical Memorandum for Evaluation for MNA for Site 38, Buildings 71 and 604 at Naval Air Station (NAS), Pensacola, Florida. The Technical Memorandum described the natural attenuation study that was performed as part of a Feasibility Study (FS) for Site 38 (Buildings 71 and 604). The MNA study found that measurements of DO, ORP, hydrogen, iron and sulfate and sulfide supported reductive dechlorination of chlorinated solvents and lead. MNA

was included in the FS for Site 38 and has also been included as the selected remedy in the Proposed Plan for chlorinated solvents and lead in Site 38 groundwater.

Therefore, based on the known favorable site conditions MNA was appropriately selected as an alternative in the FS because the shallow groundwater across NAS Pensacola is typically under reducing conditions that are favorable for reductive dechlorination of chlorinated solvents and reducing conditions that result in the sorption and immobilization of some inorganics.

NAVAL AIR STATION PENSACOLA
PENSACOLA, FLORIDA
RESPONSE TO EPA COMMENTS ON
MONITORIED NATURAL ATTENUATION

The Navy agrees with the U.S. Environmental Protection Agency (USEPA) and Florida Department of Environmental Protection (FDEP) that monitored natural attenuation (MNA) is not considered a "presumptive" or "default" remedy but is one of the options that should be evaluated with other applicable remedies. Ten years of data collection to justify MNA is a burdensome requirement and the justification of the 10 year requirement cannot be found based on a review of USEPA and Office of Solid Waste and Emergency Response (OSWER) directives. However, to determine if MNA is appropriate for contaminants at a site the USEPA developed a tiered approach in response to OSWER directive 9200.4-17P, including:

- Actively demonstrate removal from ground water. This demonstration requires site specific data and the theoretical basis for the contaminant removal from groundwater.

- Identify/confirm primary mechanism(s) of removal.

- Demonstrate long-term capacity and stability of the major attenuation mechanisms and processes.

- Design a monitoring program and define the regulatory triggers for MNA failure such as maximum concentration levels.

- Establish a contingency plan if MNA fails the regulatory triggers and clean-up levels.

Several studies have been conducted to obtain MNA data and to evaluate treatability of petroleum related constituents using oxygen enriching technologies at various sites across Naval Air Station (NAS) Pensacola that meet the intent of the above tiered approach. The preponderance of evidence for MNA from these studies suggest that the shallow groundwater across NAS Pensacola is typically under reducing (anaerobic) conditions that range from limited to strongly favorable for reductive dechlorination of chlorinated solvents and reducing conditions that potentially result in the sorption and immobilization of some inorganics.

However, it should be noted that while both anaerobic and aerobic respiration have been successfully demonstrated for petroleum, biodegradation of petroleum by aerobic mechanisms is more rapid than anaerobic reduction (ASTM, 1998). Because of the length of time required to achieve groundwater

cleanup target levels under the typical aquifer conditions at NAS Pensacola, treatability studies were conducted to document that the mildly anaerobic or aerobic conditions could be enhanced using oxygen enriching technologies to accelerate the degradation of petroleum related constituents in groundwater. Table 1 summarizes the results of some of the MNA and treatability evaluations.

Rate and timeframe of MNA: The rate of decline is typically determined by using monitoring data to construct a linear trend for log concentrations values as a function of distance from the contamination source. At NAS Pensacola, it appears that each site has some variation in the presence of limited to strong anaerobic conditions to slightly mile aerobic conditions. Because of this variation, estimates in the rate of decline can result in a substantial variation that would best be evaluated in a monitoring program that has an established contingency plan. It should also be noted that using a small number of monitoring wells, especially if they are not along the plume centerline, can result in a spurious linear fit for a concentration profile and the misinterpretation of transformation/sorption rates. Factors that distort observed concentration profiles include:

(1) assumption of steady-state conditions where none exist,
(2) fluctuation in source strength with time,
(3) the assumption of a linear relationship between the dispersive mass flux and the concentration gradient when none exits,
(4) the assumption of heterogeneous flow and transport
(5) placement of monitoring wells off of the plume centerline
(6) dilution effects due to screen length, and
(7) non-uniform degradation rate distribution.

Also, in regards to the timeframe for remedial actions, OSWER directive 9200.4-17P states that the USEPA recognizes that the determination of what timeframe is “reasonable” for attaining remediation objectives is a site-specific determination and should be reasonable when compared to other remedies which could be achieved through active restoration. This comparison is made in the feasibility study and a contingency plans should be developed for the sites should MNA fail the specified regulatory triggers, clean-up levels or reasonable estimate of the timeframe.

TABLE 1

SUMMARY OF NATURAL ATTENUATION AND TREATABILITY EVALUATIONS
NAS PENSACOLA, PENSACOLA, FLORIDA

SITE	CONTAMINANTS	SITE SUMMARY	EVIDENCE OF MNA
Site 38 Buildings 71 and 604	tetrachloroethene (PCE) and lead	Monitored Natural Attenuation (MNA) measurements included DO, oxidation reduction potential, hydrogen, iron and sulfate and sulfide support reductive dechlorination of chlorinated solvents and lead.	Limited to strong evidence of anaerobic conditions for conducive to reductive dechlorination documented by field and laboratory analytical results.
OU 4, Site 15 Pesticide Rinsate Disposal Area	arsenic	Concentrations of arsenic have decreased through time based on long-term monitoring results	Evidence of MNA documented by long-term quarterly monitoring (since 2001) and laboratory analytical results. It is possible that the arsenic removal occurred under anaerobic conditions because sufficient sulfate is present to result in the precipitation of arsenopyrite (FeAsS).
OU 1	benzene, chlorobenzene, vinyl chloride, nickel, naphthalene, xylene, 1,1,2,2-tetrachloroethane, aluminum, cadmium, chromium, iron and manganese.	Natural attenuation data was collected at OU 1 and did not provide widespread evidence for reductive dechlorination. The presence of vinyl chloride suggests that that reductive dechlorination of source materials has already occurred.	Evidence of anaerobic conditions conducive for reductive dechlorination is based on laboratory analytical results and the presence of vinyl chloride. Vinyl chloride is degraded by aerobic not anaerobic conditions.

TABLE 1

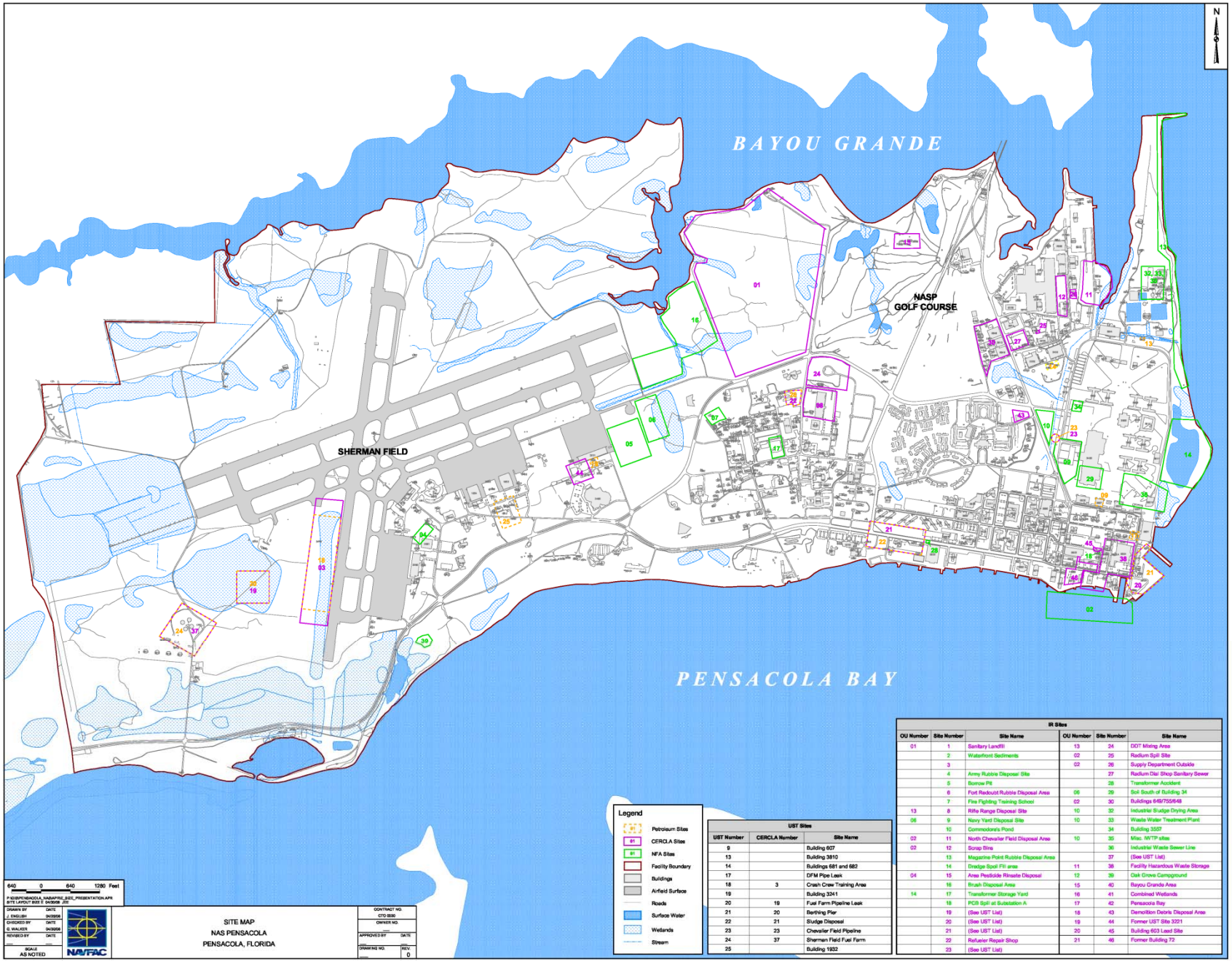
SUMMARY OF NATURAL ATTENUATION AND TREATABILITY EVALUATIONS
NAS PENSACOLA, PENSACOLA, FLORIDA

SITE	CONTAMINANTS	SITE SUMMARY	EVIDENCE OF MNA
UST Site 14	petroleum related constituents related to diesel fuel marine (DFM) and various vehicle fuels	Quarterly monitoring results indicated that MNA would not be completely effective in reducing petroleum related constituents to GCTLs in accordance with the 5-year monitoring plan. A Treatability Study was conducted for the injection of Oxygen Release Compound® (ORC) to enhance biodegradation.	Limited anaerobic to mild aerobic MNA conditions documented by field and laboratory analytical results. Treatability Study indicated that enhanced aerobic conditions would accelerate the degradation of the petroleum related constituents. Groundwater Cleanup Target Levels (GCTLs) not exceeded following the ORC injection.
UST Site 17	petroleum related constituents related to DFM	Quarterly monitoring results indicated that MNA would not be completely effective in reducing petroleum related constituents to GCTLs in accordance with the 5-year monitoring plan. A Treatability Study was conducted for the injection of ORC to enhance biodegradation.	Moderately reducing to slightly oxidizing conditions was documented by field and laboratory analytical results. Post-injection results indicated that the original plume was treated but exceedance of GCTLs occurs outside the ORC injection area but is being degraded by the reducing conditions. Currently all COC are less than GCTLs and a Site Rehabilitiation Completion Order has been requested.

TABLE 1

SUMMARY OF NATURAL ATTENUATION AND TREATABILITY EVALUATIONS
NAS PENSACOLA, PENSACOLA, FLORIDA

SITE	CONTAMINANTS	SITE SUMMARY	EVIDENCE OF MNA
UST Site 19	benzene, toluene, ethylbenzene, xylenes, Isopropylbenzene TRPH 1-Methylnaphthalene 2-Methylnaphthalene Naphthalene Dibenz(a,h)anthracene	Assessment ongoing. The number of COCs decreased from 2006 to 2007, eliminating chloride PCE, carbon tetrachloride, chloroform, methylene chloride and adding dibenz(a,h)anthracene.	Limited anaerobic to mild aerobic MNA conditions documented by field and laboratory analytical results.
UST Site 22, IR site 21	predominantly petroleum related constituents with some low concentrations of chlorinated solvents	Natural attenuation data was collected but did not provide widespread evidence for reductive dechlorination.	Limited anaerobic conditions documented by field and laboratory analytical results. Methane and sulfide detected. The presence of vinyl chloride suggests that that reductive dechlorination of chlorinated source materials has occurred.



Legend

- Petroleum Sites
- CERCLA Sites
- NFA Sites
- Facility Boundary
- Buildings
- Airfield Surface
- Roads
- Surface Water
- Wetlands
- Stream

UST Sites

UST Number	CERCLA Number	Site Name
9		Building 607
13		Building 3810
14		Buildings 681 and 682
17		DFM Pipe Leak
18	3	Crash Crew Training Area
19		Building 3241
20	19	Fuel Farm Pipeline Leak
21	20	Berthing Pier
22	21	Sludge Disposal
23	23	Chevalier Field Pipelins
24	37	Sherman Field Fuel Farm
25		Building 1932

IR Sites

OU Number	Site Number	Site Name	OU Number	Site Number	Site Name
01	1	Sanitary Landfill	13	24	DDT Mixing Area
	2	Waterfront Sediments	02	25	Radium Spill Site
	3		02	26	Supply Department Outside
	4	Army Rubble Disposal Site		27	Radium Dial Shop Sanitary Sewer
	5	Borrow Pit		28	Transformer Accident
	6	Fort Redoubt Rubble Disposal Area	06	29	Soil South of Building 34
	7	Fire Fighting Training School	02	30	Buildings 649/755/648
13	8	Rifle Range Disposal Site	10	32	Industrial Sludge Drying Area
06	9	Navy Yard Disposal Site	10	33	Waste Water Treatment Plant
	10	Commodore's Pond		34	Building 3597
02	11	North Chevalier Field Disposal Area	10	35	Misc. NVTP sites
02	12	Scrap Site		36	Industrial Waste Sewer Line
	13	Magazine Point Rubble Disposal Area		37	(See UST List)
	14	Dredge Spoil Fill area	11	38	Facility Hazardous Waste Storage
04	15	Area Pesticide Rinsate Disposal	12	39	Oak Grove Campground
	16	Brush Disposal Area	15	40	Bayou Grande Area
14	17	Transformer Storage Yard	16	41	Combined Wetlands
	18	PCB Spill at Substation A	17	42	Pensacola Bay
	19	(See UST List)	18	43	Demolition Debris Disposal Area
	20	(See UST List)	19	44	Former UST Site 3321
	21	(See UST List)	20	45	Building 603 Lead Site
	22	Refueler Repair Shop	21	46	Former Building 72
	23	(See UST List)			

640 0 640 1280 Feet

P:\GIS\PENSACOLA_NAS\APRIZ_SIZE_PRESENTATION.APR
SITE LAYOUT SIZE E 04/30/08 JEE

DRAWN BY	DATE
J. ENGLISH	04/30/08
CHECKED BY	DATE
G. WALKER	04/30/08
REVISED BY	DATE
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SCALE	
AS NOTED	

NAVFAC

SITE MAP
NAS PENSACOLA
PENSACOLA, FLORIDA

CONTRACT NO.	
CTO 0030	
OWNER NO.	
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APPROVED BY	DATE
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DRAWING NO.	REV.
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