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FEASIBILITY STUDY REPORT SITE 22 BUILDING 105 OLD DRY CLEANING FACILITY NS GREAT LAKES IL

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TETRA TECH

Comprehensive Long-term Environmental Action Navy

CONTRACT NUMBER N62467-94-D-0888

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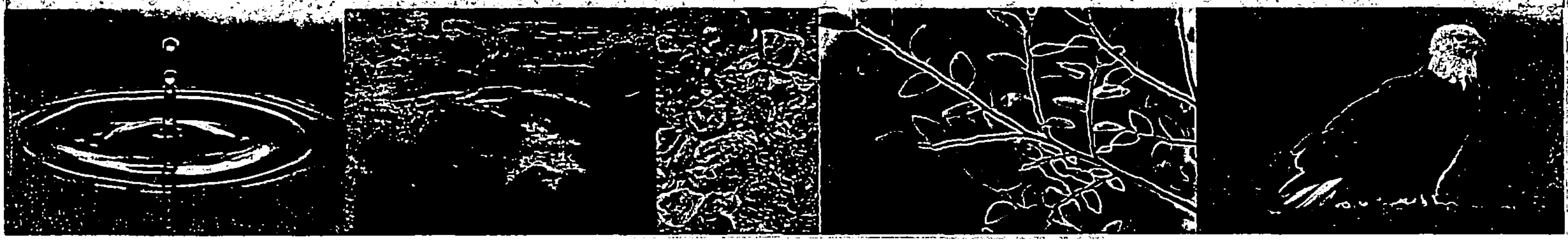

Revision 0
January 2006

Feasibility Study Report
for
Site 22 - Building 105 Old Dry Cleaning Facility

Naval Station Great Lakes
Great Lakes, Illinois

Contract Task Order 0384

January 2006

Naval Facilities Engineering Command
Southern Division
Naval Facilities Engineering Command
2155 Eagle Drive
North Charleston, South Carolina 29406

TETRA TECH NUS, Inc.

REVISION 0
JANUARY 2006

FEASIBILITY STUDY REPORT

SITE 22 – BUILDING 105
OLD DRY CLEANING FACILITY

NAVAL STATION GREAT LAKES
GREAT LAKES, ILLINOIS

COMPREHENSIVE LONG-TERM
ENVIRONMENTAL ACTION NAVY (CLEAN) CONTRACT

Submitted to:
Southern Division
Naval Facilities Engineering Command
2155 Eagle Drive
North Charleston, South Carolina 29406

Submitted by:
Tetra Tech NUS, Inc.
661 Andersen Drive
Foster Plaza 7
Pittsburgh, Pennsylvania 15220

CONTRACT NUMBER N62467-94-D-0888
CONTRACT TASK ORDER 0384

JANUARY 2006

PREPARED UNDER THE SUPERVISION OF:

ROBERT F. DAVIS, JR., P.E.
TASK ORDER MANAGER
TETRA TECH NUS, INC.

APPROVED FOR SUBMITTAL BY:

DEBRA M. HUMBERT
PROGRAM MANAGER
TETRA TECH NUS, INC.

ANTHONY ROBINSON
REMEDIAL PROJECT MANAGER
NAVAL FACILITIES ENGINEERING COMMAND

BRIAN A. CONRATH
PROJECT MANAGER
ILLINOIS EPA

MARK SCHULTZ
ENVIRONMENTAL SITE MANAGER
NAVAL STATION GREAT LAKES

HOWARD HICKEY
IR PROGRAM MANAGER
NAVAL STATION GREAT LAKES

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LIST OF ACRONYMS AND ABBREVIATIONS

ARAR	Applicable or Relevant and Appropriate Requirement
AS	Air Sparging
AWQC	Ambient Water Quality Criteria
bgs	Below ground surface
°C	Degrees Celsius
CAA	Clean Air Act
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
cfm	Cubic foot/feet per minute
CFR	Code of Federal Regulations
cm^2	Square centimeter(s)
cm/sec	Centimeter(s) per second
CMS	Corrective Measure Study
COC	Chemical of concern
COPC	Chemical of potential concern
CSF	Cancer Slope Factor
CWA	Clean Water Act
DCE	cis-1,2-dichloroethene
DoD	Department of Defense
DOT	Department of Transportation
DPT	Direct push technology
E.O.	Executive Order
EPC	Exposure Point Concentration
ERH	Electrical Resistance Heating
°F	Degrees Fahrenheit
FS	Feasibility Study
ft2	Square foot/feet
ft^3	Cubic foot/feet
GAC	Granular activated carbon
gpm	gallons per minute
GRA	General Response Action
HDPE	High density polyethylene
HHRA	Human health risk assessment
HI	Hazard Index

HSWA	Hazardous and Solid Waste Amendments
IAS	Initial Assessment Study
Illinois EPA	Illinois Environmental Protection Agency
ILCR	Incremental Lifetime Cancer Risk
ISOTEC	In-Situ Oxidative Technologies, Inc.
K	Hydraulic conductivity
kVA	kilovolt ampere
LDR	Land disposal restrictions
LTTD	Low-Temperature Thermal Desportion
LUC	Land Use Control
m3	Cubic meter
m^3/day	Cubic meter(s) per day
m^3/hour	Cubic meter(s) per hour
MCL	Maximum Contaminant Level
MCLG	Maximum Contaminant Level Goal(s)
mg	Milligram(s)
mg/day	Milligram(s) per day
mg/kg	Milligram(s) per kilogram
mg/L	Milligram(s) per liter
MOA	Memorandum of Agreement
µg/kg	Microgram(s) per kilogram
NAAQSs	National Ambient Air Quality Standards
NAVFAC EFD SOUTH	Naval Facilities Engineer, Field Division South
NCP	National Oil and Hazardous Substance Pollution Contingency Plan (also called the National Contingency Plan)
NEPA	National Environmental Policy Act
NPW	Net present worth
O&M	Operation and maintenance
OSHA	Occupational Safety and Health Administration
OVA	Organic Vapor Analysis
PAH	Polynuclear aromatic hydrocarbon
PCE	Tetrachloroethylene
PPE	Personal protection equipment
PRG	Preliminary Remediation Goal
RAO	Remedial Action Objective
RBC	Risk Based Concentration

RCRA	Resource Conservation and Recovery Act
RfD	Reference Dose
RI/RA	Remedial Investigation/Risk Assessment
RME	Reasonable Maximum Exposure
ROD	Record of Decision
SARA	Superfund Amendments Reauthorization Act
SMCL	Secondary Maximum Contaminant Level(s)
SSL	Soil Screening Level
SVE	Soil Vapor Extraction
SVOC	Semivolatile Organic Compound
TACO	Tiered Approach to Corrective Action Objectives
TBC	To Be Considered (criterion)
TCE	Trichloroethene
TSDF	Treatment, storage, and disposal facility
TtNUS	Tetra Tech NUS, Inc.
UCL	Upper Confidence Limit
UIC	Underground Injection Control
U.S.	United States
U.S.C.	United States Code
U.S. EPA	United States Environmental Protection Agency
UST	Underground storage tank
VOC	Volatile organic compound
yd^3	Cubic yard(s)

EXECUTIVE SUMMARY

E.1 PURPOSE OF THE REPORT

The purpose of this Feasibility Study (FS) Report is to develop and evaluate options for the remediation of contaminated soil and pore water for Site 22, Former Building 105, Old Dry Cleaning Facility (Site 22) at Naval Station Great Lakes in Lake County, Illinois.

E.2 SITE DESCRIPTION AND HISTORY

Building 105 was constructed in 1939 and was utilized as a dry cleaning facility until 1993 or 1994 when it was converted to a vending machine supply and repair station. From 1993 or 1994 until February 2001, the building was used to warehouse and repair vending equipment and products. The vending machine supply and repair operations ceased in February 2001, and the building was vacant until it was demolished in March 2003. Building 105 was a slab-on-grade structure measuring approximately 150 feet by 70 feet. The former 10,500-square foot building occupied a lot measuring approximately 250 feet by 115 feet.

Naval Station Great Lakes (USEPA # IL7170024577) has operated with RCRA interim status authorization since November 19, 1980. Building 105 was originally included in a RCRA Part A permit that has been modified over the past 25 years. The RCRA unit (SO1) in Building 105 consisted of a drum storage area located inside along the eastern wall. Hazardous waste consisting of spent tetrachloroethene (PCE) from the laundry facilities was stored in this area from 1980 until 1987.

Historic building foundation plans show the floor drains were connected to the storm sewer system located outside of the building. The building foundation plans also show two 6-inch drains from the gutter under the washing machines associated with previous laundry operations. These drains were connected to a grease catch basin located outside the southeastern corner of the building. The grease catch basin had a 6-inch tile effluent pipe that was connected to another catch basin. It is speculated that the effluent line from the grease catch basin was connected to the waste water (sanitary) lines for Naval Station Great Lakes. It is postulated that the majority of the soil and groundwater contamination is from this part of the dry cleaner operations.

E.3 SUMMARY OF THE INVESTIGATIONS FINDINGS

Soil and groundwater sampling was conducted at Site 22 by several contractors over the last 10 years. According to these investigations, the chemicals of concern (COCs) are PCE and cis-1,2-dichloroethene (DCE) in soil and the associated pore water. The "hot spot" of contamination is located near the southeastern corner of the building along Sampson Street near the former grease catch basin.

The following briefly summarizes the nature and extent of the current contamination in surface soil, subsurface soil, and groundwater at Site 22:

- Chlorinated volatile organic compounds (VOCs) are significant site-related contaminants at Site 22. PCE and its degradation products [e.g. trichloroethene (TCE), cis-1,2-DCE, and vinyl chloride] were detected in surface and subsurface soil at high concentrations in the vicinity of former Building 105, with the highest concentrations detected near the former drains and grease catch basin. In addition, PCE and its degradation products (TCE and cis-1,2-DCE) were detected in pore water at the same locations.

- PCE and its degradation products, TCE, DCE, and vinyl chloride, were detected in surface and subsurface soil at concentrations exceeding screening levels for groundwater protection. Some of the VOC concentrations reported for soil in the southeastern corner of the site also exceed the Illinois EPA Tiered Approach to Corrective Action Objectives (TACO) limit for human exposure (i.e., incidental ingestion, inhalation). Illinois EPA has classified the contaminated media (soil and groundwater) as a listed hazardous waste for PCE (F002). If the contaminated media is removed from this site, it would have to be identified as a listed hazardous waste.

- Impacted soil and groundwater around the former drains and grease catch basin are limited to shallow depths (up to 30 feet deep), with the highest concentrations being between 8 to 20 feet below ground surface (bgs). Impacts to the deeper aquifer zone are limited both in concentration and migration potential due to the geology of the site.

- There does not appear to be a groundwater plume currently present at the site. Contamination is limited to the pore water in the soil in the areas immediately surrounding the former drains and grease catch basin area.

E.4 REMEDIAL ACTION OBJECTIVES AND PRELIMINARY REMEDIAL ACTION GOALS

Site-specific RAOs specify COCs, media of interest, exposure pathways, and cleanup goals or acceptable contaminant concentrations. This FS addresses soil and pore water contamination at Site 22. The RAOs were developed to permit consideration of a range of treatment and containment alternatives based on the current and potential future land use as a parking lot with future neighboring barracks, galley, and commercial areas. To protect the public from current and potential future health risks, as well as to protect the environment, the following RAOs were developed:

- Prevent unacceptable human health risks associated with inhalation, ingestion, and dermal contact with soil containing chlorinated organics at concentrations greater than established PRGs.

- Prevent unacceptable human health risks associated with ingestion of groundwater or future dermal contact by workers with groundwater containing chlorinated organics at concentrations greater than established PRGs.

- Prevent further adverse impacts on groundwater from chlorinated organics migrating from soil to groundwater. It should be noted that at the current time this exposure pathway is not applicable to Site 22 because the site is capped and groundwater at Naval Station Great Lakes is not used as a source of potable water and is not expected to be in the future.

- In order to comply with the Naval Station Great Lakes RCRA permit issued by Illinois EPA, obtain closure for the drum storage area (RCRA Unit SO1). This will include conducting remedial actions to reduce chlorinated VOC mass in soil and groundwater.

In meeting these RAOs, contaminated media containing listed hazardous waste may be left in place.

E.5 SCREENING OF GENERAL RESPONSE ACTIONS, REMEDIATION TECHNOLOGIES, AND PROCESS OPTIONS

General Response Actions (GRAs) and the remediation technologies and process options associated to 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 technologies and process options were retained:

General Response Action	Remediation Technology	Process Option
No Action	None	Not Applicable
Limited Action	Monitoring	Sampling and Analysis
	Institutional Controls	Land Use Controls (LUCs)
Removal	Bulk Excavation	Excavation
In-Situ Treatment	Physical/Chemical	Chemical Oxidation
	Thermal	Electrical Resistance Heating (ERH)
Ex-Situ Treatment	Physical/Chemical	Chemical Oxidation
	Thermal	Off-Base Incineration
	Solids Processing	Size Reduction
Disposal	Landfill	Off-Base Landfilling

E.6 DEVELOPMENT OF REMEDIAL ALTERNATIVES

The following remedial alternatives were assembled:

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

- **Alternative 2: In-situ Chemical Oxidation, Monitoring, and LUCs.** Following confirmation by a pilot-scale study, a chemical oxidation reagent would be injected to a depth of up to 25 feet bgs at 660 locations in the area of contaminated soil and associated pore water. Direct push technology (DPT) would be used to perform two rounds of injection within approximately 6 months. One round of monitoring would be performed after each injection event to check the progress of remediation and verify attainment of the PRGs. Each round of monitoring would consist of collecting 12 soil and 6 groundwater samples and analyzing them for chlorinated VOCs.

- **Alternative 3: In-situ ERH, Monitoring, and LUCs.** Following confirmation by a pilot-scale study, an in-situ ERH system would be installed in the area of contaminated soil and pore water and operated for a period of up to one year. The in-situ ERH system would consist of a computer-controlled 2,000 kilovolt amperes (kVA) power-generating unit supplying electricity to field of 75 buried electrodes installed to a depth of up to 25 feet bgs on a temperature-regulated basis. The ERH system would also include a condenser and two 2,000 pounds vapor-phase granular activated carbon (GAC) adsorption units for the treatment of extracted vapors and a 500-pound liquid-phase GAC adsorption unit for the treatment of condensate. Two rounds of monitoring would be performed during the operation of the in-situ ERH system to check the progress of remediation and verify attainment of the PRGs. Each round of monitoring would consist of collecting 12 soil and 6 groundwater samples and analyzing them for chlorinated VOCs.

- **Alternative 4: Excavation, Off-Base Treatment and Disposal, Monitoring, and LUCs.** Soil and pore water with concentrations of COCs greater than the PRGs would be excavated. Approximately 10,000 cubic yards (yd^3) of contaminated soil and pore water would be excavated to a depth of up to 25 feet bgs. Following verification sampling, the excavated area would be backfilled with clean imported fill. Excavated material would be analyzed for PCE to determine treatment and disposal requirements and segregated accordingly. As required, excavated soil would also be drained to remove excess free water and/or undergo size reduction to screen and shred or crush oversized fragments (e.g., asphalt chunks, liner pieces). The excavated material would then be transported to a permitted off-base treatment, storage, and disposal facility (TSDF) for treatment and disposal. Based on guidance from the Illinois EPA, it is assumed that the excavated material would be classified as a listed RCRA-hazardous waste of F002. It is estimated that 50 percent of the soil (5,000 yd^3) would require incineration prior to landfilling, and 50 percent of the soil (5,000 yd^3) would require chemical oxidation prior to landfilling. Two rounds of monitoring would be performed following excavation activities to verify that COCs have not migrated into the surrounding groundwater. Each round would consist of collecting 6 groundwater samples and analyzing them for chlorinated VOCs.

- **Alternative 5: Focused ERH, Limited Excavation, Off-Base Treatment (incineration) and Disposal, Capping, Monitoring, and LUCs.** An in-situ ERH system would be installed and operated in the area of greatest soil contamination. This area is approximately 1,400 square feet located near the southeastern corner of Building 105 along Sampson Street near the former grease catch basin. The treatment scenario is similar to Alternative 3, although over a substantially smaller area. The in-situ ERH system would be operated for a period of 3 months. The in-situ ERH system would consist of a computer-controlled 2,000 kVA power-generating unit supplying electricity to field of eight buried electrodes installed to a depth of up to 25 feet bgs on a temperature-regulated basis. The ERH system would also include a condenser and two 2,000 pounds vapor-phase GAC adsorption units for the treatment of extracted vapors and a 500-pound liquid-phase GAC adsorption unit for the treatment of condensate. One round of monitoring would be performed after the operation of the in-situ ERH system to verify attainment of the PRGs (collection of 12 soil and 6 groundwater samples and analyzing them for chlorinated VOCs). Additionally, limited excavation would be performed in up to three locations; a total of approximately 100 cubic yards of soil would be excavated and disposed.

E.7 DETAILED ANALYSIS OF REMEDIAL ALTERNATIVES

The remedial alternatives were analyzed in detail using seven of the nine criteria provided in the National Oil and Hazardous Substance Pollution Contingency Plan (NCP) and the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA). These seven criteria are as follows:

- Overall Protection of Human Health and the Environment
- Compliance with Applicable or Relevant and Appropriate Requirements (ARARs) and To-Be-Considered (TBCs) guidance criteria
- Long-term Effectiveness and Permanence
- Reduction of Contaminant Toxicity, Mobility, or Volume through Treatment
- Short-term Effectiveness
- Implementability
- Cost

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.8 COMPARATIVE ANALYSIS OF REMEDIAL ALTERNATIVES

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

- **Overall Protection of Human Health and Environment**

Alternative 1 would not protect human health and the environment. The potential for exposure of human and ecological receptors to contaminated soil and for leaching of soil COCs to groundwater would increase over time, especially under a hypothetical future residential development of the area, because the existing asphalt pavement and HDPE liner would no longer be maintained. Alternatives 2, 3, 4, and 5 would protect human health and the environment. These alternatives would remove the soil COCs that could result in unacceptable risks to human receptors. At the same time, these four alternatives would also remove the source of potential future groundwater contamination. The degree of protection provided by these alternatives would be excellent and very similar. Due to issues with effectively delivering reagent in the low permeability soil, Alternative 2 is considered the least protective. Alternative 5 relies on capping and LUCs to minimize exposure to contaminated soil, and is slightly less protective than Alternatives 3 and 4.

- **Compliance with ARARs and TBCs**

Alternative 1 would not comply with chemical- or location-specific ARARs. No action-specific ARARs or TBCs apply to this alternative. Alternatives 2, 3, 4, and 5 would comply with chemical-, location-, and action-specific ARARs.

- **Long-Term Effectiveness and Permanence**

Alternative 1 would not provide long-term effectiveness and permanence because nothing would be done to reduce concentrations of soil COCs. Alternatives 2, 3, 4, and 5 would provide long-term effectiveness and permanence. The four alternatives would effectively and permanently remove soil COCs from the site. The four alternatives also include the use of well proven and dependable technologies and provide a high degree of long-term effectiveness and permanence. However, Alternative 4 would be slightly more long-term effective than Alternatives 3 and 5, which in turn would be more long-term effective than Alternative 2. This is because the technologies included in Alternative 4 (excavation, ex-situ chemical oxidation and incineration, and landfilling) are better established and dependable than those involved for Alternatives 3 and 5 (in-situ ERH) and Alternative 2 (in-situ chemical oxidation). ERH, although well-proven, is still slightly innovative. Alternatives 3 and 5 would be slightly more long-term effective than Alternative 2 because in-situ ERH is more suited for the low permeability Site 22 soil. The effectiveness of Alternative 2 will depend on successful delivery of chemicals to the contamination. Alternative 5 would leave some residual contamination at the site that would require LUCs.

- **Reduction of Contaminant Toxicity, Mobility, or Volume through Treatment**

Alternative 1 would not reduce the toxicity, mobility, or volume of COCs through treatment because no treatment would occur. Alternatives 2, 3, 4, and 5 would irreversibly and permanently reduce the toxicity, mobility, and volume of the soil COCs and pore water through treatment. Alternatives 2, 3, and 4 would remove approximately 1,700 pounds of chlorinated VOCs. Alternative 5 would remove approximately 1,350 pounds of chlorinated VOCs from the highly contaminated area of the site. This alternative would minimize exposure to chlorinated VOCs and the mobility of the remaining chlorinated VOCs by capping/containment and LUCs. Groundwater would also be remediated when the soil is remediated. Alternatives 2, 3, 4, and 5 would remove the chlorinated VOCs through treatment.

- **Short-Term Effectiveness**

Alternative 1 would not result in short-term risks to site workers or adversely impact the surrounding community or environment because no remedial activities would be performed. Alternatives 2, 3, and 5 would result in a slight possibility for short-term risk to remediation workers from exposure to contaminated soil and pore water during the installation of the in-situ treatment systems as well as during monitoring. However, risk from exposure would be effectively controlled by compliance with proper site-specific health and safety procedures. In addition, Alternatives 3 and 5 could result in short-term risk to remediation workers and adversely impact the surrounding community and environment because of exposure to extracted contaminated vapors. However, this would be adequately mitigated through treatment of these vapors prior to release to the atmosphere. Because of the excavation in Alternative 5 with the ERH, the corresponding risks for Alternative 5 will likely be more than Alternative 3 because excavation causes short-term risk for workers due to the off-gassing of the COCs from the excavated soils. Alternative 4 would result in a significant possibility of short-term risk to remediation workers because of exposure to contaminated soil and pore water during its excavation, staging, transportation, and off-base treatment and landfilling. However, risks from exposure would be effectively controlled by engineering controls (e.g., dust suppression) and by compliance with proper site-specific health and safety procedures. In addition, Alternative 4 could result in short-term risk to remediation workers and adversely impact the surrounding community because of exposure to contaminated material that might be spilled during transportation or to exhaust gases generated by off-base incineration. However, this would be properly mitigated by compliance with applicable transport regulations and by the implementation of appropriate incineration off-gas treatment.

Alternative 1 would not achieve the RAOs and PRGs. Alternatives 2 and 3 would achieve the RAOs and attain the PRGs within approximately one year. Alternatives 4 and 5 would achieve the RAOs and attain the PRGs within approximately 6 months.

- **Implementability**

Alternative 1 would be easiest to implement because no action would be taken.

Technical implementation of Alternative 2 may be difficult. Installation of an in-situ chemical injection system would be relatively simple and only minimum operation and maintenance (O&M) would be required as a follow-up. However, effective injection and even distribution of the oxidation reagent into the subsurface will be difficult to achieve because of the geology of Site 22. A number of qualified contractors are available to provide this service. Technical implementation of Alternative 3 would be slightly more difficult than that of Alternative 2. Installation of an in-situ ERH system would be somewhat more complex than that of an in-situ chemical injection system, and O&M would be required as a follow-up. However, as with Alternative 2, a number of qualified contractors are available to provide the required services. For both Alternatives 2 and 3, RCRA permit requirements and Land Disposal Restrictions would not be triggered because the contaminated media is treated in-situ. Technically, Alternative 4 would be the most difficult to implement. Excavation of contaminated soil and pore water would require significant shoring and dewatering. On-site analysis and staging would be required to segregate excavated material in accordance with anticipated off-base treatment requirements (i.e., none, chemical oxidation, incineration). On-site pre-treatment of excavated material might also be required for screening and size reduction and/or to remove excess free water. However, the required resources and equipment would be readily available to perform these tasks. Permitted off-base TSDFs would be readily available for the chemical oxidation, incineration, and landfilling of the excavated material. Alternative 5 would be as difficult to implement as Alternative 3. The ERH would be on a smaller scale and therefore would be easier to implement. The excavation would add some difficulty, but due to the significantly reduced aerial extent, contaminant concentration, and excavation depth, it would add substantially less difficulty than that presented for Alternative 4. The LUCs would be easily implementable.

Administrative implementation of Alternative 2 would be simple. No formal construction permit should be required, but DPT injection of chemicals might have to comply with the substantive requirements of the State's Underground Injection Control (UIC) program. Administrative implementation of Alternative 3 would be slightly more difficult. A construction permit would be required for the installation of the in-situ ERH and vapor treatment system, but this permit should not be difficult to obtain. Administrative procedures, such as manifesting would also likely be required for the off-base disposal of the spent GAC, but these procedures would not be overly demanding. Administrative implementation of Alternative 4 would be the most difficult. A construction permit would have to be obtained for excavation, and the off-site transportation and disposal of the excavated soil would require the completion of numerous administrative procedures including RCRA permit requirements, Land Disposal Restrictions, waste profiling, and manifesting. While constituting a significant effort, these procedures could readily be accomplished. Administrative implementation of Alternative 5 would be the easier than Alternative 4 since the excavation effort is reduced greatly.

- **Cost**

The capital and O&M costs and net present worth (NPW) of the soil remedial alternatives were estimated to be as follows:

Alternative	Capital ($)	NPW of O&M ($)	NPW ($)
1	0	0	0
2	1,326,000	0	1,326,000
3	3,078,000	0	3,078,000
4	9,340,000	0	9,340,000
5	990,000	0	990,000

The above cost figures have been rounded to the nearest $1,000 to reflect the preliminary nature of the estimates. The costs of Alternatives 2 and 3 include pilot-scale testing. A detailed breakdown of cost estimates is provided in Appendix B.

1.0 INTRODUCTION

This Feasibility Study (FS) was prepared for Site 22, former Building 105 Old Dry Cleaning Facility, at the United States (U.S.) Naval Station Great Lakes located in Lake County, Illinois under Contract Task Order 384. This FS was prepared in accordance with the Comprehensive Long-Term Environmental Action Navy III, Contract Number N62467-94-D-0888, the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and its governing regulations and Guidance for Conducting Remedial Investigations and Feasibility Studies [United States Environmental Protection Agency (U.S. EPA), October 1988], the Superfund Amendments and Reauthorization Act of 1986 and its governing regulations, the National Oil and Hazardous Substances Pollution Contingency Plan (NCP), 40 Code of Federal Regulations (CFR) Part 300, and the National Environmental Policy Act (NEPA) (40 CFR 1500-1508).

The Navy implemented this FS with a team including representatives from the Illinois Environmental Protection Agency (Illinois EPA), Naval Facilities Engineering Field Division Southern (NAVFAC EFD SOUTH), the Navy's consultant Tetra Tech NUS, Inc. (TtNUS), and the Naval Station Great Lakes Environmental Department. The Statement of Work requires identification of possible remedial alternatives to address the risks at Site 22. The selected remedy will be determined based on evaluation of the developed alternatives compared to the nine remedy selection criteria outlined in Section 300.430(e) of the NCP and CERCLA Section 121.

1.1 FACILITY BACKGROUND

Naval Station Great Lakes (see Figure 1-1) covers 1,632 acres of Lake County, Illinois. Lake County is located in northeastern Illinois, north of the City of Chicago, and comprises 24 miles of Lake Michigan shoreline. Lake County extends from the Wisconsin border south to Cook County and from Lake Michigan west to McHenry County. Lake County is divided into 18 townships, 52 incorporated cities and villages, and 18 unincorporated cities and villages.

There are numerous lakeside communities in Lake County. The 2000 U.S. Census Bureau data estimates the county's population at 617,975. During the 1950s and 1960s, population growth occurred primarily in the lakefront communities but, by the 1980s and 1990s, population growth moved north and west. Currently, most of Lake County's population lives in the 52 incorporated cities and villages.

Current land uses in Lake County include agricultural, industrial, and residential. Farmland and lake resorts characterize the western portions of the county, while industrial, urban, and suburban areas follow the 24 miles of Lake Michigan shoreline on the east. There are also three state parks in Lake County.

Naval Station Great Lakes administers base operations and provides facilities and related support to training activities (including the Navy's only boot camp) as well as a variety of other military commands located on base. There are a variety of land uses that currently surround Naval Station Great Lakes. Along the northern boundary of the base are the most highly urbanized and industrial areas. Much of the land beyond the northwestern site boundary comprises unincorporated lands of Lake County and lies vacant except for scattered retail and residential properties. Adjacent to the western boundary are primarily industrial properties; while along the southern boundary is a mixture of public open space and residential land (TtNUS, June 2003).

1.2 SITE CHARACTERIZATION

1.2.1 Location and Description

Site 22, former Building 105 the Old Dry Cleaning Facility, at Naval Station Great Lakes is bounded on the south by Porter Street, on the west by a vacant asphalt-paved lot, on the north by Bronson Avenue, and on the east by Sampson Street (see Figure 1-2). The building was a slab-on-grade structure measuring approximately 150 feet by 70 feet. The former 10,500-square foot building occupied a lot measuring approximately 250 feet by 115 feet. Naval Station Great Lakes (U.S. EPA # IL7170024577) has operated with Resource Conservation and Recovery Act (RCRA) interim status authorization since November 19, 1980. Building 105 was originally included in a RCRA Part A permit that has been modified over the past 25 years. This RCRA unit is located in the southeastern quarter of the northwestern quarter of the southwestern quarter of Section 4, Township 44 North, Range 12 East (TtNUS, June 2003).

1.2.2 History

Building 105 was constructed in 1939 and was utilized as a dry cleaning facility until 1993 or 1994 when it was converted to a vending machine supply and repair station. From 1993 or 1994 until February 2001, the building was used to warehouse and repair vending equipment and products. The vending machine supply and repair operations ceased in February 2001, and the building was vacant until it was demolished in March 2003.

The RCRA unit in Building 105 (SO1) consisted of a drum storage area located inside along the eastern wall. Hazardous waste consisting of spent tetrachloroethene (PCE) from the laundry facilities was stored in this area from 1980 until 1987. The maximum quantity of waste stored at this unit is unknown; however according to the revised RCRA permit, 165 gallons (three 55-gallon drums) was the maximum amount of waste stored at one time in this area. The storage area consisted of the concrete floor (no berms or curbs were present) of the building adjoining the concrete block exterior wall. Near the storage area, two cracks and construction joints were observed in the concrete floor, as well as a garage-type entry door and several floor drains. Historic building foundation plans show the floor drains were connected to the storm sewer system located outside of the building. No visual evidence of spillage (staining) was observed or reported in this area, and the floor was in good condition in February 2003 as indicated in the Remedial Investigation and Risk Assessment (RI/RA) report (TtNUS, 2004).

The building foundation plans also show two 6-inch drains from the gutter under the washing machines associated with previous laundry operations. These drains were connected to a grease catch basin located outside the southeastern corner of the building by a 6-inch cast iron pipe (see Figure 1-2). The grease catch basin was approximately 5 feet by 7.5 feet by 5.5 feet deep with two chambers and had a 6-inch tile effluent pipe that was connected to another catch basin. It is speculated that the effluent line from the grease catch basin was connected to the waste water (sanitary) lines for Naval Station Great Lakes. It is postulated that the soil and groundwater contamination is from this part of the dry cleaner operations.

1.2.3 Previous Investigations

Investigations at Site 22 resulted in correspondence with the Illinois EPA, the implementing agency for unit closure. Soil and groundwater sampling was conducted at Site 22 by several contractors over the last 10 years. The results of the last investigation are shown on Figures 1-3 to 1-6. Tables 1-1, 1-2, and 1-3 show a summary of the analytical results for soil (surface and at depth) and groundwater sampling, respectively. According to these investigations, the chemicals of concern (COCs) are PCE and cis-1,2-dichloroethene (DCE) in soil and groundwater. The "hot spot" of contamination is located near the southeastern corner of the building along Sampson Street near the former grease catch basin.

1.2.4 Site-Specific Geology and Hydrogeology

1.2.4.1 Geology

Geologic conditions at Site 22 were characterized as part of the RI/RA (TtNUS, 2004). Surface and subsurface materials at Site 22 were visually classified based on macrocore samples and split-spoon samples collected during the drilling of soil and well borings conducted as part of the TtNUS field investigation. The shallow subsurface lithology of Site 22 was characterized to a depth of 50 feet.

Fill material, consisting of gravel, sand, silt, cinders, and occasionally bricks is present over most of the site to thicknesses of up to approximately 5 feet. Below the fill material layer is a heterogeneous mixture of sandy clays, gravelly clays, and silty clays with discontinuous silt and sand stringers to a depth of 30 feet below ground surface (bgs) that is considered the undisturbed, shallow subsurface lithology of Site 22. Immediately below this is a fine- to coarse-grained sand layer that appears to be laterally extensive over much of the site. The thickness of this sand layer varies slightly, ranging from approximately 7 to 10 feet thick. Immediately below this sand layer are clays and silty clays. Laboratory sieve analysis of composite samples from these deposits indicates that the Unified Soil Classification System descriptions of these soils are ML (sandy silt) to CL (silty clay).

1.2.4.2 Hydrogeology

Two separate aquifers are present at Site 22, a shallow (water table) and a deep confined aquifer. The shallow aquifer (water table) ranges from 4 to 30 feet bgs and is composed primarily of unconsolidated clays, silts, and silty clays with discontinuous sand and gravel lenses interspersed throughout. In general, the water table within these heterogeneous soils is shallow and is typically encountered at a depth of 4 to 18 feet bgs at the site. Groundwater can be expected to migrate horizontally in the more permeable materials found in the silts and clays. The deep aquifer ranges from 30 to 40 feet bgs and is composed of fine to coarse sand. In many sections of the site, clays and silty clays directly overlay and underlay this sandy layer. It is not known whether the deep aquifer is present throughout the site. However, based on the geologic setting and lithologies encountered, it is considered likely that this deep aquifer does exist throughout the site area. Groundwater in this aquifer is confined and exhibits a reasonably strong, upward gradient. Static groundwater levels in these wells ranged from 5 to 8 feet bgs. Water level elevations vary only slightly across the site (less than 0.1 foot of head change between the monitoring wells).

Recharge to the shallow aquifer is minimal because of the presence of the high density polyethylene (HDPE) membrane installed where Building 105 once stood. This membrane covers 80 percent of the site preventing precipitation from migrating downward through the soil. Consequently, recharge via precipitation and transport through the shallow aquifer to the deep aquifer is also minimized. Historically (before the installation of the HDPE liner), precipitation infiltration was limited because of Building 105 itself and the surrounding asphalt parking lot.

The groundwater flow pattern for the shallow aquifer is fairly complicated. The horizontal groundwater gradient is very similar across most of the site, although the direction varies widely. Groundwater flow in the shallow aquifer is to the west, east, and south. From a very general perspective (considering the four monitoring wells located around the perimeter of the site – NTC22MW01S, NTC22MW02S, NTC22MW07S, and NTC22MW08S – see Figure 1-6), groundwater migrates southwest in the general direction of Pettibone Creek; although, the overall groundwater path is much more complicated. Groundwater elevation lows are observed in the southwestern corner of the former building at NTC22MW04S, the southeastern corner of the former building at NTC22MW06S and near the southeastern edge of the site at NTC22MW09S. Though the latter two locations are near utility conduits, there is no evidence from the boring logs that suggest their low elevations are anomalies due to drainage along these conduits. However, these manmade subsurface structures appear to influence groundwater elevations, particularly around NTC22MW06S.

Horizontal hydraulic conductivity (K) values for the shallow aquifer ranged from 0.00248 foot per day [8.75 x 10^{-7} centimeters per second (cm/sec)] to 3.53 feet per day (1.25 x 10^{-3} cm/sec). The geometric mean horizontal K values for the six shallow aquifer monitoring wells was calculated to be 0.186 foot per day (6.54 x 10^{-5} cm/sec). These values are within the typical range for silty clays and clayey sands (Fetter, 1980 and Freeze & Cherry, 1979). In the deep aquifer, horizontal K values ranged from 0.5 foot per day (1.76 x 10^{-4} cm/sec) to 150 feet per day (5.29 x 10^{-2} cm/sec). The geometric mean horizontal K for these deep aquifer monitoring wells was calculated to be 15.5 feet per day (5.45 x 10^{-3} cm/sec). These values are within the typical range for fine to coarse sands (Fetter, 1980 and Freeze & Cherry, 1979).

The horizontal hydraulic gradient for the shallow aquifer ranged from a high of approximately 0.0425 to 0.0320 and to 0.0419. Using an average porosity of 0.35 for the gravelly clay/silty clay (Freeze and Cherry, 1979) and the site-wide geometric mean K value for the shallow monitoring wells (0.186 foot per day), the groundwater velocity was approximated. The calculated groundwater migration rates are 0.0223 feet per day (8.15 feet per year), 0.01699 feet per day (6.21 feet per year), and 0.0226 feet per day (8.25 feet per year). This range of groundwater velocities is generally consistent with the geology/lithology present at the site.

Care must be taken when interpreting these results, though. Based on the lithologies present, horizontal groundwater flow only occurs in the continuous sand and gravel lenses. There is no evidence from the boring logs that these lenses are laterally extensive where contamination has been found. Large-scale, site-wide transport (and off-site transport) of potential contaminants in the shallow aquifer is not likely to be occurring. Furthermore, based on the direction of groundwater flow, most of the groundwater remains on site.

1.3 ENVIRONMENTAL CONDITIONS

The following briefly reviews the RI/RA investigation, the condition of Site 22 as of October 2003; more detailed information is available in Section 4.0 (Nature and Extent of Contamination) and Section 6.0 (Human Health Risk Assessment) of the RI/RA report (TtNUS, 2004). In this section, the environmental conditions, including the nature and extent of contamination and human health risk assessment results, are briefly reviewed.

1.3.1 Nature and Extent of Contamination

The following briefly summarizes the nature and extent of the current contamination in surface soil, subsurface soil, and groundwater at Site 22:

- The primary source of soil and groundwater contamination appears to be the former dry cleaner operation and associated drains and grease catch basin in the southeastern portion of the building.

- Chlorinated volatile organic compounds (VOCs) are significant site-related contaminants at Site 22. PCE and its degradation products [e.g. trichloroethene (TCE), cis-1,2-DCE, and vinyl chloride] were detected in surface and subsurface soil at high concentrations in the vicinity of former Building 105, with the highest concentrations detected near the former drains and grease catch basin. In addition, PCE and its degradation products (TCE and cis-1,2-DCE) were detected in groundwater at the same locations.

- PCE and its degradation products, TCE, DCE, and vinyl chloride, were detected in surface and subsurface soil at concentrations exceeding screening levels for groundwater protection. Some of the VOC concentrations reported for soil in the southeastern corner of the site also exceed the Illinois EPA Tiered Approach to Corrective Action Objectives (TACO) for human exposure (i.e., incidental ingestion, inhalation). Illinois EPA has classified the contaminated media (soil and groundwater) as a listed hazardous waste for PCE (F002). If the contaminated media is removed from this site, it would have to be identified as a listed hazardous waste.

- Impacted soil and groundwater around the former drains and grease catch basin are limited to shallow depths (up to 30 feet deep), with the highest concentrations being between 8 to 20 feet bgs.

Impacts to the deeper aquifer zone are limited both in concentration and migration potential due to the geology of the site.

- There does not appear to be a groundwater plume currently present at the site. Impacts to the groundwater are to areas immediately surrounding the former drains and grease catch basin area.

1.3.2 Human Health Risk Assessment

Site 22 is currently covered with asphalt. Most of the footprint of former Building 105 is also covered with a HDPE liner that was placed under the asphalt after the building was demolished. Therefore, there is no current exposure to contaminated environmental media at the site. Construction workers, maintenance workers, future occupational workers, adolescent trespassers, and hypothetical future civilian and military residents (adults and children) were evaluated as potential receptors in the site-specific human health risk assessment (HHRA).

These receptors were evaluated for direct exposure to surface soil and indirect exposure to vapors emitted from surface soil. To aid in risk management decisions, potential receptors were also evaluated for exposure to chemicals of potential concern (COPCs) in subsurface soil. Construction workers were evaluated for exposure to COPCs in groundwater (dermal contact). Potential future onsite residents were not evaluated for exposure to COPCs in groundwater because groundwater at Site 22 is not used as a potable water source under current conditions and is not anticipated to be used for this purpose under projected future land uses.

Several inhalation exposure pathways were evaluated using various predictive models because the COPCs for Site 22 are classified as volatiles. Potential receptors were evaluated for vapors emitted from soil and groundwater into outdoor ambient air and to air inside buildings. The scenarios evaluated in the HHRA assume that soil at the site has been exposed in future excavation projects and that commercial or residential buildings have been constructed on the site.

The list of COPCs based on the HHRA for Site 22 includes the following:

- Surface soil – PCE, TCE, cis-1,2-DCE
- Subsurface soil – PCE, TCE, cis-1,2-DCE, vinyl chloride
- Groundwater – PCE, TCE

The concentrations of the COPCs in soil exceeded their respective U.S. EPA and Illinois EPA Soil Screening Levels (SSLs) for the protection of groundwater, which are used to evaluate the potential of a chemical to impact groundwater quality by the migration of chemicals from soil to groundwater. Maximum soil concentrations are compared to SSLs, and exceedances of SSLs indicate the potential to adversely impact groundwater. Minimal migration of contaminants from soil to groundwater has occurred as demonstrated by the detection of chlorinated VOCs in groundwater in the area of the former drains and grease catch basin underlying Site 22.

Under future land use, quantitative estimates of noncarcinogenic and carcinogenic risks [Hazard Indices (HIs) and Incremental Lifetime Cancer Risks (ILCRs), respectively] were developed for potential receptors hypothetically exposed to COPCs in soil and groundwater.

For the Reasonable Maximum Exposure (RME) scenarios, the cumulative ILCR for adolescent trespassers ($6.6x10^{-7}$) was less than $1x10^{-6}$. The ILCRs for construction workers ($7.2x10^{-5}$), future occupational workers ($5.3x10^{-5}$), and maintenance workers ($3.0x10^{-6}$) were within U.S. EPA's risk management range, $1x10^{-6}$ to $1x10^{-4}$. ILCRs for future military adult residents ($7.5x10^{-4}$), future military child residents ($1.8x10^{-3}$), and future civilian residents ($4.7x10^{-3}$) exceeded U.S. EPA's risk management range.

Cumulative HIs for maintenance workers (0.019), occupational workers (0.36), and adolescent trespassers (0.011) under the RME scenarios were less than the Illinois EPA and U.S. EPA benchmark (1.0), indicating that adverse noncarcinogenic effects are not anticipated for these receptors under the defined exposure conditions. Total HIs for construction workers (33), hypothetical future military and civilian residents (adult HI = 24, child HI = 58) exceeded the Illinois EPA and U.S. EPA benchmark (1.0).

The elevated carcinogenic and noncarcinogenic risks for the construction worker were mainly due to exposure to PCE in soil and groundwater. Inhalation of vapors (mainly PCE and TCE) migrating from soil into air inside buildings was the major contributor (i.e., risks greater than $1x10^{-4}$) to the elevated risk for future military and civilian residents. Inhalation of indoor air impacted by vapors migrating from groundwater, inhalation of outdoor air, and incidental ingestion of soil were minor contributors to the cumulative risks for future residents (i.e., risks greater than $1x10^{-6}$ and less than $1x10^{-4}$).

The following important uncertainties are associated with the estimated ILCRs and HIs for Site 22:

- The site is currently covered with asphalt and most of the footprint of former Building 105 is also covered with a HDPE liner preventing direct contact with chemicals and greatly impeding the migration of vapors or leaching of chemicals to groundwater.

- The Exposure Point Concentrations (EPCs) used to evaluate groundwater and surface soil risks were the maximum detected concentrations.

- The air concentrations used for the indoor and outdoor inhalation exposure scenarios were not measured concentrations but were estimated from various models.

- For modeling purposes, it was assumed that the entire volume of groundwater beneath buildings contained the maximum detected concentrations of PCE and TCE.

- A number of soil and groundwater samples required dilution by the laboratory because of high concentrations of PCE, and it is possible that some compounds may have been "diluted out" resulting in an underestimation of risks.

- Dermal contact with soil was not quantitatively evaluated because U.S. EPA dermal guidance does not provide dermal absorption values for VOCs in soil.

In summary, carcinogenic and noncarcinogenic risk estimates for hypothetical future workers and residents at Site 22 exceeded U.S. EPA benchmarks, indicating the potential for adverse health effects from exposure to COPCs in soil and groundwater. The quantitative risk evaluation indicated that HIs for these receptors were greater than 1.0 and that ILCRs were greater than or within the U.S. EPA's risk management range, $1x10^{-6}$ to $1x10^{-4}$ for several receptors. There were important uncertainties in the risk assessment that could either overestimate or underestimate the risk estimates. However, because the site is paved and most of the footprint of former Building 105 is also covered with a HDPE liner and groundwater is not used as a potable water source, there is no current exposure or risk.

1.3.3 <u>Ecological Risk Assessment</u>

Site 22 provides no real terrestrial habitat, with only a strip of grass south of the site boundary. Although a few ecological receptors may be present at the site, they will not be exposed to site contaminants; therefore, an ecological risk assessment was not conducted at Site 22. Groundwater migration will be monitored in the future; if contaminants were to migrate as far as Pettibone Creek, potential ecological impacts would need to be re-evaluated.

1.4 DOCUMENT ORGANIZATION

This FS Report has been organized with the intent of meeting the general format requirements specified in the RI/FS Guidance Document (U.S. EPA, October 1988). This report consists of the following five sections:

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

- Section 2.0, Remedial Action Objectives (RAOs) and General Response Actions (GRAs) - presents the RAOs, identifies applicable or relevant and appropriate requirements (ARARs) and To Be Considered (TBC) criteria, develops Preliminary Remediation Goals (PRGs) and associated GRAs, and provides an estimate of the volume of contaminated media to be remediated. This section also discusses the uncertainties for this FS related to site-specific conditions.

- 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 the 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.

TABLE 1-1

SUMMARY OF DESCRIPTIVE STATISTICS AND CRITERIA COMPARISONS FOR RI SURFACE SOIL DATA
SITE 22 - BUILDING 105 OLD DRY CLEANING FACILITY
NAVAL STATION GREAT LAKES, ILLINOIS

Parameter	Frequency of Detection	Range of Detects	Range of Nondetects	Sample with Maximum Concentration	Average of Positive Results	Average of All Results(1)	Illinois TACO for Soil Ingestion(2)	TACO for Soil Ingestion Exceedances(3)	Region 9 Residential PRG	Region 9 Residential PRG Exceedances(3)	USEPA Generic Soil to Groundwater SSL (DAF=1)	USEPA Generic Soil to Groundwater SSL (DAF=1) Exceedances(3)	Illinois TACO Soil to Groundwater Tier 1(2)	TACO Soil to Groundwater Tier 1 Exceedances(3)	Illinois TACO for Soil Inhalation(2)	TACO for Soil Inhalation Exceedances(3)	Illinois TACO for Soil Inhalation-Industrial(2)	TACO for Soil Inhalation-Industrial Exceedances(3)
Volatiles (ug/kg)																		
CIS-1,2-DICHLOROETHENE	2/10	490 J - 52,000	4.4 - 8,700	NTC22SS150001	26,245	5,724	780,000	0	43,000	1	20	2	400	2	1,200,000	0	1,200,000	0
TETRACHLOROETHENE	10/10	0.65 J - 770,000	0	NTC22SS150001	101,183	101,183	12,000	3	1,500	6	2.9	7	60	6	11,000	3	20,000	3
TRICHLOROETHENE	2/10	730 J - 7,700 J	4.4 - 8,700	NTC22SS150001	4,215	1,318	58,000	0	53	2	2.8	2	60	2	5,000	1	8,900	0

1 - The average concentrations were calculated using one-half the detection limit for non-detects.
2 - Illinois EPA (October 2004).
3 - Number of samples that exceed criterion.
TACO - Illinois EPA Tiered Approach to Corrective Action Objectives.
J - Positive result is estimated as a result of a value less than the reporting limit or technical noncompliance.

PRG = Preliminary Remediation Goal
SSL = Soil Screening Level
DAF = Dilution Attenuation Factor

TABLE 1-2

SUMMARY OF DESCRIPTIVE STATISTICS AND COMPARISONS FOR RI SUBSURFACE SOIL DATA
SITE 22 - BUILDING 105 OLD DRY CLEANING FACILITY
NAVAL STATION GREAT LAKES, ILLINOIS

Parameter	Frequency of Detections	Range of Detects	Range of Nondetects	Sample with Maximum Concentration	Average of Positive Results	Average of All Results(1)	Illinois TACO for Soil Ingestion(2)	TACO for Soil Ingestion Exceedances(3)	Region 9 Residential PRG	Region 9 Residential PRG Exceedances(3)	USEPA Generic Soil to Groundwater SSL (DAF=1)	USEPA Generic Soil to Groundwater SSL (DAF=1) Exceedances(3)	TACO Soil to Groundwater Tier 1(2)	TACO Soil to Groundwater Tier 1 Exceedances(3)	Illinois TACO for Soil Inhalation(2)	Illinois TACO for Soil Inhalation Exceedances(3)	Illinois TACO for Soil Inhalation-Industrial(2)	Illinois TACO for Soil Inhalation-Industrial Exceedances(3)
Volatiles (ug/kg)																		
1,1,1-TRICHLOROETHANE	3/36	6.7 - 45 J	4.1 - 26,000	NTC22SB151112-D	21	694	NC	0	1,200,000	0	97	0	2,000	0	1,200,000	0	1,200,000	0
1,1,2-TRICHLOROETHANE	1/36	4.3 J	4.1 - 26,000	NTC22SB200911	4	852	310,000	0	730	0	0.91	1	20	0	1,800,000	0	1,800,000	0
1,1-DICHLOROETHANE	3/36	2 J - 51	4.1 - 26,000	NTC22SB200911	19	694	7,800,000	0	510,000	0	1,000	0	23,000	0	1,300,000	0	130,000	0
1,1-DICHLOROETHENE	3/36	2.9 J - 42 J	4.1 - 26,000	NTC22SB151112-D	20	694	700,000	0	120,000	0	2.9	2	60	0	1,500,000	0	300,000	0
CIS-1,2-DICHLOROETHENE	6/36	55 - 9,300 J	4.1 - 23,000	NTC22SB191920	4,459	762	780,000	0	43,000	0	20	6	400	4	1,200,000	0	1,200,000	0
TETRACHLOROETHENE	31/36	0.55 J - 870,000 J	2.8 - 4.8	NTC22SB060708	53,891	46,406	12,000	5	1,500	7	2.9	14	60	10	11,000	6	20,000	4
TRANS-1,2-DICHLOROETHENE	4/36	1.6 J - 89 J	4.1 - 26,000	NTC22SB151112-D	28	695	1,600,000	0	69,000	0	34	1	700	0	3,100,000	0	3,100,000	0
TRICHLOROETHENE	7/36	0.71 J - 7,300 J	4.1 - 23,000	NTC22SB060708	2,581	517	58,000	0	53	6	2.8	6	60	6	5,000	2	8,900	0
VINYL CHLORIDE	1/36	140 J	4.1 - 26,000	NTC22SB151112-D	140	696	460	0	79	1	0.67	1	10	1	280	0	1,100	0

1 - The average concentrations were calculated using one-half the detection limit for non-detects.
2 - Illinois EPA (October 2004).
3 - Number of samples that exceed criterion.
TACO - Illinois EPA Tiered Approach to Corrective Action Objectives.
J - Positive result is estimated as a result of a value less than the reporting limit or a technical noncompliance.

PRG = Preliminary Remediation Goal
SSL = Soil Screening Level
DAF = Dilution Attenuation Factor

TABLE 1-3

SUMMARY OF DESCRIPTIVE STATISTICS AND CRITERIA COMPARISONS FOR RI GROUNDWATER DATA
SITE 22 - BUILDING 105 OLD DRY CLEANING FACILITY
NAVAL STATION GREAT LAKES, ILLINOIS

Parameter	Frequency of Detection	Range of Detects	Range of Nondetects	Sample with Maximum Concentration	Average of Positive Results	Average of All Results(1)	Region 9 Tap Water PRG	Region 9 Tap Water PRG Exceedances(3)	Illinois TACO Groundwater Ingestion Tier 1(2)	TACO Groundwater Tier 1 Exceedances(3)	Federal MCL GW(4)	Fed MCL GW Exceedances (3)
Volatiles (ug/L)												
CHLOROMETHANE	1/14	0.21 J	1 - 2,000	NTC22GW10D	0.21	72	1.5	0	NC	0	NC	0
CIS-1,2-DICHLOROETHENE	1/14	2.6	1 - 2,000	NTC22GW10S	2.6	72	61	0	70	0	70	0
TETRACHLOROETHENE	6/14	0.24 J - 59,000	1 - 2.2	NTC22GW06S	9,846	4,220	0.66	4	5	3	5	3
TRICHLOROETHENE	1/14	1.3	1 - 2,000	NTC22GW10S	1.3	72	0.028	1	5	0	5	0

1 - The average concentrations were calculated using one-half the detection limit for non-detects.
2 - Illinois EPA (October 2004).
3 - Number of samples that exceed criterion.
4 - USEPA (Summer 2002).
TACO - Illinois EPA Tiered Approach to Corrective Action Objectives.
J - Positive result is estimated as a result of a value less than the reporting limit or a technical noncompliance.
NC - No criterion.

PRG = Preliminary Remediation Goal
MCL = Maximum Contaminant Level

P:\GIS\GREATLAKES_NTC\APRS\BLDG105.APR SITE LOCATION MAP 5/24/05 AJ

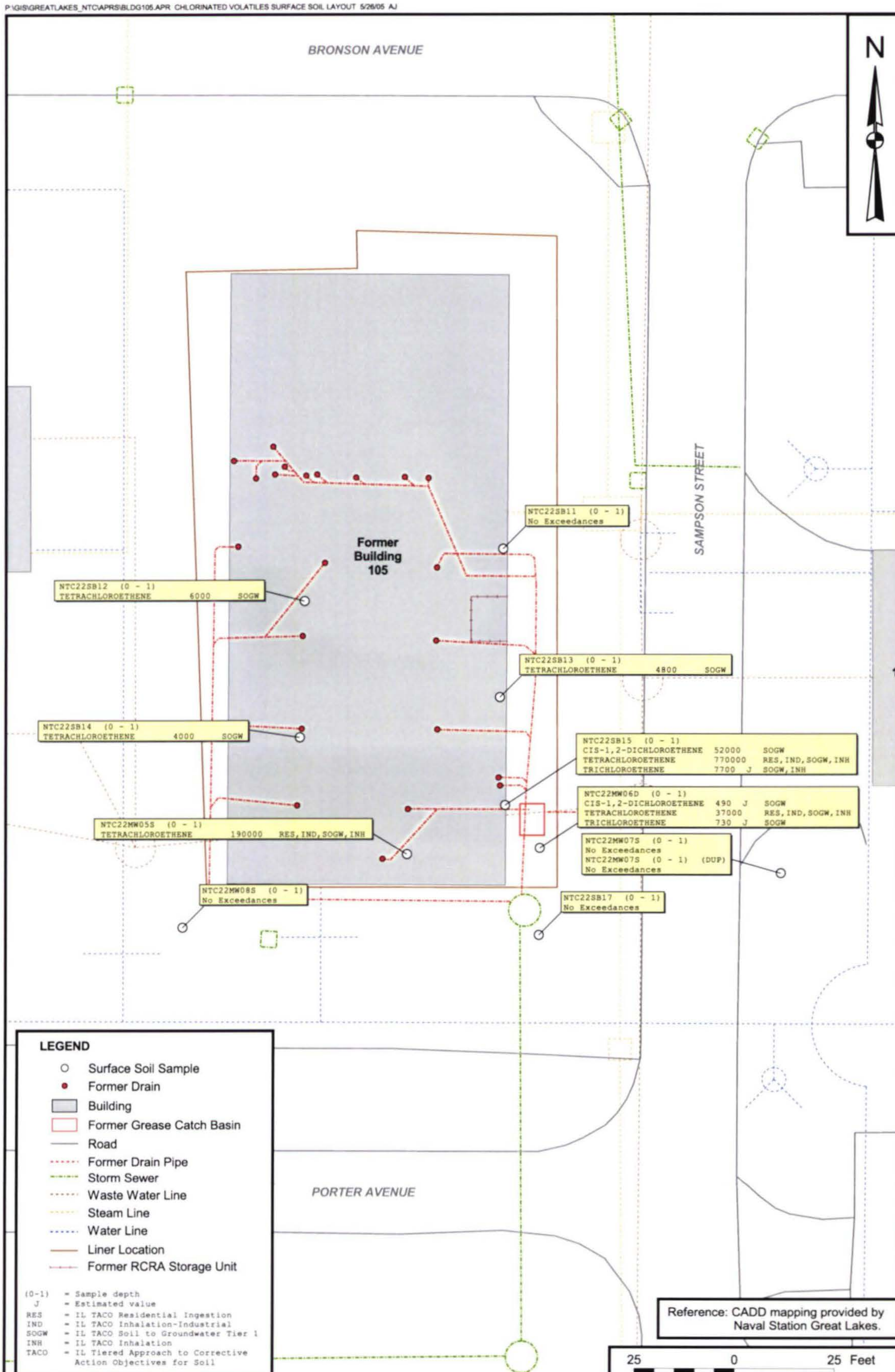
DRAWN BY K. PEILA	DATE 12/2/03	SITE LOCATION MAP
CHECKED BY R. YOUNG	DATE 5/25/05	SITE 22 - BUILDING 105 OLD DRY CLEANING FACILITY
COST/SCHEDULE-AREA		NAVAL STATION
SCALE AS NOTED		GREAT LAKES, ILLINOIS

CONTRACT NUMBER N00078		
APPROVED BY RFD	DATE 5/25/05	
APPROVED BY —	DATE —	
DRAWING NO. FIGURE 1 - 1		REV 0

P:\GIS\GREATLAKES_NTC\APRS\BLDG105.APR SITE MAP 5/26/05 AJ

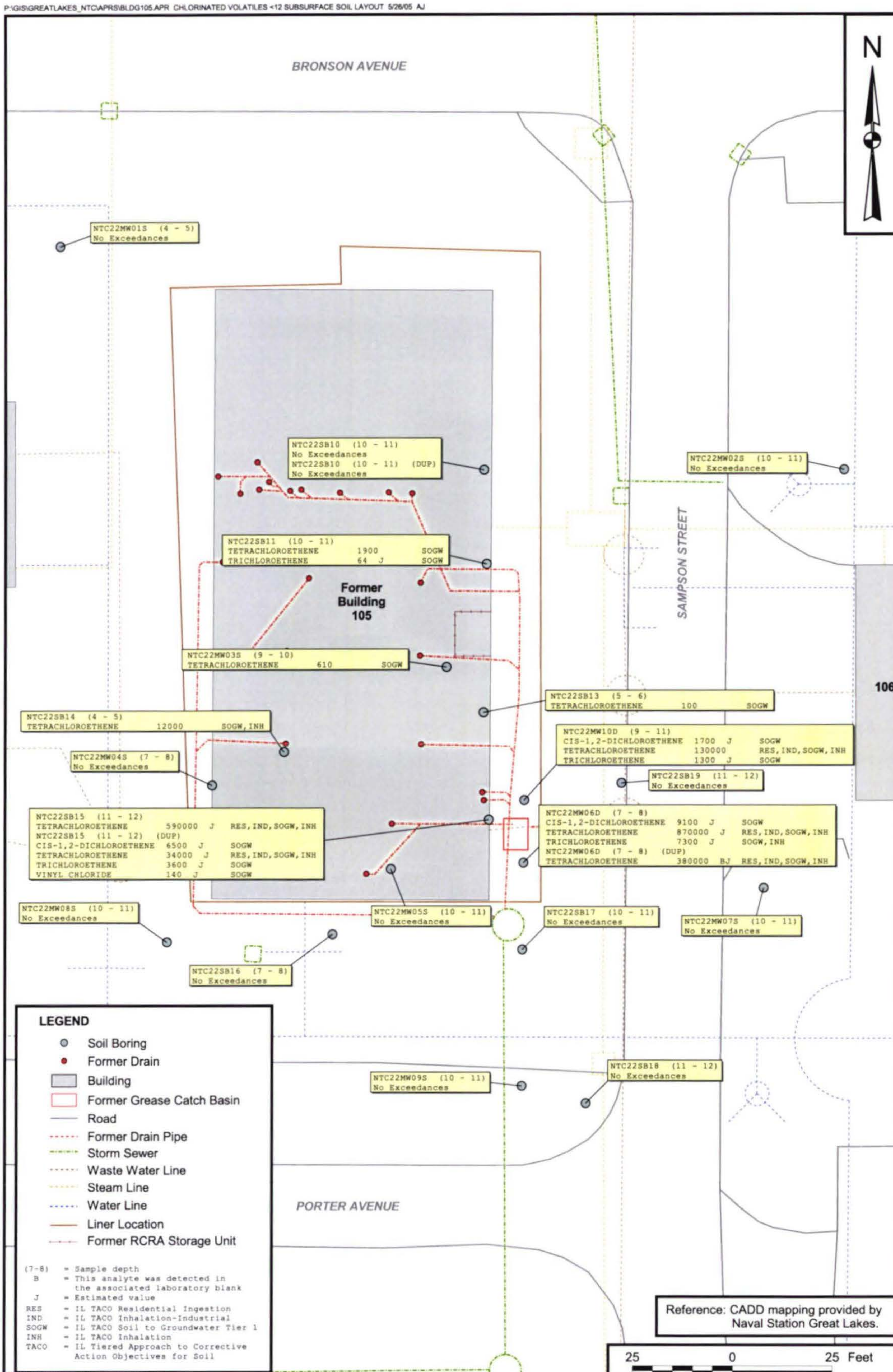
DRAWN BY K. PEILA DATE 12/2/03 CHECKED BY R. YOUNG DATE 5/25/05 COST/SCHEDULE-AREA SCALE AS NOTED	NAVFAC	SITE MAP SITE 22 - BUILDING 105 OLD DRY CLEANING FACILITY NAVAL STATION GREAT LAKES, ILLINOIS	CONTRACT NUMBER N00078 APPROVED BY RFD DATE 5/25/05 APPROVED BY — DATE — DRAWING NO. FIGURE 1 - 2 REV 0

P:\GIS\GREATLAKES_NTC\APRS\BLDG105.APR CHLORINATED VOLATILES SURFACE SOIL LAYOUT 5/26/05 AJ



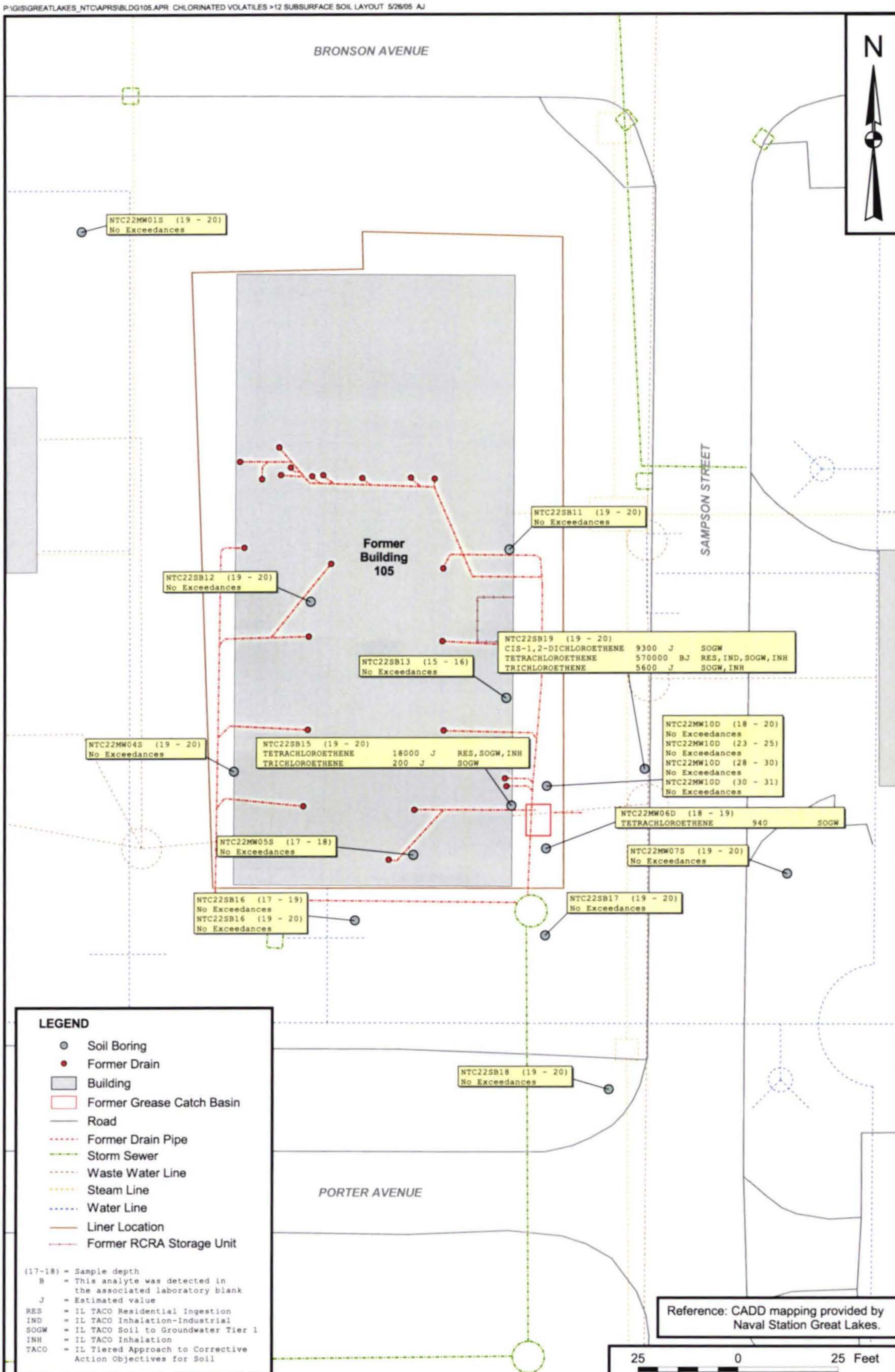
DRAWN BY A. JANOCHA DATE 1/12/04	NAVFAC	CHLORINATED VOLATILE SURFACE SOIL EXCEEDANCES	CONTRACT NUMBER N00078
CHECKED BY R. YOUNG DATE 5/25/05		SITE 22 - BUILDING 105 OLD DRY CLEANING FACILITY	APPROVED BY RFD DATE 5/25/05
COST/SCHEDULE-AREA		NAVAL STATION	APPROVED BY — DATE —
SCALE AS NOTED		GREAT LAKES, ILLINOIS	DRAWING NO. FIGURE 1 - 3 REV 0

P:\GIS\GREATLAKES_NTC\APRS\BLDG105.APR CHLORINATED VOLATILES <12 SUBSURFACE SOIL LAYOUT 5/26/05 AJ



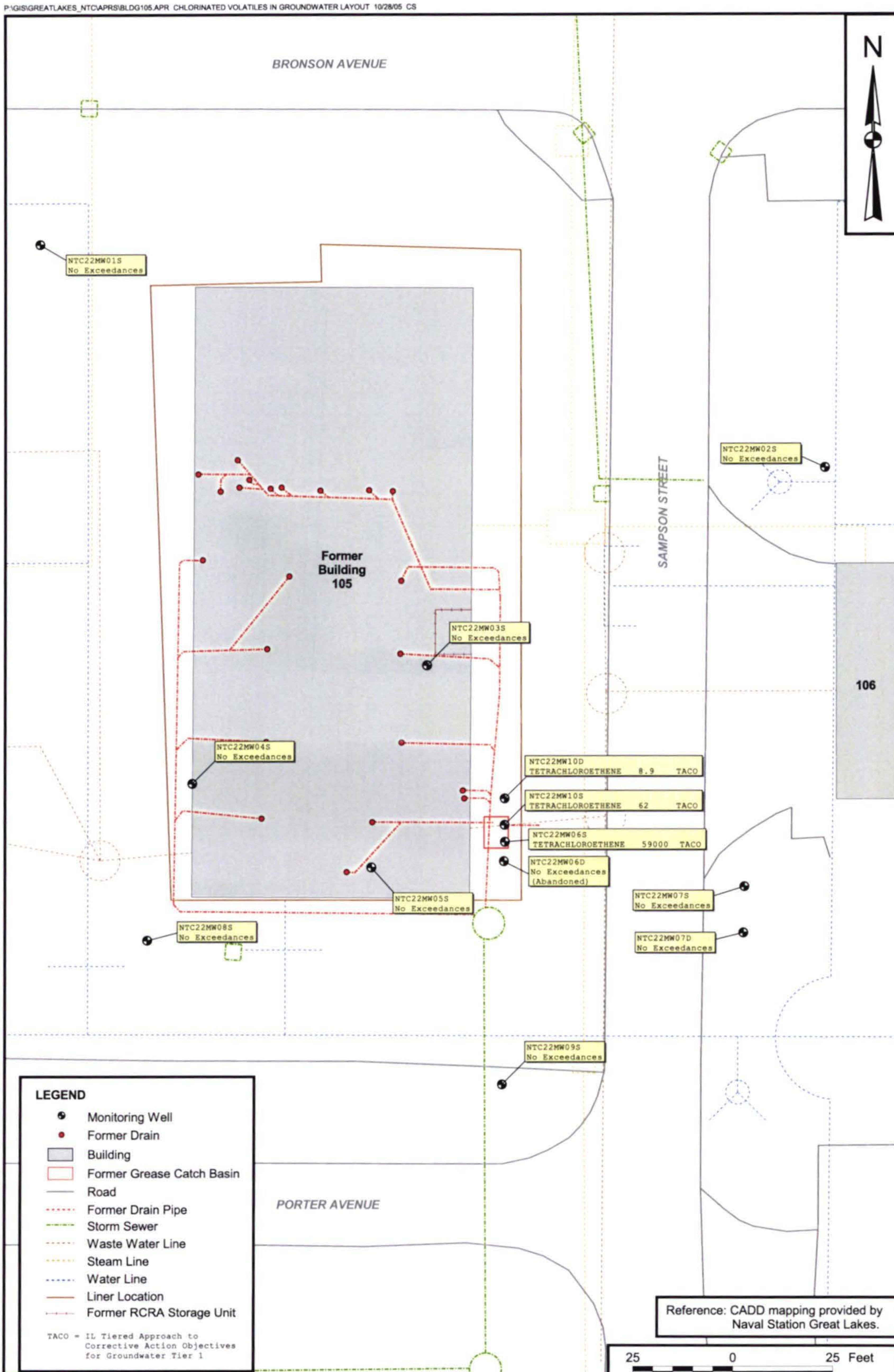
DRAWN BY A. JANOCHA — DATE 1/12/04	NAVFAC	CHLORINATED VOLATILE SUBSURFACE SOIL EXCEEDANCES (<12 BGS)	CONTRACT NUMBER N00078
CHECKED BY R. YOUNG — DATE 5/25/05		SITE 22 - BUILDING 105 OLD DRY CLEANING FACILITY	APPROVED BY RFD — DATE 5/25/05
COST/SCHEDULE-AREA		NAVAL STATION	APPROVED BY — DATE —
SCALE AS NOTED		GREAT LAKES, ILLINOIS	DRAWING NO. FIGURE 1 - 4 — REV 0

P:\GIS\GREATLAKES_NTC\APRS\BLDG105.APR CHLORINATED VOLATILES >12 SUBSURFACE SOIL LAYOUT 5/26/05 AJ



DRAWN BY A. JANOCHA — DATE 1/12/04	NAVFAC	CHLORINATED VOLATILE SUBSURFACE SOIL EXCEEDANCES (>12 BGS)	CONTRACT NUMBER N00078
CHECKED BY R. YOUNG — DATE 5/25/05		SITE 22 - BUILDING 105 OLD DRY CLEANING FACILITY	APPROVED BY RFD — DATE 5/25/05
COST/SCHEDULE-AREA		NAVAL STATION	APPROVED BY — DATE
SCALE AS NOTED		GREAT LAKES, ILLINOIS	DRAWING NO. FIGURE 1 - 5 — REV 0

P:\GIS\GREATLAKES_NTC\APRS\BLDG105.APR CHLORINATED VOLATILES IN GROUNDWATER LAYOUT 10/28/05 CS



DRAWN BY A. JANOCHA — DATE 1/12/04 CHECKED BY R. YOUNG — DATE 5/25/05 COST/SCHEDULE-AREA SCALE AS NOTED	NAVFAC	CHLORINATED VOLATILE GROUNDWATER EXCEEDANCES SITE 22 - BUILDING 105 OLD DRY CLEANING FACILITY NAVAL STATION GREAT LAKES, ILLINOIS	CONTRACT NUMBER N00078 APPROVED BY RFD — DATE 5/25/05 APPROVED BY — DATE — DRAWING NO. FIGURE 1 - 6 — REV 0

2.0 REMEDIAL ACTION OBJECTIVES AND GENERAL RESPONSE ACTIONS

This section develops RAOs and derives PRGs for contaminated soil and groundwater at Site 22, former Building 105 Old Dry Cleaning Facility, based on the site conditions presented in Section 1. The RAOs provide the basis for selecting appropriate remedial alternatives. The PRGs for the contaminated media are developed in this section, and GRAs that may be suitable to achieve the PRGs are presented.

The regulatory requirements and guidance chemical-, location-, and action-specific ARARs that may potentially govern remedial activities at the site are also presented in this section. In addition, this section presents the COCs and the conceptual pathways through which these chemicals may affect human health, derives the environmental media of concern, and discusses the uncertainties in this FS as it relates to contamination from chlorinated organics and development of site-specific PRGs. Finally, this section presents an estimate of the volume of contaminated soil and groundwater that has been impacted.

2.1 REMEDIAL ACTION OBJECTIVES

The purpose of this section is to develop RAOs for Site 22 at Naval Station Great Lakes, Illinois. Development of RAOs is an important step in the FS process. The RAOs are medium-specific goals that define the objectives of conducting remedial actions to protect human health and the environment. The RAOs specify the COCs, potential exposure routes and receptors, and acceptable ranges of contaminant concentrations (i.e., PRGs) for the site. Section 2.1.1 presents the RAOs developed for Site 22. The development of PRGs takes into consideration ARARs and TBCs. 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 for remediation.

2.1.1 Statement of Remedial Action Objectives

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 22. The RAOs were developed to permit consideration of a range of treatment and containment alternatives based on the current and potential future land use as a parking lot with neighboring barracks, galley, and commercial areas (Naval Station Great Lakes, 2003). To protect the public from current and potential future health risks, as well as to protect the environment, the following RAOs were developed:

- Prevent unacceptable human health risks associated with inhalation, ingestion, and dermal contact with soil containing chlorinated organics at concentrations greater than established PRGs.

- Prevent unacceptable human health risks associated with ingestion of groundwater or future dermal contact by workers with groundwater containing chlorinated organics at concentrations greater than established PRGs.

- Prevent further adverse impacts on groundwater from chlorinated organics migrating from soil to groundwater. It should be noted that at the current time this exposure pathway is not applicable to Site 22 because the site is capped and groundwater at Naval Station Great Lakes is not used as a source of potable water and is not expected to be used in the future.

- In order to comply with the Naval Station Great Lakes RCRA permit issued by Illinois EPA, obtain closure for the drum storage area (RCRA Unit SO1). This will include conducting remedial actions to reduce chlorinated VOC mass in soil and groundwater.

In meeting these RAOs, contaminated media containing listed hazardous waste may be left in place.

2.1.2 Applicable or Relevant and Appropriate Requirements and To Be Considered Criteria

ARARs consist of the following:

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

TBCs are nonpromulgated, nonenforceable guidelines or criteria that may be useful for developing a remedial action or are necessary for determining what is protective of human health and/or the environment. Examples of TBCs include U.S. EPA's Drinking Water Health Advisories, Reference Doses (RfDs), and Cancer Slope Factors (CSFs).

One of the primary concerns during the development of remedial action alternatives for hazardous waste sites under CERCLA is the degree of human health and environmental protection offered by a given remedy. Section 121 of CERCLA requires that primary consideration be given to remedial alternatives that attain or exceed ARARs. The purpose of this requirement is to make CERCLA response actions consistent with other pertinent federal and state environmental requirements.

2.1.2.1 Definitions

The definitions of ARARs and TBCs are as follows:

- 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. While these relevant and appropriate requirements are not "applicable" to a hazardous substance, pollutant, contaminant, or remedial action, location, or other circumstance at a CERCLA site, they address problems or situations sufficiently similar to those encountered at the CERCLA site that their use is well suited to the particular site.
- TBCs are a category created by U.S. EPA that includes nonpromulgated criteria, advisories, and guidance issued by federal or state government that are not legally binding and do not have the status of potential ARARs. However, pertinent TBCs will be considered along with the ARARs in determining the necessary level of cleanup or technology requirements.

Under CERCLA Section 121(d)(4), U.S. EPA 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 that is 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 within the state.

The NCP identifies three categories of ARARs [40 CFR Section 300.400 (g)] as follows:

- Chemical-Specific: Health-risk-based numerical values or methodologies that establish concentration or discharge limits for particular contaminants. Examples include U.S. EPA's Maximum Contaminant Levels (MCLs) and Clean Water Act (CWA) Ambient Water Quality Criteria (AWQCs).

- Location-Specific: Restrict actions or contaminant concentrations in certain environmentally sensitive areas. Examples of these 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 wastewater discharge standards and performance or design standards, controls, or restrictions on particular types of activities.

Chemical- and location-specific ARARs and TBCs are discussed in this section. 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

Table 2-1 presents federal and State of Illinois chemical-specific ARARs and TBCs applicable to this FS. The chemical-specific ARARs and TBCs provide medium-specific guidance on "acceptable" or "permissible" concentrations of contaminants. The following federal and State chemical-specific ARARs and TBCs from Table 2-1 are considered to be potentially applicable to Site 22:

- U.S. EPA Region 9 PRGs. The Region 9 PRGs are risk-based concentrations used to assess the need for remediation of soil and groundwater under residential and industrial land use. The Region 9 PRGs account for exposure to chemicals in these media by ingestion, inhalation, and dermal contact. These concentrations are calculated for a target HI of 1.0 for noncarcinogenic effects and a target risk of $1.0x10^{-6}$ for carcinogenic effects.

- U.S. EPA SSLs developed according to guidance provided in the U.S. EPA's Soil Screening Guidance and calculated on the U.S. EPA's Soil Screening Guidance website at http://risk.lsd.ornl.gov/calc_start.shtml. The SSLs applicable to Site 22 are concentrations in soil used to assess indirect exposure to chemicals that may migrate from soil to air (by volatilization or particulate emissions) or by leaching from soil to groundwater.

- Illinois EPA TACO Soil Remediation Objectives for residential and industrial/commercial properties. The remediation objectives are calculated for a target HI of 1.0 for noncarcinogenic effects and a Target Risk of 1.0×10^{-6} for carcinogenic effects and are used to evaluate direct exposure to soil by ingestion, dermal contact, and inhalation and indirect exposure by migration of contaminants from soil to groundwater.

- RCRA Subtitle C regulates the treatment, storage, and disposal of hazardous waste from its generation until its ultimate disposal. In general, RCRA Subtitle C requirements for the treatment, storage, or disposal of hazardous waste will be applicable if:

  - The waste is a listed or characteristic waste under RCRA.
  - The waste was treated, stored, or disposed (as defined in 40 CFR 260.10) after the effective date of the RCRA requirements under consideration.
  - The activity at the CERCLA site constitutes current treatment, storage, or disposal as defined by RCRA.

  The following chemical-specific requirements included in the RCRA Subtitle C regulations are potentially applicable to Site 22:

  - Identification and listing of hazardous waste (40 CFR 261)
  - Groundwater protection and groundwater monitoring (40 CFR 264.90-264.101)

2.1.2.3 Location-Specific ARARs and TBCs

Table 2-2 presents the federal and State of Illinois location-specific ARARs and TBCs for this FS. The location-specific ARARs and TBCs place restrictions on concentrations of contaminants or the conduct of activities solely based on the site's particular characteristics or location. The following presents a summary of federal and State location-specific ARARs and TBCs from Table 2-2 that is considered to be potentially applicable to Site 22:

- U.S. EPA's Groundwater Protection Strategy (U.S. EPA, 1984) policy is to protect groundwater for its highest present or potential beneficial use. The strategy designates the following three categories of groundwater:

  - Class I - Special Groundwater: Waters that are highly vulnerable to contamination and are either irreplaceable or ecologically vital sources of drinking water.

  - Class II - Current and Potential Sources of Drinking Water and Waters Having Other Beneficial Uses: Waters that are currently used or that are potentially available.

  - Class III - Groundwater Not a Potential Source of Drinking Water and of Limited Beneficial Use. Class III groundwater units are further subdivided into two subclasses.

    -- Subclass IIIA includes groundwater units that are highly to intermediately interconnected to adjacent groundwater units of a higher class and/or surface waters. They may, as a result, be contributing to the degradation of the adjacent waters. They may be managed at a similar level as Class II groundwater, depending on the potential for producing adverse effects on the quality of adjacent waters.

    -- Subclass IIIB is restricted to groundwater characterized by a low degree of interconnection to adjacent surface waters or other groundwater units of a higher class within the Classification Review Area. This groundwater is naturally isolated from sources of drinking waters in such a way that there is little potential for producing adverse effects on quality. This groundwater has low resource value outside of mining or waste disposal.

Groundwater at Site 22 is likely considered Class IIIA.

- Water Classifications set forth in 35 Illinois Administrative Code 620 and criteria specified in Title 35: Environmental Protection, Subtitle G: Waste Disposal, Chapter I: Pollution Control Board, Subchapter F: Risk Based Cleanup Objectives, Part 742. Administrative Code 620 provides criteria for defining groundwater as Class I Groundwater (Potable Resource Groundwater) or Class II Groundwater (General Resource Groundwater).

- Historic Sites, Buildings, and Antiquities Act of 1935 [16 United States Code (U.S.C.) 461 et seq.] states that it is federal policy to preserve historic and prehistoric properties of national significance. Site 22 is not classified as such a property nor is it known to possess aspects of historic or prehistoric significance; however, this Act would be applicable if information were found to classify it as such a property. As such, this Act is potentially applicable.

- Archaeological and Historic Preservation Act of 1974 (16 U.S.C. 469 et seq.) contains provisions for the protection of historic and archaeological data affected by any federal construction project or federally licensed project, activity, or program. Although no such data are known to exist within the boundaries of Site 22, this Act would be applicable if such data were to be found.

- Archaeological Resources Protection Act of 1979 [16 U.S.C. 479(aa) et seq.] requires federal land managers to issue permits for the excavation or removal of archaeological artifacts from lands under their jurisdiction. The Act requires that relevant Native American tribes be notified of permit issuance if significant religious or cultural sites will be affected. Artifacts have not previously been discovered within the boundaries of Site 22; however, if such artifacts were to be found during remedial activities, this Act would be applicable.

- Conservation Programs on Military Reservations (Sikes Act) of 1960, as amended (16 U.S.C. 670(a) et seq.) is an applicable requirement and requires that military installations manage natural resources for multipurpose uses and public access appropriate for those uses consistent with the military department's mission.

2.1.3 Media of Concern

The investigation of Site 22 consisted of evaluating potential human health risks from chemicals in soil and groundwater (pore water within the soil). Based on the results of the risk assessment, both media were determined to be of concern at Site 22. However, since soil and groundwater contamination occur in the same area with no independent groundwater contamination plume, soil and groundwater are evaluated as a single medium of concern, i.e., wet soil.

2.1.4 Chemicals of Concern for Remediation

Human health COCs for Site 22 were established based on the results of the human health risk assessment performed for Site 22 included in the Site 22 RI/RA report (TtNUS, 2004). Only potential future risks were calculated because Site 22 is currently covered with asphalt, groundwater is not a potable water source, and there is no current exposure to contaminated environmental media at the site. The results of the risk assessment indicated that carcinogenic and noncarcinogenic risk estimates for hypothetical future workers and residents exceeded U.S. EPA and Illinois EPA benchmarks, indicating the potential for adverse health effects from exposure to COCs in soil (PCE, TCE, cis-1,2-DCE, and vinyl chloride) and groundwater (PCE and TCE).

2.2 PRELIMINARY REMEDIATION GOALS

PRGs are concentrations of contaminants in environmental media that, when attained, should achieve RAOs. PRGs are developed to make sure that COCs concentrations left on site are protective of human receptors (based on future residential and industrial land-use). In general, PRGs are established with consideration given to the following:

- Protecting human receptors from adverse health effects
- Protecting the environment from detrimental impacts from site-related contamination
- Compliance with federal and state ARARs

Soil PRGs were determined for the COCs based on the protection of human health from exposure to contaminants in soil via direct exposure (dermal contact, ingestion, and inhalation), from indirect exposure to vapors emitted from surface soil, and from chemicals migrating from soil to groundwater.

Groundwater PRGs were determined for the COCs based on the protection of human health for dermal contact (construction worker only) and inhalation of vapors migrating from groundwater into future buildings.

The development of the PRGs, also referred to as cleanup concentrations, is discussed in the following sections.

2.2.1 Development of PRGs

The results of the HHRA for Site 22 indicated that carcinogenic and noncarcinogenic risks for hypothetical future workers and residents exceeded U.S. EPA benchmarks for direct exposure to soil and for indirect exposure to vapors emitted from surface soil and groundwater. The COCs in surface soil were cis-1,2-DCE, PCE, and TCE; subsurface soil COCs included cis-1,2-DCE, PCE, TCE, and vinyl chloride and groundwater COCs included PCE and TCE. A summary of human health risk-based clean up criteria is presented in Table 2-3. This table includes the most stringent criterion based on Illinois and U. S. EPA regulations.

Site-specific PRGs protective of hypothetical future workers and residents were developed for these COCs and are expected to be protective of these exposure pathways. Based on the known future uses of the site (i.e., land use is not expected to change) and comments from Illinois EPA, human health PRGs protective of hypothetical future workers and residents were developed using the exposure assumptions presented below.

In developing the PRGs protective of future construction/excavation workers, it was assumed that the workers would be exposed to COCs in soil and groundwater in a future excavation project. For soil, exposure would be assumed to occur by ingestion, dermal contact, and inhalation, and for groundwater, the construction workers would be assumed to be exposed by dermal contact and inhalation of vapors in a trench. The workers are assumed to be exposed 30 days per year with a noncarcinogenic averaging time of 42 days. The soil ingestion rate is 330 milligrams per day (mg/day), the exposed skin surface area is 5,800 square centimeters (cm^2), and the inhalation rate is 2.5 cubic meters per hour (m^3/hour). Inhalation of vapors from soil is assumed to occur 8 hours per day, and inhalation of vapors from groundwater in a trench is assumed to occur 4 hours per work day.

Hypothetical future residents (children and adults) are assumed to be exposed to COCs in soil by ingestion, dermal contact, and inhalation of fugitive dust and vapors. The future residents are also evaluated for exposure to vapors from groundwater and soil inside hypothetical future dwellings. Direct exposure to groundwater is not evaluated for this receptor because groundwater at Site 22 is not used as a potable water source under current conditions and is not anticipated to be used for this purpose under potential future land use. The following exposure assumptions were made in developing the residential cleanup values: residents are exposed 350 days per year for a total of 30 years; children ingest 200 mg of soil per day, adults 100 mg/day; the inhalation rates for children and adults are 10 m^3/day and 20 m^3/day, respectively; and the exposed skin surface areas are 2,800 cm^2 for children and 5,700 cm^2 for adults.

The cleanup concentrations for soil and groundwater were developed using the exposure factors discussed above and shown on Table 2-3. The cleanup concentrations for soil and groundwater were derived using the methodology described in the Site 22 RI/RA (TtNUS, 2004). The table below is the recommended site-specific PRGs for Site 22.

SITE 22 – CLEANUP GOALS FOR SOIL AND GROUNDWATER				
Chemical of Concern	**Frequency of Detection**	**Range of Concentrations**	**Average of Positive Results**	**Cleanup Goal**
Soil Cleanup Goals (mg/kg)[1]				
cis-1,2-Dichloroethene	8/46	0.055 - 52	9.2	780
Tetrachloroethene	41/46	0.00055 - 870	64	11
Trichloroethene	9/46	0.00071 - 7.7	2.9	5
Vinyl Chloride	1/46	0.14	0.14	0.28
Groundwater Cleanup Goals (µg/L)[2]				
Tetrachloroethene	6/14	0.24 - 59000	9850	5
Trichloroethene	1/14	1.3	1.3	5

1. Lower of TACO ingestion or inhalation Soil Remediation Objectives for Residential Properties (Illinois EPA, online, 2005)
2. USEPA and Illinois EPA MCLs

2.2.2 Uncertainty in the Site-Specific PRGs

There are several uncertainties with the human health PRGs used to establish the proposed limits of remediation and estimated volumes of contaminated soil. This section discusses each of these uncertainties. The PRGs calculated for residential and industrial exposure to soil and groundwater were primarily based on the inhalation of air inside hypothetical buildings. At the current time, there are no buildings (military or civilian) on the site. However, future plans for Naval Station Great Lakes indicate that barracks may be constructed across the street from Site 22. If this were to occur, it is possible that vapors in subsurface soil and groundwater could migrate from the site to these buildings. The PRGs for inhalation of indoor air were derived from the Johnson and Ettinger Model used in the risk assessment. There are a number of uncertainties associated with the use of this model that could significantly affect the values of the calculated PRGs. For example, the model is very sensitive to the size of the buildings, vapor infiltration rates, and ventilation rates, which are not known and can only be estimated (usually on the conservative side). In addition to these parameters, the use model uses U.S. EPA default values for other parameters, which tends to increase the uncertainty in the PRGs. The direction of the uncertainty is not known, although the model default values are generally conservative and tend to overestimate air concentrations.

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 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 an RAO for the site. Remedial action alternatives will then be composed using GRAs individually or in combination to meet the RAOs. The RAOs, composed of GRAs, will be capable of achieving the RAOs for contaminated soil and groundwater at Site 22.

The following GRAs were considered for soil and groundwater:

- No Action
- Limited Action (Institutional Controls and Monitoring)
- Containment
- Removal
- In-Situ Treatment
- Ex-Situ Treatment
- Disposal

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. Table 2-4 presents the list of federal and State action-specific ARARs and TBCs for this FS. The following federal and State action-specific ARARs and TBCs from Table 2-4 are considered to be potentially applicable to Site 22:

- RCRA Subtitle C requirements may be applicable when the waste is sufficiently similar to a hazardous waste and/or the on-site remedial action constitutes treatment, storage, or disposal, and the particular RCRA requirement is well suited to the circumstances of the contaminant release and site. RCRA Subtitle C requirements may also be applicable when the remedial action constitutes generation of a hazardous waste. On-site activities, mandated by a federally ordered Superfund cleanup, must comply with the substantive requirements of RCRA Subtitle C but not with the administrative requirements (i.e., permits) of RCRA. The RCRA Subtitle C requirements must be met if the cleanup is not under federal order and/or when the hazardous waste moves off site.

Based on information supplied by the Illinois EPA, soil and groundwater at Site 22 are considered a listed RCRA hazardous waste (F002). Therefore, waste associated with this site will be managed and disposed of as a listed hazardous waste.

- The Hazardous and Solid Waste Amendments (HSWA) is the 1984 amendments to RCRA that require phasing out land disposal of hazardous waste. Additionally, HSWA establishes a corrective actions program requiring four basic elements [assessment, investigation, Corrective Measures Study (CMS), implementation] and establishes a regulatory program for underground storage tanks (USTs).

- National Ambient Air Quality Standards (NAAQSs) (40 CFR 50) promulgated under the Clean Air Act (CAA) (42 U.S.C. 7401) require the attainment and maintenance of primary and secondary NAAQSs to protect public health and public welfare, respectively. These standards are not source specific but rather are national limitations on ambient air quality. States are responsible for assuring compliance with the NAAQSs. The implementation, maintenance, and enforcement of NAAQSs are potentially applicable ARARs.

- Department of Transportation (DOT) Rules for Hazardous Materials Transport (49 CFR Parts 107 and 171-179) regulate the transport of hazardous materials, including packaging, shipping equipment, and placarding. These rules are considered potentially applicable to wastes shipped off site for laboratory analysis, treatment, or disposal.

- The Occupational Safety and Health Administration (OSHA) Standards (29 CFR 1910) regulate occupational safety and health requirements applicable to workers engaged in on-site field activities.

- NEPA (42 U.S.C. 4321 et seq.) requires federal agencies to evaluate the environmental impacts associated with major actions that they fund, support, permit, or implement. Specifically, NEPA requires federal agencies to consider five issues during the planning of major action: the environmental impact of the proposed action; any adverse impacts that cannot be avoided with the proposed implementation; alternatives to the proposed action; the relationship between short-term and long-term effects; and any irreversible and irretrievable commitments of resources that would be involved in a proposed action.

- Soil Conservation Act (U.S.C. 5901 et seq.) provides for the application of soil conservation practices on federal lands. During remedial activities, implementation of such practices would be required.

- National Emission Standards for Hazardous Air Pollutants (40 CFR 61) sets emission standards for designated hazardous pollutants. This regulation would be potentially applicable for incineration and fugitive dust.

- Illinois Waste Disposal (Hazardous) (35 Illinois Administrative Code 721, 722, 723, 724, and 728) adopts by reference sections of the Federal hazardous waste regulations and establishes minor additions to these regulations concerning the generation, storage, treatment, transportation, and disposal of hazardous wastes. These regulations are applicable if waste onsite were deemed hazardous and needed to be stored, transported, or disposed of properly.

- Illinois Solid Waste and Special Waste Hauling (35 Illinois Administrative Code 809) establishes requirements for solid waste and hauling of special waste. These regulations would apply if waste is transported to a disposal facility.

- Illinois Emission Standards for Hazardous Air Pollutants (Illinois Administrative Code Title 35 Subtitle B, Chapter I) sets emission standards for designated hazardous pollutants. This regulation would be potentially applicable for incineration and fugitive dust.

- Illinois Environmental Protection Act (415 Illinois Compiled Statute 5/1, Titles II, III, V, and VI) establishes requirements for air pollution, water pollution, land pollution and refuse disposal, and noise pollution, respectively.

- Illinois Groundwater Quality Regulations (35 Illinois Administrative Code 620) establishes requirements for groundwater monitoring and reporting as determined under the Permit Section of the Division of Land Pollution Control.

2.4 ESTIMATED VOLUMES OF CONTAMINATED SOIL AND GROUNDWATER

For remedial action purposes, the volume of chlorinated VOC-contaminated soil at Site 22 was estimated based on the locations of samples where COCs were detected at concentrations in excess of the most conservative soil cleanup goal of 60 µg/kg. The contaminated soil area is illustrated on Figure 2-1. Subsurface soil samples were collected from below the HDPE liner and gravel and below the gravel base of the asphalt parking to a depth of 31 feet bgs. Sections 3.2.3 and 3.2.4 of the RI describes in greater detail the basis for the soil sample collection. Based on the contaminated soil profile, the soil area for remediation was divided into three depth intervals, 0 to 2 feet bgs, 2 to 12 feet bgs, and 12 to 25 feet bgs. The surface area was estimated at 13,750 square feet (ft^2). The area at 12 feet bgs was estimated at

12,100 ft^2. The area at 25 feet bgs was estimated at 2,500 ft^2. The surface volume was calculated by multiplying the surface area of 13,750 ft^2 by the total depth of 2 feet. The areas at the surface and at 12 feet bgs were averaged and then multiplied by 10 (for the total depth in feet) to calculate the volume of soil in the 2- to 12-foot interval. Similarly the area at 12 feet bgs was averaged with the area at 25 feet bgs and then multiplied by 13 (for the total depth in feet) to calculate the volume of soil in that interval. This approach was used because the contaminated area is approximately pyramid-shaped. The three volumes were summed for a total volume of the contaminated soil of 251,650 cubic feet (ft^3) [9,320 cubic yards (yd^3)]. The calculations are provided in Appendix A. The estimated mass of COCs in the soil ranges from 2,200 to 26,000 pounds based on the volume calculation above and the average and maximum soil analytical results, respectively. Mass calculations are presented in Appendix A. For this FS it has been assumed that the estimated mass of COCs in the soil at the site is 1,700 pounds.

The volume of chlorinated VOC contaminated soil at Site 22 was also estimated based on the locations of samples where COCs were detected at concentrations in excess of the selected PRG (11,000 µg/kg). The contaminated soil area is illustrated on Figure 2-2. Similar to calculations using the most conservative cleanup goal of 60 µg/kg, the soil area for remediation based on the selected PRG of 11,000 µg/kg was broken into three depth intervals, 0 to 2 feet bgs, 2 to 12 feet bgs, and 12 to 25 feet bgs. The surface area was estimated at 2,100 ft^2. The area at 12 feet bgs was estimated at 2,800 ft^2. The area at 25 feet bgs was estimated at 1,800 ft^2. The surface volume was calculated by multiplying the surface area of 2,100 ft^2 by the total depth of 2 feet. The areas at the surface and at 12 feet bgs were averaged and then multiplied by 10 (for the total depth in feet) to calculate the volume of soil in that interval. Similarly the area at 12 feet bgs was averaged with the area at 25 feet bgs and then multiplied by 13 (for the total depth in feet) to calculate the volume of soil in that interval. This approach was used because the contaminated area is approximately pyramid-shaped. The three volumes were summed for a total volume of the contaminated soil of 73,300 ft^3 (2,715 yd^3). The calculations are provided in Appendix A. The estimated mass of COCs in the soil ranges from 650 to 7,500 pounds based on the volume calculation above and the average and maximum soil analytical results, respectively. Mass calculations are presented in Appendix A. For this FS it has been assumed that the estimated mass of COCs in the soil at the site is 1,450 pounds.

The volume of chlorinated VOC contaminated soil in what is considered the "hot spot" area at Site 22 was also calculated. As discussed in Section 1.2.2 and 1.2.3, the "hot spot" of contamination is believed to originate from a grease catch basin and the associated gutters under the washing machines and drains. The "hot spot" is located near the southeastern corner of Building 105 along Sampson Street near the former grease catch basin. The "hot spot" surface area is the yellow/orange/red area shown on Figure 2-1 and 2-2 that has PCE concentrations greater than 30,000 µg/kg (approximate surface area of 1,400 ft^2).

The volume of the "hot spot" was calculated by multiplying the surface area by a depth of 25 feet for a total volume of 35,000 ft^3 (1,296 yd^3). The calculations are also provided in Appendix A. The estimated mass of COCs in the soil ranges from 300 to 3,600 pounds based on the volume calculation above and the average and maximum soil analytical results, respectively. Mass calculations are presented in Appendix A. For this FS it has been assumed that the estimated mass of COCs in the "hot spot" is 1,200 pounds.

The volume of contaminated groundwater (pore water within the contaminated soil) at Site 22 was also estimated based on the locations of samples where COCs (i.e., PCE) were detected in excess of groundwater criteria. The surface area of the pore water within the contaminated soil is illustrated on Figure 2-3. Based on the analytical results of the RI, the contaminated pore water was delineated as the area of groundwater where concentrations of COCs are greater than the remediation goals defined in Section 2.2. The plume extends over an area approximately 200 ft^2 in size and to a depth of up to 25 feet bgs. Based on a porosity of 0.35, the estimated volume of the plume was computed at approximately 13,100 gallons. The extent of the pore water within the contaminated soil is illustrated on Figure 2-3, and volume computations are presented in Appendix A. The estimated dissolved mass of COCs in the groundwater ranges from 1 to 6.5 pounds based on the volume calculation above and the average and maximum groundwater analytical results, respectively. Mass calculations are presented in Appendix A.

TABLE 2-1

FEDERAL AND STATE CHEMICAL-SPECIFIC ARARs/MEDIA CLEANUP STANDARDS AND TBCs
SITE 22 – BUILDING 105 OLD DRY CLEANING FACILITY
NAVAL STATION GREAT LAKES, GREAT LAKES, ILLINOIS

Chemical-Specific ARAR	Citation/Reference	ARAR Type	Rationale for Use at Site 22, Naval Station Great Lakes
FEDERAL			
Safe Drinking Water Act Maximum Contaminant Levels (MCLs), Maximum Contaminant Level Goals (MCLGs), and Secondary Maximum Contaminant Level (SMCLs)	40 Code of Federal Regulations (CFR) 140-143	Potentially applicable	Would be used as protective levels for groundwater that are current or potential drinking water sources; however, groundwater is not currently used as a potable water source and is not expected to be used as a potable water source in the future at Site 22.
Preliminary Remediation Goals (PRGs)	U.S. EPA Region 9, 2004	To be considered criteria (TBC)	Benchmark values for assessing the need for soil, groundwater, and air remedial action/corrective measures.
Generic Soil Screening Levels (SSLs)	U.S. EPA, 1996b	TBC	Benchmark values for assessing the need for soil remedial action/corrective measures. The SSLs assess the potential migration of chemicals from soil to air and from soil to groundwater.
Resource Conservation and Recovery Act (RCRA) Subtitle C – Hazardous Waste Identifications and Listing Regulations	40 CFR 261	Potentially applicable	Would be used to identify a material as a hazardous waste and thus determine the applicability and relevance of RCRA C Hazardous Waste Rules.
U.S. EPA Health Advisories	U.S. EPA, 1996a	TBC	Benchmark values for assessing the need for groundwater remedial action/corrective measures.
STATE			
Illinois EPA Tiered Approach to Corrective Action (TACO); residential soil remediation objectives	Illinois EPA, online, 2005	TBC	Benchmark values for assessing the need for soil, groundwater, and air remedial action/corrective measures. The remediation objectives assess ingestion of soil, inhalation of chemicals from soil, migration of chemicals from soil to groundwater, and ingestion of groundwater.

TABLE 2-2

FEDERAL AND STATE LOCATION-SPECIFIC ARARs/MEDIA CLEANUP STANDARDS AND TBCs
SITE 22 – BUILDING 105 OLD DRY CLEANING FACILITY
NAVAL STATION GREAT LAKES, GREAT LAKES, ILLINOIS

Location-Specific ARAR	Citation/Reference	ARAR Type	Rationale for Use at Site 22, Naval Station Great Lakes
FEDERAL			
U.S. EPA's Groundwater Protection Strategy	U.S. EPA, 1984	To be considered criteria (TBC)	Surficial groundwater at Site 22 is likely designated Class IIIA.
Historic Sites, Buildings, and Antiquities Act of 1935	16 U.S.C. 461 et seq.	Potentially Applicable	This Act would be applicable if information is found to classify Site 22 as a historic or prehistoric property of national significance.
Archaeological and Historic Preservation Act of 1974	16 U.S.C. 469 et seq.	Potentially Applicable	This Act would be applicable if historic and archaeological artifacts were to be affected by remedial activities. No such artifacts are known to exist within the boundaries of Site 22.
Archaeological Resources Protection Act of 1979	16 U.S.C. 479(aa) et seq.	Potentially Applicable	This Act would be applicable if archaeological artifacts were discovered during remedial activities. No such artifacts are known to exist within the boundaries of Site 22.
Conservation Programs on Military Reservations (Sikes Act) of 1960, as Amended	16 U.S.C. 670(a) et seq.	Applicable	This act requires that military installations manage natural resources for multipurpose uses and public access appropriate for those uses consistent with the military department's mission.
STATE			
There are no State Location-Specific ARARs			

TABLE 2-3

SUMMARY OF HUMAN HEALTH RISK-BASED CLEANUP CONCENTRATIONS
SITE 22 - BUILDING 105 DRY CLEANING FACILITY
NAVAL STATION GREAT LAKES, ILLINOIS

Chemical of Concern	Illinois EPA TACO Remediation Objectives for Residential Properties[1]			
	Soil			Groundwater
	Ingestion (mg/kg)	Inhalation (mg/kg)	Soil to Groundwater (mg/kg)	(ug/L)
cis-1,2-Dichloroethene	**780**	1,200	0.4	NA
Tetrachloroethene	12	**11**	0.06	**5**
Trichloroethene	58	**5**	0.06	**5**
Vinyl Chloride	0.46	**0.28**	0.01	NA

Chemical of Concern	Illinois EPA TACO Remediation Objectives for Commercial/Industrial Properties[2]			
	Soil			
	Industrial/Commercial		Construction Worker	
	Ingestion (mg/kg)	Inhalation (mg/kg)	Ingestion (mg/kg)	Inhalation (mg/kg)
cis-1,2-Dichloroethene	20,000	1,200	20,000	1,200
Tetrachloroethene	110	20	2,400	28
Trichloroethene	520	8.9	1,200	12
Vinyl Chloride	7.9	1.1	170	1.1

Chemical of Concern	U.S. EPA Region 9 Preliminary Remediation Goals[3]			U.S. EPA MCLs[4]
	Soil		Groundwater	Groundwater
	Residential (mg/kg)	Industrial (mg/kg)	(ug/L)	(ug/L)
cis-1,2-Dichloroethene	43	150	NA	NA
Tetrachloroethene	0.48	1.3	0.1	5
Trichloroethene	2.9	6.5	1.4	5
Vinyl Chloride	0.079	0.75	NA	NA

Chemical of Concern	Risk-Based Cleanup Levels (Calculated)[5]			
	Residential		Construction Worker	
	Soil[6] (mg/kg)	Groundwater[7] (ug/L)	Soil[8] (mg/kg)	Groundwater[9] (ug/L)
cis-1,2-Dichloroethene	1.5	NA	5	NA
Tetrachloroethene	0.25	0.8	59	8,000
Trichloroethene	0.125	0.3	45	90
Vinyl Chloride	0.0034	NA	5	NA

Bolded values are the recommended cleanup concentratons for Site 22. The soil values represent the lowest of applicable Illinois EPA Remediation Objectives presented in TACO. The selected values are mainly based on inhlation of vapors from soil. Soil values for the protection of groundwater are not recommended as cleanup levels because the soil-to-groundwater remediation objectives are based on the domestic use of groundwater and groundwater at Site 22 is not used as a source of potable water and is not expected to be used in the future. In addition, Site 22 is capped preventing infiltration by rainwater. Other values presented in the table (i.e., Region 9 PRGs and calculated cleanup levels) are presented for informational purposes only.

1 Illinois EPA Tiered Approach to Corrective Action Objectives (TACO), Section 742:Table A (Illinois EPA online, May 2005).
2 Illinois EPA Tiered Approach to Corrective Action Objectives (TACO), Section 742:Table B (Illinois EPA online, May 2005).
3 U.S. EPA Region 9 Preliminary Remediation Goals (U.S. EPA, Region 9, October 2004).
4 2004 Edition of the Drinking Water Standards and Health Advisories, Office of Water, EPA 822-R-04-005, Washington, DC, Winter.
5 Risk-based cleanup levels were backcalculated from the risk assessment for Site 22 based on a cancer target risk level of $1x10^{-6}$.
6 Residential cleanup concentrations for soil are based on combined exposure via ingestion and inhalation of vapors inside hyothetical future buildings.
7 Residential cleanup concentrations for groundwater are based inhlation of vapors inside hypothetical future buildings.
8 Construction worker cleanup concentrations for soil are based on combined exposure via ingestion and inhlation of ambient air.
9 Construction worker cleanup concentrations for groundwater are based on combined dermal contact and inhlation of vapors in a trench.
NA - cis-l,2-DCE and vinyl chloride were not identified as COCs for groundwater.

TABLE 2-4

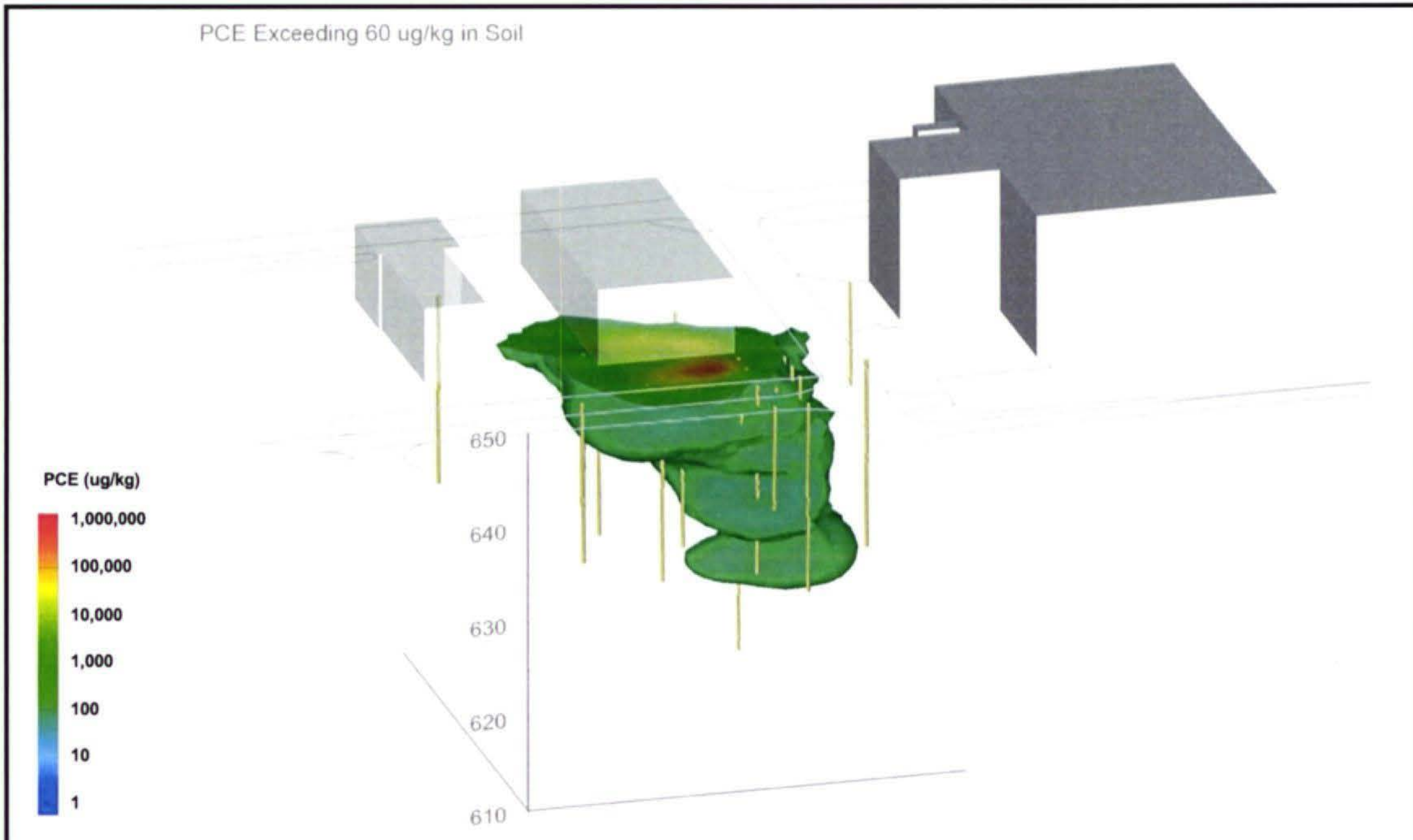
FEDERAL AND STATE ACTION-SPECIFIC ARARs/MEDIA CLEAN-UP STANDARDS AND TBCs
SITE 22 – BUILDING 105 OLD DRY CLEANING FACILITY
NAVAL STATION GREAT LAKES, GREAT LAKES, ILLINOIS

Action-Specific ARAR	Citation/Reference	ARAR Type	Rationale for Use at Site 22, Naval Station Great Lakes
FEDERAL			
Solid Waste Disposal Act/ RCRA Subtitle C	42 United States Code (U..S.C.) 6905, 6912a, 6924-6925	–	–
• Standards for Hazardous Waste Generators	40 CFR 262	Potentially applicable	Applicable for removed site wastes determined to be hazardous.
• Standards for Hazardous Waste	40 CFR 263	Potentially applicable	Applicable for site wastes determined hazardous that are transported off site.
• Standards for Owners and Operators of Hazardous Waste Treatment, Storage and Disposal Facilities (TSDFs)	40 CFR 264	Potentially applicable	These regulations would be applicable to waste removed from the site including both on-site and off-site management.
• Interim status standards for owners and operators of hazardous waste TSDFs	40 CFR 265	Relevant and appropriate	Establishes design and operating criteria for hazardous landfills.
• RCRA Land Disposal Restrictions (LDR) Requirements	40 CFR 268	Potentially applicable	If off-site treatment or disposal of contaminated media and/or disposal of treatment residuals that may be considered hazardous waste is necessary, it would be subject to LDRs.
Hazardous and Solid Waste Amendments (HSWA) of 1984	42 U.S.C. 6926	Potentially Applicable	Establishes a corrective actions program requiring four basic elements (assessment, investigation, CMS, implementation).
The Clean Water Act (CWA) National Pollution Discharge Elimination System	40 CFR 122	Potentially applicable	These requirements are applicable for alternatives that include a surface water discharge.
Clean Air Act National Ambient Air Quality Standards (NAAQSs)	42 U.S.C §7401- 7642, 40 CFR Part 50	Potentially applicable	Remedial action/corrective measures involving treatment of media could result in emissions to the atmosphere.
Department of Transportation (DOT) Hazardous Materials Transportation	49 CFR	Potentially applicable	These rules are considered potentially applicable depending on whether wastes are shipped off site for laboratory analysis, treatment, or disposal.
Occupational Safety and Health Administration (OSHA) Standards	29 CFR 1910.120	Applicable	On-site activities are required to follow OSHA requirements.
National Environmental Policies Act	42 U.S.C 4321 et seq.	Relevant and appropriate	Remedial action/corrective measures could constitute significant activities, thereby making NEPA requirements ARARs; however, activities conducted in accordance with the National Contingency Plan (NCP) are considered to meet the substantive NEPA requirements.

TABLE 2-4

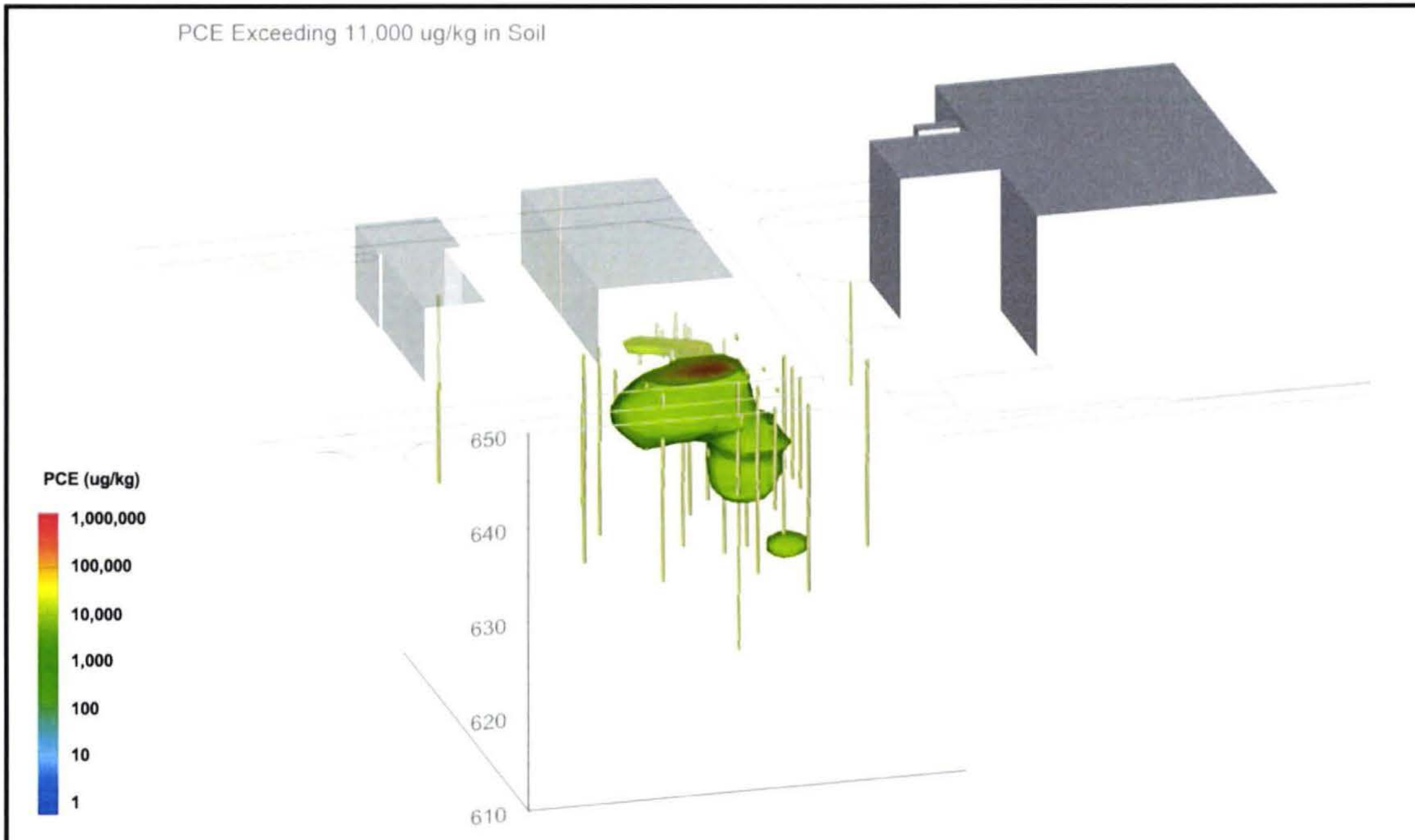
FEDERAL AND STATE ACTION-SPECIFIC ARARs/MEDIA CLEAN-UP STANDARDS AND TBCs
SITE 22 – BUILDING 105 OLD DRY CLEANING FACILITY
NAVAL STATION GREAT LAKES, GREAT LAKES, ILLINOIS

Action-Specific ARAR	Citation/Reference	ARAR Type	Rationale for Use at Site 22, Naval Station Great Lakes
Soil Conservation Act	U.S.C. 5901 et seq.	Applicable	During remedial activities, implementation of soil conservation practices would be required.
National Emission Standards for Hazardous Air Pollutants	40 CFR 61	Potentially applicable	Remedial activities that generate fugitive dust or incineration would require emission standards for designated hazardous pollutants.
STATE			
Illinois Waste Disposal (Hazardous)	35 Illinois Administrative Code 721, 722, 723, 724, and 728	Potentially Applicable	These regulations would apply if waste onsite were deemed hazardous and needed to be stored, transported, or disposed of properly.
Illinois Solid Waste and Special Waste Hauling	35 Illinois Administrative Code 809	Applicable	These regulations would apply if waste is transported to a disposal facility.
Illinois Emission Standards for Hazardous Air Pollutants	Illinois Administrative Code Title 35 Subtitle B, Chapter I	Potentially applicable	Remedial activities that generate fugitive dust or incineration would require emission standards for designated hazardous pollutants.
Illinois Environmental Protection Act	415 Illinois Compiled Statute 5/1, Titles II, III, V, and VI	Applicable	These regulations include requirements for air pollution, water pollution, land pollution and refuse disposal, and noise pollution.
Illinois Groundwater Quality Regulations	35 Illinois Administrative Code 620	Applicable	These regulations establish groundwater monitoring and reporting requirements as determined under the Permit Section of the Division of Land Pollution Control.



DRAWN BY	DATE			CONTRACT NUMBER	
A. JANOCHA	5/24/05	NAVFAC	PCE EXCEEDING 60 ug/kg IN SOIL	N00078	
CHECKED BY	DATE		SITE 22 - BUILDING 105 OLD DRY CLEANING FACILITY	APPROVED BY: RFD	DATE: 5/25/05
R. YOUNG	5/25/05		NAVAL STATION	APPROVED BY: —	DATE: —
COST/SCHEDULE-AREA			GREAT LAKES, ILLINOIS	DRAWING NO.: FIGURE 2 - 1	REV: 0
SCALE: AS NOTED					

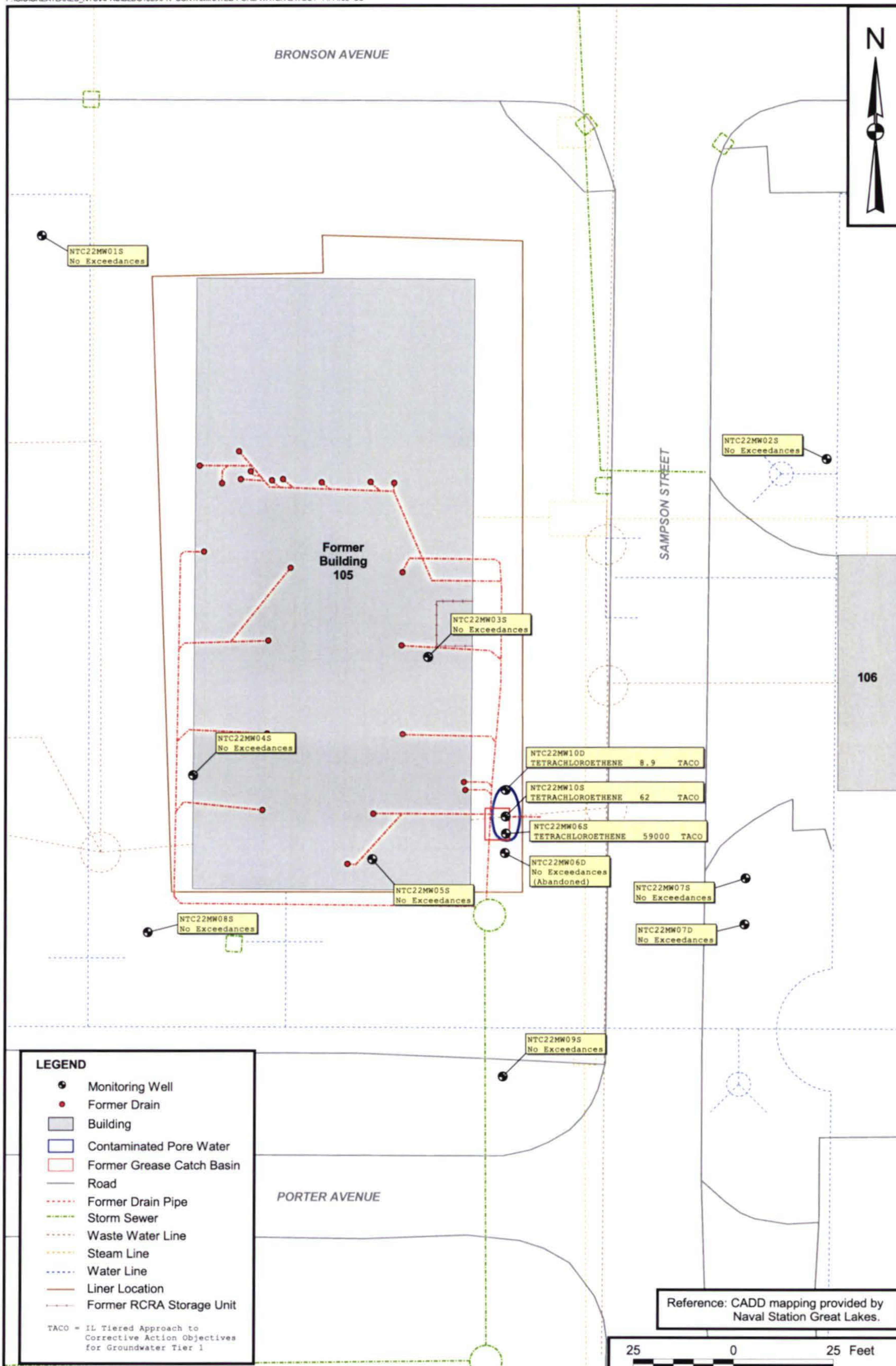
P:\GIS\GREATLAKES_NTC\MAPDOCS\APR\BLDG105.APR PCE EXCEEDING 60 UG/KG IN SOIL LAYOUT 5/26/05 AJ



DRAWN BY	DATE		PCE EXCEEDING 11,000 ug/kg IN SOIL	CONTRACT NUMBER	
A. JANOCHA	5/24/05	NAVFAC	SITE 22 - BUILDING 105 OLD DRY CLEANING FACILITY	N00078	
CHECKED BY	DATE		NAVAL STATION	APPROVED BY RFD	DATE 5/25/05
R. YOUNG	5/25/05		GREAT LAKES, ILLINOIS	APPROVED BY —	DATE —
COST/SCHEDULE-AREA				DRAWING NO. FIGURE 2 - 2	REV 0
SCALE AS NOTED					

P:\GIS\GREATLAKES_NTC\MAPDOCS\APR\BLDG105.APR PCE EXCEEDING 11,000 UG/KG IN SOIL LAYOUT 5/26/05 AJ

P:\GIS\GREATLAKES_NTC\APRS\BLDG105.APR CONTAMINATED PORE WATER LAYOUT 11/11/05 CS



DRAWN BY A. JANOCHA, DATE 1/12/04	NAVFAC	CONTAMINATED PORE WATER	CONTRACT NUMBER N00078
CHECKED BY R. YOUNG, DATE 5/25/05		SITE 22 - BUILDING 105 OLD DRY CLEANING FACILITY	APPROVED BY RFD, DATE 5/25/05
COST/SCHEDULE-AREA		NAVAL STATION	APPROVED BY —, DATE —
SCALE AS NOTED		GREAT LAKES, ILLINOIS	DRAWING NO. FIGURE 2 - 3, REV 0

3.0 SCREENING OF REMEDIATION TECHNOLOGIES AND PROCESS OPTIONS

This section identifies, screens, and evaluates the potential remediation technologies and process options that may be applicable to assemble soil remedial alternatives for Site 22 at Naval Station Great Lakes. The primary objective of this phase of the FS is to develop an appropriate range of remediation technologies and process options that will be used for developing remedial alternatives.

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

- Identification of ARARs
- Development of RAOs
- Identification of GRAs
- Identification of volumes or areas of media of concern

Remediation technology screening is performed in this section with the completion of the following analytical steps:

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

In this section, a variety of remediation technologies and process options are first identified for each of the GRAs listed in Section 2.3.1 and then screened. The selection of remediation technologies and process options for initial screening is based on the Guidance for Conducting Remedial Investigations/Feasibility Studies under CERCLA (U.S. EPA, 1988). The screening is first conducted at a preliminary level to focus on relevant remediation 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 remediation technologies that have passed the detailed evaluation and screening.

The evaluation criteria for detailed screening of remediation 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 solution.
  - Ability of the technology to address the estimated areas or volumes of contaminated media.
  - Ability of the technology to attain the PRGs required to meet the RAOs.
  - Technical reliability (innovative versus well-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 considerations (e.g., maintenance and operation requirements)

- Cost (Qualitative)
  - Capital cost
  - Operation and maintenance (O&M) costs

3.1 PRELIMINARY SCREENING OF REMEDIATION TECHNOLOGIES AND PROCESS OPTIONS

The preliminary screening of remediation technologies and process options is based on overall applicability to the media of concern (soil and pore water), COCs (chlorinated VOCs, particularly PCE), and specific conditions present at Site 22. Table 3-1 summarizes this preliminary screening. It presents the GRAs, identifies the technologies and process options, and provides a brief description of each process option followed by the screening comments.

The following are the remediation technologies and process options retained for detailed screening:

General Response Action	Remediation Technology	Process Option
No Action	None	Not Applicable
Limited Action	Monitoring	Sampling and Analysis
	Institutional Controls	Land Use Controls (LUCs)
Containment	Capping	Soil or Multimedia Cover
Removal	Bulk Excavation	Excavation
In-Situ Treatment	Physical/Chemical	Chemical Oxidation
		Air Sparging and Soil Vapor Extraction (AS/SVE)
	Thermal	Electrical Resistance Heating (ERH)
Ex-Situ Treatment	Physical/Chemical	Chemical Oxidation
	Thermal	Off-Base Incineration
		Off-Base Low-Temperature Thermal Desorption (LTTD)
	Solids Processing	Size Reduction
Disposal	Landfill	Off-Base Landfilling

3.2 DETAILED SCREENING OF REMEDIATION TECHNOLOGIES AND PROCESS OPTIONS

3.2.1 No Action

No Action would consist of "walking away" from the site without implementing any remedial action or performing any monitoring. 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 site COCs.

Effectiveness

Because no exposure control or treatment would be performed, the No Action alternative would not be effective in reducing risks or meeting the RAOs and PRGs. The potential for exposure of human receptors to contaminated soil and for leaching of soil COCs to groundwater would remain unchanged. Although these have been effectively controlled by the existing asphalt pavement and HDPE liner, this pavement and liner would no longer be maintained resulting in increased future risks, especially under the planned future residential development of the area.

Implementability

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

Cost

There would be no costs associated with "walking away" from the site.

Conclusion

Although it would not be effective the No Action alternative is retained because of NCP requirements.

3.2.2 Limited Action

The two technologies retained from preliminary screening under this GRA are monitoring and LUCs.

3.2.2.1 Monitoring

Monitoring would consist of sampling and analyzing soil and associated groundwater (pore water) throughout the contaminated area to evaluate the progress of any remedial action.

Effectiveness

Monitoring alone would not be effective to reduce concentrations of soil COCs. However, monitoring would be an effective tool to evaluate any reduction in concentrations of COCs as a result of remedial action.

Implementability

A sampling and analysis program could be readily implemented.

Cost

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

Conclusion

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

3.2.2.2 LUCs

Based on other LUCs implemented at Naval Station Great Lakes and site conditions, the LUCs would include property and/or groundwater use restrictions. The area in question may be restricted to industrial/commercial use, most likely as a parking lot, and may require maintenance of the cap. The installation of groundwater wells (other than for use as environmental monitoring wells) would be prohibited. In addition, Illinois EPA and the Navy have signed a LUC Memorandum of Agreement (MOA) that includes a Naval Station Policy Letter restricting use of groundwater on the Naval Station Great Lakes property. Each alternative will include a LUC that ensures that these restrictions apply to this site and will be enforceable regardless of changes in Navy policy regarding the use of groundwater at the base.

<u>Effectiveness</u>

LUCs alone would not effectively reduce concentrations of COCs in the soil and groundwater. However, LUCs would be an effective tool to prevent future exposure to the COCs.

<u>Implementability</u>

LUCs have been implemented throughout Naval Station Great Lakes and could be readily implemented at this site.

<u>Cost</u>

Costs to implement and maintain the LUCs would be low.

<u>Conclusion</u>

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

3.2.3 <u>Containment</u>

The only technology retained from preliminary screening under this GRA is capping. Capping would consist of providing a horizontal barrier to prevent exposure to contaminated soil and to minimize migration of soil COCs either to groundwater through percolation and leaching or offsite through mechanical erosion.

Effectiveness

Capping would not be effective in reducing concentrations of COCs. However, capping would be effective in preventing potential receptors from direct contact with the contaminated soil. The cap would also be effective in minimizing the migration of soil COCs in the environment. To date, the cap provided by the existing asphalt pavement and HDPE liner has effectively minimized direct exposure to contaminated soil and controlled migration of soil COCs to groundwater. However, under the planned future development of the Site 22 area (barracks, food galleria), the effectiveness of a cap would be more questionable and additional controls, such as LUCs, would be implemented to require that the cap be maintained.

Implementability

Installation of a cap at Site 22 would be very simple to implement because most of the site is in fact already capped with asphalt pavement and the footprint of former Building 105 is covered with an HDPE liner. This existing cap could easily be extended and/or improved as might be required. The topography of the terrain is flat and no existing structure would impede installation. Materials and services required to implement this technology are readily available. LUCs would most likely be required to implement this alternative.

Cost

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

Conclusion

The existing cap (asphalt and HDPE) and former cap (building and asphalt) have been effective in minimizing migration of soil COCs either to groundwater through percolation and leaching. This technology would be very easy to implement but it is eliminated from further consideration because it already has been implemented and because of long-term siting concerns.

3.2.4 Removal

The only technology retained from preliminary screening under this GRA is excavation. Excavation can be performed by a variety of equipment such as tractor shovels (front-end loaders), backhoes, grade-alls, etc. The type of equipment selected must take into consideration several factors, such as the type of material to be removed, the load-bearing capacity of the ground surrounding the removal area, the depth and areal extent of removal, the required rate of removal, and the elevation of the groundwater table. Excavation is the technology of choice for the removal of well-consolidated material such as soil, to depths of up to 30 feet and from well-defined areas of ground with significant load-bearing capacity (i.e., greater than 1,500 pounds per square foot), which is the case for Site 22.

The logistics of excavation must take into account the available space for operating the equipment, loading/unloading to transport the removed material, location of the site, etc. After excavation is completed, the location is filled and graded with clean fill material or treated soils. Because of the proximity to residential areas, emissions, dust, and debris produced as a result of the remedial action would have to be strictly controlled.

Effectiveness

Excavation is a well-proven and effective method of removing contaminated material from a site. Properly designed excavation would remove most of the soil contaminated at concentrations greater than PRGs, and remaining soil and pore water would not pose an unacceptable risk to human health or the environment.

Sampling is required to verify the effectiveness of the removal action. Soil samples would be collected from the sidewalls and, as applicable, from the bottom of the excavation. Groundwater samples would also be collected from surrounding wells. These samples would be analyzed for COCs to make sure that the remaining soil and pore water is not contaminated at unacceptable concentrations.

Implementability

Excavation of contaminated soil and pore water at Site 22 would be implementable. While significant, the volume of contaminated soil to be excavated (approximately 10,000 yd^3) is not overly large. Tightly packed clayey soil, such as that of Site 22, would be relatively easy to excavate. Excavation would extend to a maximum depth of approximately 25 feet bgs, which is amenable to the use of conventional equipment but would require shoring. Because perched groundwater occurs around 6 feet bgs, dewatering would also be required, but it should not be an overwhelming concern because of the low soil permeability. Excavation equipment and/or services are readily available from multiple vendors or contractors. This technology is well proven and established in the construction/remediation industry.

During excavation, site-specific health and safety procedures and OSHA regulations would have to be complied with to make sure that the exposure of the workers to COCs is minimized since the contaminants are chlorinated VOCs (mainly PCE). This would include the wearing of appropriate PPE and the implementation of dust suppression measures, as may be required. In addition health and safety procedures will be needed for nearby personnel to protect them from the emissions that would be released as the chlorinated VOCs are exposed to the atmosphere during excavation. Ambient air monitoring would be needed during implementation of this alternative. Transportation of the contaminated soil and water would also need to incorporate appropriate steps to make sure no off gassing occurred during transport.

The area of the excavation has been developed since 1939 and there are utilities and utility corridors around and through the site. A major utility corridor runs along the west side of Sampson Street and consists of steam pipes, sanitary sewer, and storm sewers. Storm sewers, sanitary sewer and water lines are also located at the southern end of the site, with a sanitary sewer and storm sewer in the area of the contamination. The excavation of soil in these areas may require shoring or removal and replacement of the utilities depending on the depth of the excavation.

Cost

Cost of excavation at Site 22 would be moderate.

Conclusion

Excavation is retained in combination with other technologies and process options for the development of remedial alternatives.

3.2.5 In-Situ Treatment

Three technologies were retained from preliminary screening under this GRA including chemical oxidation, air sparging/soil vapor extraction (AS/SVE), and electrical resistance heating (ERH).

3.2.5.1 In-Situ Chemical Oxidation

This technology involves the injection of strong oxidation agents into the contaminated soil to chemically degrade COCs. Chemical oxidation agents used for this purpose include hydrogen peroxide, or sodium persulfate with a metal catalyst such as iron, or potassium permanganate. The mixture of hydrogen peroxide with a ferrous sulfate catalyst is commonly known as Fenton's Reagent. The iron sulfate catalyst increases the oxidation potential of the hydrogen peroxide by promoting the generation of highly reactive hydroxyl radicals. These radicals react with chemical contaminants such as chlorinated VOCs to create water, carbon dioxide, oxygen, and dilute hydrochloric acid as by-products. The reaction is exothermic and temperature and pressure would increase as the reaction proceeds. Most often, the chemical oxidation agents are injected in the contaminated soil through the use of multiple direct push technology (DPT) feedpoints.

Effectiveness

In-situ chemical oxidation may be an effective technology to remove COCs from soil at Site 22. The use of Fenton's Reagent, catalyzed persulfate, or permanganate has been documented for the chemical oxidation of chlorinated VOCs such as PCE. However, there will be some limitations to that technology because of the tightly packed and low-permeability characteristics of the clayey soil at Site 22 that would impact the even subsurface distribution of injected chemicals and their adequate contact with the COCs to be treated. Treatability testing, preferably of the pilot-scale type, would be required to confirm effectiveness and to determine injection system design criteria.

Implementability

In-situ chemical oxidation may be difficult to implement at Site 22. The services of a number of qualified contractors specializing in the application of this technology would be available. However, delivery of the chemical oxidation reagent in the tightly packed low permeability soil at Site 22 will be difficult and will take some effort to implement. Multiple injections will be required for even subsurface distribution and adequate contact of the area to be treated. Installation of a pattern of chemical injection points with the use of DPT is a relatively non-obtrusive activity that would have little impact on planned site use and would be compatible with the future proximity of a housing and food galleria complex. As previously mentioned, a pilot-scale test would have to be performed to fully evaluate the impact of site-specific subsurface conditions on the effectiveness and design of the chemical injection system.

The area where chemical oxidation agents would be injected has been developed since 1939 and there are utilities and utility corridors around and through the site. A major utility corridor runs along the west side of Sampson Street and consists of steam pipes, sanitary sewer, and storm sewers. Storm sewers, sanitary sewer, and a water line are also located at the southern end of the site, with a sanitary sewer and storm sewer in the area of the contamination. The injection locations would have to be designed and located for minimum impact on the existing utilities.

Cost

Capital and O&M costs for in-situ chemical oxidation would be moderate.

Conclusion

In-situ chemical oxidation is retained in combination with other technologies and process options for the development of remedial alternatives.

3.2.5.2 Air Sparging and Soil Vapor Extraction (AS/SVE)

AS/SVE is a process that consists of volatilizing COCs and removing them from the contaminated soil or groundwater matrix with an air current induced by vacuum application (SVE) and, if required, air injection (AS). Additionally, this technology results in aerobic subsurface conditions that promote the biodegradation of numerous contaminants. Depending on site location and on the quantity and concentration of the volatilized COCs, extracted vapors may require treatment by such means as vapor-phase granular activated carbon (GAC) adsorption or catalytic oxidation prior to exhausting to the atmosphere.

Effectiveness

AS/SVE would be effective to remove the Site 22 COCs through volatilization rather than biodegradation. This technology is well proven for the removal of PCE from saturated and unsaturated soil. At Site 22, where most of the contamination occurs in soil saturated with perched groundwater, it is most likely that AS would be required to boost the effectiveness of vacuum extraction. However, the effectiveness of this technology would probably be limited by the tightly packed and low-permeability characteristics of the clayey soil at Site 22 that would impact the even distribution of the induced subsurface air current and its adequate contact with the COCs to be removed. A pilot-scale test would be required to confirm effectiveness and determine the AS/SVE system design criteria.

Implementability

AS/SVE would be simple to implement at Site 22. Resources and equipment are readily available for this purpose. The installation and operation of a network of AS and SVE wells is a relatively non-obtrusive activity that would have little impact on planned site use. However, close proximity of an AS/SVE system to the future barracks and food galleria complex would be a concern. Because of this, it is anticipated that treatment of extracted vapors would be required regardless of the quantity of COCs volatilized. As previously mentioned, a pilot-scale test would have to be performed to fully evaluate the impact of site-specific subsurface conditions on the effectiveness and design of the AS/SVE system.

The area where AS/SVE system would be installed has been developed since 1939 and there are utilities and utility corridors around and through the site. A major utility corridor runs along the west side of Sampson Street and consists of steam pipes, sanitary sewer, and storm sewers. Storm sewers, sanitary sewer, and a water line are also located at the southern end of the site, with a sanitary sewer and storm sewer in the area of the contamination. The well locations for the AS/SVE system would have to be designed and located for minimum impact on the existing utilities.

Cost

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

Conclusion

Although AS/SVE would be effective and readily implementable for the removal of the Site 22 soil COCs, this technology is eliminated from further consideration because, compared to chemical oxidation, it would not be as effective for the treatment of COCs and would only result in the transfer of these COCs from one medium (soil) to another (air) rather than actively degrading and destroying them.

3.2.5.3 In-Situ Electrical Resistance Heating (ERH)

This technology involves passing alternating current between electrodes in the ground, resulting in heating of the material through which the current passes. This technology can be employed using either three-phase or six-phase current. With the six-phase heating, six electrodes are placed in a circular array, with each connected to a single-phase transformer. With each electrode at a different voltage phase, each conducts with other electrodes in the array and provides a more uniform heating than with three-phase heating. The electrodes are steel wells using iron filings and graphite in the annular space. The heating boils the aquifer, driving volatile contaminants and water vapor into the lower portion of the vadose zone. There they are removed using the electrodes as SVE points. As required and similarly to AS/SVE systems, extracted vapors may be treated with GAC adsorption or other appropriate technologies prior to venting to the atmosphere.

Effectiveness

In-situ ERH would be an effective technology to remove COCs from soil at Site 22. The successful use of both six- and three-phase current for the removal of chlorinated VOCs such as PCE has been well documented. Compared to technologies involving subsurface air circulation or chemical injection, in-situ ERH has proven particularly effective in treating low-permeability soil such as that at Site 22. This is because while the permeability of a soil formation typically varies over several orders of magnitude, its electrical resistance and thermal conductivity are normally much less variable, and heating should be relatively uniform. Also, when perched groundwater (pore water) is associated with contaminated soil, such as is the case at Site 22, in-situ ERH generates pressurized steam that can both fracture the formation for improved circulation and effectively strip organic chemicals from soil and groundwater. Nonetheless, treatability testing, preferably of the pilot-scale type, would still be required to confirm effectiveness and determine ERH system design criteria.

Implementability

In-situ ERH would be relatively easy to implement at Site 22. The services of a number of qualified contractors specializing in the application of this technology would be available. Although the installation and operation of a network of heating electrodes and SVE system would be more obtrusive than that of an AS/SVE or DPT chemical injection system, it still would have a relatively low impact of planned future site use. Because of the close proximity of a future barracks and food galleria complex, treatment of extracted vapors would be required. A pilot-scale treatability test would probably have to be performed to confirm design criteria of the ERH system.

The area where in-situ ERH would be used has been developed since 1939 and there are utilities and utility corridors around and through the site. A major utility corridor runs along the west side of Sampson Street and consists of steam pipes, sanitary sewer, and storm sewers. Storm sewers, sanitary sewer, and a water line are also located at the southern end of the site, with a sanitary sewer and storm sewer in the area of the contamination. The electrode locations would have to be designed and located for minimum impact on the existing utilities.

Cost

Capital and O&M costs for in-situ ERH would be moderate.

Conclusion

In-situ ERH is retained in combination with other technologies and process options for the development of remedial alternatives.

3.2.6 Ex-Situ Treatment

Four technologies were retained from preliminary screening under this GRA including chemical oxidation, incineration, low-temperature thermal desorption (LTTD), and size reduction.

3.2.6.1 Off-Base Chemical Oxidation

This technology would be very similar to in-situ chemical oxidation, except that it would be performed off-base on excavated material and under more closely controlled conditions. As with in-situ chemical oxidation, off-base chemical oxidation would consist of mixing the contaminated soil with a strong oxidation agent such as catalyzed persulfate, Fenton's Reagent, or potassium permanganate to chemically degrade COCs. The mixing would typically be achieved with the use of such equipment as pug mills, and the reaction would take place in a static pile.

Effectiveness

Similarly to in-situ chemical oxidation, off-base chemical oxidation would be an effective technology to remove COCs from soil at Site 22. The use of Fenton's Reagent, catalyzed persulfate, and potassium permanganate has been documented for the chemical oxidation of chlorinated VOCs such as PCE. Because these chemicals would be effectively mixed with the contaminated soil under well controlled conditions, the process should be particularly effective. However, bench-scale treatability study would still be required to optimize the selection and dosage of the chemical reagent and to determine injection system design criteria.

Implementability

Off-base chemical oxidation would be simple to implement. This kind of service is typically available at a number of qualified treatment storage and disposal facilities (TSDFs). As previously mentioned, a bench-scale test would have to be performed to optimize the selection and dosage of the chemical reagent to be used.

During the transportation and treatment of the contaminated soil appropriate measures would need to be incorporated to make sure no off gassing occurred. Health and safety procedures, OSHA regulations, and DOT regulations would have to be complied with to make sure that the exposure of the workers to COCs is minimized and to protect them from the emissions since the contaminants are chlorinated VOCs (mainly PCE). This would include the wearing of appropriate PPE and the implementation of dust suppression measures, as may be required. Ambient air monitoring may be needed during implementation of this alternative.

Cost

Capital and O&M costs for off-base chemical oxidation would be moderate.

Conclusion

Off-base chemical oxidation is retained in combination with other technologies and process options for the development of remedial alternatives.

3.2.6.2 Off-Base Incineration

Incineration is a thermal oxidation process that converts organic solids, liquids, and gases to inorganic substances at high temperatures in the presence of oxygen. The technology uses controlled flame combustion in an enclosed reactor to decompose organic compounds. Carbon and hydrogen waste components are converted to carbon dioxide and water, respectively. Other combustion products are also present in smaller quantities. These may include carbon monoxide, nitrogen oxides, hydrochloric and fluoridic acids, and various trace metals. If a wet scrubber air pollution control system is used, a liquid waste stream could also be generated. Pre-screening and size reduction of the contaminated material is most often required to improve incineration efficiency. The noncombustible waste/debris must be treated or disposed of by other means, depending upon the level of associated contamination.

Rotary kilns are one of the most widely used types of incinerators for the treatment of contaminated soil. An integrated rotary kiln incineration system includes a solid feed system, a rotary kiln and secondary combustion chamber, air pollution control units for particulate and acid gas removal, and an exhaust stack. Such a system employs a refractory-lined rotary kiln operating at high temperatures [1,470 to 2,910 degrees Fahrenheit (°F) or 800 to 1,600 degrees Celsius (°C)] to combust wastes in the presence of oxygen.

Effectiveness

Incineration would be very effective for destroying the COCs in Site 22 soil and pore water. Incineration may in fact be the only acceptable technology for the ex-situ treatment of the most contaminated part of any soil and pore water excavated from that site prior to disposal. Incineration would typically achieve in excess of 99.99 percent destruction of such chlorinated VOCs as PCE with formation of water, carbon dioxide, and hydrochloric acid. Carbon dioxide and hydrochloric acid are typically neutralized through alkaline scrubbing of the off-gas. Incinerated soil can typically be reused as fill material.

Implementability

Treatment of Site 22 soil and pore water at an off-base incineration system would be relatively easy to implement. A number of qualified TSDFs exist that could provide this service. Pre-approval and manifesting of the soil to be incinerated would be required.

During the transportation and incineration of the contaminated soil appropriate measures would need to be incorporated to make sure no off gassing occurred. Health and safety procedures, and OSHA and DOT regulations would have to be complied with to make sure that the exposure of the workers to COCs is minimized and to protect them from the emissions since the contaminants are chlorinated VOCs (mainly PCE). This would include the wearing of appropriate PPE and the implementation of dust suppression measures, as may be required. Ambient air monitoring may be needed during implementation of this alternative.

Cost

Costs of off-base incineration would be high to very high.

Conclusion

Off-base incineration is retained in combination with other technologies and process options for the development of remedial alternatives.

3.2.6.3 Off-Base LTTD

LTTD technology uses direct or indirect heating to thermally desorb chlorinated VOCs. The temperatures used are contaminant- and matrix-specific, with a range of approximately 200 to 1,200°F (95 to 650°C). Because LTTD effectiveness is very sensitive to particle size, pre-treatment with size reduction is most often required. Following pre-treatment, the materials are typically processed through an externally fired pug mill or rotary drum system equipped with heat transfer surfaces that are heated by circulating hot oil. An induced airflow conveys the desorbed organic chemicals through a secondary treatment system, such as a vapor-phase GAC adsorption unit, a catalytic oxidation unit, a condenser unit, or even an afterburner. It should be noted, however, that use of an afterburner for secondary treatment has typically resulted in the LTTD unit being considered as an incinerator by regulatory agencies. The off-gas is then discharged through a stack.

Effectiveness

LTTD would be effective for the removal of the COCs from soil and pore water at Site 22. Because chlorinated VOCs such as PCE are relatively easily volatilized, the required operating temperature of the LTTD system would be expected to be towards the lower end of the range (probably 250 to 300° F). Contrary to chemical oxidation and incineration, LTTD would not degrade or destroy the COCs but merely remove them through volatilization. Additional treatment of the volatilized COCs would be required and could be accomplished through treatment of off-gases by such processes as condensation, vapor-phase GAC adsorption, or catalytic oxidation. Because the effectiveness of LTTD is contaminant- and matrix-specific, a full characterization of the soil to be treated would be required, and bench-scale treatability testing would have to be performed to verify the level of effectiveness and to determine the optimum operating temperature and detention time.

Implementability

Treatment of Site 22 soil and pore water at an off-base LTTD system would be relatively simple to implement. Qualified TSDFs would be readily available to provide the necessary services. As mentioned earlier, pre-treatment of the excavated soil for size reduction would most likely be required and would best be accomplished on site. Another likely pre-treatment requirement would be the removal of any associated free water, which could be accomplished on site through static stockpiling. Also as mentioned earlier, bench-scale treatability testing may have to be performed to verify removal effectiveness and to determine optimum operating criteria.

During the transportation and treatment of the contaminated soil appropriate measures would need to be incorporated to make sure no off gassing occurred. Health and safety procedures and OSHA and DOT regulations would have to be complied with to make sure that the exposure of the workers to COCs is minimized and to protect them from the emissions since the contaminants are chlorinated VOCs (mainly PCE). This would include the wearing of appropriate PPE and the implementation of dust suppression measures, as may be required. Ambient air monitoring may be needed during implementation of this alternative.

Cost

Costs of off-base LTTD would be moderate.

Conclusion

Although off-base LTTD would be effective and implementable, it is eliminated from further consideration because it would not degrade or destroy COCs but merely remove them through volatilization. Therefore, it would not be as effective as chemical oxidation for the treatment of lightly to moderately contaminated soil and pore water or as incineration for the treatment of highly contaminated soil and pore water.

3.2.6.4 Size Reduction

Size reduction would consist of reducing the size of contaminated debris so that they would meet the particle size requirements of subsequent treatment processes. This size reduction is typically accomplished in two steps by first separating oversized material with fixed or vibrating screens and then by processing this oversized material in specialized mechanical equipment such as hammer mills, grinders, or shredders.

Effectiveness

Size reduction would not of itself be effective for the removal of COCs. However, size reduction would segregate oversized material that is typically either not contaminated or less contaminated than finer soil particles. Size reduction might also be required as a pre-treatment to optimize the effectiveness of other treatment processes such as LTTD or incineration. At Site 22, screening would be effective to separate oversized material from excavated soil, including chunks of asphalt pavement or fragments of HDPE liner. Crushing would be effective to reduce the size of asphalt chunks and shredding would be effective to reduce the size of liner fragments.

Implementability

Size reduction would be readily implementable as a pre-treatment step. The equipment and labor to operate this equipment would be readily available. Due to the proximity of the future barracks and food galleria, dust emissions would have to be strictly controlled.

During the size reduction of the contaminated soil appropriate measures would need to be incorporated to make sure no off gassing occurred. Health and safety procedures and OSHA regulations would have to be complied with to make sure that the exposure of the workers to COCs is minimized and to protect them from the emissions since the contaminants are chlorinated VOCs (mainly PCE). This would include the wearing of appropriate PPE and the implementation of dust suppression measures, as may be required. Ambient air monitoring may be needed during implementation of this alternative.

Cost

Capital and O&M costs for size reduction would be low.

Conclusion

Size reduction is retained on an as-required basis and in combination with other technologies and process options for the development of remedial alternatives.

3.2.7 Disposal

The only technology retained from preliminary screening under this GRA is off-base landfilling. Off-base landfilling consists of transporting the excavated soil for burial in a permitted off-base TSDF. RCRA non-hazardous waste may be disposed in an RCRA Subtitle D, or solid waste, landfill. RCRA hazardous waste must be disposed in an RCRA Subtitle C, or hazardous waste, landfill. It is anticipated that the soil excavated from this site would be considered a listed hazardous waste.

Effectiveness

Off-base landfilling would not reduce concentrations of COCs in the contaminated soil. However, although CERCLA preference for treatment relegates landfilling to a less preferable option, this technology would be an effective disposal option for contaminated soil. Off-base landfills are only permitted to operate if they meet certain requirements of design and operation governing foundation, liner, leak detection, leachate collection and treatment, daily cover, post-closure inspections and monitoring, etc., which ensure the effectiveness of these facilities.

Implementability

Off-base landfilling would be easily implementable. Permitted RCRA Subtitle C and D TSDFs are available for this purpose. Landfills may require certain pre-treatment, mainly the removal of free liquids and, as for LTTD, this could be accomplished on site through static stockpiling. In addition, a waste profile would have to be prepared, including indications of contaminant concentrations and their leachability.

During the transportation and disposal of the contaminated soil appropriate measures would need to be incorporated to make sure no off gassing occurred. Health and safety procedures and OSHA and DOT regulations would have to be complied with to make sure that the exposure of the workers to COCs is minimized and to protect them from the emissions since the contaminants are chlorinated VOCs (mainly PCE). This would include the wearing of appropriate PPE and the implementation of dust suppression measures, as may be required. Ambient air monitoring may be needed during implementation of this alternative.

Cost

Costs of off-base landfilling would be low to moderate for that portion of the soil classified as RCRA non-hazardous and moderate to high for that portion classified as RCRA hazardous.

Conclusion

Off-base landfilling is retained in combination with other technologies and process options for the development of remedial alternatives.

3.3 SELECTION OF REMEDIATION TECHNOLOGIES AND PROCESS OPTIONS

The following remediation technologies and process options are retained to develop remedial alternatives for Site 22:

- No Action
- Limited Action: Monitoring and LUCs
- Removal: Excavation
- In-Situ Treatment: Chemical oxidation and ERH

- Ex-Situ Treatment: On-site size reduction (as required) and off-base chemical oxidation and incineration
- Disposal: Off-base landfilling

TABLE 3-1

PRELIMINARY SCREENING OF REMEDIATION TECHNOLOGIES AND PROCESS OPTIONS
SITE 22 FEASIBILITY STUDY REPORT
NAVAL STATION GREAT LAKES, ILLINOIS

General Response Action	Remedial Technology	Process Option	Description	Screening Comment
No Action	None	Not applicable	No activities conducted at the site to address contamination.	Retain. This option is required by law to be used as a baseline of comparison with other technologies.
Limited Action	Institutional Controls	Active: Access Restrictions	Control of site access through fencing, markers and warning signs.	Eliminate. This would be incompatible with planned future use of the site as a parking lot adjacent to barracks and a food galleria.
		Passive: Land Use Controls (LUCs)	Administrative action using property deeds or other land use prohibitions to restrict future site development and future groundwater use.	Retain. LUCs would be utilized to control future development in the contaminated area and prevent groundwater use.
	Monitoring	Sampling and Analysis	Sampling and analysis of soil and groundwater to evaluate natural attenuation and migration of COCs in the environment.	Retain. Although natural attenuation is unlikely at Site 22, this would be necessary to assess possible migration of COCs and to evaluate the progress of remedial actions.
	Natural Attenuation	Naturally Occurring Biodegradation and Dilution	Monitoring soil and groundwater to assess the decrease in COCs concentrations.	Eliminate. The RI concluded that there is little evidence of natural attenuation occurring.
Containment	Capping	Soil or Multimedia Cover	Use of semi-permeable or impermeable barriers to minimize direct exposure to contaminated soil and potential migration of COCs to groundwater.	Retain. This would minimize risks from direct exposure to contaminated soil and from leachability of COCs from soil to groundwater. Site 22 is already asphalt-paved and an HDPE liner was installed over part of the site.
Removal	Bulk excavation	Excavation	Use of construction equipment such as backhoe, front-end loader, gradall, etc., to remove contaminated soil.	Retain. This would effectively remove contaminated soil from the site.

TABLE 3-1

PRELIMINARY SCREENING OF REMEDIATION TECHNOLOGIES AND PROCESS OPTIONS
SITE 22 FEASIBILITY STUDY REPORT
NAVAL STATION GREAT LAKES, ILLINOIS

General Response Action	Remedial Technology	Process Option	Description	Screening Comment
In-Situ Treatment	Biological	Aerobic or Anaerobic Biodegradation	In-situ injection of carbon substrate, chemical nutrients and/or cultured microorganisms to induce biodegradation of COCs.	Eliminate. There is little evidence of natural biodegradation and injection and distribution of the substrate will be difficult in the low permeability soil.
	Physical/ Chemical	Soil Flushing	Use of water or other solvents to remove COCs from soil by flushing and collecting and treating or disposing of the contaminated fluids.	Eliminate. COCs including PCE are not particularly soluble and the soil has low hydraulic conductivity.
		Chemical Oxidation	Injection of strong oxidation agents such as catalyzed hydrogen peroxide (Fenton's Reagent), persulfate, or potassium permanganate to degrade and destroy COCs.	Retain. Has proven effective for the treatment of chlorinated VOCs including PCE.
		Air Sparging and Soil Vapor Extraction (AS/SVE)	Use of vacuum to volatilize COCs in soil and pore water. Use of air subsurface injection if required to boost vacuum.	Retain. COCs including PCE are reasonably volatile.
		Chemical Fixation and Solidification	Mixing of pozzolanic agents in the vadose zone to chemically fix COCs and solidify the matrix.	Eliminate. This technology would not be effective in immobilizing COCs including PCE.
	Thermal	Electrical Resistance Heating (ERH)	Use of electrical current to raise the temperature of soil to the boiling point of water to induce steam stripping and volatilization of COCs.	Retain. Would be applicable to the removal of COCs including PCE.

TABLE 3-1

PRELIMINARY SCREENING OF REMEDIATION TECHNOLOGIES AND PROCESS OPTIONS
SITE 22 FEASIBILITY STUDY REPORT
NAVAL STATION GREAT LAKES, ILLINOIS

General Response Action	Remedial Technology	Process Option	Description	Screening Comment
Ex-Situ Treatment	Biological	On-Site Landfarming	Spreading and tilling of contaminated soil into layers of clean surface soil to aerate and biodegrade organic COCs.	Eliminate. There is little evidence of natural biodegradation and no on-base area is available.
		Bioslurry Reactor or Biopile	Treatment of soils in a bioslurry reactor or biopile under controlled conditions using natural or cultured microorganisms to biodegrade organic COCs.	Eliminate. There is little evidence of natural biodegradation and no on-base area is available.
	Physical/ Chemical	Soil Washing or Solvent Extraction	Use of water or other solvents to remove COCs by flushing and collecting and treating or disposing the contaminated fluids.	Eliminate. COCs including PCE are not particularly soluble, and soil is not very permeable.
		Chemical Oxidation	Use of strong oxidation agents such as Fenton's Reagent,persulfate, or potassium permanganate to degrade and destroy COCs.	Retain. Has proven effective for the treatment of chlorinated VOCs including PCE.
		Chemical Fixation and Solidification	Mixing of pozzolanic agents to chemically fix COCs and solidify the matrix.	Eliminate. Would not be effective for the immobilization of COCs including PCE.
	Thermal	Incineration	Use of high temperatures to destroy COCs.	Retain. This would effectively destroy COCs including PCE.
		Low-Temperature Thermal Desorption (LTTD)	Use of low to moderate temperatures to volatilize COCs and remove them from soil.	Retain. This would effectively remove COCs including PCE.
	Solids Processing	Size Reduction	Segregation and removal of oversized soil particles with screens. Crushing and grinding of oversized soil particles with ball crushers or hammer mills.	Retain. Might be required as a pretreatment step for ex-situ treatment processes.

TABLE 3-1

PRELIMINARY SCREENING OF REMEDIATION TECHNOLOGIES AND PROCESS OPTIONS
SITE 22 FEASIBILITY STUDY REPORT
NAVAL STATION GREAT LAKES, ILLINOIS

General Response Action	Remedial Technology	Process Option	Description	Screening Comment
Disposal	Landfill	On-Base Landfilling	Disposal of excavated soil and treatment residues in an on-base landfill.	Eliminate. No suitable on-base area is available for this purpose.
		Off-Base Landfilling	Disposal of excavated soil and treatment residues in an off-base permitted TSDF.	Retain. Would be effective for the disposal of contaminated soil.

NOTES:
COC Chemical of concern
HDPE High-density polyethylene
PCE Tetrachloroethene
TSDF Treatment, storage and disposal facility
VOCs Volatile organic compounds

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 of 40 CFR Part 300, as revised in 1990. The criteria as required by the NCP and the relative importance of these criteria are described in the following subsections.

4.1.1 Evaluation Criteria

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

- Overall Protection of Human Health and the Environment
- Compliance with ARARs
- Long-Term Effectiveness and Permanence
- Reduction of Toxicity, Mobility, and Volume through Treatment
- Short-Term Effectiveness
- Implementability
- Cost
- State Acceptance
- Community Acceptance

Overall Protection of Human Health and the Environment

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

Compliance with ARARs

Alternatives are assessed to determine whether they attain ARARs under federal environmental laws and state environmental or facility siting laws. If one or more regulations that are applicable cannot be complied with, a waiver must be invoked. Grounds for invoking a waiver would depend on the following circumstances:

- The alternative is an interim measure and will become part of a total remedial action that will attain the ARAR.
- Compliance will result in greater risk to human health and the environment.
- Compliance is technically impracticable from an engineering perspective.
- The alternative will attain a standard of performance that is equivalent to that required under the otherwise applicable standard, requirement, or limitation through use of another method or approach.
- A state requirement has not been consistently applied, or the state has not demonstrated the intention to consistently apply the promulgated requirement in similar circumstances at other remedial actions within the state.
- For Fund-financed response actions only, an alternative that attains the ARAR will not provide a balance between the need for protection of human health and the environment at the site and the availability of Fund monies to respond to other sites that may present a threat to human health and the environment.

Long-Term Effectiveness and Permanence

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

- <u>Magnitude of residual risk</u>: 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.
- <u>Adequacy and reliability of controls</u>: Controls such as containment systems and LUCs that are necessary to manage treatment residuals and untreated waste must be shown reliable. In particular, the uncertainties associated with land disposal for providing long-term protection from residuals; the

assessment for the potential need to replace technical components of the alternative such as a cap, a slurry wall, or a treatment system; and the potential exposure pathways and risks posed should the remedial action need replacement.

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 is assessed, including how treatment is used to address the principal threats posed by the site. Factors that are 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.

Short-Term Effectiveness

The short-term impacts of the alternative are 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.

Implementability

The ease or difficulty of implementing the alternatives is 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, storage capacity, and disposal capacity and services; the availability of necessary equipment and specialists, and provisions to ensure any necessary additional resources; the availability of services and materials; and the availability of prospective technologies.

Cost

Capital costs include both direct and indirect costs. A net present worth (NPW) of the capital and O&M costs is also provided. Typically, the cost estimate accuracy range is plus 50 percent to minus 30 percent.

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 at this time in the FS 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 to for public comment.

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 done 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 include the following:

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

The threshold criteria must be satisfied in order 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 Toxicity, Mobility, or Volume through Treatment
- Short-Term Effectiveness
- Implementability
- Cost

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

The remaining two of the nine criteria, namely 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 Illinois and the Proposed Plan has been discussed in a public meeting. Therefore, this document addresses only seven out of the nine 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 review of the comments and a determination as to whether or not the preferred alternative continues to be the most appropriate remedial action for the site, in consultation with the State of Illinois.

4.2 DEVELOPMENT OF ALTERNATIVES

This section develops the remedial alternatives for Site 22. Additional site-specific information and assumptions will be provided in this section to further explain the alternative development process. The alternatives will be briefly explained in the following sections.

Based on the technology screening presented in Section 3.3, the following five remedial alternatives were developed for Site 22:

- Alternative1: No Action

- Alternative 2: In-Situ Chemical Oxidation, Monitoring, and LUCs

- Alternative 3: In-Situ ERH, Monitoring, and LUCs

- Alternative 4: Excavation, Off-Base Treatment (chemical oxidation or incineration) and Disposal, Monitoring, and LUCs

- Alternative 5: Focused ERH, Limited Excavation, Off-Base Treatment (incineration) and Disposal, Capping, Monitoring, and LUCs

Alternative 1 was developed and analyzed to serve as a baseline for other alternatives, as required by CERCLA and the NCP. Alternatives 2, 3, and 5 were formulated and analyzed to evaluate options for the in place cleanup of the contaminated soil and pore water. Alternative 4 was formulated and analyzed to evaluate the removal and disposal of the contaminated soil and pore water. A description and detailed analysis of these alternatives are provided in the following sections.

4.2.1 Alternative 1: No Action

4.2.1.1 Description

This alternative is a "walk-away" alternative that is required under CERCLA to establish a basis for comparison with other alternatives. Under this alternative, the property would be released for unrestricted use. This alternative cannot be chosen if waste remains on site.

4.2.1.2 Detailed Analysis

Overall Protection of Human Health and the Environment

Alternative 1 would not provide protection of human health and the environment. The potential for exposure of human receptors to contaminated soil and for leaching of soil COCs to groundwater would remain unchanged. Although these have been effectively controlled by the existing asphalt pavement and HDPE liner, this pavement and liner would no longer be maintained resulting in increased future risks, especially under a hypothetical future residential development of the area.

Compliance with ARARs and TBCs

Alternative 1 would not comply with chemical-specific ARARs and TBCs because no action would be taken to reduce COCs concentrations. Alternative 1 would also not comply with location-specific ARARs. Action-specific ARARs are not applicable.

Long-Term Effectiveness and Permanence

Alternative 1 would have no long-term effectiveness and permanence because nothing would be done to reduce concentrations of soil COCs.

Reduction of Toxicity, Mobility, or Volume through Treatment

Alternative 1 would not reduce toxicity, mobility, or volume of COCs through treatment because no treatment would occur.

Short-Term Effectiveness

Because no action would occur, implementation of Alternative 1 would not pose any risks to on-site workers or result in adverse impact to the local community and the environment.

Alternative 1 would not achieve the RAOs or the PRGs.

Implementability

Alternative 1 would be readily implementable because there would be nothing to implement. The technical feasibility criteria, including constructability, operability, and reliability, are not applicable. The implementability of administrative measures is not applicable because no such measures would be taken.

Cost

There would be no costs associated with Alternative 1.

4.2.2 Alternative 2: In-Situ Chemical Oxidation, Monitoring, and LUCs

4.2.2.1 Description

Alternative 2 is illustrated on Figure 4-1 and would consist of two major components: (1) in-situ chemical oxidation, (2) monitoring, and (3) LUCs.

Component 1: In-Situ Chemical Oxidation

In-situ chemical oxidation would consist of injecting in the contaminated soil area a special reagent formulated to chemically oxidize and degrade the soil COCs, in particular PCE. Injection would be conducted by using DPT. For the purpose of this FS, it is assumed that a modified Fenton's Reagent (iron-catalyzed hydrogen peroxide) would be used and, based on the information received from a qualified contractor [In-Situ Oxidative Technologies, Inc. (ISOTEC)], the injection system would consist of 660 DPT feed points including 250 installed to a depth of 12 feet bgs, 250 installed to a depth of 18 feet bgs and 160 installed to a depth of 25 feet bgs. The oxidation reagent would be injected in each DPT point at the rate of approximately 3 gallons per minute (gpm) with 6,000 gallons injected in the 12-foot deep points, 12,000 gallons in the 18-foot deep points and 9,000 gallons in the 25-foot deep points, for a total of 27,000 gallons per injection event. It is also assumed that two injection events would be required to achieve the PRGs.

The effectiveness and design criteria of the in-situ chemical oxidation system would be determined prior to the remedial action through pilot-scale testing and during the remedial action through monitoring. This pilot testing would involve testing/treatment of a small area near the "hot spot".

Component 2: Monitoring

Monitoring would consist of verifying the effectiveness and completeness of the in-situ chemical oxidation process following each injection event. Monitoring would consist of advancing soil borings throughout the contaminated area and field testing the samples collected at various depths for organic vapor analysis (OVA). For each boring, the sample with the highest OVA reading would also be analyzed for chlorinated VOCs by a fixed-base laboratory. Monitoring would also include collection of groundwater samples from existing monitoring wells and analysis for chlorinated VOCs by a fixed-based laboratory.

For the purpose of this FS, it is assumed that two rounds of sampling would be performed. Each sampling round would consist of advancing and sampling 12 soil borings including 5 to a depth of 12 feet bgs, 5 to a depth of 18 feet bgs and 2 to a depth of 25 feet bgs. Each sampling round would also include the collection of 6 groundwater samples using low-flow sampling procedures.

Component 3: LUCs

LUCs would be incorporated into the Base Master Plan to make sure that the restrictions on groundwater use established in the LUC MOA are applied and enforceable at this site regardless of changes in Navy policy throughout the Naval Station. These LUCs would be required until the monitoring verifies the effectiveness and completeness of the in-situ chemical oxidation process in meeting the RAOs for the site. Additionally, LUCs would require review of construction activities and intrusive work in the area to protect workers and confirm proper management of contaminated materials.

4.2.2.2 Detailed Analysis

Overall Protection of Human Health and the Environment

Alternative 2 would be protective of human health and the environment.

In-situ chemical oxidation would be protective of human health and the environment by destroying the soil COCs that could result in unacceptable risks to human receptors from exposure to contaminated soil. Although no significant groundwater contamination has been identified at Site 22, other than that of the pore water associated with the contaminated soil, in-situ chemical oxidation would also be protective of human health and the environment by removing the source of any potential future groundwater contamination.

Monitoring would be protective of human health and the environment by providing an indication of the progress of the chemical degradation process and by verifying that concentrations of COCs in soil and pore water have been reduced to concentrations less than the PRGs.

LUCs would provide protection to human health by minimizing exposure to groundwater.

<u>Compliance with ARARs and TBCs</u>

Alternative 2 would comply with the chemical-, location- and action-specific ARARs and TBCs.

<u>Long-Term Effectiveness and Permanence</u>

Alternative 2 would provide long-term effectiveness and permanence.

In-situ chemical oxidation is a well-proven technology for the permanent and irreversible destruction of the chlorinated VOCs that are the COCs at Site 22. The site-specific effectiveness of this technology would also be verified through pilot-scale testing.

Periodic collection and analysis of soil and groundwater samples would be an effective means of monitoring cleanup progress and verifying eventual attainment of the PRGs.

LUCs would be an effective means of minimizing exposure to site groundwater over the long term.

<u>Reduction of Toxicity, Mobility, or Volume through Treatment</u>

Alternative 2 would reduce toxicity, mobility, and volume of COCs through chemical degradation. This alternative would permanently and irreversibly remove an estimated 1,700 pounds of chlorinated VOCs from the Site 22 soil. Alternative 2 would not generate a treatment residual.

Short-Term Effectiveness

Implementation of Alternative 2 would result in a slight possibility for short-term risk to remediation workers from exposure to contamination during the installation of the in-situ chemical oxidation DPT injection points as well as during monitoring. However, risk from exposure would be effectively controlled by compliance with proper site-specific health and safety procedures including the wearing of appropriate PPE.

Implementation of Alternative 2 would not adversely impact the surrounding community or the environment.

It is estimated that Alternative 2 would achieve the RAOs and attain the PRGs within approximately one year.

Implementability

Alternative 2 may be difficult to implement. The services of a number of qualified contractors specializing in the application of this technology would be available; however, delivery of the chemical oxidation reagent in the tightly packed, low permeability soil at Site 22 would be difficult and take some effort to implement. Even distribution of the oxidation reagent into the subsurface may also be difficult to achieve at the site. Multiple injections would be required for even subsurface distribution and adequate contact of the area to be treated.

The area where chemical oxidation agents would be injected has been developed since 1939 and there are utilities and utility corridors around and through the site. A major utility corridor runs along the west side of Sampson Street and consists of steam pipes, sanitary sewer, and storm sewers. Storm sewers, sanitary sewer, and a water line are also located at the southern end of the site, with a sanitary sewer and storm sewer in the area of the contamination. The injection locations would have to be designed and located for minimum impact on the existing utilities.

Administrative implementation would also be simple. No formal construction permit would be required for the installation of the in-situ chemical oxidation system. In addition, the contaminated media can be treated in-situ without triggering RCRA permit requirements or the Land Disposal Restrictions. However, the DPT injection of chemicals may have to comply with the substantive requirements of the State's underground injection control (UIC) program.

Monitoring and LUCs would be easily implemented.

Cost

The estimated costs for Alternative 2 are as follows. These costs have been rounded to the nearest $1,000 to reflect the preliminary nature of the estimates:

- Capital Cost: $1,326,000
- NPW of O&M Cost: $0
- NPW: $1,326,000

This cost would increase if more than two injection events are required to meet the PRGs. A detailed cost estimate for this alternative is provided in Appendix B. The capital cost includes the performance of a pilot-scale test to verify the effectiveness of the in-situ chemical oxidation process and to determine the site-specific design criteria of the full-scale treatment system. The pilot-scale testing should be conducted in the area of the hot spot and the cost for this testing (does not include support/oversight, trailers, decontamination, site restoration, etc.) would be approximately $58,000.

4.2.3 Alternative 3: In-Situ ERH, Monitoring, and LUCs

4.2.3.1 Description

Alternative 3 is illustrated on Figure 4-2 and would consist of two major components: (1) in-situ ERH, (2) monitoring, and (3) LUCs.

Component 1: In-Situ ERH

This component would consist of installing and operating an in-situ ERH system in the contaminated soil area. This system would consist of a network of buried electrodes connected to a power generating unit. These electrodes would heat up the contaminated soil and associated pore water to approximately 212°F (100°C), resulting in the evaporation of chlorinated VOCs. The vapors would be collected in the recovery wells associated with each electrode and aspirated to a central treatment unit by a vacuum pump. The central vapor treatment unit would consist of a condenser to cool and separate water vapors and a vapor-phase GAC adsorption unit for the removal of chlorinated VOCs prior to exhaust to the atmosphere. A process flow diagram for a typical in-situ ERH system is provided on Figure 4-3.

For the purpose of this FS and based on the information received from a qualified contractor (Thermal Remediation Services and Current Environmental Services), it is assumed that the in-situ ERH system would consist of a total of 75 electrodes-recovery wells including 30 installed to a depth of 12 feet bgs, 30 installed to a depth of 18 feet and 15 installed to a depth of 25 feet bgs. The electrodes would be connected to a computer-controlled 2,000 kilovolt amperes (kVA) power-generating unit. Soil temperature would be monitored at ten locations, with temperatures being measured at three to five different depths at each location. The vapor recovery wells would be connected to a 330 cubic feet per minute (cfm) vacuum pump, and the central vapor treatment system would consist of a steam condenser and two vapor-phase GAC adsorption units in series, each holding 2,000 pounds of GAC. Anticipated operation time of the in-situ ERH system would be approximately six months.

It is estimated that the lead vapor-phase GAC adsorption unit would have to be replaced three times during the operation of the vapor treatment system, for a total vapor-phase GAC usage of 8,000 pounds. It is also estimated that approximately 5 gpm of steam condensate would be generated by the operation of the vapor treatment system. Although experience with similar projects has shown that approximately 99 percent of the removed chlorinated VOCs fractionates to the vapor phase, the condensate would still be likely to contain concentrations [up to 5 milligrams per liter (mg/L)] of these chlorinated VOCs, especially during initial operation of the in-situ ERH system. Accordingly, it is assumed that this condensate would be treated with liquid-phase GAC adsorption prior to discharge and that an estimated 500 pounds of GAC would be used for this purpose.

The effectiveness and design criteria of the in-situ ERH system would be verified through pilot-scale testing. This pilot testing would involve testing/treatment of a small area near the "hot spot". The pilot testing can be expanded into a full scale treatment if the pilot testing treatment is effective and successful.

Component 2: Monitoring

This component would be very similar to Component 2 of Alternative 2 with an estimated two rounds of monitoring, each consisting of the collection and analysis of 12 soil and 6 groundwater samples and analysis for chlorinated VOCs.

Component 3: LUCs

LUCs would be incorporated into the Base Master Plan to make sure that the restrictions on groundwater use established in the LUC MOA are applied and enforceable at this site regardless of changes in Navy policy throughout the Naval Station. These LUCs would be required until the monitoring verifies the effectiveness and completeness of the in-situ ERH process in meeting the RAOs for the site. Additionally, LUCs would require review of construction activities and intrusive work in the area to protect workers and confirm proper management of contaminated materials.

4.2.3.2 Detailed Analysis

Overall Protection of Human Health and the Environment

Alternative 3 would be protective of human health and the environment.

In-situ ERH would be protective of human health and the environment by removing the COCs that could result in unacceptable risks to human receptors. Although no significant groundwater contamination has been identified at Site 22, other than that of the pore water associated with the contaminated soil, in-situ ERH would also be protective of human health and the environment by removing the source of any potential future groundwater contamination.

Monitoring would be protective of human health and the environment by providing an indication of the progress of the chemical degradation process and by verifying that concentrations of COCs in soil and pore water have been reduced to concentrations less than the PRGs.

LUCs would provide protection to human health by minimizing exposure to groundwater.

Compliance with ARARs and TBCs

Alternative 3 would comply with the State and federal chemical-, location-, and action-specific ARARs and TBCs.

Long-Term Effectiveness and Permanence

Alternative 3 would provide long-term effectiveness and permanence.

In-situ ERH is a well-proven technology for the permanent and irreversible removal of the chlorinated VOCs that are the soil COCs at Site 22. The site-specific effectiveness of this technology would also be verified through pilot-scale testing.

Periodic collection and analysis of soil and groundwater samples would be an effective mean of monitoring cleanup progress and verifying eventual attainment of the PRGs.

LUCs would be an effective means of minimizing exposure to site groundwater over the long term.

Reduction of Toxicity, Mobility, or Volume through Treatment

Alternative 3 would reduce toxicity, mobility, or volume of COCs through evaporation and GAC adsorption. This alternative would permanently and irreversibly remove an estimated 1,700 pounds of chlorinated VOCs from the Site 22 soil. Alternative 3 would generate an estimated 8,000 pounds of spent vapor-phase GAC and 500 pounds of liquid-phase GAC as treatment residuals. This spent GAC would be regenerated or disposed off-base.

Short-term Effectiveness

Implementation of Alternative 3 would result in a slight possibility for short-term risks to remediation workers because of exposure to contaminated soil and pore water during the installation of the ERH electrodes and during monitoring. However, risk from exposure would be effectively controlled by compliance with proper site-specific health and safety procedures including the wearing of appropriate PPE.

In addition, Alternative 3 could result in short-term risk to remediation workers and adversely impact the surrounding community and environment because of exposure to extracted contaminated vapors. However, this would be adequately mitigated through treatment of these vapors with GAC adsorption prior to release to the atmosphere.

It is estimated that Alternative 3 would achieve the RAOs and attain the PRGs within approximately one year.

Implementability

Alternative 3 would be readily implementable.

Technical implementation of an in-situ ERH system would be relatively simple. GAC adsorption would be used to treat the extracted vapors. Spent GAC units would be replaced with fresh ones and the spent units would be incinerated or regenerated. A number of competent contractors are available to provide these services, and the required resources, equipment, and materials are readily available.

The area where in-situ ERH would be used has been developed since 1939 and there are utilities and utility corridors around and through the site. A major utility corridor runs along the west side of Sampson Street and consists of steam pipes, sanitary sewer, and storm sewers. Storm sewers, sanitary sewer, and a water line are also located at the southern end of the site, with a sanitary sewer and storm sewer in the area of the contamination. The electrode locations would have to be designed and located for minimum impact on the existing utilities.

Administrative implementation would also be simple. A construction permit would be required for the installation of the in-situ ERH and vapor treatment system, but this permit should not be difficult to obtain. In addition, the contaminated media would be treated in-situ without triggering RCRA permit requirements or the Land Disposal Restrictions. Administrative procedures such as manifesting would also likely be required for the off-base disposal of the spent vapor-phase GAC adsorption units, but these procedures would not be overly demanding.

Monitoring and LUCs would be easily implemented.

Cost

The estimated costs for Alternative 3 are:

- Capital Cost: $3,078,000
- NPW of O&M Cost: $0
- NPW: $3,078,000

A detailed cost estimate for this alternative is provided in Appendix B. The capital cost includes the performance of a pilot-scale test to verify the effectiveness of the in-situ ERH process and to determine the site-specific design criteria of the full-scale treatment system. The pilot-scale testing should be conducted in the area of the hot spot and the cost for this testing (does not include support/oversight, trailers, decontamination, site restoration, etc.) would be approximately $338,000.

4.2.4 Alternative 4: Excavation, Off-Base Treatment (chemical oxidation or incineration) and Disposal, Monitoring, and LUCs

4.2.4.1 Description

Alternative 4 is illustrated on Figure 4-4 and would consist of three major components: (1) excavation of soil and pore water, (2) off-base disposal of excavated material preceded, if necessary, by treatment with chemical oxidation or incineration, (3) monitoring, and (4) LUCs.

Component 1: Excavation

Soil and pore water contaminated with concentrations of COCs in excess of PRGs would be excavated. Approximately 10,000 yd^3 of contaminated material weighing an estimated 13,500 tons would be excavated to a depth of up to 25 feet bgs. As shown on Figure 2-1 the surface area of the excavation would range from 13,750 ft^2 at ground surface to 12,100 ft^2 at 12 feet bgs to 7,500 ft^2 at 18 feet bgs and to 2,500 ft^2 at 25 feet bgs. Because of the significant depth and the utilities in the area of the excavation, shoring of the excavation walls and utilities would be required. Also, because excavation would take place well below the level of the perched groundwater table that typically occurs at approximately 6 feet bgs, dewatering would be required by pumping on the periphery of the excavation area to depress the level of the perched groundwater table. Following excavation, a total of 12 samples would be collected from the bottom of the excavated area and analyzed for chlorinated VOCs to verify that the PRGs have been met. Following verification sampling, the excavated areas would be backfilled with imported clean fill and regraded to achieve desired surface elevations.

As required, the excavated material would be stockpiled in the area of Site 22 prior to on-site staging and off-base transportation to allow excess pore water to drain out. This static dewatering would take place on temporary drainage pads, and collected free water would be temporarily stored, analyzed, and either treated before being returned to the excavated area or disposed off site. Also as required, the excavated material would be pre-treated on site prior to staging and off-base transportation to screen out and crush or shred any oversized fragments (e.g., asphalt chunks, liner pieces) that might interfere with the effectiveness of the proposed off-base treatment processes. The pre-treatment unit(s) would need to meet the appropriate RCRA regulations.

The dewatered and/or pre-treated excavated material would be sampled and analyzed for chlorinated VOCs for on-site staging in accordance with anticipated off-base treatment requirements (i.e., none, chemical oxidation, incineration). For the purpose of this FS, it is assumed that one soil sample would be collected and analyzed for each 100 yd^3 of excavated material, for a total of approximately 100 characterization samples.

Component 2: Off-Base Treatment (chemical oxidation or incineration) and Disposal

The excavated material would be transported to a permitted off-base TSDF where, depending on the concentrations of COCs, it would be either directly landfilled or pre-treated with chemical oxidation or incineration and subsequently landfilled.

Based on guidance from the Illinois EPA, it is assumed that the excavated material would be identified as a listed RCRA-hazardous waste (F002). Based on site concentrations, it is estimated that 50 percent of the soil (5,000 yd^3) would require incineration prior to landfilling, and 50 percent of the soil (5,000 yd^3) would require treatment using chemical oxidation prior to landfilling.

Component 3: Monitoring

Monitoring would consist of collecting groundwater samples from existing monitoring wells surrounding the excavation area to verify that excavation activities have not resulted in migration of COCs to the surrounding groundwater. For the purpose of this FS, it is assumed that monitoring would include two rounds of sampling with each round consisting of the collection of six groundwater samples and analysis of these samples for chlorinated VOCs.

Component 4: LUCs

LUCs would be incorporated into the Base Master Plan to make sure that the restrictions on groundwater use established in the LUC MOA are applied and enforceable at this site regardless of changes in Navy policy throughout the Naval Station. These LUCs would be required until the monitoring verifies the effectiveness and completeness of the excavation and disposal in meeting the RAOs for the site. Additionally, LUCs would require review of construction activities and intrusive work in the area to protect workers and confirm proper management of contaminated materials.

4.2.4.2 Detailed Analysis

Overall Protection of Human Health and the Environment

Alternative 4 would be protective of human health and the environment.

Excavation of soil and pore water with concentrations of COCs greater than the PRGs would remove the threat of unacceptable risk from exposure of human receptors. Although no significant groundwater contamination has been identified at Site 22, other than that of the pore water associated with the contaminated soil, excavation of the contaminated soil would also be protective of human health and the environment by removing the source of any potential future groundwater contamination.

Off-base chemical oxidation, incineration, and landfilling of the excavated material would protect human health and the environment by permanently destroying the COCs contained in that soil and/or safely containing them.

LUCs would provide protection to human health by minimizing exposure to groundwater.

Compliance with ARARs and TBCs

Alternative 4 would comply with the chemical-, location-, and action-specific ARARs and TBCs.

Long-Term Effectiveness and Permanence

Alternative 4 would provide long-term effectiveness and permanence.

Excavation of soil and pore water with concentrations of COCs greater than the PRGs would effectively and permanently remove COCs from the site. Pre-treatment of excavated material with chemical oxidation or incineration would effectively destroy the majority of soil COCs and landfilling would effectively contain residual concentrations of these COCs. The effectiveness and reliability of these technologies is well established. However, bench-scale treatability testing might be required to optimize the selection and dosage of the reagent to be used for chemical oxidation.

LUCs would be an effective means of minimizing exposure to site groundwater over the long term.

Reduction of Toxicity, Mobility, or Volume through Treatment

Alternative 4 would reduce the toxicity, mobility, and volume of the majority of the Site 22 COCs through pre-treatment with chemical oxidation or incineration. Approximately 1,700 pounds of chlorinated VOCs would be permanently and irreversibly destroyed. With the possible exception of an undetermined volume of incineration gas scrubbing waste, Alternative 4 would not generate a treatment residual.

Short-Term Effectiveness

Implementation of Alternative 4 could result in short-term risk to remediation workers because of exposure to contaminated soil and pore water during excavation, staging, transportation, and off-base treatment and landfilling. However, potential for exposure would be minimized by the implementation of engineering controls, such as dust suppression, and air quality monitoring. The potential for worker exposure would be further reduced by compliance with site-specific health and safety procedures including the wearing of appropriate PPE. Ambient air monitoring would also be implemented for this alternative to measure emissions from the excavation activities.

In addition, Alternative 4 could result in short-term risk to remediation workers and adversely impact the surrounding community because of exposure to contaminated soil and pore water spilled during transportation, emissions that would be released as the chlorinated VOCs are exposed to the atmosphere during excavation and transportation, or to exhaust gases generated by off-base incineration. However, this would be properly mitigated by wearing of appropriate PPE, the implementation of dust suppression measures, ambient air monitoring, compliance with applicable DOT regulations, and by the implementation of appropriate incineration off-gas treatment.

It is estimated that Alternative 4 would achieve the RAOs and attain the PRGs within approximately 6 months.

Implementability

Alternative 4 would be easily implementable.

Technical implementation of the excavation would require significant shoring and dewatering. The area of the excavation has been developed since 1939 and there are utilities and utility corridors around and through the site. A major utility corridor runs along the west side of Sampson Street and consists of steam pipes, sanitary sewer, and storm sewers. Storm sewers, sanitary sewer, and a water line are also located at the southern end of the site, with a sanitary sewer and storm sewer in the area of the contamination. The excavation of soil in these areas may require shoring or removal and replacement of the utilities depending on the depth of the excavation.

On-site analysis and staging would be required to segregate excavated material in accordance with anticipated off-base treatment requirements (i.e., none, chemical oxidation, incineration). On-site pre-treatment of excavated material might also be required for screening and size reduction and/or to remove excess free water. However, the required resources and equipment would be readily available to perform these tasks. Permitted off-base TSDFs would be readily available for the chemical oxidation, incineration, and landfilling of the excavated material.

Administrative implementation of Alternative 4 would be relatively simple. A construction permit would have to be obtained for excavation, and the off-site transportation and disposal of the excavated material would require the completion of numerous administrative procedures including RCRA permit requirements, Land Disposal Restrictions, waste profiling, and manifesting. While constituting a significant effort, these procedures could readily be accomplished.

Monitoring and LUCs would be easily implemented.

Cost

The estimated costs for Alternative 4 are:

- Capital Cost: $9,340,000
- NPW of O&M Cost: $ 0
- NPW: $9,340,000

A detailed cost estimate for this alternative is provided in Appendix B.

4.2.5 Alternative 5: Focused ERH, Limited Excavation, Off-Base Treatment (incineration) and Disposal, Capping, Monitoring, and LUCs

4.2.5.1 Description

Alternative 5 is illustrated on Figure 4-5 and would consist of six major components: (1) focused in-situ ERH; (2) limited excavation; (3) off-base treatment (incineration) and disposal; (4) containment via asphalt cap; (5) monitoring; and (6) LUCs.

Component 1: Focused In-Situ ERH

This component would consist of installing and operating an in-situ ERH system in the area of greatest soil contamination. This includes an area of approximately 1,400 square feet extending from the location of soil boring NTC22SB19 to approximately the location of monitoring well NTC22MW05S. The treatment scenario is similar to Alternative 3, although over a substantially smaller area.

For the purpose of this FS and based on the information received from a qualified contractor (Thermal Remediation Services and Current Environmental Solutions), it is assumed that the in-situ ERH system would consist of a total of eight electrodes and seven recovery wells, installed to a depth of 25 feet bgs. The layout and depth of these electrodes will be determined based on existing soil data and additional data from soil samples collected prior to initiation of ERH. The electrodes would be connected to a computer-controlled 2,000 kVA power-generating unit. Soil temperature would be monitored at up to four locations, with temperatures being measured at three to five different depths at each location. The vapor recovery wells would be connected to a 110 cfm vacuum pump, and the central vapor treatment system would consist of a steam condenser and two vapor-phase GAC adsorption units in series, each holding 2,000 pounds of GAC. Anticipated operation time of the in-situ ERH system would be approximately 3 months.

It is estimated that a total of 6,000 pounds of vapor-phase GAC would be utilized. It is also estimated that up to 1 gpm of steam condensate would be generated by the operation of the vapor treatment system. Although experience with similar projects has shown that approximately 99 percent of the removed chlorinated VOCs fractionates to the vapor phase, the condensate would still be likely to contain elevated concentrations (up to 5 mg/L) of these chlorinated VOCs, especially during initial operation of the in-situ ERH system. Accordingly, it is assumed that this condensate would be treated with liquid-phase GAC adsorption prior to discharge and that an estimated 500 pounds of GAC would be used for this purpose.

Due to the reduced treatment area in this alternative (as compared to Alternative 3), no pilot testing will be needed to determine site-specific design criteria for an effective/optimized remedial action (for both cost and operations) prior to implementation of the ERH.

Component 2: Limited Excavation

Soil above the remedial goal that is not treated via ERH would be removed via excavation. It is estimated that up to three separate locations may require excavation. These areas center on sample locations GL95-105S-8, GL95-105S-13, and NTC22MW05S. The necessity of excavation in these areas will be assessed based on soil samples collected from the locations prior to remedial action. Additionally, the soil contamination in one or more of these locations, if present, may be addressed via ERH. The type of remediation utilized at each location will depend on a cost analysis performed after receipt of the sampling results. The maximum volume of soil excavated is expected to be 100 cubic yards (135 tons). It is assumed that soil excavated as part of this alternative would require incineration prior to landfilling.

Component 3: Off-Base Treatment (incineration) and Disposal

The excavated material would be transported to a permitted off-base TSDF where, depending on the concentrations of COCs, it would be pre-treated with chemical oxidation or incineration and subsequently landfilled.

Based on guidance from the Illinois EPA, it is assumed that the excavated material would be identified as a listed RCRA-hazardous waste (F002). Based on concentrations and the fact that the excavation will be centered on known areas of significant contamination, it is assumed that the excavated soil would require incineration prior to landfilling.

Component 4: Capping

The asphalt cover and HDPE liner currently present at the site would be left in place. Damage to these components during investigation and remediation would be repaired as necessary to maintain the integrity of the cap. The cap would be regularly inspected and maintained as necessary to ensure its continued integrity.

Component 5: Monitoring

Approximately 20 soil samples would be collected following completion of the ERH and the limited excavation field activities. The samples would be utilized to demonstrate the reductions in chlorinated VOC concentrations in the soil. Additionally, groundwater samples would be collected from up to six locations following treatment to demonstrate the reductions in groundwater concentrations obtained via ERH and to monitor for rebound in groundwater concentrations.

Component 6: LUCs

Appropriate LUCs would be implemented at the site. Based on the LUCs for Buildings 415 and 912 at Naval Station Great Lakes, the LUCs would include property, soil, and groundwater use restrictions. The site will be utilized in an industrial/commercial scenario, most likely as a parking lot. The current asphalt cover and HDPE liner would continue to be utilized to prevent contact with site soil. The LUCs will specify that prior to any other site use, the groundwater to indoor air pathway would be re-evaluated and the risks re-calculated utilizing post-remediation soil and groundwater concentrations. Also, the LUCs would prohibit the installation of groundwater wells, other than for use as environmental monitoring wells.

LUCs would be also incorporated to make sure that the restrictions on groundwater use established in the LUC MOA are applied and enforceable at this site regardless of changes in Navy policy throughout the Naval Station. Additionally, LUCs would require review of construction activities and intrusive work in the area to protect workers and confirm proper management of contaminated materials.

4.2.5.2 Detailed Analysis

Overall Protection of Human Health and the Environment

Alternative 5 would be protective of human health and the environment.

Focused in-situ ERH would be protective of human health and the environment by removing the COCs that could result in unacceptable risks to human receptors from the areas of greatest contamination. Although no significant groundwater contamination has been identified at Site 22, other than that of the pore water associated with the contaminated soil, in-situ ERH would also be protective of human health and the environment by removing the source of potential future groundwater contamination and addressing COC concentrations observed in monitoring wells NTC22MW06S, NTC22MW10S, and NTC22MW10D.

Excavation would be protective of human health and the environment by removing mass of COCs from the site and preventing contact with site soils.

Capping would provide protection to human health by minimizing exposure to soil and protect the environment by limiting the mobility of chlorinated VOCs remaining in the subsurface.

Off-base incineration and landfilling of the excavated material would protect human health and the environment by permanently destroying the COCs contained in that soil and/or safely containing them.

Monitoring would be protective of human health and the environment by providing an indication of the progress of the chemical degradation process and by verifying that concentrations of COCs in soil and pore water have been reduced to concentrations less than the PRGs.

LUCs would be protective of human health by minimizing contact with contaminated soil and preventing future use of site groundwater.

Compliance with ARARs and TBCs

Alternative 5 would comply with the State and federal chemical-, location-, and action-specific ARARs and TBCs.

Long-Term Effectiveness and Permanence

Alternative 5 would provide long-term effectiveness and permanence.

In-situ ERH is a well-proven technology for the permanent and irreversible removal of the chlorinated VOCs. ERH would effectively remove chlorinated VOC mass from the site and reduce chlorinated VOC concentrations in the soil throughout the treatment area.

Excavation would also permanently and irreversibly remove chlorinated VOCs from the site.

Since this alternative treats the area of greatest soil contamination, some residual contamination (outside of the treatment and excavation area as well as possible residual contamination within the treatment and excavation area) may remain on the site. Periodic collection and analysis of soil and groundwater samples would be an effective means of monitoring cleanup progress and verifying eventual attainment of the PRGs.

The combination of the asphalt cap and LUCs would minimize human contact with the contaminated soil.

Reduction of Toxicity, Mobility, or Volume through Treatment

Alternative 5 would reduce toxicity, mobility, or volume of COCs through evaporation, GAC adsorption, soil removal, and capping. This alternative would permanently and irreversibly remove an estimated 1,200 pounds of chlorinated VOCs from the Site 22 soil via evaporation and GAC adsorption via ERH. Approximately 150 pounds of chlorinated VOCs would be removed via excavation and landfilling. Alternative 5 would generate an estimated 6,000 pounds of spent vapor-phase GAC and 500 pounds of spent liquid-phase GAC as treatment residuals. This spent GAC would be regenerated or disposed off-base. The asphalt cap would also limit the mobility of chlorinated VOCs remaining in the subsurface.

Short-term Effectiveness

Implementation of Alternative 5 would result in short-term risks to remediation workers because of exposure to contaminated soil and pore water during the installation of the ERH electrodes, excavation, and monitoring. However, risk from exposure would be effectively controlled by compliance with proper site-specific health and safety procedures including the wearing of appropriate PPE.

In addition, Alternative 5 could result in short-term risk to remediation workers and adversely impact the surrounding community and environment because of exposure to extracted contaminated vapors. However, this would be adequately mitigated through treatment of these vapors with GAC adsorption prior to release to the atmosphere.

It is estimated that Alternative 5 would achieve reach its remedial goals within approximately six months.

Implementability

Alternative 5 would be readily implementable.

Technical implementation of an in-situ ERH system, excavation and landfilling, and monitoring would be relatively simple. GAC adsorption would be used to treat the extracted vapors. Spent GAC units would be replaced with fresh ones and the spent units would be incinerated or regenerated. A number of competent contractors are available to provide these services, and the required resources, equipment, and materials are readily available.

Administrative implementation would also be simple. A construction permit would be required for the installation of the in-situ ERH and vapor treatment system, but this permit should not be difficult to obtain. In addition, the contaminated media would be treated with ERH without triggering RCRA permit requirements or the Land Disposal Restrictions. Administrative procedures such as RCRA permit requirements, Land Disposal Restrictions, and manifesting would also likely be required for the off-base disposal of the excavated contaminated media and spent vapor-phase GAC adsorption units, but these procedures would not be overly demanding.

Capping, monitoring and LUCs would be easily implemented.

Cost

The estimated costs for Alternative 5 are:

- Capital Cost: $990,000
- NPW of O&M Cost: $0
- NPW: $990,000

A detailed cost estimate for this alternative is provided in Appendix B.

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IN-SITU CHEMICAL OXIDATION, MONITORING, AND LAND USE CONTROLS

IN-SITU CHEMICAL OXIDATION

PERFORM TWO ROUNDS OF CHEMICAL INJECTION, EACH CONSISTING OF THE FOLLOWING:

- INSTALL 660 DPT INJECTION POINTS OVER A 13,750 FT^2 AREA INCLUDING 250 POINTS TO 12 FEET BGS, 250 POINTS TO 18 FEET BGS, AND 160 POINTS TO 25 FEET BGS
- INJECT 27,000 GALLONS OF OXIDATION REAGENT INCLUDING 6,000 GALLONS IN 12-FOOT-DEEP DPTs, 12,000 GALLONS IN 18-FOOT-DEEP DPTs AND 9,000 GALLONS IN 25-FOOT-DEEP DPTs

→

MONITORING

PERFORM TWO ROUNDS OF MONITORING (ONE AFTER EACH INJECTION EVENT), EACH ROUND CONSISTING OF THE FOLLOWING:

- INSTALLATION OF 12 SOIL BORINGS INCLUDING 5 TO A DEPTH OF 12 FEET BGS, 5 TO A DEPTH OF 18 FEET BGS, AND 2 TO A DEPTH OF 25 FEET BGS
- COLLECTION OF SOIL SAMPLES EVERY 2 FEET
- FIELD ANALYSIS OF SOIL SAMPLES EVERY 2 FEET
- FOR EACH BORING, LABORATORY ANALYSIS FOR CHLORINATED VOCs OF THE SAMPLE WITH THE HIGHTEST OVA READING
- COLLECTION OF 6 GROUNDWATER SAMPLES FROM EXISTING MONITORING WELLS AND LABORATORY ANALYSIS FOR CHLORINATED VOCs

→

LAND USE CONTROLS

- ESTABLISH LUC IMPLEMENTATION PLAN IN LUC MOA
- RESTRICT GROUNDWATER AND PROPERTY USAGE
- REVIEW CONSTRUCTION ACTIVITIES/INTRUSIVE WORK TO ENSURE WORKERS SAFETY AND PROPER MANAGEMENT OF CONTAMINATED MATERIALS
- PERFORM REGULAR SITE INSPECTIONS

KEY:

BGS	BELOW GROUND SURFACE
DPT	DIRECT PUSH TECHNOLOGY
FT^2	SQUARE FEET
OVA	ORGANIC VAPOR ANALYZER
VOCs	VOLATILE ORGANIC COMPOUNDS

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BLOCK FLOW DIAGRAM
ALTERNATIVE 2
SITE 22 FEASIBILITY STUDY
NAVAL STATION GREAT LAKES, ILLINOIS

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IN-SITU ERH, MONITORING, AND LAND USE CONTROLS

IN-SITU ERH

INSTALL AND OPERATE AN IN-SITU ERH SYSTEM CONSISTING OF THE FOLLOWING:

- 75 HEATING ELECTRODES AND VAPOR RECOVERY WELLS OVER A 13,750 FT^2 AREA AT DEPTHS RANGING FROM 12 TO 30 FEET BGS, 18 TO 30 FEET BGS, AND 15 TO 25 FEET BGS
- 10 MULTI-LEVEL SOIL TEMPERATURE SENSORS
- ONE COMPUTER-CONTROLLED 2,000 kVA POWER-GENERATING UNIT
- ONE VAPOR TREATMENT SYSTEM CONSISTING OF ONE 330 CFM VACUUM PUMP, ONE CONDENSER, TWO 2,000-LB VAPOR-PHASE GAC ADSORPTION UNITS, AND ONE 500-LB LIQUID-PHASE GAC ADSORPTION UNIT

MONITORING

PERFORM TWO ROUNDS OF MONITORING, EACH ROUND CONSISTING OF THE FOLLOWING:

- INSTALLATION OF 12 SOIL BORINGS INCLUDING 5 TO A DEPTH OF 12 FEET BGS, 5 TO A DEPTH OF 18 FEET BGS, AND 2 TO A DEPTH OF 25 FEET BGS
- COLLECTION OF SOIL SAMPLES EVERY 2 FEET
- FIELD ANALYSIS OF SOIL SAMPLES FOR VOCs WITH OVA METER
- FOR EACH BORING, LABORATORY ANALYSIS FOR CHLORINATED VOCs OF THE SAMPLE WITH THE HIGHTEST OVA READING
- COLLECTION OF 6 GROUNDWATER SAMPLES FROM EXISTING MONITORING WELLS AND LABORATORY ANALYSIS FOR CHLORINATED VOCs

LAND USE CONTROLS

- ESTABLISH LUC IMPLEMENTATION PLAN IN LUC MOA
- RESTRICT GROUNDWATER USAGE
- REVIEW CONSTRUCTION ACTIVITIES/INTRUSIVE WORK TO ENSURE WORKERS SAFETY AND PROPER MANAGEMENT OF CONTAMINATED MATERIALS
- PERFORM REGULAR SITE INSPECTIONS

KEY:

BGS	BELOW GROUND SURFACE
CFM	CUBIC FEET PER MINUTE
ERH	ELECTRICAL RESISTANCE HEATING
FT^2	SQUARE FEET
GAC	GRANULAR ACTIVATED CARBON
kVA	KILOVOLT AMPERES
LB	POUND
OVA	ORGANIC VAPOR ANAYZER
VOCs	VOLATILE ORGANIC COMPOUNDS

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BLOCK FLOW DIAGRAM
ALTERNATIVE 3
SITE 22 FEASIBILITY STUDY
NAVAL STATION GREAT LAKES, ILLINOIS

CONTRACT NO. 0078	
OWNER NO. 0000	
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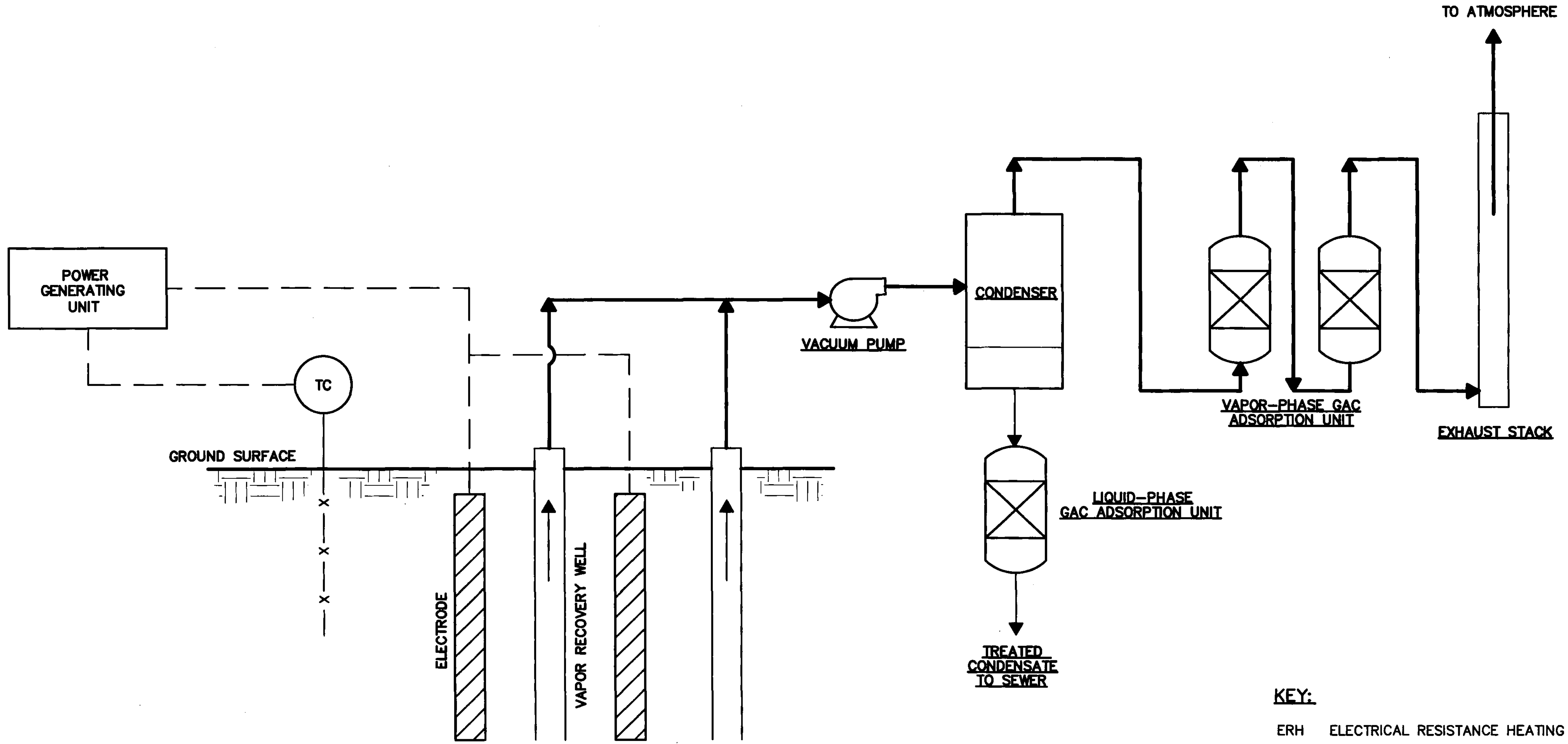

KEY:

ERH	ELECTRICAL RESISTANCE HEATING
GAC	GRANULAR ACTIVATED CARBON
TC	TEMPERATURE CONTROL

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EXCAVATION, OFF–BASE TREATMENT (CHEMICAL OXIDATION OR INCINERATION) AND DISPOSAL, MONITORING AND LAND USE CONTROLS

EXCAVATION

- EXCAVATE 10,000 YD^3 OF CONTAMINATED SOIL TO A DEPTH OF UP TO 25 FEET BGS
- COLLECT 12 VERIFICATION SOIL SAMPLES AND ANALYZE FOR CHLORINATED VOCs
- BACKFILL EXCAVATION AREA WITH 10,000 YD^3 OF CLEAN IMPORTED FILL
- COLLECT ONE SAMPLE PER 100 YD^3 OF EXCAVATED SOIL (100 SAMPLES) AND ANAYLZED FOR CHLORINATED VOCs
- SEGREGATE AND STAGE EXCAVATED SOIL IN ACCORDANCE WITH PCE CONCENTRATION (< 6 MG/KG, 6 TO 60 MG/KG, AND > 60 MG/KG)

→

OFF–BASE TREATMENT AND DISPOSAL

- TRANSPORT EXCAVATED SOIL TO PERMITTED OFF–BASE TSDF
- CHEMICALLY OXIDIZE AND LANDFILL SOIL WITH PCE CONCENTRATIONS OF 6 TO 60 MG/KG (5,000 YD^3/6,750 TONS)
- INCINERATE AND LANDFILL SOIL WITH PCE CONCENTRATIONS > 60 MG/KG (5,000 YD^3/6,750 TONS)

→

MONITORING

PERFORM TWO ROUNDS OF MONITORING, EACH ROUND CONSISTING OF THE FOLLOWING:

- COLLECTION OF 6 GROUNDWATER SAMPLES FROM EXISTING MONITORING WELLS AND LABORATORY ANALYSIS FOR CHLORINATED VOCs

→

LAND USE CONTROLS

- ESTABLISH LUC IMPLEMENTATION PLAN IN LUC MOA
- RESTRICT GROUNDWATER USAGE
- REVIEW CONSTRUCTION ACTIVITIES/INTRUSIVE WORK TO ENSURE WORKERS SAFETY AND PROPER MANAGEMENT OF CONTAMINATED MATERIALS
- PERFORM REGULAR SITE INSPECTIONS

KEY:

BGS	BELOW GROUND SURFACE
MG/KG	MILLIGRAMS PER KILOGRAM
PCE	TETRACHLOROETHENE
TSDF	TREATMENT STORAGE AND DISPOSAL FACILITY
VOCs	VOLATILE ORGANIC COMPOUNDS
YD^3	CUBIC YARDS

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FOCUSED IN-SITU ERH, LIMITED EXCAVATION, OFF-BASE TREATMENT (CHEMICAL OXIDATION OR INCINERATION) AND DISPOSAL, CAPPING, MONITORING AND LAND USE CONTROLS

FOCUSED IN-SITU ERH

INSTALL AND OPERATE AN IN-SITU ERH SYSTEM CONSISTING OF THE FOLLOWING:

- 8 HEATING ELECTRODES AND VAPOR RECOVERY WELLS OVER A 1,400 FT^2 AREA AT DEPTHS RANGING FROM 8 TO 25 BGS
- 2 MULTI-LEVEL SOIL TEMPERATURE SENSORS
- ONE COMPUTER-CONTROLLED 2,000 kVA POWER-GENERATING UNIT
- ONE VAPOR TREATMENT SYSTEM CONSISTING OF ONE 110 CFM VACUUM PUMP, ONE CONDENSER, TWO 2,000-LB VAPOR-PHASE GAC ADSORPTION UNITS, AND ONE 500-LB LIQUID-PHASE GAC ADSORPTION UNIT

→

LIMITED EXCAVATION

- COLLECT SOIL SAMPLES FROM THREE AREAS TO DETERMINE THE NEED FOR EXCAVATION OF SURFACE AND NEAR SURFACE SOIL
- EXCAVATE UP TP 100 CUBIC YARDS OF SOIL FROM THE THREE LOCATIONS AS NECESSARY, TO A DEPTH OF UP TO 6 FEET
- COLLECT UP TO 5 POST EXCAVATION CONFIRMATION SAMPLES

→

OFF-BASE TREATMENT AND DISPOSAL

- COLLECT UP TO 12 SAMPLES OF EXCAVATED SOIL FOR DISPOSAL PURPOSES THE NEED FOR EXCAVATION OF SURFACE AND NEAR SURFACE SOIL
- TRANSPORT EXCAVATED SOIL TO PERMITTED OFF-BASE TSDF
- INCINERATE AND LANDFILL EXCAVATED SOIL

→

MONITORING

PERFORM COLLECTION OF CONFIRMATION SAMPLES CONSISTING OF THE FOLLOWING:

- INSTALLATION OF 7 SOIL BORINGS FOR THE COLLECTION OF 20 SOIL SAMPLES FOR LABORATORY ANALYSIS AT VARIOUS DEPTHS THROUGHOUT THE TREATMENT AREA
- COLLECTION OF SOIL SAMPLES EVERY 2 FEET FOR FIELD ANALYSIS OF VOCs WITH OVA METER
- FIELD ANALYSIS OF SOIL SAMPLES FOR VOCs WITH OVA METER
- LABORATORY ANALYSIS FOR CHLORINATED VOCs OF THE SAMPLE WITH THE HIGHEST OVA READING
- COLLECTION OF 6 GROUNDWATER SAMPLES FROM EXISTING MONITORING WELLS AND LABORATORY ANALYSIS FOR CHLORINATED VOCs

→

CAPPING

- LEAVE IN PLACE THE ASPHALT COVER AND HDPE LINER CURRENTLY PRESENT AT THE SITE
- REPAIR ANY DAMAGE CAUSED BY INVESTIGATION AND REMEDIAL ACTION
- MAINTAIN THE CAP AS NECESSARY TO ENSURE ITS INTEGRITY

→

LAND USE CONTROLS

- ESTABLISH LUC IMPLEMENTATION PLAN IN LUC MOA
- RESTRICT GROUNDWATER USAGE
- PREVENT RESIDENTIAL DEVELOPMENT AND RESTRICT REUSE TO INDUSTRIAL/COMMERCIAL
- PRIOR TO ANY OTHER SITE USE, RE-EVALUATE GROUNDWATER TO INDOOR AIR PATHWAY AND RE-EVALUATE RISKS USING POST-REMEDIATION SOIL AND GROUNDWATER CONCENTRATIONS
- REVIEW CONSTRUCTION ACTIVITIES/INTRUSIVE WORK TO ENSURE WORKERS SAFETY AND PROPER MANAGEMENT OF CONTAMINATED MATERIALS
- PERFORM REGULAR SITE INSPECTIONS

KEY:

BGS	BELOW GROUND SURFACE
CFM	CUBIC FEET PER MINUTE
ERH	ELECTRICAL RESISTANCE HEATING
FT^2	SQUARE FEET
GAC	GRANULAR ACTIVATED CARBON
kVA	KILOVOLT AMPERES
LB	POUND
OVA	ORGANIC VAPOR ANAYZER
VOCs	VOLATILE ORGANIC COMPOUNDS

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BLOCK FLOW DIAGRAM
ALTERNATIVE 5
SITE 22 FEASIBILITY STUDY
NAVAL STATION GREAT LAKES, ILLINOIS

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5.0 COMPARATIVE ANALYSIS OF ALTERNATIVES

This section compares the analyses that were presented for each of the remedial alternatives 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 REMEDIATION ALTERNATIVES BY CATEGORY

The following remedial alternatives are being compared in this section:

- Alternative 1: No Action
- Alternative 2: In-Situ Chemical Oxidation, Monitoring, and LUCs
- Alternative 3: In-Situ ERH, Monitoring, and LUCs
- Alternative 4: Excavation, Off-Base Treatment (chemical oxidation or incineration) and Disposal, Monitoring, and LUCs
- Alternative 5: Focused ERH, Limited Excavation, Off-Base Treatment (incineration) and Disposal, Capping, Monitoring, and LUCs

5.1.1 Overall Protection of Health and Environment

Alternative 1 would not protect human health and the environment. The potential for exposure of human receptors to contaminated soil and pore water and for leaching of soil COCs to groundwater would increase over time, especially under a hypothetical future residential development of the area, because the existing asphalt pavement and HDPE liner would no longer be maintained.

Alternatives 2, 3, 4, and 5 would protect human health and the environment. These four alternatives would remove the soil COCs that could result in unacceptable risks to human receptors. At the same time, the four alternatives would also remove the source of potential future groundwater contamination. The degree of protection provided by these alternatives would be excellent and very similar. Due to issues with effectively delivering reagent in the low permeability soil and even distribution of the oxidation reagent into the subsurface, Alternative 2 is considered the least protective. Alternative 5 relies on capping and LUCs to minimize exposure to contaminated soil, and is slightly less protective than Alternatives 3 and 4.

5.1.2 Compliance with ARARs and TBCs

Alternative 1 would not comply with chemical- or location-specific ARARs. No action-specific ARARs or TBCs apply to this alternative.

Alternatives 2, 3, 4, and 5 would comply with chemical-, location-, and action-specific ARARs.

5.1.3 Long-Term Effectiveness and Permanence

Alternative 1 would not provide long-term effectiveness and permanence because nothing would be done to reduce concentrations of soil COCs.

Alternatives 2, 3, 4, and 5 would provide long-term effectiveness and permanence. These four alternatives would effectively and permanently remove COCs from soil and pore water. These four alternatives also include the use well proven and dependable technologies and provide a high degree of long-term effectiveness and permanence. However, Alternative 4 would be slightly more long-term effective than Alternatives 3 and 5, which in turn would be more long-term effective than Alternative 2. This is because the technologies included in Alternative 4 (excavation, ex-situ chemical oxidation and incineration, and landfilling) are better established and dependable than those involved for Alternatives 3 and 5 (in-situ ERH) and Alternative 2 (in-situ chemical oxidation). ERH, although well proven, is still slightly innovative. Alternatives 3 and 5 would be more long-term effective than Alternative 2 because in-situ ERH is more suited for the low permeability Site 22 soil. However, the remedial action for Alternative 5 may result in residual contamination remaining at the site compared to Alternatives 2, 3, and 4.

5.1.4 Reduction of Toxicity, Mobility, or Volume through Treatment

Alternative 1 would not reduce the toxicity, mobility, or volume of COCs through treatment because no treatment would occur.

Alternatives 2, 3, 4, and 5 would irreversibly and permanently reduce the toxicity, mobility, and volume of the soil and pore water COCs through treatment. Alternatives 2, 3, and 4 would remove approximately 1,700 pounds of chlorinated VOCs. Alternative 5 would remove approximately 1,350 pounds of chlorinated VOCs from the most highly contaminated area of the site. This alternative would minimize exposure to chlorinated VOCs and the mobility of the chlorinated VOCs via capping and LUCs. In each exposure to chlorinated VOCs and the mobility of the chlorinated VOCs via capping and LUCs. In each alternative, chlorinated VOCs in the groundwater will also be remediated in conjunction with soil remediation. Alternatives 2, 3, 4, and 5 would remove the chlorinated VOCs through treatment.

5.1.5 Short-Term Effectiveness

Implementation of Alternative 1 would not result in short-term 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 RAOs and PRGs.

Implementation of Alternative 2 would result in a slight possibility for short-term risk to remediation workers from exposure to contaminated soil and pore water during the installation of the in-situ chemical oxidation DPT injection points as well as during monitoring. However, risk from exposure would be effectively controlled by compliance with proper site-specific health and safety procedures including the wearing of appropriate PPE. Alternative 2 would not adversely impact the surrounding community or environment. Alternative 2 would achieve the RAOs and attain the PRGs within approximately one year.

Implementation of Alternative 3 would result in the same kind of slight possibility for short-term risks to remediation workers as Alternative 2 because of exposure to contaminated soil and pore water during the installation of the in-situ ERH electrodes and during monitoring. However, as with Alternative 2, risk from exposure would be effectively controlled by compliance with proper site-specific health and safety procedures including the wearing of appropriate PPE. In addition, Alternative 3 could result in short-term risk to remediation workers and adversely impact the surrounding community and environment because of exposure to extracted contaminated vapors. However, this would be adequately mitigated through treatment of these vapors prior to release to the atmosphere. Alternative 3 would achieve the RAOs and attain the PRGs within approximately one year.

Implementation of Alternative 4 would result in a significant possibility of short-term risk to remediation workers because of exposure to contaminated soil and pore water and off-gassing of the COCs during the excavation, staging, transportation, and off-base treatment and landfilling. However, risks from exposure would be effectively controlled by engineering controls (e.g., dust suppression) and, as with Alternatives 2 and 3, by compliance with proper site-specific health and safety procedures including the wearing of appropriate PPE. In addition, Alternative 4 could result in short-term risk to remediation workers and adversely impact the surrounding community because of exposure to contaminated soil and pore water that might be spilled during transportation or to exhaust gases generated by off-base incineration. However, this would be properly mitigated by compliance with applicable DOT regulations and by the implementation of appropriate incineration off-gas treatment. Alternative 4 would achieve the RAOs and attain the PRGs within approximately 6 months.

Implementation of Alternative 5 would result in the slight to moderate possibility of short-term risk to remediation workers and could adversely impact the surrounding community because of the same type of exposure as described in Alternatives 3 and 4. Because of the reduced volume of excavation in Alternative 5, the corresponding risks for Alternative 5 will likely be more than Alternative 3 but less than Alternative 4. As detailed above, the risks could be adequately mitigated through dust suppression, treatment of vapors, appropriate PPE, and compliance with applicable DOT regulations. Alternative 5 would achieve the RAOs and attain the PRGs within approximately 6 months.

5.1.6 Implementability

Alternative 1 would be easiest to implement because no action would be taken.

Alternative 2 may be difficult to implement. Installation of an in-situ chemical injection system would be relatively simple and only minimum O&M would be required as a follow-up. However, effective injection and even distribution of the oxidation reagent into the subsurface will be difficult to achieve because of the geology of Site 22. A number of qualified contractors are available to provide this service. No formal construction permit should be required, but DPT injection of chemicals might have to comply with the substantive requirements of the State's UIC program. The RCRA permit requirements and Land Disposal Restrictions would not be triggered by this alternative since the contaminated media is treated in-situ.

Implementation of Alternative 3 would be about the same as Alternative 2. Installation of an in-situ ERH system would be somewhat more complex than that of an in-situ chemical injection system, and O&M would be required as a follow-up. However, as with Alternative 2, a number of qualified contractors are available to provide the required services. A construction permit would be required for the installation of the in-situ ERH and vapor treatment system, but this permit should not be difficult to obtain. The RCRA permit requirements and Land Disposal Restrictions would not be triggered by this alternative since the contaminated media is treated in-situ. Administrative procedures such as manifesting would also likely be required for the off-base disposal of the spent GAC, but these procedures would not be overly demanding.

Alternative 4 would be most difficult to implement. Excavation of contaminated soil and pore water would require significant shoring and dewatering. On-site analysis and staging would be required to segregate excavated material in accordance with anticipated off-base treatment requirements (i.e., none, chemical oxidation, incineration). On-site pre-treatment of excavated material might also be required for screening and size reduction and/or to remove excess free water. However, the required resources and equipment would be readily available to perform these tasks. Based on guidance from the Illinois EPA, it is assumed that the excavated soil and water from dewatering would be managed as a listed RCRA-hazardous waste of F002. Permitted off-base TSDFs would be readily available for the chemical oxidation, incineration, and landfilling of the excavated soil. A construction permit would have to be obtained for excavation, and the off-site transportation and disposal of the excavated soil would require the completion of numerous administrative procedures including RCRA permit requirements, Land Disposal Restrictions, waste profiling, and manifesting. While constituting a significant effort, these procedures could readily be accomplished.

Alternative 5 would be approximately as difficult to implement as Alternative 3. The ERH would be on a smaller scale and therefore would be easier to implement. The excavation would add some difficulty, but due to the significantly reduced aerial extent, contaminant concentrations, and excavation depth, it would add substantially less difficulty than that presented for Alternative 4. The LUCs would be easily implementable.

5.1.7 Cost

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

Alternative	Capital ($)	NPW of O&M ($)	NPW ($)
1	0	0	0
2	1,326,000	0	1,326,000
3	3,078,000	0	3,078,000
4	9,340,000	0	9,340,000
5	990,000	0	990,000

The above cost figures have been rounded to the nearest $1,000 to reflect the preliminary nature of the estimates. The costs of Alternatives 2 and 3 include pilot-scale testing. A detailed breakdown of cost estimates is provided in Appendix B.

5.2 SUMMARY OF COMPARATIVE ANALYSIS OF REMEDIAL ALTERNATIVES

Table 5-1 summarizes the comparative analysis of the five remedial alternatives.

TABLE 5-1

SUMMARY OF COMPARATIVE EVALUATION OF REMEDIAL ALTERNATIVES
SITE 22 FEASIBILITY STUDY REPORT
NAVAL STATION GREAT LAKES, ILLINOIS

Evaluation Criteria	Alternative 1: No Action	Alternative 2: In-Situ Chemical Oxidation, Monitoring, and LUCs	Alternative 3: In-Situ ERH, Monitoring, and LUCs	Alternative 4: Excavation, Off-Base Treatment and Disposal, Monitoring, and LUCs	Alternative 5: Focused ERH, Limited Excavation, Off-Base Treatment and Disposal, Capping, Monitoring, and LUCs
Overall Protection of Human Health and Environment	Would not be protective because existing asphalt pavement and HDPE liner would not be maintained and site development would be unrestricted. This could result in exposure to contaminated soil and pore water.	Protective due to substantial and permanent reductions of chlorinated VOCs. Considered less protective than Alternatives 3, 4, and 5 due to difficulties in delivering the reagent in the low permeability soil.	Protective due to substantial and permanent reductions of chlorinated VOCs. More protective than Alternatives 2 and 5.	Protective due to substantial and permanent reductions of chlorinated VOCs. More protective than Alternatives 2 and 5.	Slightly less protective than Alternatives 3 and 4 because less contamination is permanently removed. Capping and LUCs are relied upon to minimize exposure to, and mobility of COCs in soil.
Compliance with ARARs and TBCs: Chemical-Specific Location-Specific Action-Specific	 Would not comply Would not comply Not applicable	 Would comply Would comply Would comply	 Would comply Would comply Would comply	 Would comply Would comply Would comply	 Would comply Would comply Would comply
Long-Term Effectiveness and Permanence	Would not be long-term effective or permanent because nothing would be done to reduce concentrations of soil COCs.	Would be long-term effective and permanent. Would use a well-proven and dependable technology. However, a pilot-scale treatability study would be required to verify site-specific effectiveness and design.	Would be slightly more long-term effective than Alternative 2 because in-situ ERH is typically better suited than in-situ chemical oxidation to treat low permeability soil. However, a pilot-scale treatability study would still be required.	Would be the most long-term effective and permanent because it includes slightly better proven and more dependable technologies.	More long-term effective than Alternative 2 because in-situ ERH is typically better suited than in-situ chemical oxidation to treat low permeability soil. However, the alternative may result in residual contamination remaining on the site.

TABLE 5-1

SUMMARY OF COMPARATIVE EVALUATION OF REMEDIAL ALTERNATIVES
SITE 22 FEASIBILITY STUDY REPORT
NAVAL STATION GREAT LAKES, ILLINOIS

Evaluation Criteria	Alternative 1: No Action	Alternative 2: In-Situ Chemical Oxidation, Monitoring, and LUCs	Alternative 3: In-Situ ERH, Monitoring, and LUCs	Alternative 4: Excavation, Off-Base Treatment and Disposal, Monitoring, and LUCs	Alternative 5: Focused ERH, Limited Excavation, Off-Base Treatment and Disposal, Capping, Monitoring, and LUCs
Reduction of Contaminant Toxicity, Mobility, or Volume through Treatment	Would not achieve reduction of toxicity, mobility, or volume of contaminants through treatment because no treatment would occur.	Would reduce toxicity, mobility and volume of COCs through in-situ chemical oxidation. An estimated 1,700 pounds of COCs would be irreversibly and permanently removed (if distribution is effective). No residuals would result from treatment.	Would reduce toxicity, mobility and volume of COCs through in-situ ERH. An estimated 1,700 pounds of COCs would be irreversibly and permanently removed. An estimated 8,000 pounds of spent GAC would result from treatment.	Would reduce toxicity, mobility and volume of COCs through off-base incineration and chemical oxidation. An estimated 1,700 pounds of COCs would be irreversibly and permanently removed. No residual would result from treatment.	Would reduce toxicity, mobility, and volume of COCs through in-situ ERH and off-base incineration. An estimated 1,350 pounds of COCs would be irreversibly and permanently removed. Would also reduce mobility through capping.
Short-Term Effectiveness	Would not result in short-term risks to remediation workers or adversely impact the surrounding community because no action would occur. Would not achieve RAOs or attain PRGs.	Would result in a slight possibility for short-term risk to remediation workers from exposure to contamination. This would be effectively controlled by compliance with health and safety procedures. Would not adversely impact the surrounding community or environment. Would achieve RAOs and PRGs within approximately one year.	Would result in similar possibility of short-term risk to remediation workers as Alternative 2 from exposure to contamination. This would be effectively controlled by compliance with health and safety procedures. Could also result in short-term risk to workers and adversely impact the surrounding community and environment because of exposure to contaminated vapors. This would be adequately mitigated through treatment. Would achieve RAOs and PRGs within approximately one year.	Would result in significant possibility of short-term risk to remediation workers from exposure to contamination. This would be effectively mitigated by engineering controls and compliance with health and safety procedures. Could result in short-term risk to workers and adversely impact the surrounding community from exposure to spillage or to incineration exhaust gases. This would be adequately mitigated by compliance with DOT regulations and by treatment of incineration off-gas. Would achieve the RAOs and PRGs within approximately 6 months.	Would result in the slight to moderate possibility of short-term risk to remediation workers and could adversely impact the surrounding community. The risks for Alternative 5 will likely be more than Alternative 3 but less than Alternative 4 because of the excavation. The risks could be adequately mitigated through measures such as dust suppression, treatment of vapors, appropriate PPE, and compliance with applicable DOT regulations. Would achieve the RAOs and attain the PRGs within approximately 6 months.

TABLE 5-1

SUMMARY OF COMPARATIVE EVALUATION OF REMEDIAL ALTERNATIVES
SITE 22 FEASIBILITY STUDY REPORT
NAVAL STATION GREAT LAKES, ILLINOIS

Evaluation Criteria	Alternative 1: No Action	Alternative 2: In-Situ Chemical Oxidation, Monitoring, and LUCs	Alternative 3: In-Situ ERH, Monitoring, and LUCs	Alternative 4: Excavation, Off-Base Treatment and Disposal, Monitoring, and LUCs	Alternative 5: Focused ERH, Limited Excavation, Off-Base Treatment and Disposal, Capping, Monitoring, and LUCs
Implementability	Would be easiest to implement because no action would be undertaken.	May be difficult to implement. Although installation of the in-situ chemical injection system would be relatively simple, effective delivery and adequate distribution of the oxidation reagent into the low permeability soil would be difficult. Qualified contractors are available. No construction permit should be required, but DPT injection of chemicals might have to comply with the substantive requirements of the State's UIC program. In-situ treatment would not trigger RCRA permit requirements and Land Disposal Restrictions.	Would be slightly less difficult to implement than Alternative 2. Installation of an in-situ ERH system would be somewhat more complex, and O&M would be required; however, this alternative is better suited to the low permeability soil. Qualified contractors are available to provide the required services. A construction permit would be required. In-situ treatment would not trigger RCRA permit requirements and Land Disposal Restrictions. Manifesting might also be required for the off-base disposal of the spent GAC.	Would be the most difficult to implement. Excavation would require shoring and dewatering. On-site staging would be required to segregate excavated soil in accordance with off-base treatment requirements. On-site screening, size reduction, or removal of free water might also be required. Resources and equipment would be readily available for these tasks. Permitted off-base TSDFs are available for the chemical oxidation, incineration, and landfilling of the excavated soil. A construction permit RCRA permit requirements, Land Disposal Restrictions, and manifesting of the excavated soil would be required.	Would be approximately as difficult to implement as Alternative 3. The ERH would be on a smaller scale and therefore would be easier to implement. The excavation would add some difficulty, but due to the significantly reduced aerial extent, contaminant concentration, and excavation depth, it would add substantially less difficulty than that presented for Alternative 4. The LUCs would be easily implementable.
Costs: Capital NPW of O&M NPW	 $0 $0 $0	 $1,326,000 $0 $1,326,000	 $3,078,000 $0 $3,078,000	 $9,340,000 $0 $9,340,000	 $990,000 $0 $990,000

<u>NOTES</u>:

ARARs	Applicable or relevant and appropriate requirements	GAC	Granular activated carbon	RAOs	Remedial Action Objectives
COCs	Chemicals of concern	NPW	Net present worth	TBC	To be considered
DOT	Department of Transportation	O&M	Operation and maintenance	TSDF	Treatment storage and disposal facility
DPT	Direct push technology	PRGs	Preliminary Remedial Goal	UIC	Underground Injection Control
ERH	Electrical resistance heating				

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APPENDIX A

CONTAMINATED SOIL AND GROUNDWATER VOLUME/MASS COMPUTATIONS

Client:	**Great Lakes, CTO 384, Site 22**		**Project Number: N00078**
Subject:	Volume Calculations		Page: 1 of 2
By:	RY	Checked by: RFD	Date: 5/10/05

Volume Estimates for Site 22 - Groundwater

Contaminated Groundwater/Pore Water Dimensions (Approximate)

Length:	20	feet
Width:	10	feet
Thickness:	25	feet
Porosity:	0.35	fraction

Area and Volume of Contaminated Groundwater/Pore Water (Approximate)

Area = length x width = 200 ft^2

Volume = length x width x thickness x porosity
Convert to gallons using a density of water of 7.48 gallons per cubic foot

Volume =	1,750	cubic feet
or	13,090	gallons
Say	13,100	gallons

Volume Estimates for Site 22 - Soil (exceeding 60 ug/kg)

Area at 2' bgs (exceeding 60 ug/kg)

Length: 125 feet
Width: 110 feet
Area = length x width = 13750 ft^2

Area at 12' bgs (exceeding 60 ug/kg)

Length: 110 feet
Width: 110 feet
Area = length x width = 12100 ft^2

Area at 25' bgs (exceeding 60 ug/kg)

Length: 50 feet
Width: 50 feet
Area = length x width = 2500 ft^2

Volume (0 to 2' bgs)

Depth = 2 feet
Area at 2' bgs x depth = 27500 ft^3

Volume (2' bgs to 12' bgs)

Depth = 10 feet
(Area at 2' bgs+Area at 12' bgs)/2 x 10 = 129,250 ft^3

Volume (12' bgs to 25' bgs)

Depth = 13 feet
(Area at 12' bgs+Area at 25' bgs)/2 x 13 = 94900 ft^3

Total Volume (0 to 25' bgs) (exceeding 60 ug/kg)

Volume (0 to 2' bgs) + Volume (2' to 12' bgs) + Volume (12' to 25' bgs) = 251,650 ft^3
or
9,320 yd^3

Client: Great Lakes, CTO 384, Site 22	Project Number: N00078
Subject: Mass/Volume Calculations	Page: 2 of 2
By: RY	Date: 5/10/05

Volume Estimates for Site 22 - Soil (exceeding 11,000 ug/kg)

Area at 2' bgs (exceeding 11,000 ug/kg)

Length:	30 feet	and	30 feet
Width:	70 feet		70 feet
Area = length x width =	4200 ft^2		

Area at 12' bgs (exceeding 11,000 ug/kg)

Length:	40 feet
Width:	70 feet
Area = length x width =	2800 ft^2

Area at 25' bgs (exceeding 11,000 ug/kg)

Length:	45 feet
Width:	40 feet
Area = length x width =	1800 ft^2

Volume (0 to 2' bgs)

Depth =	2 feet
Area at 2' bgs x depth =	8400 ft^3

Volume (2' bgs to 12' bgs)

Depth =	10 feet
(Area at 2' bgs+Area at 12' bgs)/2 x 10 =	35,000 ft^3

Volume (12' bgs to 25' bgs)

Depth =	13 feet
(Area at 12' bgs+Area at 25' bgs)/2 x 13 =	29900 ft^3

Total Volume (0 to 25' bgs) (exceeding 60 ug/kg)

Volume (0 to 2' bgs) + Volume (2' to 12' bgs) + Volume (12' to 25' bgs) = 73,300 ft^3
or
2,715 yd^3

Volume Estimates for Site 22 - Soil ("Hot Spot")

"Hot Spot" area defined by soil samples NTC22SB15, GL95-105-12, NTC22SB05, TOLGP06, NTC22SB06, NTC22SB10, TOLGP04, NTC22SB19, and maybe include GL95-105-13

Surface area

Length:	70 feet
Width:	20 feet
Area = length x width =	1400 ft^2

Volume (0 to 25' bgs)

Depth =	25 feet
Area at 2' bgs x depth =	35,000 ft^3 or 1,296 yd^3

Client:	Naval Station Great Lakes, CTO 0384, Site 22		Project Number: 000078
Subject:	Mass Calculations		Page: 1 of 2
By:	RY	Checked by: RFD	Date: 6/23/05

Mass Estimates

Groundwater

Based on Measured Areas for the Contaminated Groundwater/Pore Water

Volume = Area x thickness x porosity x 7.48 gallons per cf

Chlorinated VOC Contaminated Groundwater/Pore Water 13,100 gallons

Average Concentration and Soluble Mass of Contaminants

Use the average concentration of contaminants from Table 1-3

	Max conc. (ug/l)	Average Conc. (ug/l)	Soluble Mass (average) (lbs)	PRG ug/l	Soluble Mass (maximum) (lbs)
Chloromethane	0.21	0.21	0.00	---	0.00
cis-1,2-DCE	2.6	2.6	0.00	70	0.00
PCE	59000	9846.0	1.08	5	6.45
TCE	1.3	1.3	0.00	5	0.00
Total VOC mass in Groundwater =			**1.08**		**6.45**

Soil

Volume of soil exceeding 60 ug/kg	251,650 ft^3	or	9320 yd^3
Volume of soil exceeding 11,000 ug/kg	73,300 ft^3	or	2715 yd^3
Volume of soil in the hot spot/source area	35,000 ft^3	or	1296 yd^3

At an assumed soil density of 110 lb/cf and an assumed concentration of 0.093% (0.00093) using the chlorinated VOCs maximum concentrations (see calculations below) from the RI report

The mass of contamination present is (based on maximum concentration)

Exceeding	60 ug/kg	11,000 ug/kg	Hot Spot	
Calculated	25,739	7,497	3,580	pounds
Say	26,000	7,500	3,600	pounds

At an assumed soil density of 110 lb/cf and an assumed concentration of 0.00779% (0.0000779) using the chlorinated VOCs average concentrations (see calculations below) from the RI report

The mass of contamination present is (based on average concentration)

Exceeding	60 ug/kg	11,000 ug/kg	Hot Spot	
Calculated	2,157	628	300	pounds
Total VOC mass in Soil =	**2,200**	**650**	**300**	**pounds**
Mass indicated by In-Situ Thermal Contractors (CES/TRS) =	---/1800		477/280	pounds

Chemical	Concentration Average* ug/kg (ppb)	Concentration Maximum* ug/kg (ppb)
Vinyl chloride	140	140
Trichloroethene	2900	7700
cis-1,2-DCE	9900	52000
Tetrachloroethene	65000	870000
TOTAL	77940	929840
Change to ppm (/1000)	77.94	929.84
Change to % (1%=10000 ppm)	0.007794	0.092984

* From Table 1-1 and 1-2

Client:	**Naval Station Great Lakes, CTO 0384, Site 22**		**Project Number: 000078**
Subject:	Mass Calculations		
By:	RY	Checked by: RFD	Date: 6/23/05

The above "hot spot" calculation using the average is most likely biased low, so using the soil concentrations in the "hot spot" area only [an average concentration of 0.0301% (0.000301) PCE] and at an assumed soil density of 110 lb/cf

The mass of contamination present in the "hot spot" is (based on concentrations in that area)

Calculated	1,160	pounds	
Total VOC mass in Soil =	**1200**	**pounds**	**(biased high)**

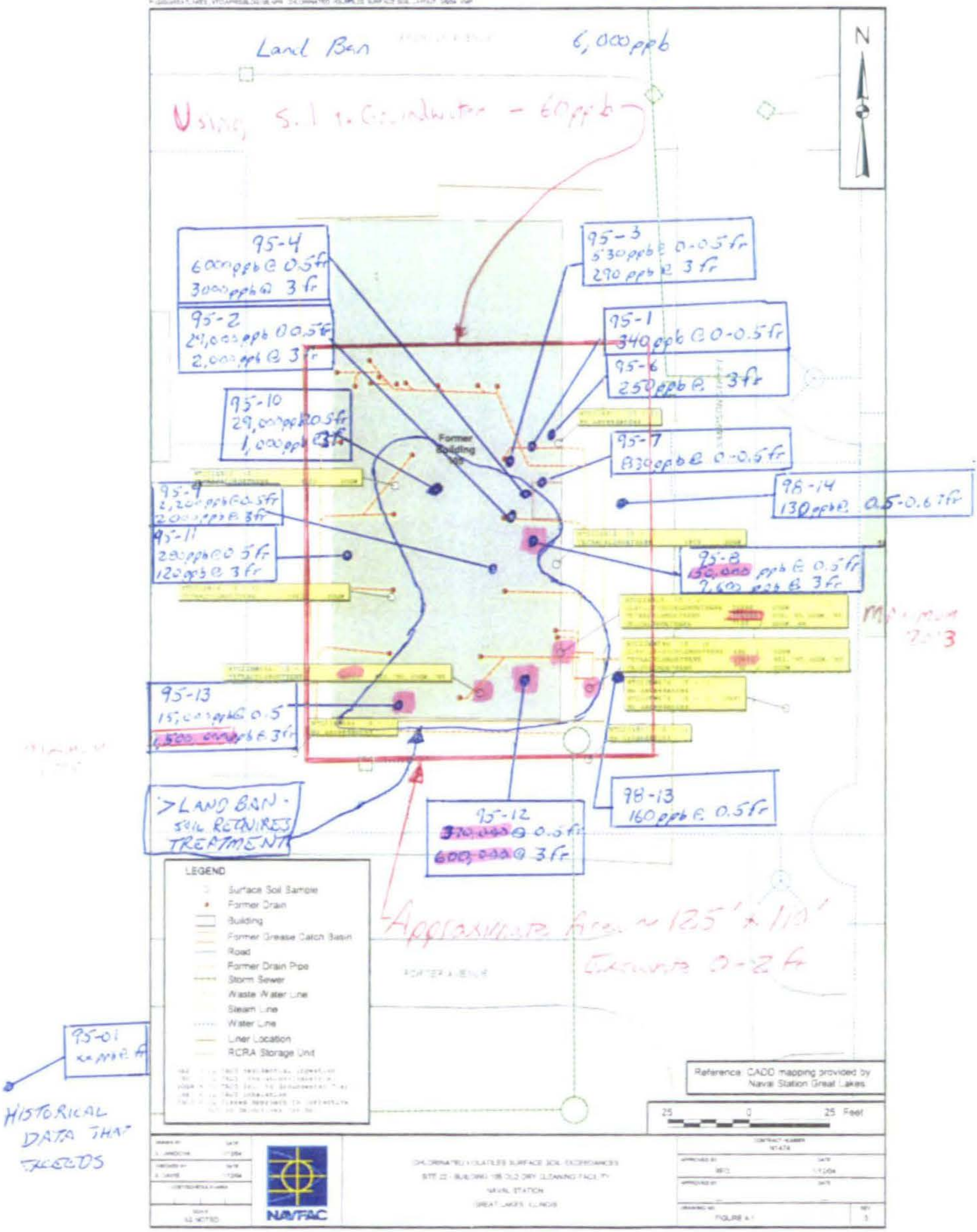
			Concentration*		
Chemical - ug/kg (ppb)	GL95-105-13	NTC22SB15	GL95-105-12	NTC22SB10	NTC22SB05
PCE @ Surface	15000	770000	370000		190000
PCE @ Depth	1500000	590000	600000	130000	60
PCE @ Depth	28000	34000	26600	60	60
		18000			

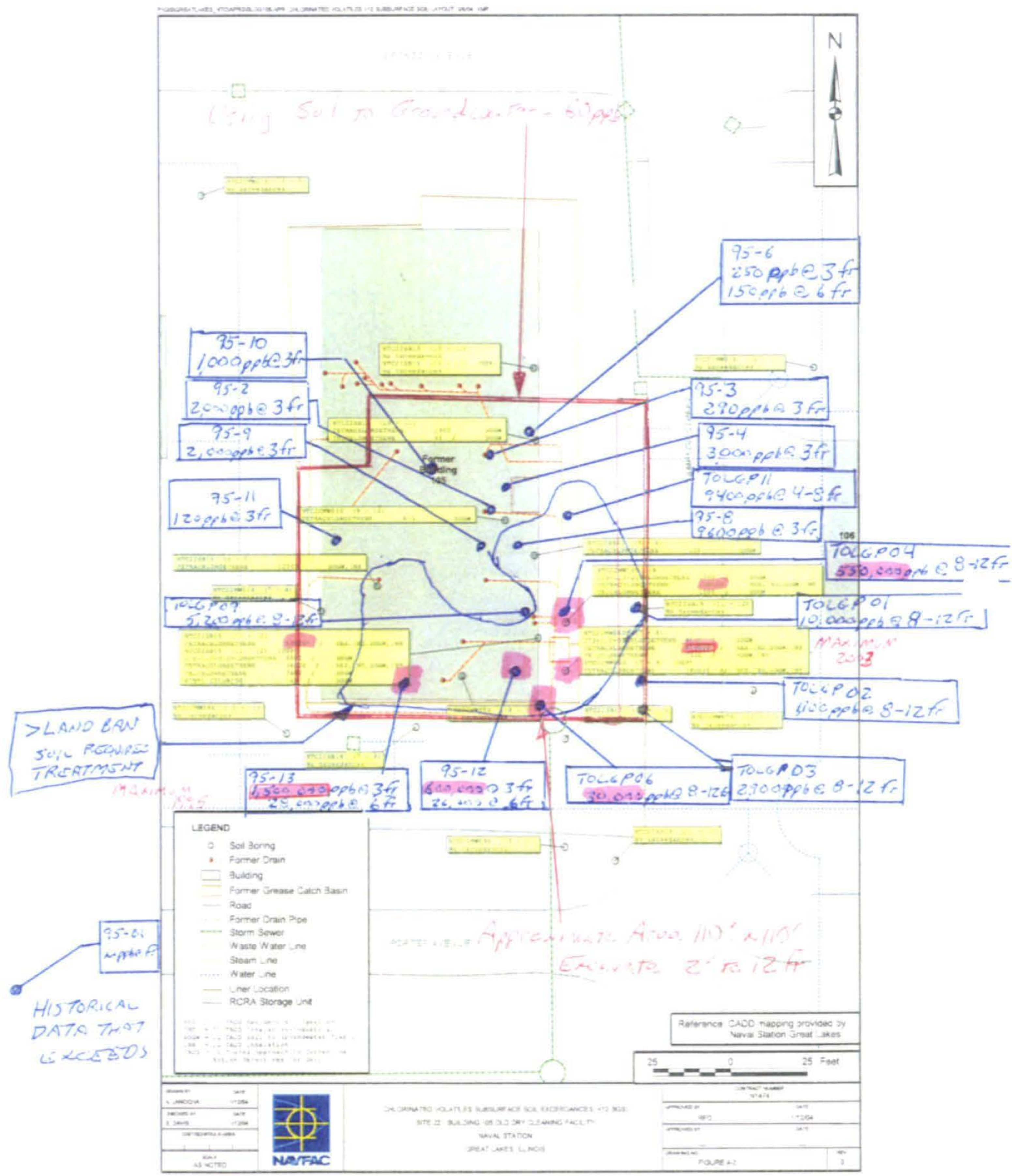
Chemical - ug/kg (ppb)	TOLGP04	NTC22SB19	TOLGP06	NTC22SB06	Average
PCE @ Surface				37000	
PCE @ Depth	550000	570000	30000	870000	301415
				940	

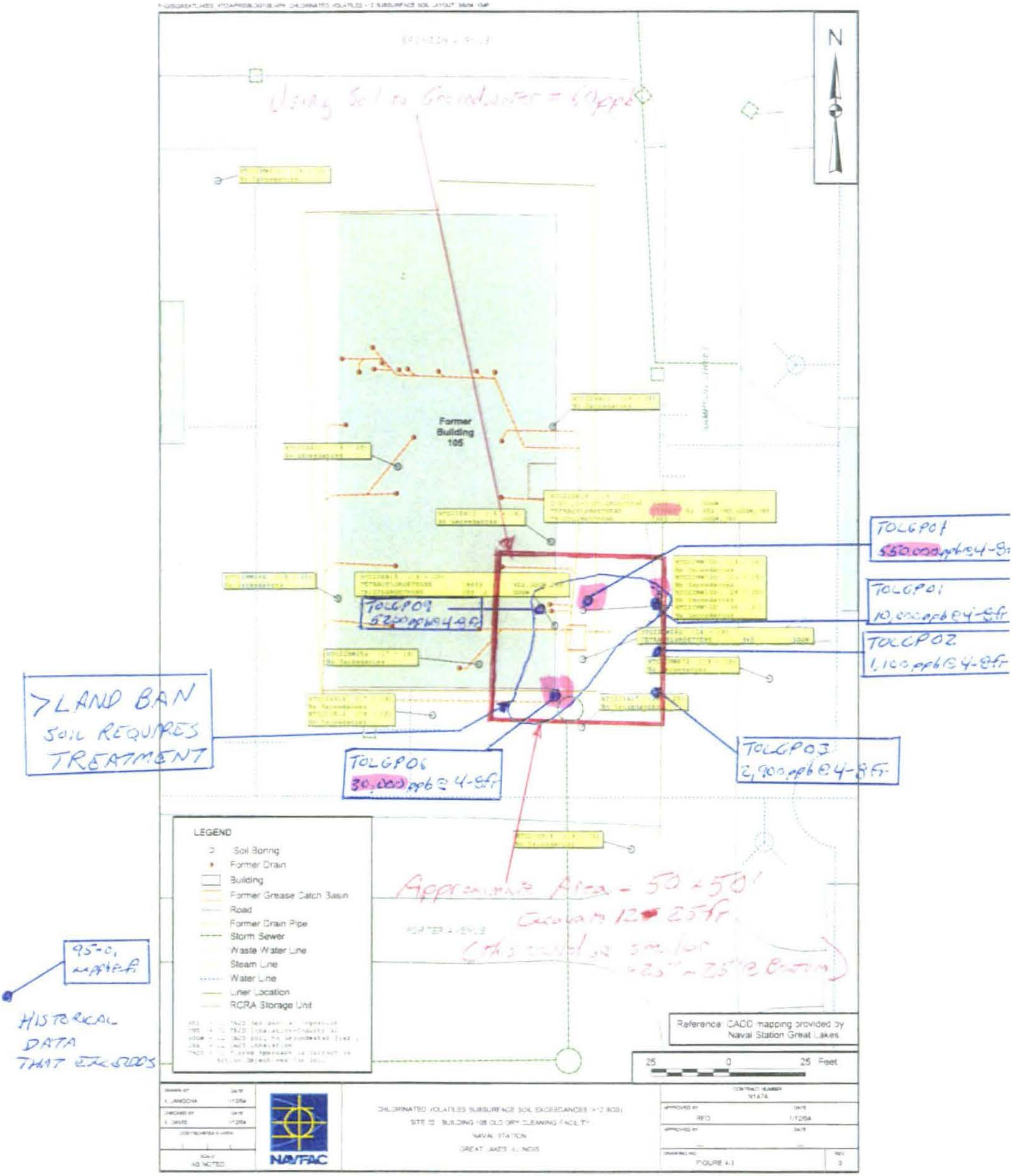
Change to ppm (/1000)	301.415
Change to % (1%=10000 ppm)	0.030142

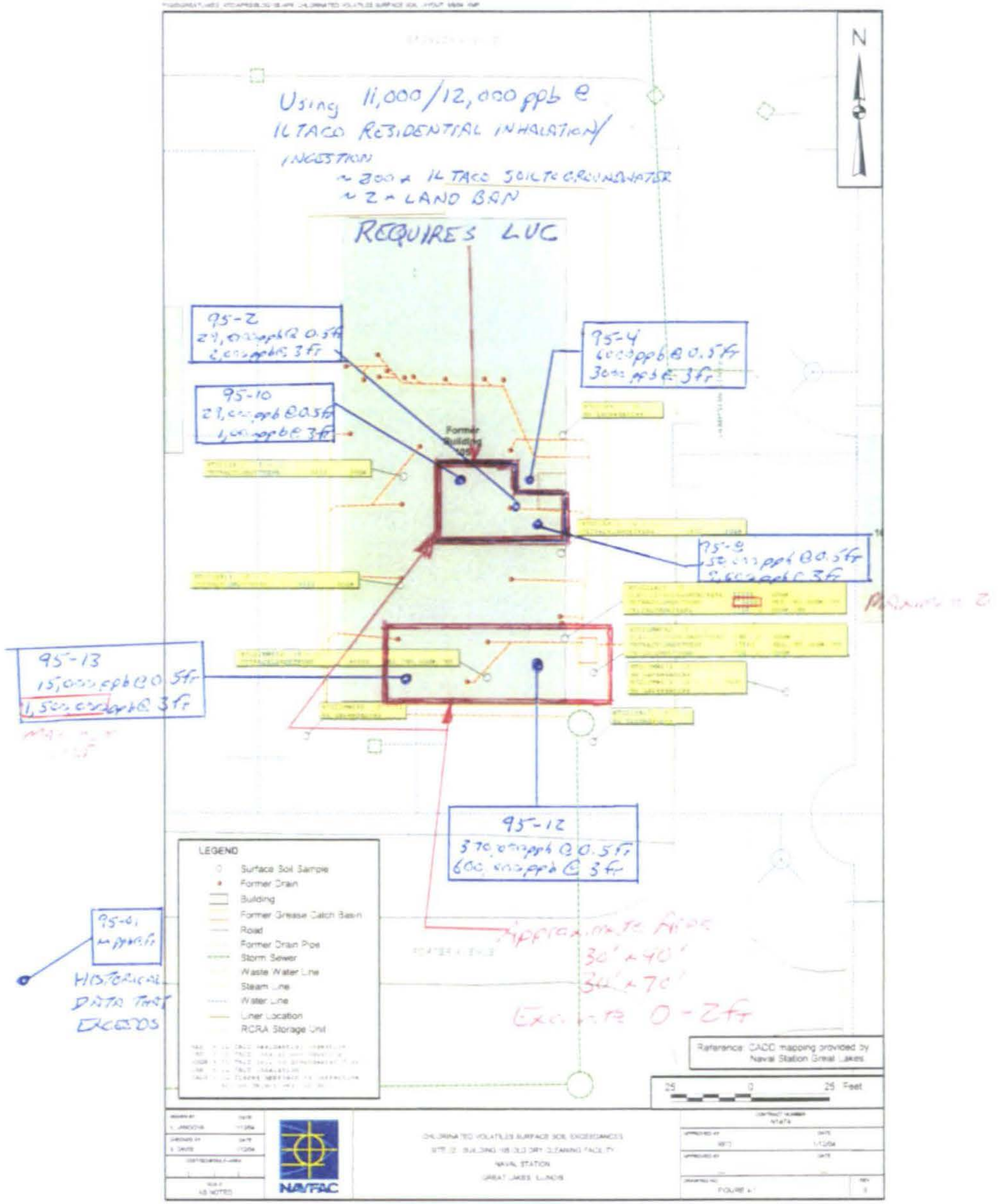
* From Appendix Figures

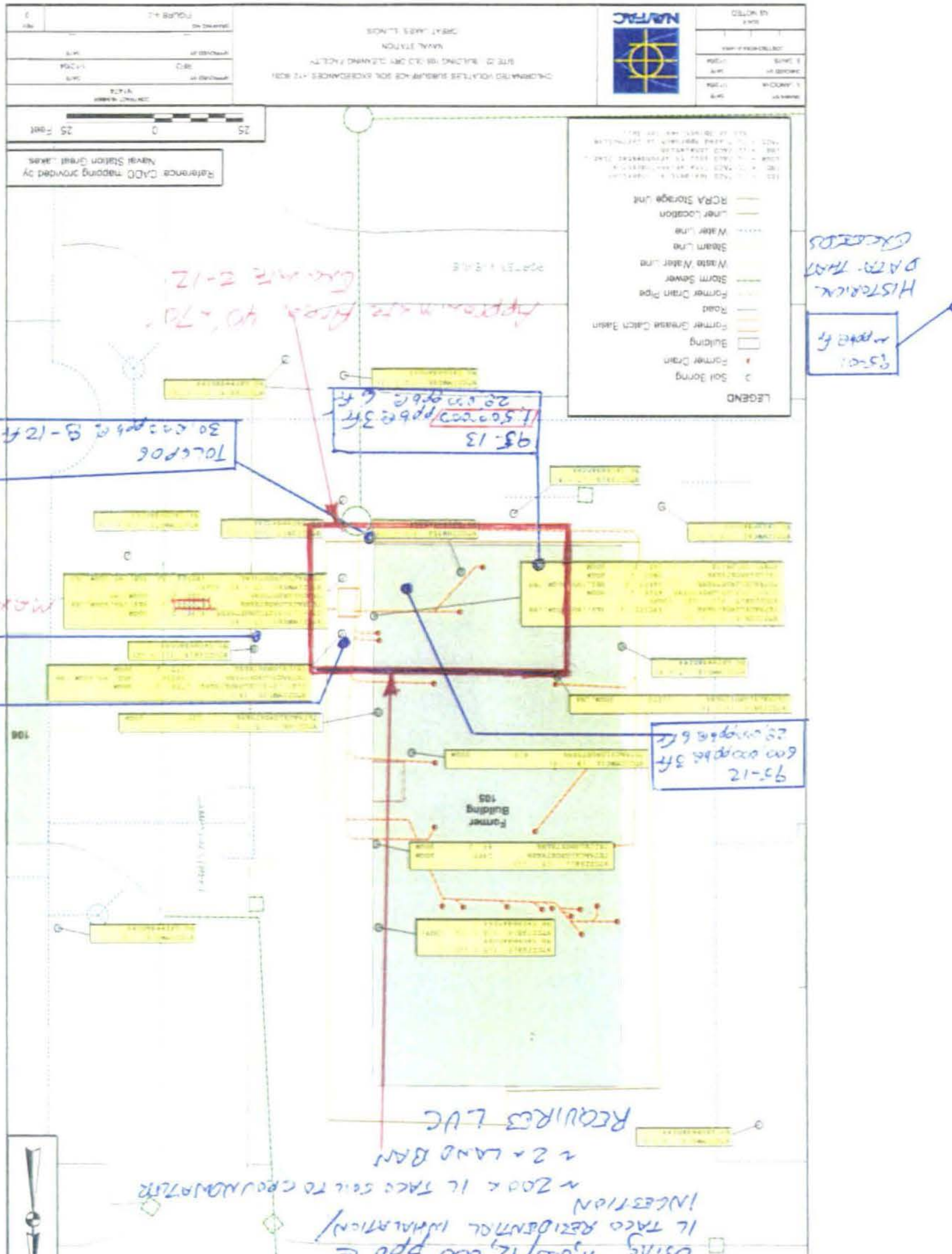
PCE - Soil Ingestion/Inhalation (residential) = 12,000ppb/11,000ppb (IL TACO)
Soil to Groundwater = 60ppb (IL TACO)
EPA Region 9 PRG = 1,500ppb



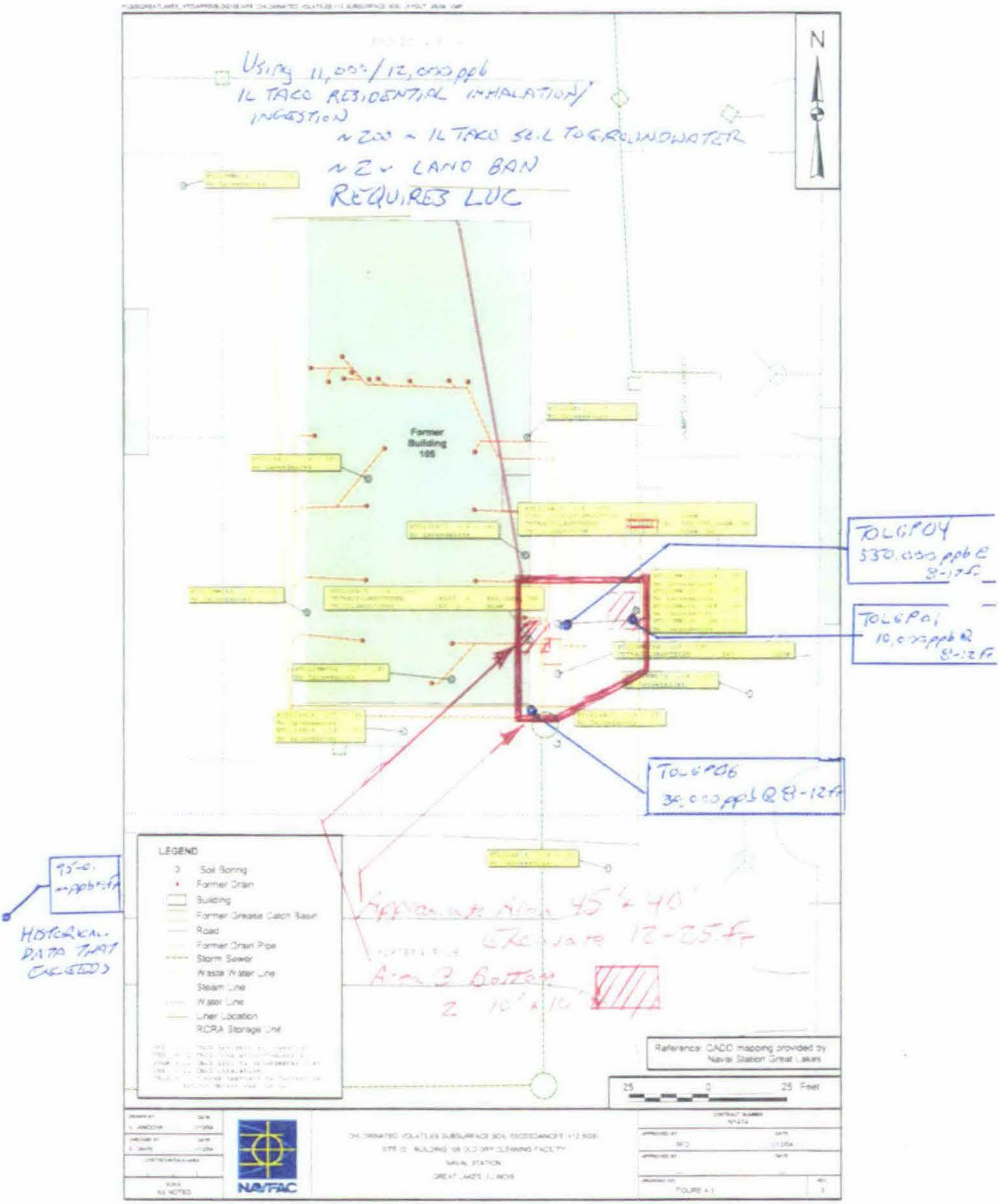

N
Using Soil to Groundwater - 60ppb
95-6
250 ppb @ 3 ft
150 ppb @ 6 ft
95-10
1,000 ppb @ 3 ft
95-2
2,000 ppb @ 3 ft
95-9
2,000 ppb @ 3 ft
95-3
290 ppb @ 3 ft
95-4
3,000 ppb @ 3 ft
TOLGP11
9400 ppb @ 4-8 ft
95-11
120 ppb @ 3 ft
95-8
9600 ppb @ 3 ft
Former Building 105
106
TOLGP04
550,000 ppb @ 8-12 ft
TOLGP09
5,200 ppb @ 8-12 ft
TOLGP01
10,000 ppb @ 8-12 ft
MAXIMUM 2003
TOLGP02
1100 ppb @ 8-12 ft
>LAND BAN
SOIL REQUIRES
TREATMENT
MAXIMUM 1995
95-13
1,500,000 ppb @ 3 ft
28,000 ppb @ 6 ft
95-12
600,000 @ 3 ft
26,400 @ 6 ft
TOLGP06
30,000 ppb @ 8-12 ft
TOLGP03
2,900 ppb @ 8-12 ft
LEGEND
Soil Boring
Former Drain
Building
Former Grease Catch Basin
Road
Former Drain Pipe
Storm Sewer
Waste Water Line
Steam Line
Water Line
Liner Location
RCRA Storage Unit
95-01
HISTORICAL DATA THAT EXCEEDS
Approximate Area 110' x 110'
Excavate 2' to 12 ft
Reference: CADD mapping provided by Naval Station Great Lakes
25 0 25 Feet
NAVFAC
CHLORINATED VOLATILES SUBSURFACE SOIL EXCEEDANCES
SITE 22 - BUILDING 105 OLD DRY CLEANING FACILITY
NAVAL STATION
GREAT LAKES, ILLINOIS
AS NOTED
FIGURE 4-2


N
Using Soil to Groundwater = 60ppb
Former Building 105
TOLGP07
550,000 ppb @ 4-8ft
TOLGP01
10,000 ppb @ 4-8ft
TOLGP02
1,100 ppb @ 4-8ft
TOLGP09
5200 ppb @ 4-8ft
>LAND BAN SOIL REQUIRES TREATMENT
TOLGP06
30,000 ppb @ 4-8ft
TOLGP03
2,900 ppb @ 4-8ft
Approximate Area - 50 x 50'
LEGEND
Soil Boring
Former Drain
Building
Former Grease Catch Basin
Road
Former Drain Pipe
Storm Sewer
Waste Water Line
Steam Line
Water Line
Liner Location
RCRA Storage Unit
HISTORICAL DATA THAT EXCEEDS
Reference: CADD mapping provided by Naval Station Great Lakes
25 0 25 Feet
NAVFAC
CHLORINATED VOLATILES SUBSURFACE SOIL EXCEEDANCES (>12 BGS)
SITE 22 - BUILDING 105 OLD DRY CLEANING FACILITY
NAVAL STATION
GREAT LAKES, ILLINOIS
AS NOTED
RFO
1/12/04
FIGURE 4-1


N
Using 11,000/12,000 ppb @
ILTACO RESIDENTIAL INHALATION/
INGESTION
~200 x IL TACO SOIL TO GROUNDWATER
~2 x LAND BAN
REQUIRES LUC
Former Building
LEGEND
Surface Soil Sample
Former Drain
Building
Former Grease Catch Basin
Road
Former Drain Pipe
Storm Sewer
Waste Water Line
Steam Line
Water Line
Liner Location
RCRA Storage Unit
HISTORICAL DATA THAT EXCEEDS
Approximate Area
30' x 40'
30' x 70'
Excavate 0 - 2ft
Reference: CADD mapping provided by Naval Station Great Lakes
25 0 25 Feet
NAVFAC
CHLORINATED VOLATILES SURFACE SOIL EXCEEDANCES
NAVAL STATION
GREAT LAKES, ILLINOIS
AS NOTED



CHLORINATED VOLATILES SUBSURFACE SOIL EXCEEDANCES
SITE 12 - BUILDING 105 OLD DRY CLEANING FACILITY
NAVAL STATION
GREAT LAKES, ILLINOIS
FIGURE 4-2
NAVFAC
Reference: CADD mapping provided by Naval Station Great Lakes
LEGEND
Soil Boring
Former Drain
Building
Former Grease Catch Basin
Road
Former Drain Pipe
Storm Sewer
Waste Water Line
Steam Line
Water Line
Liner Location
RCRA Storage Unit
Former Building 105
106
N
HISTORICAL DATA THAT EXCEEDS
95-01 [illegible] ppb [illegible] ft
Approximate Area 40' x 70' Excavate 2-12'
95-13 1,500,000 ppb @ 3 ft 22,000 ppb 6 ft
TOLCP06 30,000 ppb @ 8-12 ft
MAXIMUM 2002
TOLCP01 10,000 ppb @ 8-12
TOLCP04 550,000 ppb @ 8-11
95-12 600,000 ppb 3 ft 25,000 ppb 6 ft
REQUIRES LUC
≈ 2 × LAND BAN
≈ 200 × IL TACO SOIL TO GROUNDWATER
IL TACO RESIDENTIAL INHALATION/ INGESTION
Using 11,000/12,000 ppb @



N
Using 11,000/12,000 ppb
IL TACO RESIDENTIAL INHALATION/
INGESTION
~200 ~ IL TACO SOIL TO GROUNDWATER
~2 ~ LAND BAN
REQUIRES LUC
Former
Building
105
TOLGP04
530,000 ppb @
8-12 ft
TOLGP01
10,000 ppb @
8-12 ft
TOLGP06
30,000 ppb @ 8-12 ft
HISTORICAL
DATA THAT
EXCEEDS
LEGEND
Soil Boring
Former Drain
Building
Former Grease Catch Basin
Road
Former Drain Pipe
Storm Sewer
Waste Water Line
Steam Line
Water Line
Liner Location
RCRA Storage Unit
Approximate Area 45' x 40'
Excavate 12-25 ft
Area 3 Bottom
2 10' x 10'
Reference: CADD mapping provided by
Naval Station Great Lakes
25
0
25 Feet
NAVFAC
NAVAL STATION
AS NOTED

APPENDIX B

DETAILED COST ESTIMATES

CLIENT: Naval Station Great Lakes		JOB NUMBER: CTO 384 G00078	
SUBJECT: Site 22 - Area and Calculations			
BASED ON:		DRAWING NUMBER:	
BY: TJR Date: 5-20-05	CHECKED BY: Date:	APPROVED BY:	DATE:

Alternative 2

DPT Injection

Pilot-Scale Study: use 60 injection points to complete study.
Assume 5 days to complete.
In-situ Treatment: Use 660 injection points each round.
Assume 25 days with 2 rigs each round to complete.

Sampling for soils

Sampling for treatment verification. Analytical only
Collect samples and analyze for chlorinated VOCs
5 samples from study, 12 for each treatment

type	cost each	number	total
chlorinated VOCs	$ 100	1	$ 100
			$ 100
2x for fast lab turn-a-round			$ 100
			$ 200
40% QA/QC & Data Validation of normal pricing			$ 40
cost per sample			$ 240

Sampling for groundwater

Sampling for treatment verification. Analytical only
Collect samples and analyze for chlorinated VOCs
2 samples from study, 6 for each treatment

type	cost each	number	total
chlorinated VOCs	$ 75	1	$ 75
			$ 75
2x for fast lab turn-a-round			$ 75
			$ 150
40% QA/QC & Data Validation of normal pricing			$ 30
cost per sample			$ 180

Time to Complete Work

	Working Days	Calendar Days
Mobilization	10 days	
Pilot-Scale Study	10 days	
Time between Pilot-Scale and Treatment	43 days	60 days
In-situ Treatment Round 1(2 rigs)	25 days	
Time between Treatment	64 days	90 days
In-situ Treatment Round 2 (2 rigs)	25 days	
Restoration & Demobilization	10 days	
	187 days	150 days
Total Job Time	187 days	
	37 weeks	
	9 months	

CLIENT: Naval Station Great Lakes		JOB NUMBER: CTO 384 G00078	
SUBJECT: Site 22 - Area and Calculations			
BASED ON:		DRAWING NUMBER:	
BY: TJR Date: 5-20-05	CHECKED BY: Date:	APPROVED BY:	DATE:

Alternative 3

Sampling for soils

Sampling for treatment verification. Analytical only
Collect samples and analyze for chlorinated VOCs
5 samples from study, 12 for each treatment

type	cost each	number	total
chlorinated VOCs	$ 100	1	$ 100
			$ 100
2x for fast lab turn-a-round			$ 100
			$ 200
40% QA/QC & Data Validation of normal pricing			$ 40
cost per sample			$ 240

Sampling for groundwater

Sampling for treatment verification. Analytical only
Collect samples and analyze for chlorinated VOCs
2 samples from study, 6 from treatment

type	cost each	number	total
chlorinated VOCs	$ 75	1	$ 75
			$ 75
2x for fast lab turn-a-round			$ 75
			$ 150
40% QA/QC & Data Validation of normal pricing			$ 30
cost per sample			$ 180

Time to Complete Work

	Working Days	Calendar Days
Mobilization	10 days	
Pilot-Scale Study Installation	10 days	
Pilot-Scale Study Treatment	64 days	90 days
Time between Pilot-Scale and Full-Scale	43 days	60 days
Full-Scale Study Installation	20 days	
Full-Scale Study Treatment	64 days	90 days
Restoration & Demobilization	10 days	
	221 days	240 days
Total Job Time	221 days	
	44 weeks	
	11 months	

CLIENT: Naval Station Great Lakes		JOB NUMBER: CTO 384 G00078
SUBJECT: Site 22 - Area and Calculations		
BASED ON:		DRAWING NUMBER:
BY: TJR Date: 5-20-05	CHECKED BY: Date:	APPROVED BY: DATE:

Alternative 4

Sheet Pile

Sheet Pile excavation 100' by 125' by 25' deep

length	sides	depth	area
100	2	25	5,000 sf
125	2	25	6,250 sf
			11,250 sf

time to complete, assume 10 days

Excavation

assume 250 cy per day

volume	rate	days
10,000	250	40

stockpile asphalt, gravel base and liner; use as fill, do not dispose offsite

Transportation and Disposal

assume 20 trucks per day with 16 cy per truck

volume	rate	days
10,000	320	31

say excavate for 10 days and excavate and haul for 30 days

Sampling for post-excavation verification. Analytical only

Collect 12 samples and analyze for chlorinated VOCs

type	cost each	number	total
chlorinated VOCs	$ 100	1	$ 100
			$ 100
2x for fast lab turn-a-round			$ 100
			$ 200
40% QA/QC & Data Validation of normal pricing			$ 40
cost per sample			$ 240

Sampling for disposal 100 samples at same cost each.

CLIENT: Naval Station Great Lakes		JOB NUMBER: CTO 384 G00078	
SUBJECT: Site 22 - Area and Calculations			
BASED ON:		DRAWING NUMBER:	
BY: TJR Date: 5-20-05	CHECKED BY: Date:	APPROVED BY:	DATE:

Sampling for groundwater

Sampling for treatment verification. Analytical only

Collect 6 samples and analyze for chlorinated VOCs

	type	cost each	number		total
chlorinated VOCs		$ 75	1	$	75
				$	75
2x for fast lab turn-a-round				$	75
				$	150
40% QA/QC & Data Validation of normal pricing				$	30
cost per sample				$	180

Backfill

Assume: first 5,000 cy backfilled with no compaction using clamshell and loader
second 5,000 cy backfilled with compaction using dozer and compactor

time to backfill 10,000 cy @ 16 cy per truck =	625	trucks
assume 30 trucks per day =	21	say 20 days

Restoration

Excavated area	100	125	12,500 sf
add 50% for support areas			6,250 sf
			18,750 sf

Replace 350 lf of curb and 12 trees.

Time to complete Alternative 4

Mobilization	10 days
Sheet pile	10 days
Excavation and T/D	40 days
Backfill	20 days
Restoration	5 days
Demobilization	5 days
	90 days or
approximately	4.3 months

B.1 ALTERNATIVE 2

NAVAL STATION GREAT LAKES
Great Lakes, Illinois
Site 22 - Former Building 105, Old Dry Cleaning Facility
Alternative 2: In-situ Chemical Oxidation and Monitoring
CAPITAL COST

Item	Quantity	Unit	Unit Cost				Extended Cost				Subtotal
			Subcontract	Material	Labor	Equipment	Subcontract	Material	Labor	Equipment	
1 PROJECT PLANNING AND MOBILIZATION/DEMOBILIZATION											
1.1 Prepare Documents & Plans including Permits	300	hour			$27.50		$0	$0	$8,250	$0	$8,250
2 MOBILIZATION/DEMOBILIZATION AND FIELD SUPPORT											
2.1 Office Trailer	9	mo				$286.00	$0	$0	$0	$2,574	$2,574
2.2 Storage Trailer	9	mo				$105.00	$0	$0	$0	$945	$945
2.3 Trailers Mob/Demo	2	ea				$225.00	$0	$0	$0	$450	$450
2.4 Field Office Support	9	mo		$143.00			$0	$1,287	$0	$0	$1,287
2.5 Utility Connection/Disconnection (phone/electric)	1	ls	$1,500.00				$1,500	$0	$0	$0	$1,500
2.6 Site Utilities (phone & electric)	9	mo		$302.00			$0	$2,718	$0	$0	$2,718
2.7 Mobilization/Demobilization Construction Equipment	8	ea			$147.00	$350.00	$0	$0	$1,176	$2,800	$3,976
2.8 Construction Survey	1	ls	$1,000.00				$1,000	$0	$0	$0	$1,000
3 DECONTAMINATION											
3.1 Decontamination Services	3	mo		$375.00	$1,200.00	$900.00	$0	$1,125	$3,600	$2,700	$7,425
3.2 Pressure Washer	3	mo				$1,100.00	$0	$0	$0	$3,300	$3,300
3.3 Equipment Decon Pad	1	ls		$500.00	$450.00	$155.00	$0	$500	$450	$155	$1,105
3.4 Decon Water Storage Tank, 6,000 gallon	3	mo				$645.00	$0	$0	$0	$1,935	$1,935
3.5 Clean Water Storage Tank, 4,000 gallon	3	mo				$580.00	$0	$0	$0	$1,740	$1,740
3.6 Disposal of Decon Waste (liquid & solid)	3	mo	$900.00				$2,700	$0	$0	$0	$2,700
4 PILOT-SCALE TREATABILITY STUDY											
4.1 DPT Injection Points, 60 points	5	day	$1,600.00				$8,000	$0	$0	$0	$8,000
4.2 ISOTEC Material	2,400	gal		$8.00			$0	$19,200	$0	$0	$19,200
4.3 Soil Borings, 2	1	ls	$2,500.00				$2,500	$0	$0	$0	$2,500
4.4 Soil Boring Samples	5	ea	$240.00	$30.00	$50.00	$20.00	$1,200	$150	$250	$100	$1,700
4.5 Collect/Containerize IDW	1	drum	$55.00				$55	$0	$0	$0	$55
4.6 Transport/Dispose IDW	1	drum	$170.00				$170	$0	$0	$0	$170
4.7 Groundwater Samples	2	ea	$180.00	$30.00	$50.00	$20.00	$360	$60	$100	$40	$560
5 IN-SITU CHEMICAL OXIDATION (Round 1)											
5.1 DPT Injection Points, 660 points	50	day	$1,600.00				$80,000	$0	$0	$0	$80,000
5.2 ISOTEC Material	27,000	gal		$8.00			$0	$216,000	$0	$0	$216,000
5.3 Soil Borings, 12	1	ls	$6,000.00				$6,000	$0	$0	$0	$6,000
5.4 Soil Boring Samples	12	ea	$240.00	$30.00	$50.00	$20.00	$2,880	$360	$600	$240	$4,080
5.5 Collect/Containerize IDW	1	drum	$55.00				$55	$0	$0	$0	$55
5.6 Transport/Dispose IDW	1	drum	$170.00				$170	$0	$0	$0	$170
5.7 Groundwater Samples	6	ea	$180.00	$30.00	$50.00	$20.00	$1,080	$180	$300	$120	$1,680
6 IN-SITU CHEMICAL OXIDATION (Round 2)											
6.1 DPT Injection Points, 660 points	50	day	$1,600.00				$80,000	$0	$0	$0	$80,000
6.2 ISOTEC Material	27,000	gal		$8.00			$0	$216,000	$0	$0	$216,000
6.3 Soil Borings, 12	1	ls	$6,000.00				$6,000	$0	$0	$0	$6,000
6.4 Soil Boring Samples	12	ea	$240.00	$30.00	$50.00	$20.00	$2,880	$360	$600	$240	$4,080
6.5 Collect/Containerize IDW	1	drum	$55.00				$55	$0	$0	$0	$55
6.6 Transport/Dispose IDW	1	drum	$170.00				$170	$0	$0	$0	$170
6.7 Groundwater Samples	6	ea	$180.00	$30.00	$50.00	$20.00	$1,080	$180	$300	$120	$1,680
7 RESTORATION											
7.1 Pavement Repair & Replacement	1	ls	$2,000.00				$2,000	$0	$0	$0	$2,000
7.2 Trees	12	ea	$350.00				$4,200	$0	$0	$0	$4,200
8 MISCELLANEOUS											
8.1 Construction Oversight (2 p * 80 days)	160	day			$200.00		$0	$0	$32,000	$0	$32,000
8.2 Post Construction Documents	250	hr			$27.50		$0	$0	$6,875	$0	$6,875

NAVAL STATION GREAT LAKES
Great Lakes, Illinois
Site 22 - Former Building 105, Old Dry Cleaning Facility
Alternative 2: In-situ Chemical Oxidation and Monitoring
CAPITAL COST

Item	Quantity	Unit	Unit Cost				Extended Cost				Subtotal
			Subcontract	Material	Labor	Equipment	Subcontract	Material	Labor	Equipment	
Subtotal							$204,055	$458,120	$54,501	$17,459	$734,135
Local Area Adjustments							100.0%	96.9%	90.9%	90.9%	
							$204,055	$443,918	$49,541	$15,870	$713,385
Overhead on Labor Cost @ 30%									$14,862		$14,862
G & A on Labor Cost @ 10%									$4,954		$4,954
G & A on Material Cost @ 10%								$44,392			$44,392
G & A on Equipment Cost @ 10%										$1,587	$1,587
G & A on Subcontract Cost @ 10%							$20,406				$20,406
Total Direct Cost							$224,461	$488,310	$69,358	$17,457	$799,586
Indirects on Total Direct Cost @ 35%		(not including chemical, transportation & disposal cost)									$120,812
Profit on Total Direct Cost @ 10%											$79,959
Subtotal											$1,000,356
Health & Safety Monitoring @ 2%											$20,007
Total Field Cost											$1,020,363
Contingency on Total Field Costs @ 20%											$204,073
Engineering on Total Field Cost @ 10%											$102,036
TOTAL COST											**$1,326,472**

51 Everett Drive
Suite A-10
West Windsor, New Jersey 08550
(609) 275-8500 phone
(609) 275-9608 fax

5000 S. Quebec Street
Suite 320D
Greenwood Village, CO 80111
(303) 843-9079 phone
(303) 843-9094 fax

ISOTEC

Sent Via Fax (412) 921-4040 and First Class Mail

May 19, 2004

TETRA TECH NUS, Inc.
Foster Plaza 7
661 Anderson Drive
Pittsburgh, PA 15220
Attn: Mr. Seth Staffen

RE: ***Budgetary Estimate for ISCO Pilot Treatment Program***
Unsaturated Soil and Ground Water Contamination
ISOTEC Budgetary Estimate #800744

Dear Mr. Staffen:

In-Situ Oxidative Technologies, Inc. (ISOTEC[SM]) has reviewed the information received with respect to the above referenced site for possible use with in-situ chemical oxidation (ISCO) remedial treatment processes. Based on our review of the information received, plus type and levels of contaminants present, we believe this site may be a viable candidate to reduce the organic contaminant loading using the ISOTEC's modified Fenton's reagent chemical oxidation (chem-ox) process. Budget costs associated with an ISOTEC treatment program are as indicated.

The scope of work for the ISCO treatment program consists of unsaturated soil, ground water and saturated soil treatment within 5-27' bgs aquifer interval. Depth to ground within the proposed pilot area is approximately 10' bgs. At each injection location three separate aquifer intervals will be targeted (the 5-10' bgs unsaturated aquifer interval and 10-18' and 18-27' bgs saturated aquifer intervals). Average hydraulic conductivity has been calculated at 6.54×10^{-5} cm/sec (0.186 ft/day) for the upper aquifer and 5.45×10^{-3} cm/sec (15.5 ft/day) for the deeper aquifer. Compounds of concern (COC) are volatile organic compounds (VOC) consisting primarily of chlorinated organics. Targeted levels of VOC's in ground water have exceeded 55,000 ppb while targeted levels of VOC's within the unsaturated soils have exceeded 865,000 ug/kg.

Treatment of surface soils (0-3' bgs) via chemical oxidation is difficult as these soils will need to undergo complete mixing after exposure to the two chemical oxidation reagents. As a result surface soil treatment is not covered under this pilot program. Site geology consists of unconsolidated clays, silts and silty clays with discontinuous sand and gravel lenses within the upper aquifer and fine to coarse sand within the deeper aquifer. Based on site geology ISOTEC believes a large mass or sorbed organic contamination exists at the site within the saturated aquifer interval. The ISOTEC process targets both sorbed phase and dissolved phase organic contamination within an aquifer.

Based upon site conditions reagents would be delivered into the subsurface under a constant low pressure in an effort to distribute materials in a homogeneous fashion within the formation throughout each injection interval. ISOTEC proposes the use of a direct push rig for reagent injections. The ISCO reagents would be injected directly through the direct push rod thereby eliminating the need for temporary or permanent injection wells. **Since ISCO is a contact remedial treatment technology, numerous treatment applications may be required to reach regulatory cleanup levels.** Based on the organic loading present and site geology within the target area reagent injections will initially be conducted on 15' centers (175 sq. ft. per injection point) for this pilot program. TETRA TECH NUS will be responsible for obtaining and payment for the direct push rig and operator.

The ISOTEC Process

ISCO technologies destroy organic contamination through oxidative processes. ISOTEC's modified Fenton's reagent chem-ox process treats organic contaminants within the subsurface, by utilizing our proprietary blends of catalysts, oxidizers, viscosity enhancers and mobility control agents. ISOTEC compounds are injected through a site-specific delivery system providing sufficient distribution to selectively treat the contaminants around an area of concern. A specific stoichiometry is typically determined through a lab study, with preliminary treatment quantities calculated. Application is next tested in the field during a pilot program to determine the efficiency and extent of treatment, which varies depending on the site's subsurface characteristics. Based upon a successful lab study and remedial pilot treatment program, design and implementation of full-scale remediation is proposed (if required). The ISOTEC approach works via the in-situ destruction of contaminants, while creating minimal disturbance to site operations. ISOTEC's modified Fenton's reagent chem-ox process is most effective on dissolved phase contamination in areas with no ongoing sources of contamination.

ISOTEC does not utilize any acids or pH modifiers as part of their treatment process. ISOTEC injection activities typically utilize low peroxide concentrations and a gravity feed or low-pressure injection system (15-40 psi). ISOTEC does not perform reagent injections within or adjacent to active tank fields, tanks or natural gas lines. Increases in ground water temperature are typically limited to a 3-5 degree C increase at the point of injection.

ISOTEC's modified Fenton's reagent chem-ox process injection rate and volume of discharge are interrelated to the reaction rates of hydroxyl radicals with the contaminants, the contaminant distribution coefficients in the subsurface systems, and the rate of hydrogen peroxide decomposition within the subsurface. The rate at which the reagent flow can be injected into the subsurface is initially determined by the soil/aquifer characteristics, or possible premature stoppage due to reagent material seeping up from monitoring well seals or injection points. Field decisions regarding injection volumes will be based on the subsurface intake, radial effects noted during injection, and the distance of the injection point from the nearest monitoring point. If it becomes impossible to inject the proposed volume and/or no radial effects are noted in the monitoring point, the next closest injection point may be tested and/or reagent concentrations or volumes may be increased until influence can be determined in the nearest monitoring point. The extent of remediation is preliminary during the initial injection event and may vary plus/minus pending site subsurface characteristics. It should be noted, the scope of this budgetary estimate may be modified for subsequent treatment applications based upon results of the initial application.

Remedial treatment program cost estimates, description and assumptions are listed below:

Remedial Pilot Treatment Program Assumptions-2 one week injection events
Proposed Pilot Injection Area: ~2,300 sf
Unsaturated Thickness: 5' (one injection interval @ 5-10' bgs)
Saturated Thickness: 17' (two injection intervals @ 10-18', 18-27' bgs)
Radius of Influence: 7.5' (~175 sf) around each injection point within the aquifer
Number of Injection Locations: 13 injection locations (2,300 sf/175 sf)
Number of Aquifer Intervals Per Location: 3
Estimated reagent flow rate = 2-4 gallons/minute
Estimated dosage = Approx. 150-200 gallons per aquifer interval per event

Total Number of Aquifer Intervals Treated	*39*
Average Cost Per Injection Interval	*$987.00*

COSTS

Bench-scale Treatability Study (Soil Slurry & GW)	*$7,500.00*
Pilot Program ISCO Treatment ***(2 one week injection events)***	*$78,970.00**
Pilot Program Consulting/Monitoring/Reporting/H&S Plan	*$11,500.00*
TOTAL TREATMENT PROGRAM w/Laboratory Study	*$97,970.00*

Notes:

1 The above quote is not a guaranteed price to clean up the contamination noted at the referenced site. The number of ISOTEC treatments will be dependent on the amount of contamination and site geology. The higher the concentration of contamination and the tighter the geology, the greater the number of necessary treatments.

2. *ISOTEC will require standard AC electrical power and an on-site source (within 200 feet) of water supply (5 gpm minimum) to perform treatment program activities. Access and costs associated with this request will be provided/incurred by the Client and/or Property Owner. ISOTEC can supply AC electrical power at a cost of $100/day, if requested.*
3. *Work to be performed in modified Level D personal protective equipment (PPE). Higher-level PPE will require a change order for additional costs associated with such.*
4. *ISOTEC will require adequate and secure staging areas for chemical preparation and storage.*
5. *Treatment program reagent volume costs presented within this proposal are based on optimum treatment dosage as determined within the Lab Study (LS) using determined treatment dosage of ISOTEC Catalyst 4260, with 8-12.5% H_2O_2 as the oxidant.*
6. *Regulatory approval will be the responsibility of TETRA TECH NUS. ISOTEC will provide assistance to procure regulatory approvals.*
7. *Scheduling is based on a first come first serve basis, with an authorized proposal (or subcontract) being the primary basis for scheduling, followed by payment history. ISOTEC will not schedule fieldwork without an authorized proposal (or subcontract), or outstanding receivables over 30 days.*
8. *Cancellation of a scheduled treatment program within 3 weeks of authorized program start will be subject to a $7,500 cancellation fee.*
9. ***A typical ISOTEC pilot study is performed as two injection events to allow for (a) any desorbed contamination or converted product from the first injection event to be readily attacked during the second injection event, and (b) make changes to the reagent stoichiometry and/or injection approach based on information generated from the first event.***
10. *Traffic control, if required, will be the responsibility of TETRA TECH NUS.*
11. *Work performed will be completed during regular business hours between 8 AM and 5 PM. Alternative scheduling will require a change order.*
12. *Disposal of hazardous wastes collected will be invoiced on a time and materials basis.*
13. **Each full round of injection activities will be billed separately at $39,485 per injection event, as necessary. ISOTEC will not proceed with a second injection event unless client approval is received in writing.*
14. *The Scope of Work may be modified for the second injection event based on initial injection event data review and costs will be adjusted accordingly.*

ISOTEC would like to thank TETRA TECH NUS for the opportunity to provide a cost estimate for the site. If you have any questions or need additional information, please feel free to contact me at (609) 275-8500 (ext. 119).

Very truly yours,
In-Situ Oxidative Technologies, Inc.

David S. Zervas
Managing Director

ISOTEC

Procedure for a Groundwater Treatability Study

The ISOTEC[SM] groundwater test is designed to simulate a situation where the reagents would attack only dissolved contaminants in site groundwater. For most contaminated sites, the soil-slurry test also needs to be performed except for a situation where the soil interference is anticipated to be minimal (e.g. fractured bedrock contamination). Typically, the results from this test are used to evaluate the performance of the chemox process under ideal conditions (i.e. no interference from soil organic matter) and compare to soil-slurry results. ISOTEC[SM] performs groundwater bench scale testing to achieve the following objectives:

- Evaluate the effectiveness of the ISOTEC[SM] oxidative process on a representative site-specific groundwater sample.
- For each ISOTEC catalyst under evaluation, determine the amount of catalyst/oxidant mix (reagent) required to oxidize the measured site contaminants (i.e. site-specific stoichiometry per catalyst);
- Determine the most effective reagent for a potential pilot scale application at the site.

Typical bench scale study procedures are outlined below. *Comparative studies using modified Fenton's, Permanganate, or Persulfate can also be performed at an additional cost.* The study consists of the experimental setup, establishing initial conditions, conducting the experiments through application of various catalysts and oxidants, and then submitting the treated samples for chemical analysis.

Experimental Setup

The groundwater test experiment is performed in multiple pairs of 140 ml sealed batch reactors (reactors). Groundwater is introduced into each reactor, leaving enough headspace for predetermined reagent volumes to be injected. The reactors are sealed with aluminum caps fitted with Teflon®-lined rubber septa to facilitate reagent injections.

Each pair receives either a different reagent, or a different volume of a particular reagent. One reactor of each pair serves as the "treatment reactor" while the other serves as the "monitoring reactor". Both reactors of each pair will receive identical reagent doses. The treatment reactor is not opened or sampled until the end of the experiment. The monitoring reactor is used to monitor the extent of the oxidation reaction of the pair, by periodically extracting small samples for hydrogen peroxide analysis. Additional reactors are set up for control purposes. Control reactors are discussed below.

Initial Conditions

The initial untreated/baseline conditions of groundwater are established prior to initiating the experiment. The initial sample results are compared to treated sample results to evaluate treatment effectiveness.

Samples are analyzed for contaminants of concern by applicable EPA methods (e.g. EPA 624/625) and for dissolved iron and dissolved manganese by EPA method 6010.

Experimental Control

Experimental control samples (Control) are set up the same way as all other experimental samples during the study to document the following:

- reduction in contaminant concentrations due to sample dilution by reagent volumes injected, and
- reduction in contaminant concentrations due to volatilization caused by room temperature test conditions.

The control sample is set up in a treatment reactor but is injected with distilled water instead of reagents. The volume of distilled water injected is identical to the volumes of reagent injected into treatment reactors. The control sample will remain at and is subject to the same conditions as all other treatment and monitoring reactors.

Application of Reagents

The study experiments are performed on the groundwater samples. Where multiple pairs of reactors are prepared, a series of different reagents or different volumes of the same reagent are injected into each pair of reactors (treatment and monitoring). Each monitoring reactor receives an identical dose as its paired treatment reactor. Samples are periodically withdrawn from the monitoring reactors for hydrogen peroxide analysis, the results of which may lead to additional treatment dosages of the reagent under study, for its paired treatment reactor. Distilled water is used to equalize the total volume of reagent used between reactor pair.

Following the last application of reagent, all reactors remain undisturbed at room temperature for a minimum of 24 hours or until the oxidizer is completely consumed as determined by Hach H_2O_2 testing equipment. The reaction is quenched using catalase, which is an organic enzyme catalyst naturally present in most soils that decomposes hydrogen peroxide directly to oxygen <u>without</u> generating hydroxyl radicals as shown below.

$$H_2O_2 \rightarrow H_2O + \frac{1}{2} O_2$$

After the resting period, excess catalase is injected into each reactor to decompose residual hydrogen peroxide and terminate the study. The use of catalase for quenching purposes is a standard practice in Fenton's chemistry and does not interfere with laboratory analysis. However, for control purposes, the exact volume of excess catalase injected into each treatment reactor is also injected into control reactors. The treatment effectiveness is evaluated by calculating the percent VOC reduction in each treatment reactor relative to the control reactors.

Sample Collection and Analysis

After the soil slurry test is terminated by injecting catalase into the reactors, the initial untreated/baseline samples and treated samples are collected in appropriate preserved containers (e.g. 40 ml vials with HCl for VOCs). Final values of pH, TDS and hydrogen peroxide are determined from the monitoring reactors. The samples are submitted to a New Jersey certified laboratory for contaminant analysis. The samples will include:

- The 40-ml/1-liter "field" collected sample (for VOCs/SVOCs);
- The 250-ml glass jar for initial dissolved iron and manganese analysis;
- The "control" sample decanted from the reactor vessel to which only distilled water was injected; and
- The treatment samples decanted from the reactor vessels to which varying volumes of catalyst and hydrogen peroxide were injected.

ISOTEC

ISOTEC[SM] Laboratory Study Sample Collection

In order to perform an ISOTEC lab study, a representative soil and/or groundwater sample must be collected from an area of concern at the site exhibiting the highest detected levels of contaminants.

Please purge the well prior to groundwater sampling. Field and trip blanks are not required. For soil samples, please collect a representative soil sample or a composite. A summary of the sample containers required for the laboratory study is provided below. **Please contact ISOTEC for sample requirements other than those listed below.**

*****Please ensure zero head space in 1 liter jars and 40 ml vials*****

Container Type	Number of Containers				Sample Type	Preservative
	VOCs	SVOCs	TPH	Pesticide		
1 liter, amber glass (VOCs)	5	-	-	-	Groundwater	None
1-gallon, Glass/HDPE/ Teflon (SVOC/TPH/Pesticides)	-	5	5	5	Groundwater	None
40 ml vials (VOCs)	2	-	-	-	Groundwater	HCl
1-liter amber jars/ 1 gal-Zip lock bags/ other jars	2 (approx. 10-lbs soil)	2 (approx. 10-lbs soil)	2 (approx. 10-lbs soil)	2 (approx. 10-lbs soil)	Soil	None

Lab study samples are requested to be collected on a Monday/Tuesday and received by ISOTEC on Tuesday/Wednesday. The samples should be packaged in a cooler (with ice) and shipped overnight (AM) delivery to the following address:

In-Situ Oxidative Technologies, Inc.
51 Everett Drive, Suite #A-10
West Windsor, New Jersey 08550
Attn: Prasad Kakarla

If you should need to be supplied with sample containers and/or a sample shuttle, they are provided by ISOTEC at an additional charge. Please enclose a standard chain-of-custody with the samples. **In addition, please enclose contaminant information by including latest laboratory analytical data on the above samples collected.**

ISOTEC must be notified **at least 48 hours** prior to sample shipment to prepare for lab study.

If you should have any questions concerning the sampling event, please do not hesitate to contact Prasad Kakarla at (609) 275-8500 (ext. 111).

B.2 ALTERNATIVE 3

NAVAL STATION GREAT LAKES
Great Lakes, Illinois
Site 22 - Former Building 105, Old Dry Cleaning Facility
Alternative 3: In-situ ERH and Monitoring
CAPITAL COST

Item	Quantity	Unit	Unit Cost				Extended Cost				Subtotal
			Subcontract	Material	Labor	Equipment	Subcontract	Material	Labor	Equipment	
1 PROJECT PLANNING AND MOBILIZATION/DEMOBILIZATION											
1.1 Prepare Documents & Plans including Permits	150	hour			$27.50		$0	$0	$4,125	$0	$4,125
2 MOBILIZATION/DEMOBILIZATION AND FIELD SUPPORT											
2.1 Office Trailer	11	mo				$286.00	$0	$0	$0	$3,146	$3,146
2.2 Storage Trailer	11	mo				$105.00	$0	$0	$0	$1,155	$1,155
2.3 Trailers Mob/Demo	2	ea				$225.00	$0	$0	$0	$450	$450
2.4 Field Office Support	11	mo		$143.00			$0	$1,573	$0	$0	$1,573
2.5 Utility Connection/Disconnection (phone/electric)	1	ls	$1,500.00				$1,500	$0	$0	$0	$1,500
2.6 Site Utilities (phone & electric)	11	mo		$302.00			$0	$3,322	$0	$0	$3,322
2.7 Mobilization/Demobilization Construction Equipment	2	ea			$147.00	$350.00	$0	$0	$294	$700	$994
2.8 Construction Survey	1	ls	$1,000.00				$1,000	$0	$0	$0	$1,000
3 DECONTAMINATION											
3.1 Decontamination Services	2	mo		$375.00	$1,200.00	$900.00	$0	$750	$2,400	$1,800	$4,950
3.2 Pressure Washer	2	mo				$1,100.00	$0	$0	$0	$2,200	$2,200
3.3 Equipment Decon Pad	1	ls		$500.00	$450.00	$155.00	$0	$500	$450	$155	$1,105
3.4 Decon Water Storage Tank, 6,000 gallon	2	mo				$645.00	$0	$0	$0	$1,290	$1,290
3.5 Clean Water Storage Tank, 4,000 gallon	2	mo				$580.00	$0	$0	$0	$1,160	$1,160
3.6 Disposal of Decon Waste (liquid & solid)	2	mo	$900.00				$1,800	$0	$0	$0	$1,800
4 PILOT-SCALE TREATABILITY STUDY											
4.1 Thermal Remediation Services	1	ls	$251,000.00				$251,000	$0	$0	$0	$251,000
4.2 Drilling, Soil Sampling & Disposal	1	ls	$25,000.00				$25,000	$0	$0	$0	$25,000
4.3 Electrical Connections	1	ls	$15,000.00				$15,000	$0	$0	$0	$15,000
4.4 Electrical Usage	1	ls		$23,000.00			$0	$23,000	$0	$0	$23,000
4.5 Carbon Usage	1	ls		$10,000.00			$0	$10,000	$0	$0	$10,000
4.6 Water/Condensate Disposal	1	ls	$1,000.00				$1,000	$0	$0	$0	$1,000
4.7 Other Operational Cost	1	ls	$13,000.00				$13,000	$0	$0	$0	$13,000
4.8 Soil Borings, 2	1	ls	$2,500.00				$2,500	$0	$0	$0	$2,500
4.9 Soil Boring Samples	5	ea	$240.00	$30.00	$50.00	$20.00	$1,200	$150	$250	$100	$1,700
4.10 Collect/Containerize IDW	1	drum	$55.00				$55	$0	$0	$0	$55
4.11 Transport/Dispose IDW	1	drum	$170.00				$170	$0	$0	$0	$170
4.12 Groundwater Samples	2	ea	$180.00	$30.00	$50.00	$20.00	$360	$60	$100	$40	$560
5 IN-SITU ERH											
5.1 Thermal Remediation Services	1	ls	$739,700.00				$739,700	$0	$0	$0	$739,700
5.2 Drilling, Soil Sampling & Disposal	1	ls	$223,600.00				$223,600	$0	$0	$0	$223,600
5.3 Electrical Usage	1	ls		$250,900.00			$0	$250,900	$0	$0	$250,900
5.4 Carbon Usage	1	ls		$23,400.00			$0	$23,400	$0	$0	$23,400
5.5 Water/Condensate Disposal	1	ls	$1,300.00				$1,300	$0	$0	$0	$1,300
5.6 Other Operational Cost	1	ls	$23,400.00				$23,400	$0	$0	$0	$23,400
5.7 Soil Borings, 12	1	ls	$6,000.00				$6,000	$0	$0	$0	$6,000
5.8 Soil Boring Samples	12	ea	$240.00	$30.00	$50.00	$20.00	$2,880	$360	$600	$240	$4,080
5.9 Collect/Containerize IDW	1	drum	$55.00				$55	$0	$0	$0	$55
5.10 Transport/Dispose IDW	1	drum	$170.00				$170	$0	$0	$0	$170
5.11 Groundwater Samples	6	ea	$180.00	$30.00	$50.00	$20.00	$1,080	$180	$300	$120	$1,680
6 RESTORATION											
6.1 Pavement Repair & Replacement	18,750	sf	$1.98				$37,125	$0	$0	$0	$37,125
6.2 Trees	12	ea	$350.00				$4,200	$0	$0	$0	$4,200
7 MISCELLANEOUS											
7.1 Construction Oversight (2 p * 55 days)	360	day			$200.00		$0	$0	$72,000	$0	$72,000
7.2 Post Construction Documents	250	hr			$27.50		$0	$0	$6,875	$0	$6,875

NAVAL STATION GREAT LAKES
Great Lakes, Illinois
Site 22 - Former Building 105, Old Dry Cleaning Facility
Alternative 3: In-situ ERH and Monitoring
CAPITAL COST

Item	Quantity	Unit	Unit Cost				Extended Cost				Subtotal
			Subcontract	Material	Labor	Equipment	Subcontract	Material	Labor	Equipment	
Subtotal							$1,353,095	$314,195	$87,394	$12,556	$1,767,240
Local Area Adjustments							100.0%	96.9%	90.9%	90.9%	
							$1,353,095	$304,455	$79,441	$11,413	$1,748,405
Overhead on Labor Cost @ 30%									$23,832		$23,832
G & A on Labor Cost @ 10%									$7,944		$7,944
G & A on Material Cost @ 10%								$30,445			$30,445
G & A on Equipment Cost @ 10%										$1,141	$1,141
G & A on Subcontract Cost @ 10%							$135,310				$135,310
Total Direct Cost							$1,488,405	$334,900	$111,218	$12,555	$1,947,077
Indirects on Total Direct Cost @ 15%											$292,062
Profit on Total Direct Cost @ 10%											$194,708
Subtotal											$2,433,847
Health & Safety Monitoring @ 2%											$48,677
Total Field Cost											$2,482,524
Contingency on Total Field Costs @ 20%											$496,505
Engineering on Total Field Cost @ 4%											$99,301
TOTAL COST											**$3,078,329**

THERMAL REMEDIATION services inc.

Great Lakes Remediation Parameters

Scenario 2

Electrical Resistance Heating Treatment Area:	750 sq. ft.
Shallow Extent of Electrical Resistance Heating:	2 ft
Deep Extent of Electrical Resistance Heating:	25 ft
Typical Depth to Groundwater:	6 ft
Treatment Volume:	500 cu yds
Total Organic Carbon Content of Soil:	0.60%
Number of Electrodes:	7
Electrode Boring Diameter:	1,1-DCA-inch o.d.
Average Distance Between Electrodes:	10 ft
Total Depth of Electrodes	26 ft
Depth to Top of Electrodes	3 ft
Number of Co-located Vapor Recovery Wells:	7
Number of Temperature Monitoring Points:	2 (6 sensors each)
Is a New Surface Cap Required?*	no
Controlling Contaminant:	PCE
Overall Clean-up Percent:	**94.25%**
Assumed VOC Mass:	150 lbs
Vapor Recovery Air Flow Rate (scfm):	80 scfm
Minimum Vapor Recovery Blower:	10 horsepower
Condensate Production Rate:	0.4 gpm
Liquid Groundwater Pumping Rate:	0 gpm
Vapor Treatment Method:	carbon
Assumed Activated Carbon Required:	4,000 lbs
Power Control Unit (PCU) Capacity:	500 kW
Average Electrical Heating Power Input:	98 kW
Total Heating Treatment Time:	72 - 98 days
Design Remediation Energy (kW-hr):	187,000
Assumed Number of Confirmatory Borings:	2
Number of Soil Samples per Boring:	5

The above remediation parameters are estimated +/- 20%. Final parameters will be determined during system design.

Budgetary (+/- 20%) Standard Fixed Price for Great Lakes

Thermal Remediation Services Price	
Design, Work Plans, Permits:	$23,000
Subsurface Installation:	$14,000
Surface Installation and Start-up:	$93,000
Remediation System Operation:	$94,000
Demobilization and Final Report:	$27,000
Total TRS Price	**$251,000**
Estimated Costs by Others	
Drilling and Soil Sampling:	$24,000
Drill Cuttings and Waste Disposal:	$1,000
Electrical Utility Connection to PCU:	$10,000
Electrical Energy Usage:	$23,000
Carbon Usage, Transportation & Regeneration:	$10,000
Water/Condensate Disposal:	$1,000
Other Operational Costs:	$13,000
Total Estimated Costs by Others	**$82,000**
Total Remediation Cost:	**$333,000**

Costs by Others are conservatively high. TRS recomends using site knowledge or getting quotes.

Some Included Items for Remediation of Great Lakes

Design, Work Plans, Permits:	TRS Scope	Shared Scope	Scope by Others	Estimated Cost by Others (included above)
Design or "Kick-off" Meeting	□	■	□	
Work Plan	□	■	□	
Health and Safety Plan	□	■	□	
QA/QC Plan	□	□	□	
Sample Analysis Plan	□	□	□	
Air Permit	□	■	□	
Sewer Discharge Permit	□	■	□	
Building Permit	□	■	□	
Regulatory Negotiations and Client Interface	□	□	■	difficult to estimate by TRS
Subsurface Installation:				
Pre-installation Building Structural Survey	□	□	□	
Electrode materials and well screen	■	□	□	
Drilling Subcontractor for Electrodes	□	□	■	$7,180 for 182 feet.
Drilling Subcontractor for VR Wells	□	□	□	Co-located with electrodes.
Drilling Subcontractor for TMPs	□	□	■	$1,670 for 54 feet.
Drilling Subcontractor for new MWs	□	□	□	
Concrete Cutting	□	□	■	$0,900 for 9 cores.
Utility Locator Survey	□	□	■	$1,280
Installation (pre- ERH) Soil Sample Analysis	□	□	■	$2,500 for 10 samples.
Drill Cutting Disposal	□	□	■	$0,900 for 3 tons.
Drill Cutting Disposal Labor	□	□	■	$1,040
Forklift or Skid-Steer for Drilling	□	□	■	$730
Photoionization Detector for Drilling	□	□	■	$240
Boring Logs and Report	□	□	■	$1,040
TRS On-Site Electrode Installation Supervision	■	□	□	
Traffic-rated Well Vaults and Installation	□	□	□	
Trenching and Restoration	□	□	□	
Biological Amendment and Addition	□	□	□	
Surface Installation and Start-up:				
Surface Remediation Equipment Mobilization	■	□	□	
Crane to Offload/Position Equipment	■	□	□	
Remediation Perimeter or Equipment Fence	■	□	□	
Vapor Recovery Piping	□	□	□	
Steam Condenser	■	□	□	
10 hp VR Blower	■	□	□	
Granular Activated Carbon	□	□	■	$10,000 for 4,000 pounds.
200 scfm Chlorinated VOC Oxidizer	□	□	□	
Oil-Water Separator	□	□	□	
Equipment Sound Wall	■	□	□	
Electrical Utility Connection to PCU	□	□	■	$10,000
Telephone Connection to PCU	□	□	■	$390
Garden Hose Connection to Condenser	□	□	■	$330
Remediation System Operation:				
ERH Control and Temperature Monitoring	■	□	□	
Vapor Sampling and Analysis	□	□	■	$3,406 for 12 samples.
Condensate/Discharge Sampling and Analysis	□	□	■	$1,052 for 4 samples.
Sampling Labor and Operational Checks	□	□	■	$5,253 for 61 hours.
Groundwater Sampling and Analysis	□	□	■	difficult to estimate by TRS
Electricity Usage	□	□	■	$18,000 for 177,000 kW-hr.
Water/Condensate Disposal	□	□	■	$1,000 for 1,400 gallons.
Separate Phase Product Disposal	□	□	□	
Demobilization and Final Report:				
Drilling Subcontractor for Confirmatory Borings	□	□	■	$1,550 for 50 feet.
Soil Sample Analysis	□	□	■	$2,500 for 10 samples.
Well Abandonment	□	□	■	$1,650 for 7 wells.
Demobilize Surface Equipment	■	□	□	
Final Report	□	■	□	

Site 22 Great Lakes Remediation Parameters

THERMAL REMEDIATION services inc.

Electrical Resistance Heating Treatment Area:	10,000 sq. ft.
Shallow Extent of Electrical Resistance Heating:	5 ft
Deep Extent of Electrical Resistance Heating:	25 ft
Typical Depth to Groundwater:	6 ft
Treatment Volume:	7,400 cu yds
Total Organic Carbon Content of Soil:	0.60%
Number of Electrodes:	51
Electrode Boring Diameter:	12-inch o.d.
Average Distance Between Electrodes:	15 ft
Total Depth of Electrodes	26 ft
Depth to Top of Electrodes	7 ft
Number of Co-located Vapor Recovery Wells:	51
Number of Temperature Monitoring Points:	7 (5 sensors each)
Is a New Surface Cap Required?	no
Controlling Contaminant:	PCE
Overall Clean-up Percent:	**94.25%**
Assumed VOC Mass:	1,700 lbs
Vapor Recovery Air Flow Rate (scfm):	330 scfm
Minimum Vapor Recovery Blower:	25 horsepower
Condensate Production Rate:	4.1 gpm
Liquid Groundwater Pumping Rate:	0 gpm
Vapor Treatment Method:	carbon
Assumed Activated Carbon Required:	8,000 lbs
Power Control Unit (PCU) Capacity:	2000 kW
Average Electrical Heating Power Input:	801 kW
Total Heating Treatment Time:	85 - 118 days
Design Remediation Energy (kW-hr):	1,820,000
Assumed Number of Confirmatory Borings:	7
Number of Soil Samples per Boring:	4

The above remediation parameters are estimated +/- 20%. Final parameters will be determined during system design.

Budgetary (+/- 20%) Standard Fixed Price for Site 22 Great Lakes

Thermal Remediation Services Price		Percent
Design, Work Plans, Permits:	$34,000	3%
Subsurface Installation:	$109,000	11%
Surface Installation and Start-up:	$194,000	20%
Remediation System Operation:	$187,000	19%
Demobilization and Final Report:	$45,000	5%
Total TRS Price	**$569,000**	58%
Estimated Costs by Others		
Drilling and Soil Sampling:	$156,000	16%
Drill Cuttings and Waste Disposal:	$16,000	2%
Electrical Utility Connection to PCU:	$15,000	2%
Electrical Energy Usage:	$193,000	20%
Carbon Usage, Transportation & Regeneration:	$18,000	2%
Water/Condensate Disposal:	$1,000	0%
Other Operational Costs:	$18,000	2%
Total Estimated Costs by Others	**$417,000**	42%
Total Remediation Cost:	**$986,000**	$133/cu yd

"Costs by Others" are conservatively high. TRS recomends using site knowledge or getting quotes.

Some Included Items for Remediation of Site 22 Great Lakes

Design, Work Plans, Permits:	TRS Scope	Shared Scope	Scope by Others	Estimated Cost by Others (included above)
Design or "Kick-off" Meeting	□	■	□	
Work Plan	□	■	□	
Health and Safety Plan	□	■	□	
QA/QC Plan	□	□	□	
Sample Analysis Plan	□	□	□	
Air Permit	□	■	□	
Sewer Discharge Permit	□	■	□	
Building Permit	□	■	□	
Regulatory Negotiations and Client Interface	□	□	■	difficult to estimate by TRS
Subsurface Installation:				
Pre-installation Building Structural Survey	□	□	■	$2,580
Electrode materials and well screen	■	□	□	
Drilling Subcontractor for Electrodes	□	□	■	$94,980 for 1,326 feet.
Drilling Subcontractor for VR Wells	□	□	□	Co-located with electrodes.
Drilling Subcontractor for TMPs	□	□	■	$7,480 for 189 feet.
Drilling Subcontractor for new MWs	□	□	□	
Concrete Cutting	□	□	■	$6,560 for 58 cores.
Utility Locator Survey	□	□	■	$1,280
Installation (pre- ERH) Soil Sample Analysis	□	□	■	$7,000 for 28 samples.
Drill Cutting Disposal	□	□	■	$15,600 for 52 tons.
Drill Cutting Disposal Labor	□	□	■	$1,860
Forklift or Skid-Steer for Drilling	□	□	■	$1,230
Photoionization Detector for Drilling	□	□	■	$2,020
Boring Logs and Report	□	□	■	$1,970
TRS On-Site Electrode Installation Supervision	■	□	□	
Traffic-rated Well Vaults and Installation	□	□	□	
Trenching and Restoration	□	□	□	
Biological Amendment and Addition	□	□	□	
Surface Installation and Start-up:				
Surface Remediation Equipment Mobilization	■	□	□	
Crane to Offload/Position Equipment	■	□	□	
Remediation Perimeter or Equipment Fence	■	□	□	
Vapor Recovery Piping	■	□	□	
Steam Condenser	■	□	□	
25 hp VR Blower	■	□	□	
Granular Activated Carbon	□	□	■	$18,000 for 8,000 pounds.
500 scfm Chlorinated VOC Oxidizer	□	□	□	
Oil-Water Separator	□	□	□	
Equipment Sound Wall	■	□	□	
Electrical Utility Connection to PCU	□	□	■	$15,000
Telephone Connection to PCU	□	□	■	$390
Garden Hose Connection to Condenser	□	□	■	$330
Remediation System Operation:				
ERH Control and Temperature Monitoring	■	□	□	
Vapor Sampling and Analysis	□	□	■	$6,256 for 24 samples.
Condensate/Discharge Sampling and Analysis	□	□	■	$3,003 for 10 samples.
Sampling Labor and Operational Checks	□	□	■	$7,949 for 93 hours.
Groundwater Sampling and Analysis	□	□	■	difficult to estimate by TRS
Electricity Usage	□	□	■	$193,000 for 1,876,000 kW-hr.
Water/Condensate Disposal	□	□	■	$1,000 for 19,600 gallons.
Separate Phase Product Disposal	□	□	□	
Demobilization and Final Report:				
Drilling Subcontractor for Confirmatory Borings	□	□	■	$6,930 for 175 feet.
Soil Sample Analysis	□	□	■	$7,000 for 28 samples.
Well Abandonment	□	□	■	$10,450 for 51 wells.
Demobilize Surface Equipment	■	□	□	
Final Report	□	■	□	

B.3 ALTERNATIVE 4

NAVAL STATION GREAT LAKES
Great Lakes, Illinois
Site 22 - Former Building 105, Old Dry Cleaning Facility
Alternative 4: Excavation, Off-Base Treatment (chemical oxidation or incineration) and/or Disposal
CAPITAL COST

Item	Quantity	Unit	Unit Cost				Extended Cost				Subtotal
			Subcontract	Material	Labor	Equipment	Subcontract	Material	Labor	Equipment	
1 PROJECT PLANNING AND MOBILIZATION/DEMOBILIZATION											
1.1 Prepare Documents & Plans including Permits	150	hour			$27.50		$0	$0	$4,125	$0	$4,125
2 MOBILIZATION/DEMOBILIZATION AND FIELD SUPPORT											
2.1 Office Trailer	4	mo				$286.00	$0	$0	$0	$1,144	$1,144
2.2 Storage Trailer	4	mo				$105.00	$0	$0	$0	$420	$420
2.3 Trailers Mob/Demo	2	ea				$225.00	$0	$0	$0	$450	$450
2.4 Field Office Support	4	mo		$143.00			$0	$572	$0	$0	$572
2.5 Utility Connection/Disconnection (phone/electric)	1	ls	$1,500.00				$1,500	$0	$0	$0	$1,500
2.6 Site Utilities (phone & electric)	4	mo		$302.00			$0	$1,208	$0	$0	$1,208
2.7 Mobilization/Demobilization Construction Equipment	4	ea			$147.00	$350.00	$0	$0	$588	$1,400	$1,988
2.8 Construction Survey	1	ls	$1,000.00				$1,000	$0	$0	$0	$1,000
3 DECONTAMINATION											
3.1 Decontamination Services	3	mo		$375.00	$1,200.00	$900.00	$0	$1,125	$3,600	$2,700	$7,425
3.2 Pressure Washer	3	mo				$1,100.00	$0	$0	$0	$3,300	$3,300
3.3 Equipment Decon Pad	1	ls		$500.00	$450.00	$155.00	$0	$500	$450	$155	$1,105
3.4 Decon Water Storage Tank, 6,000 gallon	3	mo				$645.00	$0	$0	$0	$1,935	$1,935
3.5 Clean Water Storage Tank, 4,000 gallon	3	mo				$580.00	$0	$0	$0	$1,740	$1,740
3.6 Disposal of Decon Waste (liquid & solid)	3	mo	$900.00				$2,700	$0	$0	$0	$2,700
4 EXCAVATION & SOIL STOCKPILE											
4.1 Soil Staging Containment Area	1	ls		$750.00	$600.00	$295.00	$0	$750	$600	$295	$1,645
4.2 Sheet Pile installation & removal	11,250	sf		$7.70	$3.91	$4.14	$0	$86,625	$43,988	$46,575	$177,188
4.3 Bracing/Waler/Struts (equal to sheet pile cost)							$0	$86,625	$43,988	$46,575	$177,188
4.4 Trash Pump, 4" dia.	40	day				$71.26	$0	$0	$0	$2,850	$2,850
4.5 Groundwater Storage Tank, 6,000 gallon	2	mo				$645.00	$0	$0	$0	$1,290	$1,290
4.6 Labor (2)	40	day			$427.00		$0	$0	$17,080	$0	$17,080
4.7 Loader, 3 cy	40	day			$788.00	$277.20	$0	$0	$31,520	$11,088	$42,608
4.8 Power Shovel, Clamshell	40	day			$876.60	$287.20	$0	$0	$35,064	$11,488	$46,552
4.9 Post-Excavation Conformation Samples	12	ea	$240.00	$30.00	$50.00	$20.00	$2,880	$360	$600	$240	$4,080
4.10 Groundwater Samples	6	ea	$180.00	$30.00	$50.00	$20.00	$1,080	$180	$300	$120	$1,680
5 TRANSPORTATION & DISPOSAL											
5.1 Soil Disposal Samples	100	ea	$240.00	$30.00	$50.00	$20.00	$24,000	$3,000	$5,000	$2,000	$34,000
5.2 Landfilled without Treatment	6,750	ton	$120.00				$810,000	$0	$0	$0	$810,000
5.3 Incineration then Landfilled	6,750	ton	$615.00				$4,151,250	$0	$0	$0	$4,151,250
5.4 Chemical Oxidation then Landfilled	0	ton	$255.00				$0	$0	$0	$0	$0
6 BACKFILL AND RESTORATION											
6.1 Loader, 3 cy (first 10 days)	10	day			$788.00	$277.20	$0	$0	$7,880	$2,772	$10,652
6.2 Power Shovel, Clamshell (first 10 days)	10	day			$876.60	$287.20	$0	$0	$8,766	$2,872	$11,638
6.3 Dozer, 105 H. P. (second 10 days)	10	day			$277.20	$453.80	$0	$0	$2,772	$4,538	$7,310
6.4 Vibratory Roller (second 10 days)	10	day			$277.20	$344.80	$0	$0	$2,772	$3,448	$6,220
6.5 Labor (2)	20	day			$427.00		$0	$0	$8,540	$0	$8,540
6.6 Backfill Material	10,000	cy		$7.20			$0	$72,000	$0	$0	$72,000
6.7 Pavement Repair & Replacement	18,750	sf	$1.98				$37,125	$0	$0	$0	$37,125
6.8 Concrete Curb	350	lf	$10.65				$3,728	$0	$0	$0	$3,728
6.7 Trees	12	ea	$350.00				$4,200	$0	$0	$0	$4,200
7 MISCELLANEOUS											
7.1 Construction Oversight (2 p * 4 month * 21 days/month)	168	day			$200.00		$0	$0	$33,600	$0	$33,600
7.2 Post Construction Documents	250	hr			$27.50		$0	$0	$6,875	$0	$6,875

NAVAL STATION GREAT LAKES
Great Lakes, Illinois
Site 22 - Former Building 105, Old Dry Cleaning Facility
Alternative 4: Excavation, Off-Base Treatment (chemical oxidation or incineration) and/or Disposal
CAPITAL COST

Item	Quantity	Unit	Unit Cost				Extended Cost				Subtotal
			Subcontract	Material	Labor	Equipment	Subcontract	Material	Labor	Equipment	
Subtotal							$5,039,463	$252,945	$258,107	$149,395	$5,699,910
Local Area Adjustments							100.0%	96.9%	90.9%	90.9%	
							$5,039,463	$245,104	$234,619	$135,800	$5,654,986
Overhead on Labor Cost @	30%								$70,386		$70,386
G & A on Labor Cost @	10%								$23,462		$23,462
G & A on Material Cost @	10%							$24,510			$24,510
G & A on Equipment Cost @	10%									$13,580	$13,580
G & A on Subcontract Cost @	10%						$503,946				$503,946
Total Direct Cost							$5,543,409	$269,614	$328,467	$149,380	$6,290,870
Indirects on Total Direct Cost @	35%	(not including transportation & disposal cost)									$464,422
Profit on Total Direct Cost @	10%										$629,087
Subtotal											$7,384,379
Health & Safety Monitoring @	2%										$147,688
Total Field Cost											$7,532,067
Contingency on Total Field Costs @	20%										$1,506,413
Engineering on Total Field Cost @	4%										$301,283
TOTAL COST											**$9,339,763**

B.4 ALTERNATIVE 5

NAVAL STATION GREAT LAKES
Great Lakes, Illinois
Site 22 - Former Building 105, Old Dry Cleaning Facility
Alternative 5: In-situ ERH (1,400 ft2), Hot Spot Excavation (100 CY), Off-Base Treatment (Incineration) and Disposal, and Monitoring
CAPITAL COST

Item	Quantity	Unit	Unit Cost				Extended Cost				Subtotal
			Subcontract	Material	Labor	Equipment	Subcontract	Material	Labor	Equipment	
1 PROJECT PLANNING AND MOBILIZATION/DEMOBILIZATION											
1.1 Prepare Documents & Plans including Permits	150	hour			$27.50		$0	$0	$4,125	$0	$4,125
2 MOBILIZATION/DEMOBILIZATION AND FIELD SUPPORT											
2.1 Office Trailer	3	mo				$286.00	$0	$0	$0	$858	$858
2.2 Storage Trailer	3	mo				$105.00	$0	$0	$0	$315	$315
2.3 Trailers Mob/Demo	2	ea				$225.00	$0	$0	$0	$450	$450
2.4 Field Office Support	3	mo		$143.00			$0	$429	$0	$0	$429
2.5 Utility Connection/Disconnection (phone/electric)	1	ls	$1,500.00				$1,500	$0	$0	$0	$1,500
2.6 Site Utilities (phone & electric)	3	mo		$302.00			$0	$906	$0	$0	$906
2.7 Mobilization/Demobilization Construction Equipment	2	ea			$147.00	$350.00	$0	$0	$294	$700	$994
2.8 Construction Survey	1	ls	$1,000.00				$1,000	$0	$0	$0	$1,000
3 DECONTAMINATION											
3.1 Decontamination Services	3	mo		$375.00	$1,200.00	$900.00	$0	$1,125	$3,600	$2,700	$7,425
3.2 Pressure Washer	3	mo				$1,100.00	$0	$0	$0	$3,300	$3,300
3.3 Equipment Decon Pad	1	ls		$500.00	$450.00	$155.00	$0	$500	$450	$155	$1,105
3.4 Decon Water Storage Tank, 6,000 gallon	3	mo				$645.00	$0	$0	$0	$1,935	$1,935
3.5 Clean Water Storage Tank, 4,000 gallon	3	mo				$580.00	$0	$0	$0	$1,740	$1,740
3.6 Disposal of Decon Waste (liquid & solid)	3	mo	$900.00				$2,700	$0	$0	$0	$2,700
4 IN-SITU ERH											
4.1 Thermal Remediation Services	1	ls	$273,000.00				$273,000	$0	$0	$0	$273,000
4.2 Drilling, Soil Sampling & Disposal	1	ls	$24,000.00				$24,000	$0	$0	$0	$24,000
4.3 Electrical Connections	1	ls	$15,000.00				$15,000	$0	$0	$0	$15,000
4.4 Electrical Usage	1	ls		$38,000.00			$0	$38,000	$0	$0	$38,000
4.5 Carbon Usage	1	ls		$20,000.00			$0	$20,000	$0	$0	$20,000
4.6 Water/Condensate Disposal	1	ls	$1,000.00				$1,000	$0	$0	$0	$1,000
4.7 Other Operational Cost	1	ls	$16,000.00				$16,000	$0	$0	$0	$16,000
4.8 Soil Borings, 12	1	ls	$6,000.00				$6,000	$0	$0	$0	$6,000
4.9 Soil Boring Samples	12	ea	$240.00	$30.00	$50.00	$20.00	$2,880	$360	$600	$240	$4,080
4.10 Collect/Containerize IDW	1	drum	$55.00				$55	$0	$0	$0	$55
4.11 Transport/Dispose IDW	1	drum	$170.00				$170	$0	$0	$0	$170
4.12 Groundwater Samples	6	ea	$180.00	$30.00	$50.00	$20.00	$1,080	$180	$300	$120	$1,680
5 EXCAVATION & SOIL STOCKPILE											
5.1 Soil Staging Containment Area	1	ls		$750.00	$600.00	$295.00	$0	$750	$600	$295	$1,645
5.2 Sheet Pile installation & removal	0	sf		$7.70	$3.91	$4.14	$0	$0	$0	$0	$0
5.3 Bracing/Waler/Struts (equal to sheet pile cost)							$0	$0	$0	$0	$0
5.4 Trash Pump, 4" dia.	0	day				$71.26	$0	$0	$0	$0	$0
5.5 Groundwater Storage Tank, 6,000 gallon	0	mo				$645.00	$0	$0	$0	$0	$0
5.6 Labor (2)	10	day			$427.00		$0	$0	$4,270	$0	$4,270
5.7 Loader, 3 cy	5	day			$788.00	$277.20	$0	$0	$3,940	$1,386	$5,326
5.8 Power Shovel, Clamshell	5	day			$876.60	$287.20	$0	$0	$4,383	$1,436	$5,819
5.9 Post-Excavation Conformation Samples	5	ea	$240.00	$30.00	$50.00	$20.00	$1,200	$150	$250	$100	$1,700
6.0 Groundwater Samples	6	ea	$180.00	$30.00	$50.00	$20.00	$1,080	$180	$300	$120	$1,680
6 TRANSPORTATION & DISPOSAL											
6.1 Soil Disposal Samples	12	ea	$240.00	$30.00	$50.00	$20.00	$2,880	$360	$600	$240	$4,080
6.2 Landfilled without Treatment	0	ton	$120.00				$0	$0	$0	$0	$0
6.3 Incineration then Landfilled	135	ton	$615.00				$83,025	$0	$0	$0	$83,025
6.4 Chemical Oxidation then Landfilled	0	ton	$255.00				$0	$0	$0	$0	$0
7 BACKFILL AND RESTORATION											
7.1 Loader, 3 cy	2	day			$788.00	$277.20	$0	$0	$1,576	$554	$2,130
7.2 Power Shovel, Clamshell	2	day			$876.60	$287.20	$0	$0	$1,753	$574	$2,328
7.3 Dozer, 105 H. P.	1	day			$277.20	$453.80	$0	$0	$277	$454	$731

NAVAL STATION GREAT LAKES
Great Lakes, Illinois
Site 22 - Former Building 105, Old Dry Cleaning Facility
Alternative 5: In-situ ERH (1,400 ft2), Hot Spot Excavation (100 CY), Off-Base Treatment (incineration) and Disposal, and Monitoring
CAPITAL COST

Item	Quantity	Unit	Unit Cost				Extended Cost				Subtotal
			Subcontract	Material	Labor	Equipment	Subcontract	Material	Labor	Equipment	
7.4 Vibratory Roller	1	day			$277.20	$344.80	$0	$0	$277	$345	$622
7.5 Labor (2)	6	day			$427.00		$0	$0	$2,562	$0	$2,562
7.6 Backfill Material	150	cy		$7.20			$0	$1,080	$0	$0	$1,080
7.7 Pavement Repair & Replacement	675	sf	$1.98				$1,337	$0	$0	$0	$1,337
7.8 Concrete Curb	50	lf	$10.65				$533	$0	$0	$0	$533
7.9 Trees	12	ea	$350.00				$4,200	$0	$0	$0	$4,200
8 MISCELLANEOUS											
8.1 Construction Oversight (2 p * 45 days)	45	day			$200.00		$0	$0	$9,000	$0	$9,000
8.2 Post Construction Documents	250	hr			$27.50		$0	$0	$6,875	$0	$6,875
9 MONITORING/LUC											
9.1 Monitoring	1	LS	$2,880.00	$1,000.00	$2,500.00		$2,880	$1,000	$2,500	$0	$6,380
9.2 LUC	1	LS		$5,000.00	$10,000.00		$0	$5,000	$10,000	$0	$15,000

NAVAL STATION GREAT LAKES
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Alternative 5: In-situ ERH (1,400 ft2), Hot Spot Excavation (100 CY), Off-Base Treatment (incineration) and Disposal, and Monitoring
CAPITAL COST

Item	Quantity	Unit	Unit Cost				Extended Cost				Subtotal
			Subcontract	Material	Labor	Equipment	Subcontract	Material	Labor	Equipment	
Subtotal							$441,519	$70,020	$58,533	$18,017	$588,089
Local Area Adjustments							100.0%	96.9%	90.9%	90.9%	
							$441,519	$67,849	$53,206	$16,378	$578,952
Overhead on Labor Cost @	30%								$15,962		$15,962
G & A on Labor Cost @	10%								$5,321		$5,321
G & A on Material Cost @	10%							$6,785			$6,785
G & A on Equipment Cost @	10%									$1,638	$1,638
G & A on Subcontract Cost @	10%						$44,152				$44,152
Total Direct Cost							$485,671	$74,634	$74,489	$18,016	$652,809
Indirects on Total Direct Cost @	15%										$97,921
Profit on Total Direct Cost @	10%										$65,281
Subtotal											$816,012
Health & Safety Monitoring @	2%										$16,320
Total Field Cost											$832,332
Contingency on Total Field Costs @	15%										$124,850
Engineering on Total Field Cost @	4%										$33,293
TOTAL COST											**$990,475**

Great Lakes Remediation Parameters

THERMAL REMEDIATION services inc.

Electrical Resistance Heating Treatment	1,410 sq. ft.	
Shallow Extent of Electrical Resistance	2 ft	
Deep Extent of Electrical Resistance He	25 ft	
Typical Depth to Groundwater:	6 ft	
Treatment Volume:	1,200 cu yds	
Total Organic Carbon Content of Soil:	0.60%	**% Reduction Goals**
Number of Electrodes:	7	**94.25% = 870 mg/kg to 50 mg/kg**
Electrode Boring Diameter:	12-inch o.d.	
Average Distance Between Electrodes:	15 ft	
Total Depth of Electrodes	26 ft	
Depth to Top of Electrodes	4 ft	
Number of Co-located Vapor Recovery Wel	7	
Number of Temperature Monitoring Points	2 (6 sensors each)	
Is a New Surface Cap Required?	no	
Controlling Contaminant:	PCE	
Overall Clean-up Percent:	**94.25%**	
Assumed VOC Mass:	280 lbs	
Vapor Recovery Air Flow Rate (scfm):	100 scfm	
Minimum Vapor Recovery Blower:	10 horsepower	
Condensate Production Rate:	0.6 gpm	
Liquid Groundwater Pumping Rate:	0 gpm	
Vapor Treatment Method:	carbon	
Assumed Activated Carbon Required:	4,000 lbs	
Power Control Unit (PCU) Capacity:	500 kW	
Average Electrical Heating Power Input:	145 kW	
Total Heating Treatment Time:	86 - 116 days	
Design Remediation Energy (kW-hr):	331,000	
Assumed Number of Confirmatory Borings:	2	
Number of Soil Samples per Boring:	5	

The above remediation parameters are estimated +/- 20%. Final parameters will be determined during system design.

Budgetary (+/- 20%) Standard Fixed Price for Great Lakes

Thermal Remediation Services Price		
Design, Work Plans, Permits:	$24,000	
Subsurface Installation:	$17,000	
Surface Installation and Start-up:	$93,000	
Remediation System Operation:	$111,000	
Demobilization and Final Report:	$28,000	
Total TRS Price	**$273,000**	
Estimated Costs by Others		
Drilling and Soil Sampling:	$27,000	**assumes $39 per foot**
Drill Cuttings and Waste Disposal:	$2,000	**assumes $300 per ton**
Electrical Utility Connection to PCU:	$10,000	
Electrical Energy Usage:	$38,000	**assumes $0.10 per kW-hr**
Carbon Usage, Transportation & Regenera	$10,000	**assumes $2.50 per pound**
Water/Condensate Disposal:	$1,000	
Other Operational Costs:	$16,000	**includes vapor sampling**
Total Estimated Costs by Others	**$104,000**	
Total Remediation Cost:	**$377,000**	$314/cu yd

"Costs by Others" are conservatively high. TRS recomends using site knowledge or getting quotes.

Some Included Items for Remediation of Great Lakes

Design, Work Plans, Permits:	TRS Scope	Shared Scope	Scope by Others	Estimated Cost by Others (included above)
Design or "Kick-off" Meeting	□	■	□	
Work Plan	□	■	□	
Health and Safety Plan	□	■	□	
QA/QC Plan	□	□	□	
Sample Analysis Plan	□	□	□	
Air Permit	□	■	□	
Sewer Discharge Permit	□	■	□	
Building Permit	□	■	□	
Regulatory Negotiations and Client Interface	□	□	■	difficult to estimate by TRS
Subsurface Installation:				
Pre-installation Building Structural Survey	□	□	□	
Electrode materials and well screen	■	□	□	
Drilling Subcontractor for Electrodes	□	□	■	$7,180 for 182 feet.
Drilling Subcontractor for VR Wells	□	□	□	Co-located with electrodes.
Drilling Subcontractor for TMPs	□	□	■	$1,670 for 54 feet.
Drilling Subcontractor for new MWs	□	□	□	
Concrete Cutting	□	□	■	$0,900 for 9 cores.
Utility Locator Survey	□	□	■	$1,280
Installation (pre- ERH) Soil Sample Ana	□	□	■	$2,500 for 10 samples.
Drill Cutting Disposal	□	□	■	$0,900 for 3 tons.
Drill Cutting Disposal Labor	□	□	■	$1,040
Forklift or Skid-Steer for Drilling	□	□	■	$730
Photoionization Detector for Drilling	□	□	■	$240
Boring Logs and Report	□	□	■	$1,040
TRS On-Site Electrode Installation Supervision	■	□	□	
Traffic-rated Well Vaults and Installation	□	□	□	
Trenching and Restoration	□	□	□	
Biological Amendment and Addition	□	□	□	
Surface Installation and Start-up:				
Surface Remediation Equipment Mobilizat	■	□	□	
Crane to Offload/Position Equipment	■	□	□	
Remediation Perimeter or Equipment Fenc	■	□	□	
Vapor Recovery Piping	□	□	□	
Steam Condenser	■	□	□	
10 hp VR Blower	■	□	□	
Granular Activated Carbon	□	□	■	$10,000 for 4,000 pounds.
200 scfm Chlorinated VOC Oxidizer	□	□	□	
Oil-Water Separator	□	□	□	
Equipment Sound Wall	■	□	□	
Electrical Utility Connection to PCU	□	□	■	$10,000
Telephone Connection to PCU	□	□	■	$390
Garden Hose Connection to Condenser	□	□	■	$330
Remediation System Operation:				
ERH Control and Temperature Monitoring	■	□	□	
Vapor Sampling and Analysis	□	□	■	$3,406 for 12 samples.
Condensate/Discharge Sampling and Analy	□	□	■	$1,052 for 4 samples.
Sampling Labor and Operational Checks	□	□	■	$5,253 for 61 hours.
Groundwater Sampling and Analysis	□	□	■	difficult to estimate by TRS
Electricity Usage	□	□	■	$18,000 for 177,000 kW-hr.
Water/Condensate Disposal	□	□	■	$1,000 for 1,400 gallons.
Separate Phase Product Disposal	□	□	□	
Demobilization and Final Report:				
Drilling Subcontractor for Confirmatory	□	□	■	$1,550 for 50 feet.
Soil Sample Analysis	□	□	■	$2,500 for 10 samples.
Well Abandonment	□	□	■	$1,650 for 7 wells.
Demobilize Surface Equipment	■	□	□	
Final Report	□	■	□	

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CES
CURRENT ENVIRONMENTAL SOLUTIONS

Great Lakes Naval Station Pilot - Site 22

Six-Phase Heating™ Conceptual Design

CES Proposal: **P-451**

Prepared for: Robert Davis, PE
Tetra Tech NUS
Foster Plaza 7, 661 Anderson Drive
Pittsburgh, PA 15220-2745
412-921-7251 davisb@ttnus.com
412-921-4040 fax

Site Specifics & Design Overview

State?	IL
Site Zip Code?	60088
Six Phase Heating Treatment Area (ft^2):	1,411
Shape of Treatment Area (circle, rectangle, oval):	circle
Treatment Area Length (ft):	n/a
Treatment Area Width/Diameter (ft):	30
Shallow Extent of Six Phase Heating (ft):	3
Deep Extent of Six Phase Heating (ft):	25
Typical Depth to Groundwater (ft):	6
Treated Volume (yd^3):	1,149
Compare to Excavation Option (tons):	1,800
Annual Rainfall (in):	33
Groundwater Flow Velocity (ft/day):	0.20
Ambient Air Temperature(°C):	19
Ambient Groundwater Temperature (°C):	9
Proposed Treatment Temperature (°C):	123
Treat Sequentially as # Sections:	1
Per-cent of site under building/pavement?	0%
What per-cent of cover material is concrete?	0%
What per-cent of site is public access?	0%
Is this a single array pilot test?	yes
Vapor Extraction Required?	yes
Are Vents in Same Boreholes as Electrodes?	yes
Insulating Surface Cover Required?	yes
Impermeable Surface Seal Required?	yes
Separate Electrode Interval for Saturated Zone ?	no
Does Vadose Zone Need to be Pre-Heated?	no
Does Vadose Zone Need to be Pre-Dried?	no
Air Sparging?	no
Multiphase Extraction Required?	yes
Account for In Situ Degradation?	no
Degradation Mechanism:	hydrolysis

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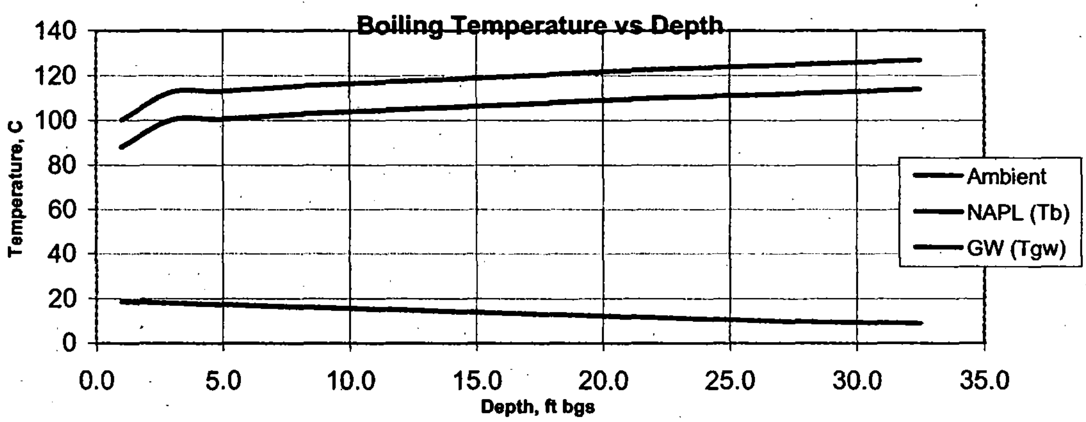
Contaminant Distribution and Cleanup Targets

	Heated Layer 1	Heated Layer 2	Heated Layer 3	Heated Layer 4	Heated Layer 5
Zone:	Vadose	Saturated	Saturated	Saturated	Saturated
Volume (yd^3):	104.5	219.4	219.4	219.4	334.4
	Initial Soil Concentrations, Dry Basis (mg/kg)				
Peak (mg/kg):	770	770	870	870	600
Average (mg/kg):	154	154	174	174	120
Target (mg/kg):	0	0	0	0	0
	Initial Groundwater Concentrations (µg/L)				
Maximum (µg/L):	n/a	59,000.0	59,000	59,000	59,000
Target (µg/L):	n/a	5.0	5	5	5
	Initial Mass Distribution (lb)				
NAPL present?:	yes	yes	yes	yes	yes
Mass in Soil (lb):	46.1	96.9	109.5	109.5	115.0
Dissolved (lb):	46.1	7.9	7.9	7.9	12.0
Total Mass (lb):	46.1	96.9	109.5	109.5	115.0

Estimated Treatment Temperatures



	GW (°C) Boiling Temperature	NAPL (°C) Boiling Temperature	Ambient (°C) Subsurface Temperature	Hydrostatic Head mm Hg	Layer Midpoint ft bgs
Upper Layer 1	100.1	88.0	18.7	761	1.0
Upper Layer 2	112.7	100.3	18.0	1,175	3.0
Heated Layer 1	112.9	100.4	17.3	1,183	5.0
Heated Layer 2	115.4	102.8	16.3	1,281	8.1
Heated Layer 3	117.6	104.9	14.9	1,376	12.3
Heated Layer 4	119.6	106.9	13.5	1,471	16.5
Heated Layer 5	122.6	109.8	11.7	1,615	21.8
Lower Layer 1	124.8	111.9	9.8	1,728	27.5
Lower Layer 2	126.8	113.9	9.0	1,840	32.5

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Electrode Design Specifications

Number of Electrode Phases:	6	
Number of Vertical Heating Intervals:	1	
Electrode and Extraction Well Terminations:	100% above grade	
Number of Temperature Monitoring Wells:	4	
Soil Cuttings from Electrode Installation:	6.7	tons
Number of Drip Assemblies Required:	14	
Average Electrode Wetting Rate:	0.26	gpm
Total Volume of Drip Water Added:	23,918	gallons
Total Amount of Electrolyte Required:	7,495	Lb

	Primary	Upper
Electrode Diameter (inches):	3.0	n/a
Borehole Diameter (inches):	12.00	n/a
Array to Electrode Ratio (D/d):	30	n/a
Distance between Electrodes (ft):	15.0	n/a
Total Number of Electrodes:	7	n/a
Depth to Top of Electrode (ft):	4.0	n/a
Total Depth of Electrode (ft):	25.0	n/a
Conductive Zone Length (ft):	21.0	n/a
Length of Electrode in Vadose Zone (ft):	2.0	n/a
Length of Electrode in Groundwater (ft):	19.0	n/a
Number of Drip Intervals per Primary Electrode:	2	n/a
Electrode Drill Cuttings (tons):	6.7	n/a

Extraction System Design

Design Extraction Vaccum:	0.92	atm
Well Vacuum:	2	in. Hg
Peak Steam Production Rate	100	scfm
Vapor Extraction Design Flow Rate:	110	scfm
Recommended Blower Vacuum:	5	in. Hg
Vapor Extraction Blower:	5	hp
SVE/DVE Wells Co-Located with Electrodes?	yes	
Average Condensate Production Rate:	0.29	gpm
Total Condensate Produced:	23,800	gallons
Peak Vapor Extraction Rate:	38.9	lb/day
Peak In Situ Degradation Rate:	0.0	lb/day
Average Total Cleanup Rate:	8.1	lb/day
Final Extraction Rate:	0.0	lb/day
Vapor Treatment Method:	carbon	
Secondary Acid Gas Stack Scrubber:	not required	
Soil Cuttings from VE Well Installation:	0.0	tons

	Shallow/VE	Horizontal	Deep/DVE
Type of Vents Required:	yes	yes	yes
Vent Spacing (ft):	15	26	15
Number of Vents:	7	3	7
Wellbore/Trench Diameter (in.):	12.00	12.00	12.00
Screened Length per Vent (ft):	4.0	10.0	21.0

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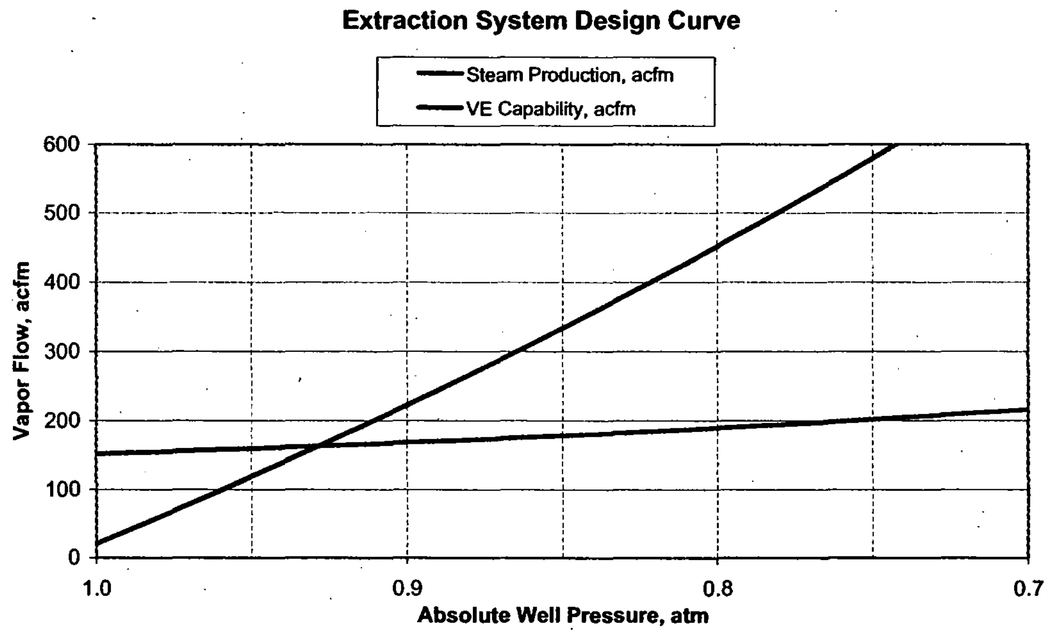

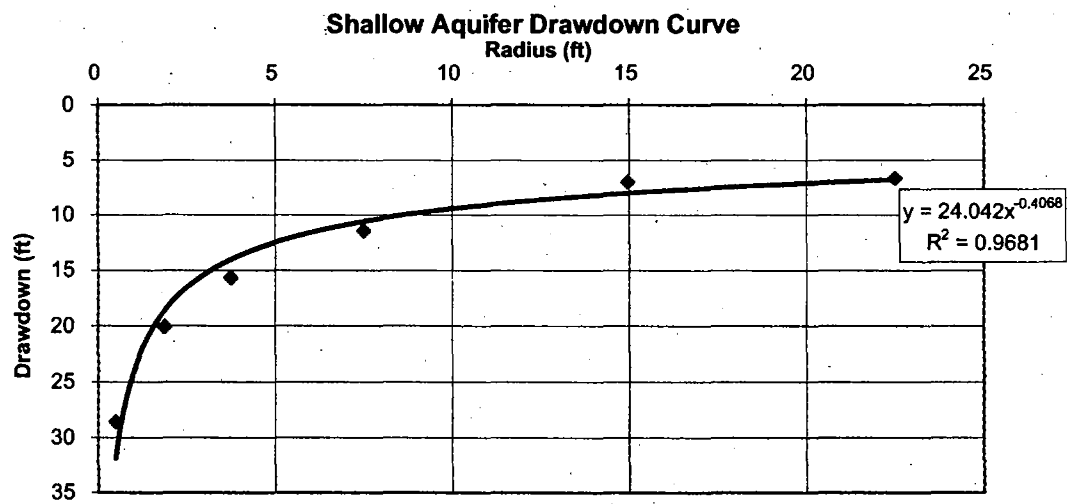

Typical Depth to Groundwater:	6.0	ft bg
Total NAPL Extracted:	298	lb
Total Groundwater Extracted:	40,572	gal

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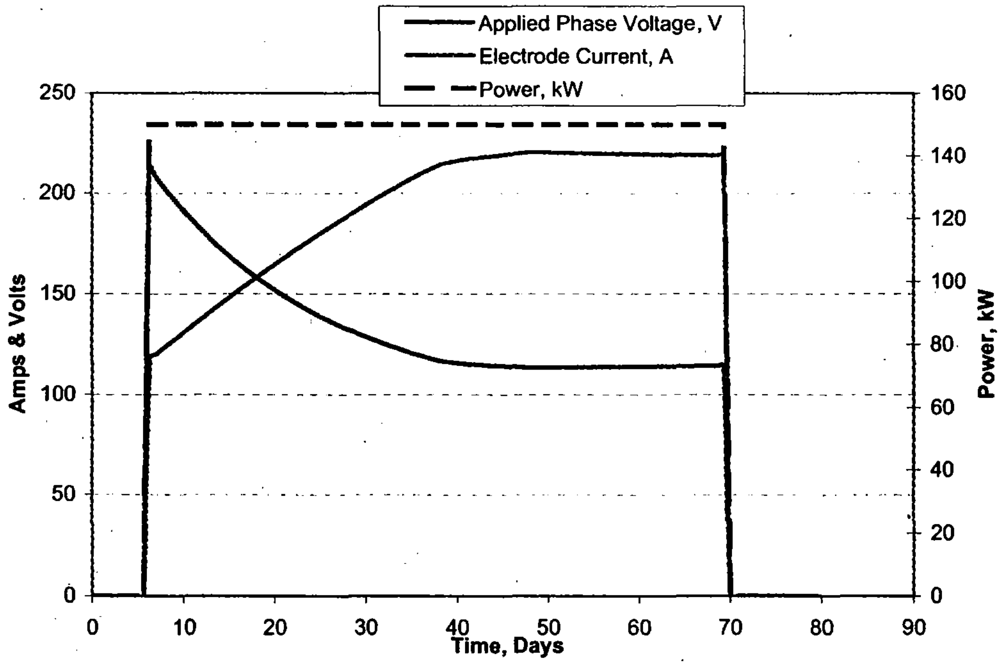
Power Supply Operating Curve



Power Supply Specifications & Electrical Requirements

Site Electrical Power Requirement:	700	kW
Site Service Requirement at 480V, 3-Phase:	800	Amps
Power Supply Rating:	500	kW
Maximum Electrode Voltage:	213	Volts
Maximum Phase Current:	765	Amps

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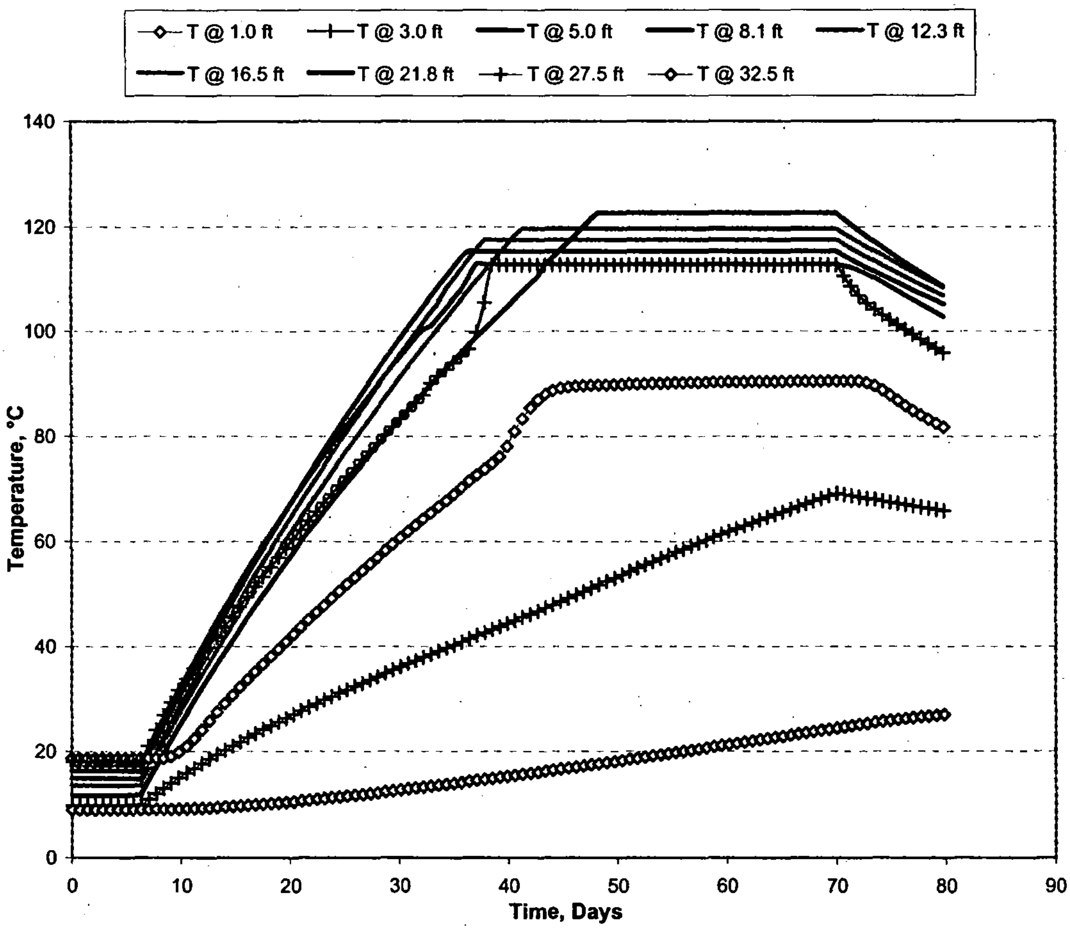
Predicted Subsurface Temperature Trends



Estimated Treatment Time & Energy Requirements

Time to Pre-Heat/Dry Vadose Zone:	0	days
Time to Heat-up Site:	38	days
Time to Treat Site:	26	days
Extra Time for Multiphase Extraction:	6	days
Total Treatment Time:	64	days
Subsurface Energy Estimate:	590,800	kW-hr
Subsurface Energy Density:	538	kw hr/yd3

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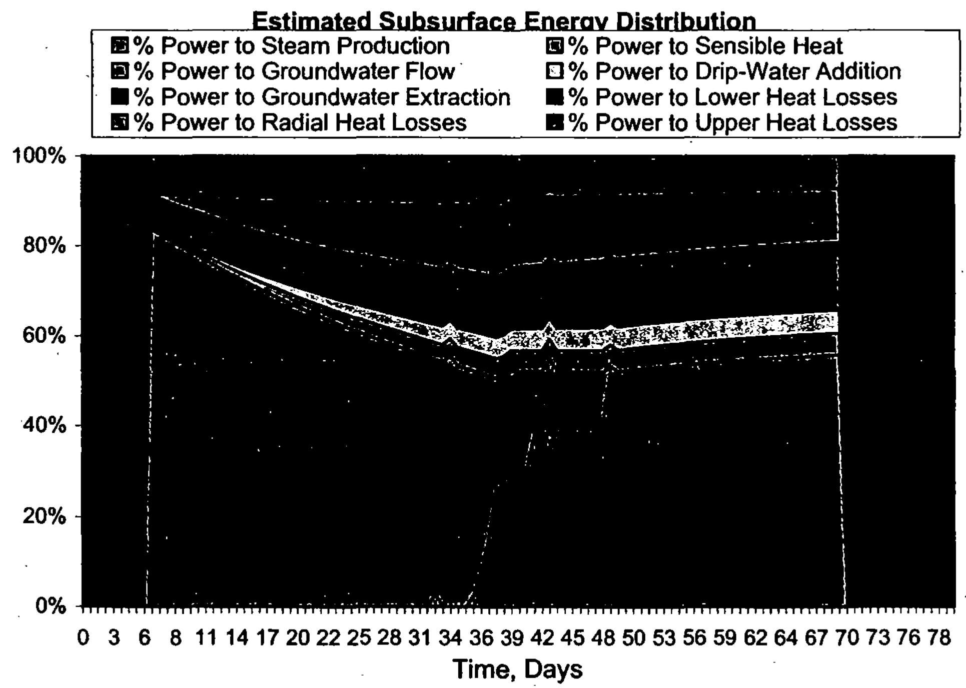
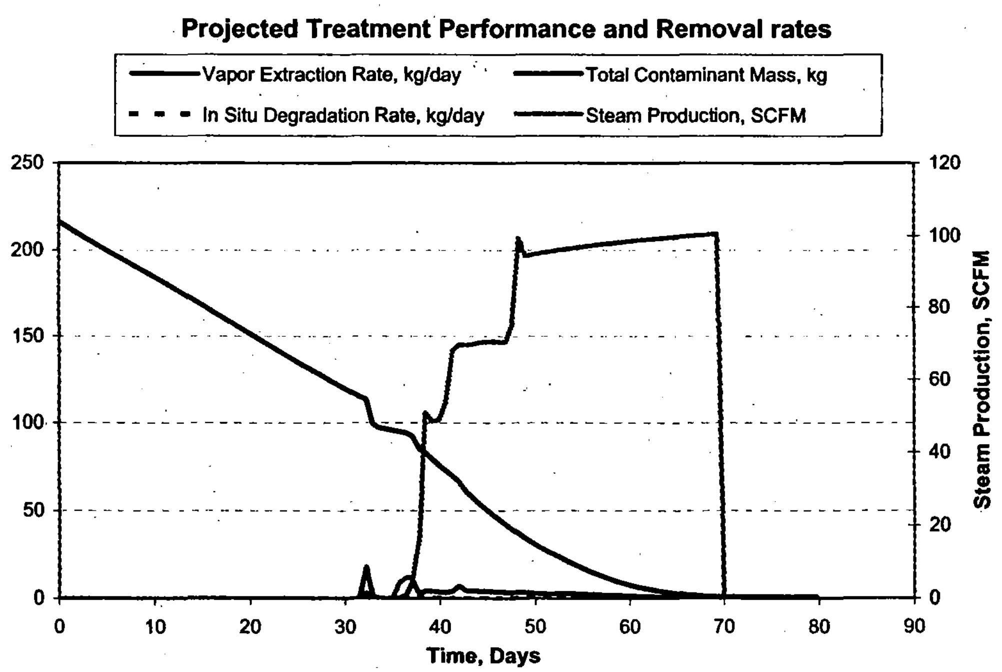
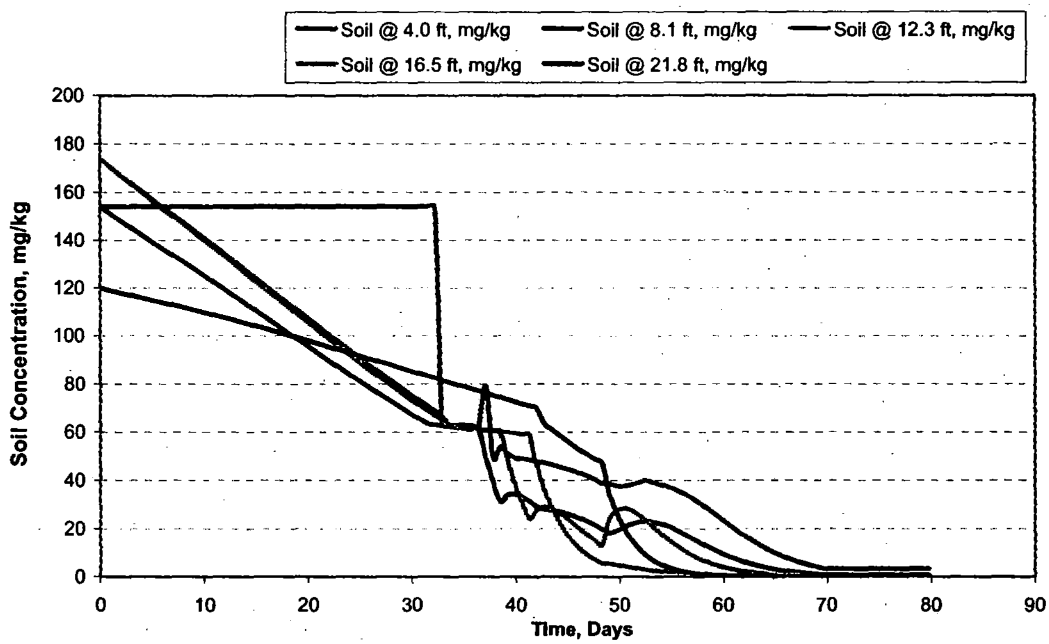




OFFER VALID 60 DAYS

Projected Treatment Performance and Removal rates



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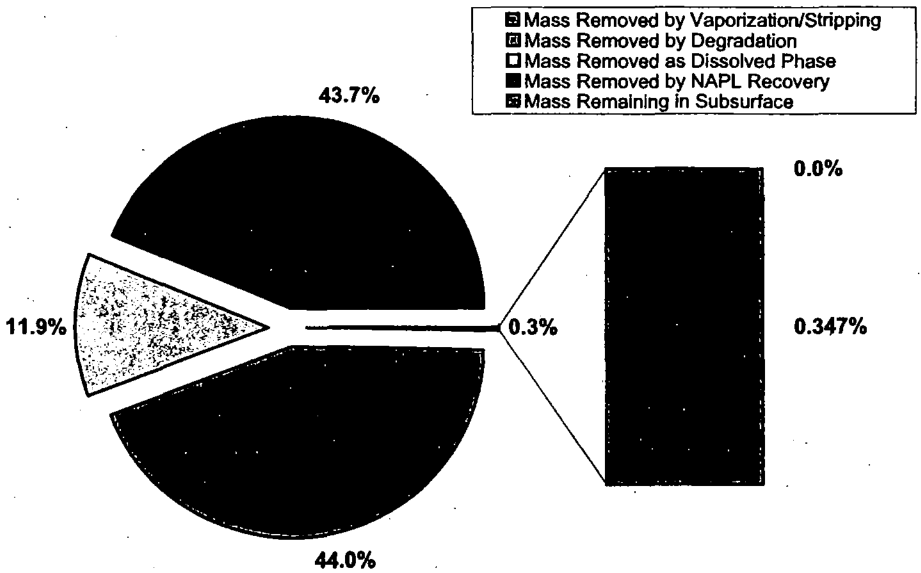
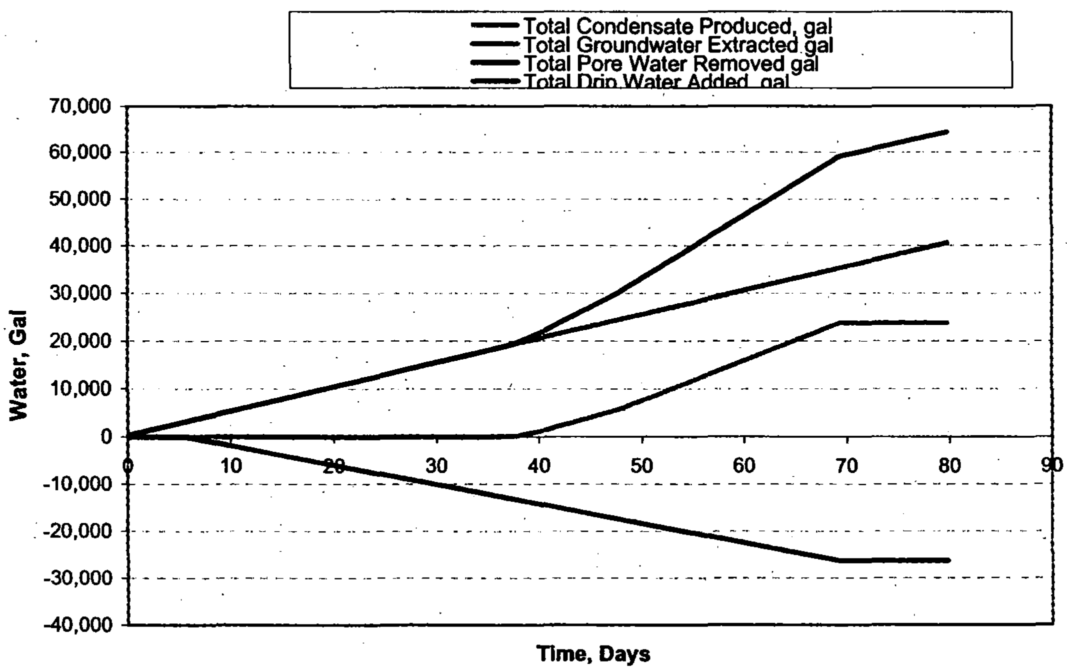
Contaminant Fate Projection



Overall Water Balance



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Preliminary Project Schedule

Assumed Project Start Date: 8/19/2005

Task	Task Description	Duration (Wks)	Total (Wks)	Completion
0	Testing, Modeling, Site Evaluation:	5	5	9/23/2005
1	Design, Work Plans, Permits:	6	11	11/4/2005
2	Subsurface Installation:	1	12	11/11/2005
3	Equipment Mobilization:	2	14	11/25/2005
4	SPH Construction and Setup:	0	14	11/25/2005
5	SVE Construction and Setup:	1	15	12/2/2005
6	Start-Up Operations:	1	16	12/9/2005
7	SPH, DVE and SVE Operation:	11	27	2/24/2006
8	Demobilization and Final Report:	2	29	3/10/2006

Cost Assumptions

Electricity	@ $0.10 per kW-hr	
Granular Activated Carbon	@ $3.10 per pound	
Condensate Water Disposal	@ $0.05 per gallon	
Drilling Waste Disposal	@ $50 per ton	(via spread and heat)
Electrode Drilling Installation	@ $41 per foot	
Vent Drilling Installation	@ $37 per foot	
Monitoring Well Installation	@ $23 per foot	

There is a source of potable water on site
Operations proceed with no delay outside of CESs control
Well abandonment by filling with grout is acceptable
Proposed schedule assumes regulatory permit approval time of 3 weeks.
Pre-existing plastic (PVC) monitoring wells have been removed or grouted in place.
Telephone service can be installed at site

Budgetary Project Cost Estimate

Estimated Total Project Cost	**$395,400**
Estimated CES Costs	$380,400
Estimated Costs by Others	n/a

Breakdown of Estimated CES Budget

Lab Testing, Modeling, and Site Evaluation:	$10,400	3%
Design, Work Plans, Permits:	$27,800	7%
Supervise Subsurface Installation:	$38,100	10%
Equipment Construction & Mobilization:	$39,800	10%
SPH Field Construction and Setup:	$33,400	8%
SVE Construction and Setup:	$20,200	5%
Start-Up Operations:	$14,800	4%
SPH Equipment Lease & Operational Support:	$173,700	44%
Demobilization and Final Report:	$22,200	6%
Total Budgetary Estimate for CES Service:	**$380,400**	96%
Service Cost per Additional Week of Operation:	**$10,200**	

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Service Options Included in CES Budget

Number of Confirmatory Soil Borings:	0	
Number of Confirmatory Soil Samples:	0	
Site Evaluation Test?	yes	
Lab Electrical Test?	yes	
Lab Corrosion Tests?	no	Not required
Laboratory Bench Tests?	no	Not required
Contaminant Degradation Tests?	no	Not required
Numerical Modeling?	no	Not required
Air Permit?	yes	
Sewer Discharge Permit?	no	Client to provide
Building Permit?	yes	
Well Logs and Report?	no	Client to provide
Soil Analyses?	yes	
Vapor Analyses?	yes	
Water Analyses?	yes	
Locator Survey?	yes	
Forklift Rental?	no	Client to provide
Security/Exclusion Zone Fence?	yes	
Sound Wall for Blower?	yes	
Electrode Abandonment?	yes	
Post-Remediation Site Restoration?	no	Client to provide

Budgetary Estimate for Services not Included in CES Budget

Electrical Utility Connection:	$15,000.00	4%
Electrical Use:	$0.00	0%
Drill Cuttings and Water Disposal:	$0.00	0%
Carbon Use, Trans. & Regeneration:	$0.00	0%
Soil, Water, Vapor Analyses:	$0.00	0%
Well Logs, Geologist Supervision:	$0.00	0%
Subcontract Drilling Service:	$0.00	0%
Trenching & Concrete Cutting Service:	$0.00	0%
Construction Clearing, Grading Service:	$0.00	0%
Site Cap Materials:	$0.00	0%
Other Work Performed by Client:	$0.00	0%
Services Typically Required but Not Included:	**$15,000.00**	4%