



Remedial Alternatives Evaluation Report  
Old Navy Fuel Farm, Naval Air Station,  
Brunswick, Maine

Contract No. N62472-92-D-1296  
Contract Task Order No. 0035



Prepared for

Department of the Navy  
Northern Division  
Naval Facilities Engineering Command  
10 Industrial Highway  
Mail Stop No. 82  
Lester, Pennsylvania 19113-2090

Prepared by

EA Engineering, Science, and Technology  
The Maple Building  
3 Washington Center  
Newburgh, New York 12550

June 2000  
FINAL  
296.0035



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Alexander C. Easterday, P.G.  
CTO Manager

23 JUNE 2000

Date



Robert S. Pace  
Program Manager

23 JUN 2000

Date

June 2000  
FINAL  
Project No. 296.0035

## QUALITY REVIEW STATEMENT

Contract No. N62472-92-D-1296

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Contract Task Order No. 0035

Activity: Naval Air Station, Brunswick, Maine

### Description of Report/Deliverable:

Final Remedial Alternatives Evaluation Report, Old Navy Fuel Farm, Naval Air Station, Brunswick, Maine

EA CTO Manager: Alexander C. Easterday, P.G.

In compliance with EA's Quality Procedures for review of deliverables outlined in the Quality Management Plan, this final deliverable has been reviewed for quality by the undersigned Senior Technical Reviewer(s). The information presented in this report/deliverable has been prepared in accordance with the approved Implementation Plan for the Contract Task Order (CTO) and reflects a proper presentation of the data and/or the conclusions drawn and/or the analyses or design completed during the conduct of the work. This statement is based upon the standards identified in the CTO and/or the standard of care existing at the time of preparation.

Senior Technical Reviewer(s)



Douglas E. McClure, P.E., L.E.P.

Senior Technical Reviewer

6/23/00

(Date)

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## 1. INTRODUCTION

### 1.1 GENERAL

Under Contract No. N62472-92-D-1296, Northern Division, Naval Facilities Engineering Command issued Contract Task Order No. 0035 to EA Engineering, Science, and Technology to perform a remedial technology evaluation at the Old Navy Fuel Farm, Naval Air Station (NAS), Brunswick, Maine. The purpose of this evaluation is to determine the best available treatment technology to remediate the petroleum-impacted soil. This evaluation is based on the findings reported in the *Final Bi-Annual Progress Report on Soil Vapor Extraction/Aquifer Air Sparging Remedial System Operations for the Period 1 January through 30 June 1999, Old Navy Fuel Farm, Naval Air Station, Brunswick, Maine* and the direct-push investigation conducted in August 1999 (EA 1999a, 2000). The location of the subject site is shown on Figure 1-1 (as adapted from the Brunswick, Maine, U.S. Geological Survey 7.5-minute series topographic quadrangle map).

### 1.2 SITE DESCRIPTION

The Old Navy Fuel Farm site is located on the northeast portion of NAS Brunswick. The site is bounded on the south by Fitch Avenue, on the west by 6<sup>th</sup> Street, and to the north and east by undeveloped land. The general site layout that constitutes the areas undergoing remediation via the soil vapor extraction (SVE) and aquifer air sparging (AAS) system is provided on Figure 1-2. The topography of the site area is characterized as flat and exhibits little relief. Surface grade consists of a level field of grass and paved access roads. The site is not located within 2,000 ft of the Brunswick public water supply wells, and the site ground water is not used for public drinking water.

### 1.3 SITE HISTORY

Prior to decommissioning in 1993, the Old Navy Fuel Farm consisted of two separate petroleum bulk storage tank farms which included a total of 9 mounded underground storage tanks (Figure 1-3). The underground storage tanks, piping, and associated appurtenances were removed during facility decommissioning. The older, western tank farm included 5 underground storage tanks, previously identified as underground storage tanks T-101 through T-105. Underground storage tanks T-101 through T-103 were 100,000-gal capacity tanks used for storage of petroleum sludge, unleaded gasoline, and aviation gasoline, respectively. Underground storage tanks T-104 and T-105 were 25,000-gal capacity tanks used for storage of ethylene glycol (deicing fluid). The newer eastern Fuel Farm included four underground storage tanks previously identified as underground storage tanks T-202 through T-205, which were used from 1953 to 1993. Each of these 567,000-gal capacity underground storage tanks was used for storage of JP-5 fuel.

## 1.4 PREVIOUS ENVIRONMENTAL INVESTIGATIONS/REMEDIATION

O'Brien & Gere Engineers, Inc. performed site investigations at the Old Navy Fuel Farm and identified two distinct dissolved-phase hydrocarbon plumes (O'Brien & Gere Engineers, Inc. 1990, 1992). The first plume was identified in the east-central portion of the Old Navy Fuel Farm and appeared to originate in the vicinity of a former JP-5 underground storage tank. The second dissolved-phase hydrocarbon plume was located in the north-central portion of the western half of the Old Navy Fuel Farm and appeared to originate in the vicinity of the former glycol tanks (T-104 and T-105). Both dissolved-phase ground-water plumes exhibited elevated concentrations of benzene, toluene, ethylbenzene, and total xylenes (BTEX); total petroleum hydrocarbon (TPH) diesel range organics (DRO); and TPH gasoline range organics (GRO) compounds. Glycol is not a contaminant of concern at the Old Navy Fuel Farm. Figures 1-4 and 1-5 depict the approximate present extent of the combined dissolved-phase ground-water plume based on the June 1999 sampling data for BTEX and TPH-GRO (EA 1999a).

### 1.4.1 Soil Vapor Extraction/Aquifer Air Sparging System Installation

In order to actively remediate the dissolved-phase hydrocarbon plume, an SVE/AAS system was installed in 1995 (OHM Remediation Services Corporation 1995; EA 2000) (Figure 1-2). However, following system startup, normal SVE operations could not be initiated due to the shallow depth of ground water. The system was idle until August 1996 when the AAS system was activated as a biosparging system to promote degradation of soil volatile organic compounds (VOCs). The system operated in this mode until December 1998. A significant reduction in the concentrations of dissolved-phase hydrocarbons in ground water was observed from 1996 to 1998 as noted in bi-annual ground-water sampling reports (EA 1997a, 1997b, 1998a, 1998b, 1999a, 1999b). The biosparging system was deactivated in December 1998 to construct a more efficient system using normal SVE/AAS operations, including a dewatering system to lower the site ground-water table. Note that the location of the SVE/AAS system on Figure 1-2 is approximate and not based on survey information.

### 1.4.2 Dewatering Pilot and Full-Scale Study

In order to effectively utilize the SVE system, a dewatering pilot study was completed to lower the water table surrounding the SVE process piping to allow SVE operations and to capture VOCs liberated by sparging (EA 1999c). The system included the installation of a 2,000-gal underground moisture separation tank, dewatering pump and discharge piping, system controls, and process instrumentation. The moisture separation tank was piped in series with the SVE system for ground-water removal from the SVE piping under vacuum. Installation of the dewatering system was completed by the end of February 1999, and the system was activated in March 1999. The recovered ground water was pumped to the sanitary sewer under the Brunswick Sewer District's consent with monthly sampling. As dewatering activities continued, a corresponding gradual increase in VOC emissions necessitated the need for off-gas treatment. In June 1999, a 5,000-lb vapor-phase carbon vessel was added to the system to reduce VOC emissions to below base-permitted levels.

### 1.4.3 Soil Vapor Extraction/Aquifer Air Sparging System Expansion

Based on the bi-annual ground-water sampling conducted from 1996 to 1998, it was determined that impacted ground water to the north of the western dissolved-phase plume was outside the influence of the existing SVE/AAS system. In October 1998, 6 additional sparge wells were installed to remediate impacted ground water in this area (Figure 1-2). In June 1999, trenches were excavated for installation of the AAS feed piping to connect the additional sparge points and install slotted SVE piping. During excavation, it was observed that the excavated soil was visually impacted with petroleum hydrocarbons. The system expansion was completed and brought on-line at the end of June 1999 which resulted in a significant increase in the intake rate of hydrocarbons. During July 1999, the system was de-activated due to saturation of the 5,000-lb vapor-phase carbon vessel.

### 1.5 DIRECT-PUSH SOIL INVESTIGATION

Based upon observations during the system expansion (visual observation of petroleum-contaminated soils), and the increased intake rate of petroleum hydrocarbons, it was recommended to perform a direct-push site investigation throughout the Old Navy Fuel Farm. The purpose of the direct-push site investigation program was to delineate petroleum-impacted source soil and to quantify the volume of soil that needs to be addressed. Therefore, from 9 August to 2 September 1999, a direct-push site investigation was conducted in areas of suspected contamination (EA 2000). The direct-push sampling locations are shown on Figure 1-6. Soil samples were collected by Geoprobe<sup>®</sup> and analyzed using a mobile gas chromatograph for BTEX with select samples analyzed for TPH-gasoline range organics and TPH-diesel range organics. Samples were also screened for total VOCs utilizing a Foxboro Total Vapor Analyzer-1000 photoionization detector (PID)/flame ionization detector (FID) utilizing the jar headspace technique (MEDEP 1996). An interpretive isopleth map based on PID/FID headspace readings is shown on Figure 1-7. It should be noted that the PID/FID headspace readings are field data values; no calibration set point adjustment was conducted.

### 1.6 ESTABLISHING CLEANUP STANDARDS

The State of Maine Department of Environmental Protection (MEDEP) *Procedural Guidelines for Establishing Standards for the Remediation of Oil-Contaminated Soil and Ground Water in Maine* (Appendix A) was reviewed as a first step in establishing a defensible performance standard for soil and ground-water cleanup at the Old Navy Fuel Farm. Following the guidance document's decision tree approach, the Old Navy Fuel Farm is located within a non-attainment zone, a zone where ground water will not be withdrawn for human use because of environmental and/or institutional factors.

Further clarification of the non-attainment definition includes meeting the following: (1) the zone is in an urban or other heavily developed area comprised predominantly of dense commercial or industrial land uses, or dense residential (0.5-acre lots or less); (2) the area within 2,000 ft downgradient and 1,000 ft upgradient of the leak or spill must be served by public water;

(3) no public drinking water supply wells are located within 1,000 ft of the discharge; and (4) the site of the leak or spill must not be within 2,000 ft of a public water supply well or within the wellhead protection zone of a public water supply well.

The next step in the decision tree is to address whether or not there is a potential for vapor problems within buildings or for a confined space fire or explosion. Since the site is currently not occupied by any structures or confined spaces, there is limited or no potential for these problems to occur at the Old Navy Fuel Farm. This fact leads to the final step under the MEDEP guidelines, which establishes the Old Navy Fuel Farm as a baseline site. Under Baseline Cleanup Goals, two established standards exist: Baseline-1 (BL1) and Baseline-2 (BL2). The two categories reflect current and historical land use. The BL1 standard is for industrial areas and the BL2 standard is for other land uses. Since the Old Navy Fuel Farm has historically been an industrial area, the BL1 standard applies. The BL1 cleanup goal is to remove free-product and to remove or remediate soil "saturated" with gasoline, kerosene, or fuel oil. Appendix A provides further definition of "saturated" soil. Free-product has historically not been observed at the Old Navy Fuel Farm. There are no cleanup standards for dissolved-phase ground-water contamination under the BL1 standard. After removal of free-product and saturated soil, residual contamination left in the soil may be a source for dissolved contamination in ground water. Where this goal is applied, it is assumed that the ground water will not be used for human consumption and will not discharge to the surface until significant natural attenuation of the contamination has occurred.

Based on the proposed reuse of the Old Navy Fuel Farm site, the Navy does not feel that the State of Maine BL1 cleanup goal would be protective of human health. Therefore, historical Department of Defense risk assessments performed at sites in the State of Maine that were similar to the Old Navy Fuel Farm were examined for applicability. Risk-based preliminary remediation goals (PRGs) have been developed at two sites in the State of Maine that are similar to the Old Navy Fuel Farm. The first was developed by the Navy at Casco Bay in Harpswell, Maine. The calculated risk-based PRG at Casco Bay was 870 mg/kg of TPHs in soil. The second risk-based PRG was developed by the Air Force at Loring Air Force Base in Limestone, Maine. The calculated risk-based PRG at Loring was 842 mg/kg of TPHs in soil. For the purposes of this remedial alternatives report, 870 mg/kg will be used as the PRG at the Old Navy Fuel Farm.

## 1.7 OBJECTIVES

The volume of soil in excess of 870 mg/kg to be addressed at the Old Navy Fuel Farm was approximated based on PID/FID field measurements taken during the 1999 direct-push site investigation (EA 2000). An interpretive isopleth map based on PID/FID headspace readings is found on Figure 1-7. It should be noted that the PID/FID headspace readings are field data values; no calibration set point adjustment was conducted. The data used to generate the isopleth contours are found in Appendix B. For the purposes of this technology evaluation, soil concentrations in excess of 870 mg/kg has been defined as a PID reading of greater than 328 ppm based on a 2.65 PID set point adjustment and/or an occurrence of FID flameout during collection of headspace readings. The 2.65 set point adjustment is based on the MEDEP jar/poly bag headspace technique for the conversion of a Foxboro Total Vapor Analyzer-1000 PID

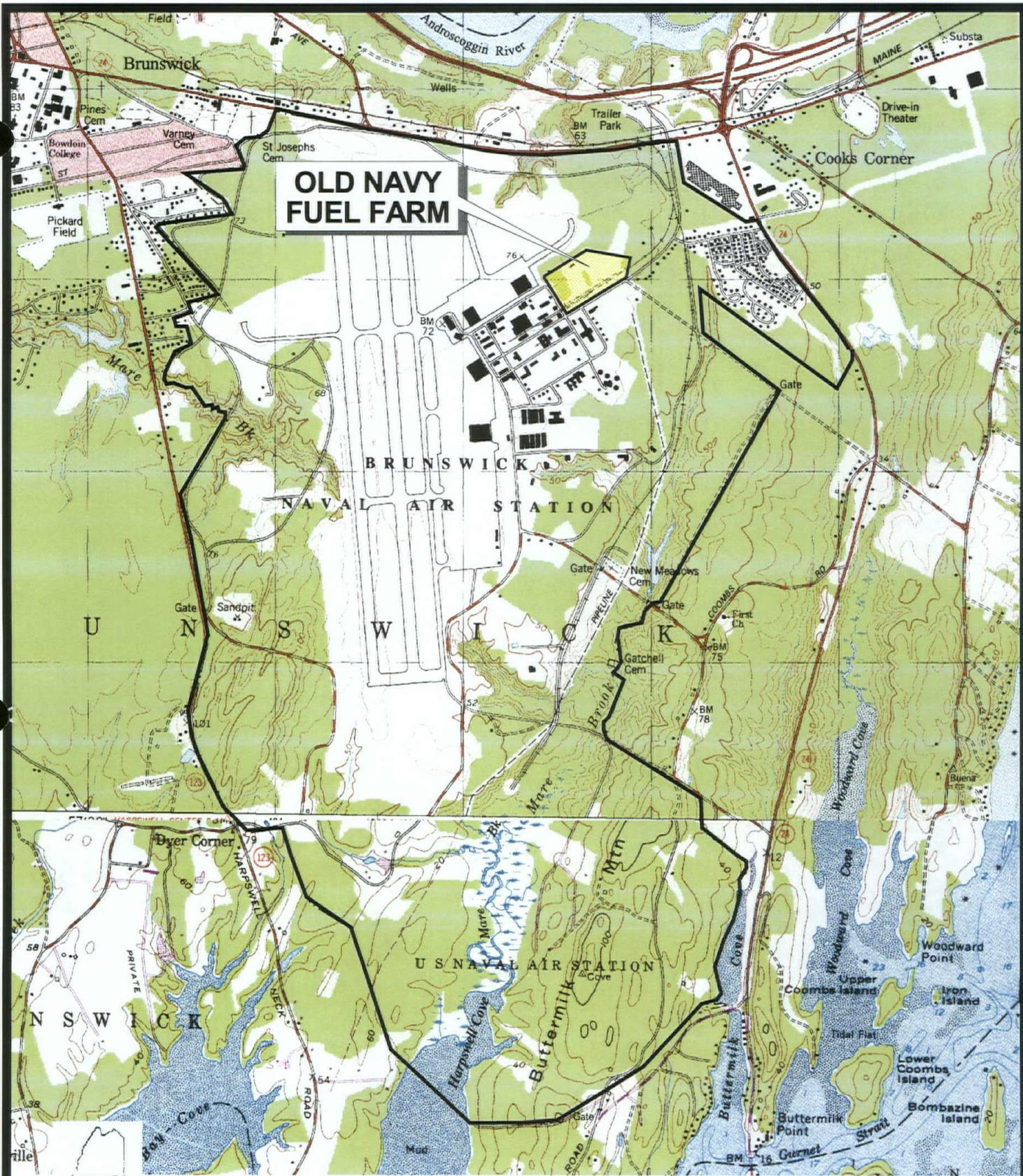
produce an equivalent result for gasoline work based on validated instrument response factors (Appendix C). FID flameout occurred when total volatile hydrocarbons are present in a headspace at concentrations greater than 22.7 percent. Based upon the interpretive isopleth found on Figure 1-7, in conjunction with a 3-ft average thickness of contamination as observed in the direct-push sampling data (Appendix B), there is approximately 12,500 yd<sup>3</sup> of soil in excess of 870 mg/kg at the Old Navy Fuel Farm. This volume includes a 25 percent contingency as a safety factor.

The Navy has identified a target date for site closure by June 2001. Therefore, the objective of this report is to evaluate alternative remedial technologies to address the 12,500 yd<sup>3</sup> of soil contamination in excess of 870 mg/kg TPH within a 1-year time frame at the Old Navy Fuel Farm. Dissolved-phase ground-water contamination will not be addressed in this report.

The technologies selected for evaluation for the remediation of soil contamination are listed below and can be found in the following sections:

Section	Remedial Technology
2.1.1	Excavation of Soil Outside the Influence of SVE/AAS System/Continue Current SVE/AAS Operations
2.1.2	<i>In Situ</i> Chemical Oxidation
2.1.3	Excavation/Offsite Asphalt Blending
2.1.4	Excavation/Onsite Thermal Desorption
2.1.5	Excavation/Land Farming Offsite
2.1.6	Excavation/Land Farming Onsite
2.1.7	Excavation/Offsite Thermal Desorption
2.1.8	Excavation/Biopile Constructed Onsite
2.1.9	<i>Ex Situ</i> Chemical Oxidation

It must be noted that with the limited time between February 2000 and June 2001, the target date for site closure will require an aggressive schedule be set forth for the selected alternative, and that field work commence in early Spring 2000.



**OLD NAVY FUEL FARM**

**BRUNSWICK NAVAL AIR STATION**

**U S NAVAL AIR STATION**

2000 0 2000 Feet

SOURCE MAPS: USGS ORRS ISLAND (1978) AND BRUNSWICK (1980) 7.5 MINUTE QUADRANGLES.

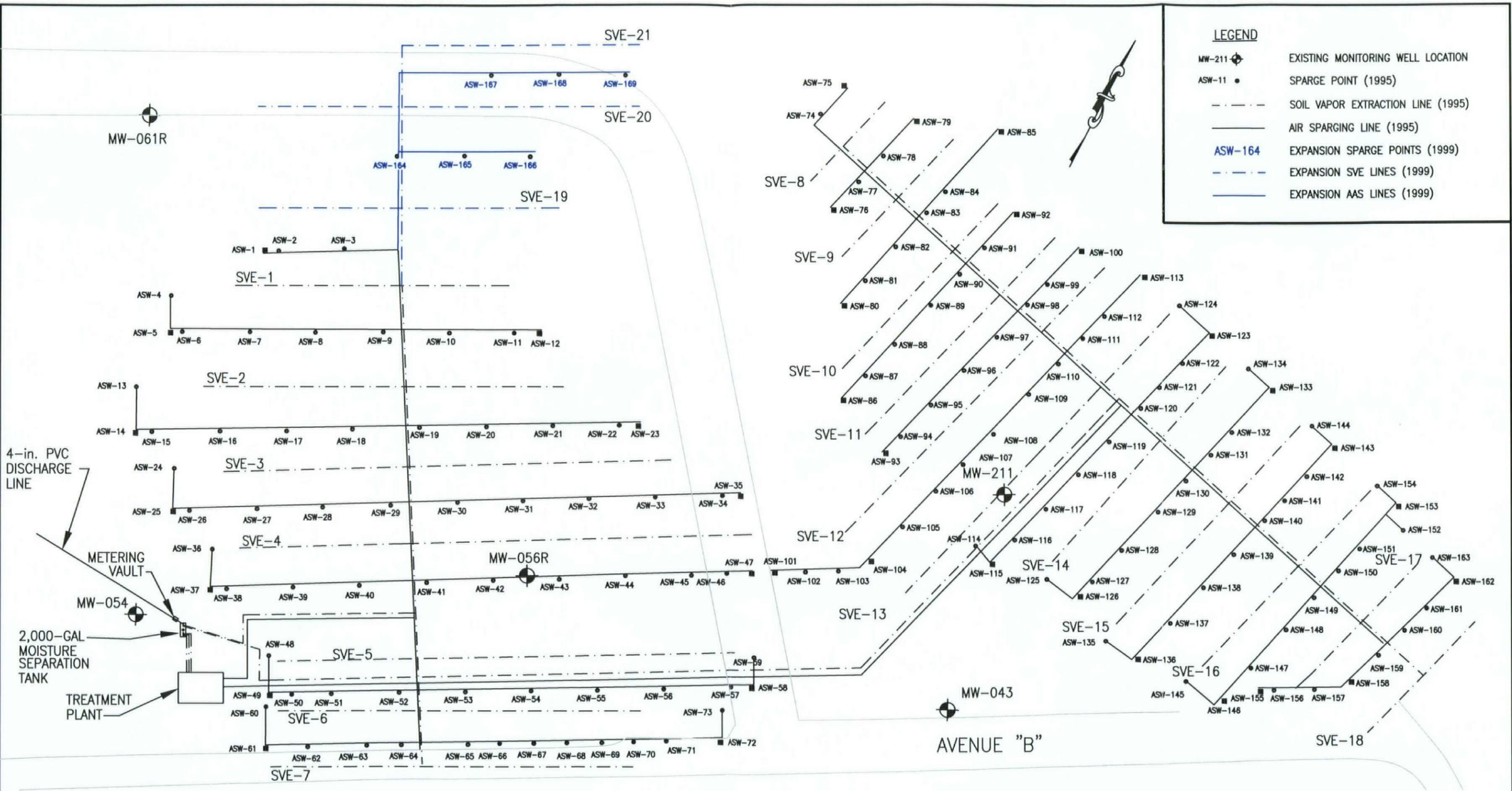


EA ENGINEERING,  
SCIENCE, AND  
TECHNOLOGY

OLD NAVY FUEL FARM  
NAVAL AIR STATION  
BRUNSWICK, MAINE

FIGURE I - I  
SITE LOCATION MAP

PROJECT MGR	DESIGNED BY	DRAWN BY	CHECKED BY	SCALE	DATE	PROJECT No	FILE No
JAC	BT	BT	CEM	AS SHOWN	29 DEC. 1999	29600.35	I:\NASB_GIS \NAVY.APR



**LEGEND**

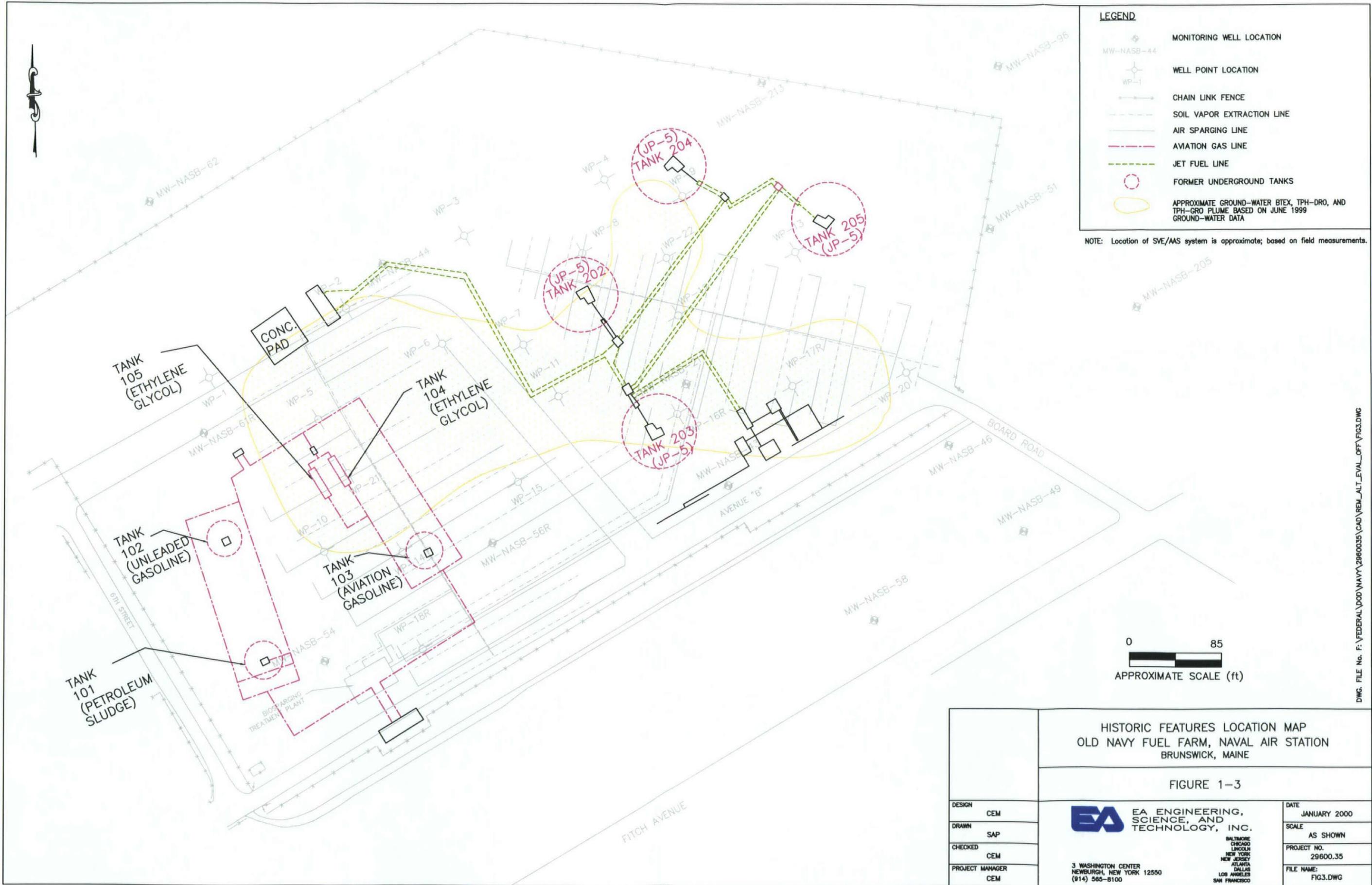
- MW-211 EXISTING MONITORING WELL LOCATION
- ASW-11 SPARGE POINT (1995)
- - - - - SOIL VAPOR EXTRACTION LINE (1995)
- AIR SPARGING LINE (1995)
- ASW-164 EXPANSION SPARGE POINTS (1999)
- - - - - EXPANSION SVE LINES (1999)
- EXPANSION AAS LINES (1999)

100' 0 100'  
SCALE: 1"=100'

DWG. FILE No. F:\FEDERAL\DOD\NAVY\2960035\CAD\REM\_ALT\_EVAL\_OFF\FIG2.DWG

GENERAL SITE LAYOUT OLD NAVY FUEL FARM, NAVAL AIR STATION BRUNSWICK, MAINE		FIGURE 1-2		
DESIGN CEM	 <b>EA ENGINEERING, SCIENCE, AND TECHNOLOGY, INC.</b>  3 WASHINGTON CENTER NEWBURGH, NEW YORK 12550 (914) 565-8100	DATE 11 OCTOBER 1999	SCALE AS SHOWN	
DRAWN BT		MULTIPLE CHECKS LINDA NEW YORK NEW JERSEY ALAN ILLINOIS LOS ANGELES SAN FRANCISCO	PROJECT NO. 29600.35	FILE NAME FIG2.DWG
CHECKED DSS				
PROJECT MANAGER JAC				

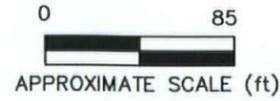
ADAPTED FROM PRELIMINARY OPERATIONS AND MAINTENANCE PLAN (OHM 1995)



**LEGEND**

- MONITORING WELL LOCATION
- WELL POINT LOCATION
- CHAIN LINK FENCE
- SOIL VAPOR EXTRACTION LINE
- AIR SPARGING LINE
- AVIATION GAS LINE
- JET FUEL LINE
- FORMER UNDERGROUND TANKS
- APPROXIMATE GROUND-WATER BTEX, TPH-DRO, AND TPH-GRO PLUME BASED ON JUNE 1999 GROUND-WATER DATA

NOTE: Location of SVE/AAS system is approximate; based on field measurements.

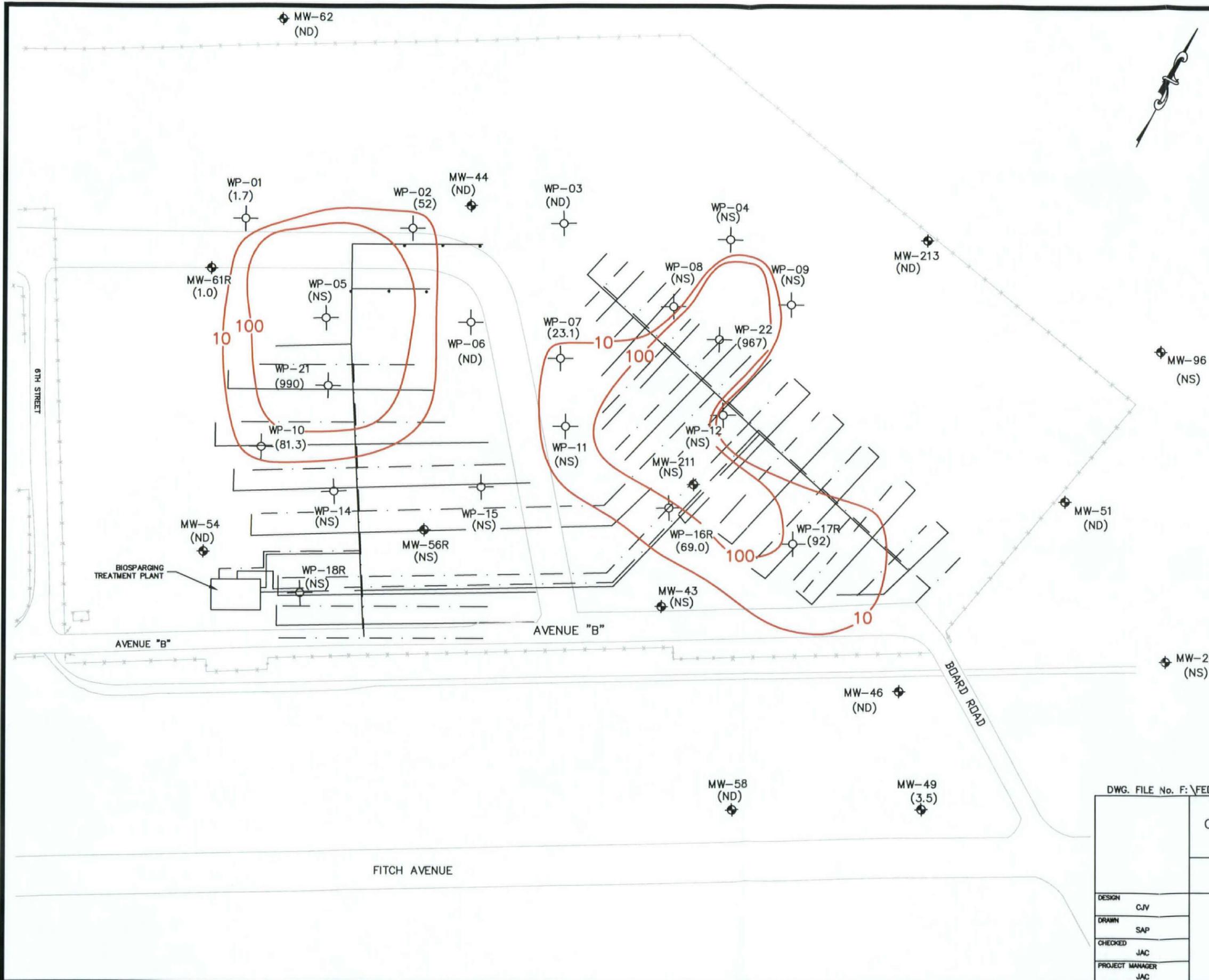


HISTORIC FEATURES LOCATION MAP  
 OLD NAVY FUEL FARM, NAVAL AIR STATION  
 BRUNSWICK, MAINE

FIGURE 1-3

DESIGN	CEM	 <b>EA ENGINEERING,          SCIENCE, AND          TECHNOLOGY, INC.</b> <small>BALTIMORE          CHICAGO          LINCOLN          NEW YORK          NEW JERSEY          NEW JERSEY          ATLANTA          DALLAS          LOS ANGELES          SAN FRANCISCO</small>	DATE	JANUARY 2000
DRAWN	SAP		SCALE	AS SHOWN
CHECKED	CEM		PROJECT NO.	29600.35
PROJECT MANAGER	CEM		FILE NAME:	FIG3.DWG

DWG. FILE No. F:\FEDERAL\DOO\NAVY\2960035\CAD\REM\_ALT\_LEVEL\_OFF\FIG3.DWG



**LEGEND**

- MONITORING WELL LOCATION  
 DISSOLVED-PHASE BTEX  
 CONCENTRATION, ug/L  
 NS = LOCATION NOT SAMPLED  
 ND = NOT DETECTED
- WELL POINT LOCATION  
 DISSOLVED-PHASE BTEX  
 CONCENTRATION, ug/L  
 NS = LOCATION NOT SAMPLED  
 ND = NOT DETECTED
- CHAIN LINK FENCE
- SOIL VAPOR EXTRACTION LINE
- AIR SPARGING LINE
- 100 ——— INTERPRETED GROUND-WATER  
 DISSOLVED-PHASE BTEX  
 CONCENTRATION ISOPLETH  
 (DASHED WHERE INFERRED)

**NOTE:**

- CONTOURS SHOWN REPRESENT EA'S EVALUATION OF THE PROBABLE CONDITIONS BASED UPON INTERPRETATION OF THE PRESENTLY AVAILABLE DATA. SOME VARIATIONS FROM THESE CONDITIONS COULD BE EXPECTED.

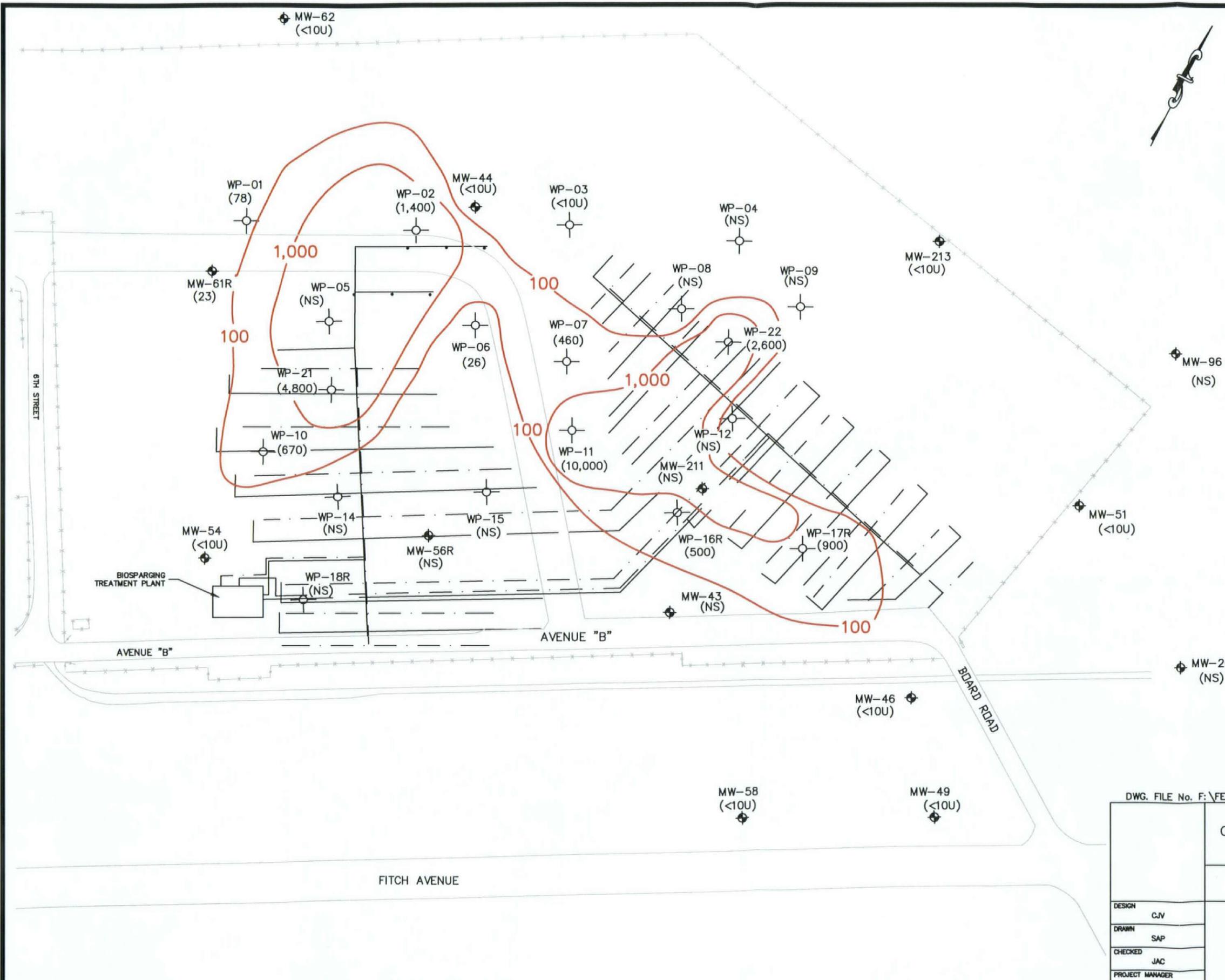
**BTEX INTERPRETED ISOPLETH INTERVAL**

10 ug/L  
100 ug/L

0 85  
APPROXIMATE SCALE (ft)

DWG. FILE No. F:\FEDERAL\DOD\NAVY\2960035\CAD\FFO&M\JANJUN99\FIG1-4.DWG

INTERPRETED DISSOLVED-PHASE BTEX CONCENTRATION ISOPLETH MAP, GROUND-WATER SAMPLES COLLECTED 15-18 JUNE 1999 OLD NAVY FUEL FARM, NAS BRUNSWICK, MAINE	
FIGURE 1-4	
DESIGN CJV DRAWN SAP CHECKED JAC PROJECT MANAGER JAC	EA ENGINEERING, SCIENCE, AND TECHNOLOGY, INC. BALTIMORE CHICAGO LINCOLN NEW YORK NEW JERSEY ATLANTA DALLAS LOS ANGELES SAN FRANCISCO
DATE 13 OCTOBER 1999 SCALE AS SHOWN PROJECT NO. 29600.35 FILE NAME: FIG1-4.DWG	3 WASHINGTON CENTER NEWBURGH, NEW YORK 12550 (914) 565-8100



**LEGEND**

- MONITORING WELL LOCATION  
 DISSOLVED-PHASE TPH-GRO  
 CONCENTRATION, ug/L  
 NS = LOCATION NOT SAMPLED  
 (<10U) = NOT DETECTED > 10 ug/L
- WELL POINT LOCATION  
 DISSOLVED-PHASE TPH-GRO  
 CONCENTRATION, ug/L  
 NS = LOCATION NOT SAMPLED
- CHAIN LINK FENCE
- SOIL VAPOR EXTRACTION LINE
- AIR SPARGING LINE
- 100 — INTERPRETED GROUND-WATER  
 DISSOLVED-PHASE TPH-GRO  
 CONCENTRATION ISOPLETH  
 (DASHED WHERE INFERRED)

**NOTE:**  
 1. CONTOURS SHOWN REPRESENT EA'S EVALUATION OF THE PROBABLE CONDITIONS BASED UPON INTERPRETATION OF THE PRESENTLY AVAILABLE DATA. SOME VARIATIONS FROM THESE CONDITIONS COULD BE EXPECTED.

**TPH AS GASOLINE RANGE ORGANICS (TPH-GRO) ISOPLETH INTERVAL**

100 ug/L  
 1,000 ug/L

0 85  
 APPROXIMATE SCALE (ft)

DWG. FILE No. F:\FEDERAL\DOD\NAVY\2960035\CAD\FFO&M\JANJUN99\FIG1-5.DWG

**INTERPRETED DISSOLVED-PHASE TPH-GRO CONCENTRATION ISOPLETH MAP, GROUND-WATER SAMPLES COLLECTED 15-18 JUNE 1999 OLD NAVY FUEL FARM, NAS BRUNSWICK, MAINE**

**FIGURE 1-5**

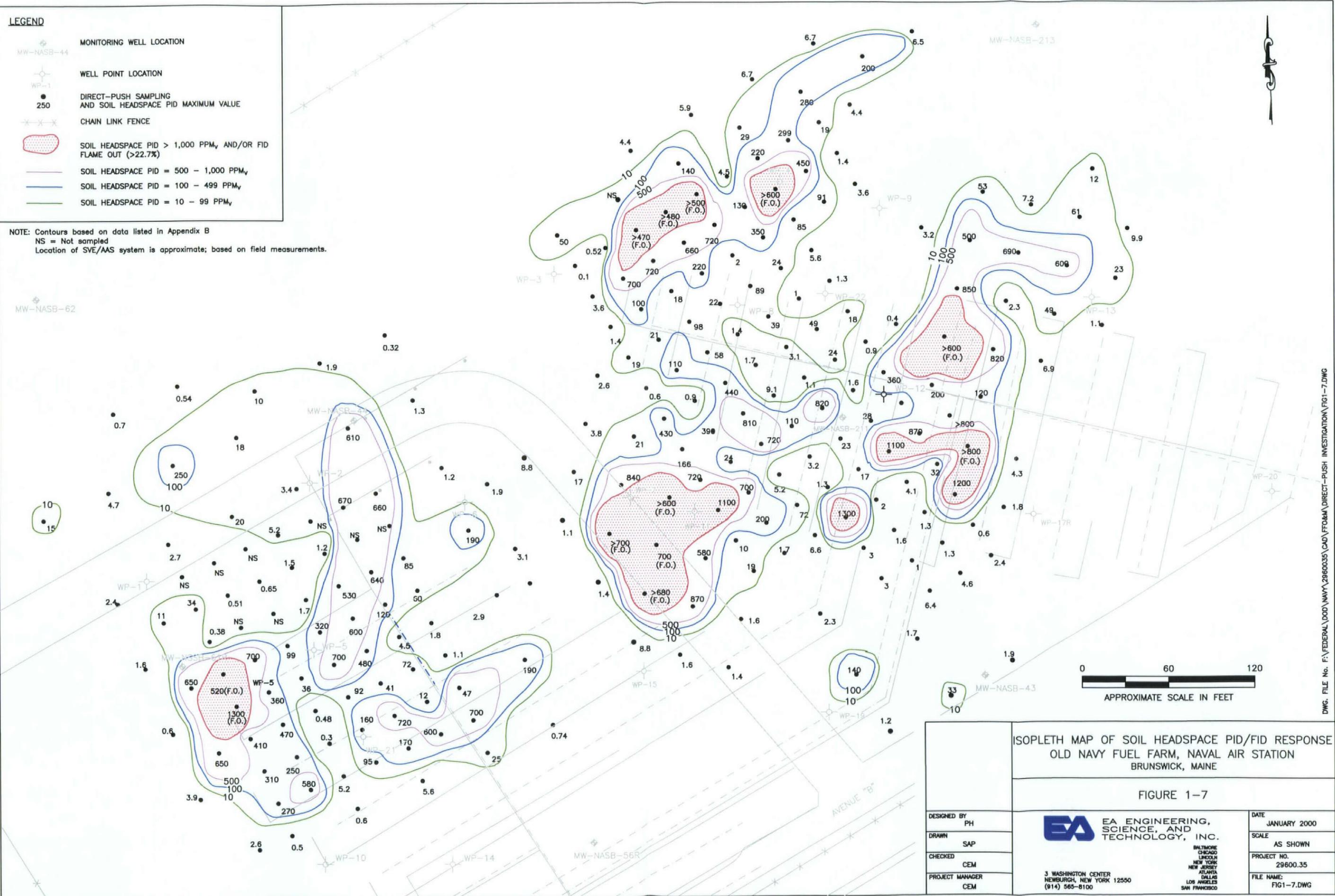
DESIGN	CJV	 <b>EA ENGINEERING, SCIENCE, AND TECHNOLOGY</b> BALTIMORE CHICAGO LINCOLN NEW YORK NEW JERSEY ATLANTA DALLAS LOS ANGELES SAN FRANCISCO	DATE	13 OCTOBER 1999
DRAWN	SAP		SCALE	AS SHOWN
CHECKED	JAC		PROJECT NO.	29600.35
PROJECT MANAGER	JAC		FILE NAME:	FIG1-5.DWG
3 WASHINGTON CENTER NEWBURGH, NEW YORK 12550 (914) 565-8100				



**LEGEND**

-  MONITORING WELL LOCATION
-  WELL POINT LOCATION
-  DIRECT-PUSH SAMPLING AND SOIL HEADSPACE PID MAXIMUM VALUE
-  CHAIN LINK FENCE
-  SOIL HEADSPACE PID > 1,000 PPM<sub>v</sub> AND/OR FID FLAME OUT (>22.7%)
-  SOIL HEADSPACE PID = 500 - 1,000 PPM<sub>v</sub>
-  SOIL HEADSPACE PID = 100 - 499 PPM<sub>v</sub>
-  SOIL HEADSPACE PID = 10 - 99 PPM<sub>v</sub>

NOTE: Contours based on data listed in Appendix B  
 NS = Not sampled  
 Location of SVE/AAS system is approximate; based on field measurements.



ISOPLETH MAP OF SOIL HEADSPACE PID/FID RESPONSE  
 OLD NAVY FUEL FARM, NAVAL AIR STATION  
 BRUNSWICK, MAINE

FIGURE 1-7

DESIGNED BY PH	 <b>EA ENGINEERING, SCIENCE, AND TECHNOLOGY, INC.</b> BALTIMORE CHICAGO LINCOLN NEW YORK NEW JERSEY NEW JERSEY ATLANTA DALLAS LOS ANGELES SAN FRANCISCO	DATE JANUARY 2000
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PROJECT MANAGER CEM		FILE NAME: FIG1-7.DWG

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## 2. IDENTIFICATION AND SCREENING OF TECHNOLOGY TYPES AND PROCESS OPTIONS

In this chapter, the technologies selected for evaluation are assembled and screened for applicability at the Old Navy Fuel Farm. The technologies are evaluated against the short-term and long-term aspects of three broad criteria: effectiveness, implementability, and cost. A screening step is used to identify those technologies for further consideration as remedial action alternatives.

### 2.1 SCREENING OF TECHNOLOGIES

The first step in a technology screening for site remediation is to examine the remedial technologies and to identify those technologies that warrant further consideration based on the applicability of the technology for the site-specific conditions. The technologies listed in Section 1.6 are screened in this chapter for their ability primarily to address the soil contamination in excess of 870 mg/kg TPH within a 1-year time frame at the Old Navy Fuel Farm. The primary focus of this screening evaluation is on the effectiveness and implementability of each option, with less emphasis on cost. A brief description of each evaluation criterion is provided below:

- **Effectiveness**—The effectiveness evaluation is focused on the following elements:
  - Reliability and proven effectiveness of process options in handling the estimated volume of petroleum contaminated soil and site-specific conditions.
  - Potential impacts to human health and the environment during the construction and implementation phase.
- **Implementability**—The implementability evaluation includes both the technical and institutional (administrative) feasibility of implementing each technology or process option. This initial technology screening eliminates technology types or process options that are clearly ineffective or unworkable at the site. These include:
  - Potential for obtaining regulatory approval
  - Availability of necessary equipment and skilled workers to implement the technology
  - Availability of treatment, storage, and disposal services
  - Time required for implementation
  - Ability to achieve the applicable remediation standards within the given 1-year time frame.
- **Cost**—The screening of alternatives is intended to evaluate the technical feasibility and implementability of remedial technologies in addressing the remedial action objectives under site-specific operating conditions. For this screening evaluation, a qualitative cost analysis has been presented for overview purposes only. Preliminary cost estimates for the remedial technologies retained in this chapter are presented in Appendix D and summarized in Chapter 3.

### 2.1.1 Excavation of Soil Outside the Influence of Soil Vapor Extraction/Aquifer Air Sparging System/Continue Current Soil Vapor Extraction/Aquifer Air Sparging Operations

AAS refers to the application of ambient air injection for the remediation of ground water within the saturated zone. Compressed air is forced through “sparging” wells into the saturated zone. As the air rises through the aquifer matrix, VOCs partition from the dissolved-phase (ground water) into the gas phase (injected air). The VOC vapors continue to be transported with the air through the ground water into the unsaturated zone. AAS is often used in conjunction with SVE, which involves the vacuum extraction of soil gas located within the vadose zone (thereby capturing the injected air containing the volatilized compounds). An additional benefit of SVE/AAS is that the increased dissolved oxygen concentrations in ground water and oxygen concentrations in the unsaturated zone can promote the biodegradation of organic compounds. Some remediation of vadose and saturated soil can also be initiated by desorbing VOCs through either increased ground-water movement (resulting from the pressure of the injected air) or by disrupting the subsurface VOC equilibrium and creating a diffusion gradient for transferring VOCs from soil to either ground water or soil gas (which will then be captured by the SVE/AAS system). Application of SVE/AAS is limited by the heterogeneity and permeability of the soil matrix as well as the volatility characteristics of the target contaminants of concern (vapor pressure >1mm Hg).

- **Effectiveness**—SVE/AAS is a proven technology that has demonstrated effectiveness in volatilizing petroleum-related compounds in the dissolved-phase ground water. It is less effective in reducing elevated levels of petroleum contamination that are sorbed onto soil that act as a continuing source area to the dissolved-phase ground water as the ground-water level fluctuates annually, submerging the source material. In addition, there are approximately 4,200 yd<sup>3</sup> of soil above the PRG of 870 mg/kg TPH outside the influence of the existing SVE/AAS system that would have to be excavated as evidenced by the direct-push investigation. Based on the historical removal rate from operations of the dewatering pilot study (EA 1999a) and the estimated volume and concentration of petroleum-contaminated soil at the Old Navy Fuel Farm (EA 2000), it is estimated that remediation could be accomplished in approximately 2 years with this alternative.
- **Implementability**—As the SVE/AAS system, dewatering vessel, and 5,000-lb vapor phase carbon vessel are already in place, there would be no additional effort to implement this alternative. The majority of the petroleum-contaminated soil is located at or below the ground-water table. Therefore, excavation of the soil outside the influence of the SVE/AAS system and confirmation sampling would be difficult without dewatering or sheet piling.
- **Cost**—Following the 1999 system expansion, the carbon usage rate increased by approximately 300 percent, necessitating a carbon vessel change-out after 1 month. This would lead to an annual carbon usage cost of approximately \$100,000. Therefore, the total annual operation and maintenance cost of the existing SVE/AAS system would be approximately \$215,000.

**Conclusion**—This alternative will not be retained for further consideration. The Excavation of Soil Outside the Influence of SVE/AAS System/Continue Current SVE/AAS Operations alternative will not reach the PRG for soil in the given 1-year time frame. The Navy also desires to abandon the existing SVE/AAS remedial technology.

### 2.1.2 *In Situ* Chemical Oxidation

Enhanced *in situ* chemical oxidation systems are now being used more frequently to treat VOC contaminated sites. Oxidation reactions chemically convert hazardous constituents to non-hazardous compounds that are more stable, less mobile, and/or inert. The oxidizing agents most commonly used for treatment of hazardous constituents are ozone, hydrogen peroxide, hypochlorites, chlorine, and chlorine dioxide. Blends of catalysts, oxidizers, viscosity enhancers, and mobility control agents are injected through site-specific delivery systems providing sufficient distribution to selectively treat the contaminants around the area of concern. A specific stoichiometry is first determined through a laboratory study, with preliminary treatment quantities calculated. Application is typically tested in the field during a pilot program to determine the efficiency and extent of treatment that varies depending on the site's subsurface characteristics. Based upon a successful laboratory study and remedial pilot treatment program, design and implementation of full-scale remediation is proposed (if required).

- **Effectiveness**—The *in situ* chemical oxidation process is effective for treatment of hydrocarbon contamination in soil and ground water. Since the majority of the contaminated soil is at or below the ground water table, the Old Navy Fuel Farm is an excellent candidate for *in situ* chemical oxidation consideration.
- **Implementability**—The equipment and vendors necessary to perform *in situ* oxidation are available. A treatability study would be required to identify parameters such as alkaline metals and humus content in soil and total organic halides that could affect processing time and cost, followed by the implementation of a pilot program.
- **Cost**—A laboratory/pilot study could be performed for approximately \$30,000. The total cost of site remediation cannot be estimated with any measure of certainty prior to the pilot study. The costs for *In Situ* Chemical Oxidation are generally higher than for bioremediation or other passive technologies, but significantly less than for dig-and-haul or incineration technologies.

**Conclusion**—The *In Situ* Chemical Oxidation alternative will be retained for further consideration. This option is capable of meeting remedial action objectives within 1 year, providing work begins in early Spring 2000.

### 2.1.3 Excavation/Offsite Asphalt Blending

Hot mix asphalt batch recycling is the process of mixing soils already exhibiting elevated levels of petroleum hydrocarbons with asphalt resin and aggregate to produce a usable product. Some oxidation occurs due to elevated processing temperatures, however, that is not the primary treatment objective.

- **Effectiveness**—Asphalt blending is an effective method of utilizing petroleum-contaminated soil. Because the source is removed, a reduction of dissolved-phase hydrocarbons in the ground water would follow.
- **Implementability**—An appropriate asphalt batch recycling facility is located approximately 40 mi from NAS Brunswick. The excavated material would not have to be screened prior to transportation; materials are processed through a crusher prior to batching. However, a reduction in total cost would be realized by screening out construction debris and rocks to reduce transported weight. It would be necessary to obtain a “spill letter” from MEDEP to pre-classify excavated material; otherwise, sampling and analysis of transported soil for BTEX and lead would have to be conducted on the order of one set of tests per 500 tons delivered to the batch facility. The majority of the petroleum-contaminated soil is located at or below the ground-water table. Therefore, excavation of soil and confirmation sampling would be difficult without dewatering or sheet piling. Since a large portion of the excavated material would originate from below the ground-water table, dewatering of the excavated material may be necessary to achieve acceptable soil moisture content.
- **Cost**—The costs associated with asphalt blending, including excavation, confirmation sampling, treatment, and backfilling, would range from \$75 to \$100/yd<sup>3</sup>.

**Conclusion**—The Excavation/Offsite Asphalt Blending alternative will be retained for a more detailed cost analysis. This option is capable of reaching the PRG for the Old Navy Fuel Farm within the given 1-year time frame.

#### 2.1.4 Excavation/Onsite Thermal Desorption

Low temperature thermal desorption is a physical separation process and is not designed to destroy organics. Excavated wastes are heated to volatilize water and organic constituents. A carrier gas or vacuum system transports the vapors to a gas treatment system. The bed temperatures and residence times designed into these systems will volatilize hydrocarbons but will typically not oxidize them. Thermal desorption is a full-scale technology that has been proven successful for remediating petroleum hydrocarbon in different types of soil. Destruction efficiencies in the afterburners of these units are greater than 95 percent. Treated soil retains its physical properties and the ability to support biological activity if back-filled.

Two common thermal desorption designs are the rotary dryer and thermal screw. Rotary dryers are horizontal cylinders that can be indirect- or direct-fired. The dryer is normally inclined and rotated. For the thermal screw units, screw conveyors or hollow augers are used to transport the medium through an enclosed trough. Hot oil or steam circulates through the auger to indirectly heat the medium. All thermal desorption systems require treatment of the off-gas to remove particulates and volatilized compounds. Particulates are removed by conventional equipment, such as wet scrubbers or fabric filters. VOCs are removed through condensation followed by carbon adsorption, or they are destroyed in a secondary combustion chamber or a catalytic oxidizer. Most of these units are transportable. Soil throughput rates are typically 15-20 tons per

hour for sandy soil and less than 7 tons per hour for clay soil when more than 10 percent of the material passes a 200-mesh screen. Units with capacities ranging from 25 to 50 tons per hour require four or five trailers for transport and 2 days for setup.

- **Effectiveness**—Low temperature thermal desorption can be effective for treating fuels in excavated soil. The material is remediated onsite to levels that can be used as fill. Because the source is removed, a reduction of dissolved-phase hydrocarbons would follow.
- **Implementability**—The Old Navy Fuel Farm has sufficient area for staging a mobile thermal desorption system. The required equipment and services are readily available. Many vendors offer low temperature thermal desorption units mounted on a single trailer. The majority of the petroleum-contaminated soil is located at or below the ground-water table. Therefore, excavation of soil and confirmation sampling would be difficult without dewatering or sheet piling. Since a large portion of the excavated material will originate from below the ground-water table, dewatering may be necessary to achieve acceptable soil moisture content levels. Due to the type of fill material beneath the Old Navy Fuel Farm, screening would also be required, as previous excavations have demonstrated that there are large pieces of asphalt, concrete, and ledge that would have to be removed prior to introduction into the system. Necessary air quality permits are required from MEDEP.
- **Cost**—Soil treatment costs, including excavation, confirmation sampling, and backfilling, range from \$65 to \$105/yd<sup>3</sup>. Costs will increase based on the nature and concentration of the hydrocarbons present in the soil.

**Conclusion**—The Excavation/Onsite Thermal Desorption alternative will be retained for a more detailed cost analysis. This option is potentially capable of reaching the remedial action objectives for the excavated soils within the given 1-year time frame.

### 2.1.5 Excavation/Land Farming Offsite

Land treatment has been used successfully to remediate petroleum hydrocarbons from contaminated soil. During the land treatment process, excavated soil is spread in thickness between 6 and 9 in., and the hydrocarbons are converted by naturally occurring or indigenous soil micro-organisms to carbon dioxide, water, bacterial cells (biomass), and humic materials. Numerous factors are known to affect both the degradation rate and the extent of hydrocarbon removal from contaminated soil. Conditions normally controlled include: moisture content (usually by irrigation or spraying); oxygen level (by mixing the soil using tilling or aerating); nutrients, primarily nitrogen and phosphorus (by fertilizing); pH (increased slightly by adding lime); and soil bulking (by adding soil amendments such as wood chips, and by mixing using tilling, etc.). During land treatment, these parameters must be optimized to achieve the fastest and most complete biodegradation of petroleum hydrocarbons present in contaminated soil. The design of a statistically defensible soil sampling plan is also critical in the success of a land treatment alternative.

- **Effectiveness**—Land farming technology is effective in breaking down petroleum-related compounds sorbed in excavated soil. Because lighter, more volatile hydrocarbons such as gasoline are treated very successfully by *in situ* processes such as SVE or bioventing, the use of aboveground bioremediation is usually limited to heavier hydrocarbons. However, that does not preclude its use in this particular case. Because the source is removed, a reduction of dissolved-phase hydrocarbons would follow.
- **Implementability**—Regulatory approval would have to be gained from MEDEP prior to implementation of a land farming option at an offsite facility. A total of 12,500 yd<sup>3</sup> spread 9-in. thick would occupy approximately 10.4 acres of land. The majority of the petroleum-contaminated soil is located at or below the ground-water table. Therefore, excavation of soil and confirmation sampling would be difficult without dewatering or sheet piling. Since a large portion of the excavated material will originate from below the ground-water table, dewatering may be necessary to achieve acceptable soil moisture content levels. Runoff control measures would have to be implemented to prevent contamination of the surrounding soil. Due to the type of fill material beneath the Old Navy Fuel Farm, screening would also be required as previous excavations have demonstrated that there are large pieces of asphalt, concrete, and ledge that would have to be removed prior to land farming.
- **Cost**— Soil treatment costs, including excavation, confirmation sampling, and backfilling, range from \$60 to \$80/yd<sup>3</sup>. Costs will increase based on the nature and concentration of the hydrocarbons present in the soil.

**Conclusion**—The Excavation/Land Farming Offsite alternative will be retained for a more detailed cost analysis. This option is potentially capable of reaching the remedial action objectives for the excavated soils within the given 1-year time frame.

### 2.1.6 Excavation/Land Farming Onsite

The description of the technology for the Excavation/Land Farming Onsite alternative is the same as the description of the technology for the Excavation/Land Farming Offsite alternative outlined in Section 2.1.5.

- **Effectiveness**—Land farming technology is effective in breaking down petroleum-related compounds sorbed in excavated soil. Because lighter, more volatile hydrocarbons such as gasoline are treated very successfully by *in situ* processes such as SVE or bioventing, the use of aboveground bioremediation is usually limited to heavier hydrocarbons. However, that does not preclude its use in this particular case. Because the source is removed, a reduction of dissolved-phase hydrocarbons would follow.
- **Implementability**—Regulatory approval would have to be gained from MEDEP prior to implementation of a land farming option at the Old Navy Fuel Farm. A total of 12,500 yd<sup>3</sup> spread 9-in. thick would occupy approximately 10.4 acres of land. Therefore, land farming would have to be performed in stages to allow room for open excavations and

reuse of treated soil. Because of the necessity to stage the implementation phase, this alternative would not meet the 1-year time frame for site closure.

- **Cost**— Soil treatment costs, including excavation, confirmation sampling, and backfilling, would range from \$45 to \$75/yd<sup>3</sup>. Costs will increase based on the nature and concentration of the hydrocarbons present in the soil.

**Conclusion**—The Excavation/Land Farming Onsite will not be retained for a more detailed cost analysis. This option is not capable of reaching the remedial action objectives for the excavated soils within the given 1-year timeframe due the necessity of staging the implementation of the land farm.

### 2.1.7 Excavation/Offsite Thermal Desorption

This option will not be retained for consideration. There are no appropriate fixed thermal desorption/incinerator facilities within close proximity to the NAS Brunswick site. Therefore, the Excavation/Offsite Thermal Desorption option is economically unfeasible in comparison with other alternative technologies.

### 2.1.8 Excavation/Biopile Constructed Onsite

Biopile technology involves forming petroleum-contaminated soil into piles or cells above ground and stimulating aerobic microbial activity within the soil through aeration (NFESC 1996). Adding moisture and nutrients such as nitrogen and phosphorus can enhance microbial activity. The aerobic microbial activity degrades the petroleum-based constituents adsorbed to soil particles, thus reducing the concentrations of these contaminants. Biopiles are typically constructed on an impermeable base to reduce the potential migration of leachate to the subsurface environment. A perforated piping network installed above the base is connected to a blower that facilitates the aeration of the pile. In some cases, a leachate collection system is constructed, especially if a moisture addition system is being considered for the pile. The piles generally are covered with an impermeable membrane to prevent the release of contaminants and/or contaminated soil to the environment and to protect the soil from wind and precipitation. Biopiles operate effectively in temperate climates, but can be operated in colder climates by introducing warm air through the aeration process.

- **Effectiveness**—Biopile technology is effective in destroying petroleum-related compounds sorbed in excavated soil. Remediation can be completed in a relatively short time (3-6 months), and future containment of the treated soil is not required. Because the source is removed, a reduction of dissolved-phase hydrocarbons in the ground water would follow.
- **Implementability**—Biopiles are relatively easy to design and construct and the equipment and supplies are readily available. One of the existing AAS blowers could be modified to introduce aeration to the constructed biopile. The bituminous pavement at the Old Navy Fuel Farm could be used as a stable foundation to support the biopile and associated soil handling operations and provide a barrier against potential migration of

contaminants into the underlying soil. The existing fire suppression system could be used to provide moisture addition and nutrients.

- **Cost**—A sample cost analysis was conducted for various temporary biopile configurations in the Naval Facilities Engineering Service Center Technical Memorandum (NFESC 1996). The costs ranged from \$40 to \$70/yd<sup>3</sup> for biopile construction. Utilizing a cost of \$45/yd<sup>3</sup> from the Naval Facilities Engineering Service Center, and \$25/yd<sup>3</sup> for excavation and backfilling, a biopile constructed and maintained for 12,500 yd<sup>3</sup> of soil would cost approximately \$70/yd<sup>3</sup>.

**Conclusion**—The Excavation/Biopile Constructed Onsite alternative will be retained for a more detailed cost analysis. This option is potentially capable of reaching the PRG for the excavated soil within the given 1-year time frame.

### 2.1.9 *Ex Situ* Chemical Oxidation

*Ex situ* chemical oxidation systems (Pios<sup>®</sup> soil remediation technology) utilize the process of chemical addition to treat VOC contaminated soil after the soil is excavated and stockpiled. Oxidation reactions chemically convert hazardous constituents to non-hazardous compounds that are more stable, less mobile, and/or inert. The oxidizing agents most commonly used for treatment of hazardous constituents are hydrogen peroxide and potassium permanganate. The most efficient oxidation occurs when the soil and additives are allowed to “bake” in direct sunlight. Petroleum-contaminated sites similar to the Old Navy Fuel Farm utilizing the Pios<sup>®</sup> technology have documented acceptable analytical results and typical soil treatment times of 24-48 hours.

- **Effectiveness**—The *ex situ* chemical oxidation process would be effective in remediation of excavated source material at the Old Navy Fuel Farm. The processed soil could be backfilled within 24-48 hours under optimum conditions.
- **Implementability**—The equipment and vendors necessary to perform *ex situ* oxidation, while not as widely available as *in situ* chemical oxidation, could perform this remediation technology. A treatability study would be required to identify parameters such as water content, alkaline metals, humus content in soil, and total organic halides that could affect processing time and cost. Since direct sunlight is desirable for optimal remediation to occur, the excavation would have to be performed in late spring, summer, or early fall. The majority of the petroleum-contaminated soil is located at or below the ground-water table. Therefore, excavation of soil and confirmation sampling would be difficult without dewatering or sheet piling. Since a large portion of the excavated material will originate from below the ground water table, dewatering may be necessary to achieve acceptable soil moisture content levels.

- **Cost**—Mobilization of a vendor to provide the Pios<sup>®</sup> soil remediation technology is \$65,000. An additional \$75/yd<sup>3</sup> would be required for soil processing (including analytical, excavation, and backfilling). Generally, the break even point for cost-effectiveness of this technology is approximately 10,000 yd<sup>3</sup> when compared to more conventional technologies.

**Conclusion**—The *Ex Situ* Chemical Oxidation alternative will be retained for further consideration. This option is potentially capable of reaching the PRG for the excavated soil within the given 1-year time frame.

## 2.2 SUMMARY OF TECHNOLOGY EVALUATION

Table 2-1 summarizes the remedial technologies/approaches that were evaluated in this chapter.

Based on the screening of remedial alternatives, the following technologies have been eliminated from further consideration because they do not adequately address the 1-year time frame:

- Excavation of Soil Outside the Influence of SVE/AAS System/Continue Current SVE/AAS Operations
- Excavation/Land Farming Onsite
- Excavation/Offsite Thermal Desorption

The following alternatives were retained for further consideration. Chapter 3 provides preliminary cost estimates for each retained alternative:

- Alternative 1—*In Situ* Chemical Oxidation
- Alternative 2—Excavation/Offsite Asphalt Blending
- Alternative 3—Excavation/Onsite Thermal Desorption
- Alternative 4—Excavation/Land Farming Offsite
- Alternative 5—Excavation/Biopile Constructed Onsite
- Alternative 6—*Ex Situ* Chemical Oxidation

TABLE 2-1 SUMMARY OF INITIAL SCREENING OF ALTERNATIVE TECHNOLOGIES  
OLD NAVY FUEL FARM, NAVAL AIR STATION, BRUNSWICK, MAINE

General Response Action	Remedial Technology	Process Option	Description	Old Navy Fuel Farm
Excavation of Soil Outside the Influence of SVE/AAS System/Continue Current SVE/AAS Operations	Soil Excavation	Mechanical Excavation	Removal of soil in excess of 870 mg/kg total petroleum hydrocarbons outside the influence of the SVE/AAS system using conventional earthmoving equipment above or below the ground-water table	<del>Not retained—Would not meet Preliminary Remediation Goals within intended reuse schedule</del>
	Physical/Chemical	SVE/AAS	Operation and maintenance would continue to be performed on the existing SVE/AAS system	
<i>In Situ</i> Chemical Oxidation	Chemical	Chemical Oxidation	<i>In situ</i> addition of an oxidizing agent to oxidize volatile organic compounds	Retained for consideration
Excavation/Offsite Asphalt Blending	Soil Excavation	Mechanical Excavation	Removal of soil in excess of 870 mg/kg total petroleum hydrocarbons using conventional earthmoving equipment above or below the ground-water table	Retained for consideration
	Physical/Thermal	Thermoplastic Solidification/Stabilization	Mixing/heating of soil with asphalt, bitumen, paraffin, polyethylene, or other organic polymers to form a stable solid	
Excavation/Onsite Thermal Desorption	Soil Excavation	Mechanical Excavation	Removal of soil in excess of 870 mg/kg total petroleum hydrocarbons using conventional earthmoving equipment above or below the ground-water table	Retained for consideration
	Thermal	Thermal Desorption	Moderate heating to remove organic contaminants of concern from excavated soil by volatilization; vapor phase is treated by incineration or carbon adsorption	
Excavation/Land Farming Offsite	Soil Excavation	Mechanical Excavation	Removal of soil in excess of 870 mg/kg total petroleum hydrocarbons using conventional earthmoving equipment above or below the ground-water table	Retained for consideration
	Biological	Land Farming	Treatment of excavated soil by tilling under controlled conditions using natural or cultured micro-organisms to biodegrade organic contaminants of concern	

NOTE: SVE/AAS = Soil vapor extraction/aquifer air sparging.

General Response Action	Remedial Technology	Process Option	Description	Old Navy Fuel Farm
Excavation/Land Farming Onsite	Soil Excavation	Mechanical Excavation	Removal of soil in excess of 870 mg/kg total petroleum hydrocarbons using conventional earthmoving equipment above or below the ground-water table	Not retained—Would not meet Preliminary Remediation Goals within intended reuse schedule.
	Biological	Land Farming	Treatment of excavated soil by tilling under controlled conditions using natural or cultured micro-organisms to biodegrade organic contaminants of concern	
Excavation/Offsite Thermal Desorption	Soil Excavation	Mechanical Excavation	Removal of soil in excess of 870 mg/kg using conventional earthmoving equipment above or below the ground-water table	Not retained—Offsite facility not available within economically feasible distance from NAS Brunswick.
	Thermal	Thermal Desorption	Moderate heating to remove organic contaminants of concern from excavated soil by volatilization; vapor phase is treated by incineration or carbon adsorption	
Excavation/Biopile Constructed Onsite	Soil Excavation	Mechanical Excavation	Removal of soil and/or buried waste using conventional earthmoving equipment above or below the ground-water table	Retained for consideration
	Biological	Biopile	<i>Ex situ</i> soil treatment cell supplied with air to promote biodegradation of organic contaminants of concern; may be inoculated with microbes if indigenous microbes are not effective	
<i>Ex Situ</i> Chemical Oxidation	Soil Excavation	Mechanical Excavation	Removal of soil and/or buried waste using conventional earthmoving equipment above or below the ground-water table	Retained for consideration
	Chemical	Chemical Oxidation	<i>Ex situ</i> addition of an oxidizing agent to oxidize volatile organic compounds	

### 3. COST ANALYSIS

Preliminary cost estimates were performed for each of the following 6 retained remedial alternatives:

- Alternative 1—*In Situ* Chemical Oxidation
- Alternative 2—Excavation/Offsite Asphalt Blending
- Alternative 3—Excavation/Onsite Thermal Desorption
- Alternative 4—Excavation/Land Farming Offsite
- Alternative 5—Excavation/Biopile Constructed Onsite
- Alternative 6—*Ex Situ* Chemical Oxidation.

The cost tables can be found in Appendix Tables D-1 through D-6, respectively.

The preliminary cost estimates identify both the initial (capital) and annual (operations and maintenance) costs for each alternative. The total project cost was generated based on the capital cost and 1 year of operations and maintenance for each alternative (if required). The cost estimates are based upon approximate design specifications, costs incurred from similar operations, vendor quotes, and product information, where possible (Appendix E). Costs are shown in present day dollars. The cost analysis does not include provisions for replacement of monitoring wells destroyed or damaged during the excavation of source material. Additional dewatering costs during excavation would apply to Alternatives 2 through 6; Alternative 1 is the only *in situ* option. Since much of the source material is located within the 3- to 6-ft interval below ground surface, the assumption was made that, during excavation, the top 3 ft of “clean” soil would be removed and stockpiled for reuse. A 25 percent contingency was added to the total volume of soil to be addressed in the event additional source areas are discovered during excavation or the depth of the source increases. Contingencies were also added to the treatment technology capital or annual costs in the event additional source areas are discovered.

Capital costs for Alternatives 2 through 6 consist primarily of dewatering, excavation, confirmation sampling, site restoration, and initiating or completing soil remediation. Costs were calculated based on an estimated 12,500 yd<sup>3</sup> (18,750 tons) of soil to be removed. It is anticipated that unit costs for remedial components (e.g., excavation, treatment processes) would decrease if the amount of soil to be removed increased (due to identification of additional source or incorrect estimation); however, any savings would be offset by additional cost for manpower, equipment, confirmatory samples, etc. The capital cost is highest for Alternative 3 (\$1,402,574) and lowest for Alternative 1 (\$529,168).

Annual operation and maintenance costs apply only for Alternatives 4 and 5, the land farming and biopile alternatives, respectively. Operation and maintenance costs are highest for Alternative 5 (\$240,000) due to the more extensive operation and maintenance costs associated with biopile operations for 1 year compared to land farming.

The following table summarizes the total project costs from lowest to highest for each of the 6 retained alternatives (rounded to the nearest thousand dollars):

Remedial Alternative	Total Capital Cost (\$)	Total 1-Year Operation and Maintenance Cost (\$)	Total Projected Cost (\$)
1	529,000	0	529,000
4	774,000	150,000	924,000
5	924,000	240,000	1,164,000
2	1,328,000	0	1,328,000
6	1,346,000	0	1,346,000
3	1,403,000	0	1,403,000

#### 4. CONCLUSIONS

This remedial alternatives evaluation was conducted for the Old Navy Fuel Farm at NAS Brunswick. The assessment consisted of analyzing 9 remediation options to address the approximate 12,500 yd<sup>3</sup> of petroleum-contaminated soil in excess of 870 mg/kg TPH within a 1-year time frame. An initial screening of the 9 alternate technologies determined that 3 were unsuitable for use at the Old Navy Fuel Farm. Therefore, only 6 alternatives were retained for an economic assessment. The economic assessment was conducted for the 6 alternatives to evaluate the cost effectiveness of each to meet the given remedial action objectives. The assessment identified capital costs and annual operations and maintenance costs for a 1-year time frame.

Based on the economic evaluations detailed in this report, and review and discussion with the Navy, the remedial alternative of choice is Alternative 1—*In Situ* Chemical Oxidation. However, it should be noted that for Alternative 1 to be a feasible remedial option, an aggressive schedule (i.e., work must have commenced by early Spring 2000) needed to be implemented in order to meet the stringent time constraints of the project. Because time has become a critical factor, Alternative 2—Excavation/Offsite Asphalt Blending should be utilized as the preferred remedial alternative.

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## **Appendix A**

# **Procedural Guidelines for Establishing Standards for the Remediation of Oil-Contaminated Soil and Ground Water in Maine**

**PROCEDURAL GUIDELINES FOR  
ESTABLISHING STANDARDS FOR THE  
REMEDICATION OF OIL  
CONTAMINATED SOIL AND GROUND  
WATER IN MAINE**



**MAINE DEPARTMENT OF ENVIRONMENTAL PROTECTION**

**PROCEDURAL GUIDELINES FOR ESTABLISHING  
STANDARDS FOR REMEDIATION OF OIL  
CONTAMINATED SOIL AND GROUND WATER**

**MAINE DEPARTMENT OF ENVIRONMENTAL PROTECTION  
BUREAU OF HAZARDOUS MATERIALS & SOLID WASTE CONTROL**

**APPROVED JANUARY 11, 1995**

**EFFECTIVE FEBRUARY 1, 1995**

## INTRODUCTION

This guidance document outlines a decision tree approach using site specific geologic and human exposure related criteria to establish remediation standards for oil contaminated soil and groundwater. Bureau staff are directed to utilize the February 1, 1995 revised edition of the "Decision Tree for Setting Cleanup Standards for Petroleum Contaminated Site" in decisions regarding the initiation and termination of remediation at underground storage facilities, other subsurface oil discharges, bulk plants, above ground storage facilities, and transportation spill sites contaminated by gasoline, methyl tertiary butyl ether (MTBE), kerosene, #2 heating oil and diesel fuel, or other comparable petroleum hydrocarbons, including waste oil that is not a hazardous waste. Decisions regarding remediation objectives for site contaminated by heavy oils are not governed by this procedure and will continue to be made on a case-by case basis by Bureau project staff responsible for remediation oversight. This guidance does not apply to any site or a portion of a site where hazardous substances contamination is documented or likely. These guidelines apply to both Bureau funded remediation projects as well as those undertaken by responsible parties or other persons.

The objectives of these guidelines are threefold. The guidelines' first objective is to ensure greater consistency in the level of clean up required of responsible parties statewide, while providing sufficient flexibility to accomodate greatly varying site conditions. Secondly, the guidelines are intended to ensure that decisions regarding remediation are based on the risk of environmental and public health effects. These guidelines emphasize preventing human exposure to oil and petroleum hydrocarbons from contaminated groundwater and vapors. Lastly, these procedures are meant to provide guidance to Bureau remediation staff, responsible parties, professional consultants, and others who undertake oil remediation, on the performance standards such efforts will be expected to meet by the Department. The final decision on the level of clean-up at a particular site is that of the Department's project remediation staff.

These guidelines, through the decision tree, establish three levels of remediation standards. The first and most stringent is for areas of current or future groundwater use for drinking water. Areas in close proximity to public and private drinking water supplies or sand and gravel aquifers would fall under the "stringent standards". For sites where use of groundwater as drinking water is less likely because of its quality and quantity, "intermediate standards" are established to abate on-

going sources of groundwater contamination and to minimize the risk of petroleum vapor problems in buildings and utility conduits. Lastly, "baseline standards" are established for all remaining sites, including those located where groundwater has already been contaminated beyond use. As part of the revisions included in this edition, baseline soil contamination standards were divided into two sub-categories: one for industrial sites, and one for non-industrial urban areas. At a minimum, all sites shall be cleaned of oil saturated soil and free petroleum products.

Within limits established in Maine statute, Title 38 M.R.S.A. Subsection 568(6), flexibility is provided in the guidelines and the decision tree to allow alternate site specific remediation standards for oil contaminated soil and groundwater. Such an alternate standard must adequately protect public health, safety and the environment and be well supported by hydrogeological investigation results or other technical studies approved by the Bureau's remediation staff. Such studies may include risk assessments or contaminant transport studies. Alternate standards may be either less or more stringent than those indicated by the decision tree methodology and shall be approved by the Bureau. If the terms of this paragraph are satisfied, the Bureau may require more stringent remediation standards as well as allow less stringent standards, within statutory limits established by the Maine Legislature. In no case involving a leak or other discharge of oil at an underground oil storage facility may we require cleanup standards for soil and ground water at lower concentrations than specified in the "stringent clean up goals" listed in the decision tree. This statutory restriction only applies to the clean up of oil contamination in the general environment and does not effect our authority to provide for temporary treatment of or the replacement of contaminated drinking water supplies.

The revisions made in this edition implement many of the recommendations of a 1993 Department study of the original 1992 guidelines conducted for and presented to the Maine Legislature's Standing Committee on Energy and Natural Resources <sup>1</sup> and are a product of the Department's Total Quality Management (TQM) Program. Input was also solicited from the Maine Oil Dealers Association and members of the professional environmental consulting community. Among the changes are a fourth soil clean-up standard in order to further improve the consistency of clean-up decisions, clarification of the applicability of the guidelines with respect to waste oil (included), and better

<sup>1</sup> Maine Dept. of Environmental Protection. Evaluation Report: Procedural Guidelines for Establishing Standards for Remediation of Oil Contaminated Soil and Ground Water. April, 1993. 39pp..

defining "non-attainment areas" to avoid unnecessarily stringent clean-ups in such areas where ground water is unusable or unlikely to be used. Some recommendations to the Legislature upon further study could not be implemented and were not technically feasible at this time (e.g. developing a quantitative remediation standard for heavy oil contaminated soil). One notable change not identified in the evaluation study, but included here, is allowing for the first time the use of field headspace analyses versus more expensive and time consuming laboratory testing for determining attainment of soil remediation standards at sites that are not sensitive ("baseline") and where the degree of error associated with field instruments would not significantly increase the risk of public exposure or the degradation of important ground water resources due to petroleum contamination.

A summary of the decision tree is presented as a flowchart at the end of these Guidelines for use as a quick reference. Also provided at the end of this document is a table summarizing the Guidelines' clean-up goals and standards (Table 1).

These procedural guidelines shall be effective on February 1, 1995 and will apply to all applicable oil contamination remediation decisions approved by the Bureau after this date. These guidelines replace the April 15, 1992 edition of these remediation guidelines.

DECISION TREE FOR SETTING CLEANUP STANDARDS  
FOR PETROLEUM-CONTAMINATED SITES

The decision tree which follows was developed for use by BHMSWC personnel to determine the level of clean-up required for hydrocarbon releases. The clean-up goals are designed to protect groundwater aquifers that are presently used or may be used in the future to supply drinking water for human use. The goals are also intended to minimize public health and safety problems caused by petroleum vapors. The investigator always has the option of setting more strict clean-up goals if appropriate for the specific characteristics of a site. Less strict standards should not be used until appropriate hydrogeologic review and/or investigation has been completed.

The decision tree is intended to standardize the decision-making process used both in response field work and in long-term site remediation such as soil venting and groundwater treatment. It can be used during the initial field response investigation as well as after a detailed hydrogeological study (if necessary). However, use of this decision tree in the early stages of investigation may not negate the need for additional site characterization or monitoring.

Some of the information required calls for the investigator's judgment of conditions which cannot be directly observed, such as water table location or soil material at the site. The investigator will sometimes be able to obtain this information from people who are familiar with the area (water table information from homeowners with dug wells; location of private wells from area residents). Other information may come from observation of the tank excavation itself; from presence/absence of hydrocarbon odors in basements; from topographic, sand/gravel aquifer or geologic maps; or from field instruments such as PIDs, CGI, pop level; or the pacing off of distances.

There will be instances where a needed piece of information cannot be readily obtained. In these cases the investigator should assume the most reasonable "worst case" and note this as a point to be followed up by a geologist at a later time if necessary. At some sites, the published information may conflict with observed conditions (a site overlying sand and gravel which is not mapped as a sand/gravel aquifer). Again the initial

investigator should assume the worst case (that the site is an aquifer which has not been mapped) and note the conflict.

If extensive fill is present at a site it should be classified as the natural material it resembles most closely until natural surficial materials underlying and around the filled area can be investigated.

### Instructions

Proceed thru the decision tree criteria until you have reached a clean-up goal then stop. If there is something you don't understand about a question or criteria please refer to the corresponding number on the attached explanation sheet. Once you have reached a 12, 13, or 14A or 14B you have chosen a clean-up goal. Example: Your answer to question 1 is no; you then go to question 2 and your answer is yes; you then go to question 2A and your answer is no; you then go to 12 which gives you the clean-up goal. You do not need to look at any other criteria. You then use the clean-up goal to determine how much soil to remove, etc.

**HYDROCARBON SPILL DECISION TREE**

Investigator: \_\_\_\_\_ Site Name, Address: \_\_\_\_\_

Spill Number: \_\_\_\_\_ Town: \_\_\_\_\_

	If "Yes" Go To	If "No" Go To
1. Is a public water supply well or intake located within 2000 feet of the leak or discharge site, or is the site located within wellhead protection zones 1 or 2 of a public water supply well?	12	2
2. Is the leak or discharge site located in or over a sand and gravel deposit?	2A	3
2A. Is the entire area, within a 2000 foot radius of the leak or discharge site, a non-attainment zone?	2B	12
2B. Is there potential for vapor problems within buildings or for a confined space fire or explosion hazard?	13	11A
3. Was the release directly into bedrock or is the bedrock groundwater system contaminated?	9	4
4. Was the release directly into a glacial till deposit?	9	5
5. The release was into a silt or clay deposit.	6	N/A
6. Is there at least 10 feet of silt and/or clay between the contaminated zone and underlying more permeable surficial deposits (such as glacial till or sand and gravel) or bedrock	7	9
7. Are the area's gradients approximately horizontal (topographic gradient flat or groundwater gradient <1%)?	8	9

	If "Yes" Go To	If "No" Go To
8. Does the seasonal low of the water table fall below the top of the underlying aquifer (sand and gravel deposit or bedrock)? If unknown, the answer is yes.	9	10
9. Is the area within 2000 feet downgradient or 1000 feet upgradient served by a public water supply?	10	12
10. Is there potential for vapor problems within buildings or for a confined space explosion hazard?	13	11
11. Is the entire area, within a 2000 foot radius of the leak or discharge site, a non-attainment zone?	11A	13
11A. Is the site now or in the past been in a predominantly industrial land use?	14A	14B

#### CLEAN-UP GOALS

#### 12. Stringent (ST) Clean-Up Goals

Remove all free product.

Remove or remediate contaminated soil containing greater than 10 mg/kg total fuel oil or kerosene, or 5 mg/kg total gasoline as determined by DEP-approved laboratory method.

Remediate groundwater containing greater than 50 ug/l total hydrocarbons (gasoline, kerosene, or fuel oil by DEP-approved laboratory analytical methods), 50 ug/l MTBE or 5 ug/l benzene by DEP or EPA approved lab methods.

#### 13. Intermediate (IN) Clean-Up Goals

Remove all free product.

Remove or remediate contaminated soil containing greater than 10 mg/kg total fuel oil or kerosene, or 5 mg/kg total gasoline as determined by DEP-approved laboratory method.

#### 14. Baseline Clean-up Goals

##### 14A. Baseline-1 (BL1):

Remove all free product.  
Remove or remediate soil "saturated" with gasoline, kerosene, or fuel oil.<sup>1</sup>

##### 14B. Baseline-2 (BL2):

Remove all free product.  
Remove or remediate contaminated soil to: 500 to 1,000 ppm gasoline and 200 to 400 ppm heating oil or kerosene, each as measured by the DEP field headspace analysis or its Department approved equivalent field method.

**Note:** Where there is significant uncertainty regarding the identity of the product, the lower of gasoline or fuel oil standards shall apply; and, in the stringent category, groundwater shall be analyzed for MTBE and benzene.

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<sup>1</sup> "Saturated" is defined in paragraph 14 in the Explanation section of this document, page 13.

EXPLANATION OF CRITERIA  
AND  
CLEAN-UP STANDARDS

The following explanatory notes are numbered to correspond to the numbering of the decision tree's questions and criteria.

1. The local water supply agency should be contacted to determine the area served, well locations, and the locations of wellhead protection zones.
2. This will be pretty obvious if you excavate into it. If you aren't able to or haven't done this yet you can refer to the surficial geologic maps published by the Maine Geologic Survey for many quadrangles in the state. Units on these maps which are dominantly sand and/or gravel include beach, aeolian (wind deposited), coarse grained glaciomarine, glacial outwash, and esker deposits. Some moraine and glacial till deposits may also be composed predominantly of sand and gravel. The Presumpscot Formation contains some sandy deposits. You should answer yes if the area is mapped as a sand and gravel aquifer on the significant aquifer maps published by the Maine Geologic Survey unless detailed investigation proves that the answer is no.

If wells are located on or close to the site, the well drillers may be able to give you descriptions and thicknesses of surficial materials.

2A. See explanation 11.

3. Answer yes if a tank (or contaminated soil) lies directly on bedrock or if a surface spill is partially or completely on the bedrock surface. Distinguishing bedrock (called "ledge" by some people in Maine) from large boulders can be a problem. If there are several rock surfaces exposed in an area and they are composed of the same rock type (s) or have structures that trend in the same direction they are likely to be exposures of the true bedrock surface.

4. Till is material deposited directly by a glacier at its base as it moves over the earth's surface or as the glacier melts. Tills generally contain a wide range of grain sizes from large boulders to clay sized material more or less randomly intermixed. Such tills are very cohesive and are often referred to as "hardpan" in Maine. Surficial geologic maps show areas where tills are exposed at the earth's surface. In many areas of Maine tills underlie Presumpscot Formation silt/clay deposits or glacial outwash sand and gravels.

Unfortunately for our purposes some tills contain very little silt or clay sized material and are not very cohesive. Such deposits look more like sand and gravel deposits and contaminants may be transported through such deposits almost as readily. Such tills should be treated as sand and gravel deposits (potential aquifers) when setting clean-up levels. A good indication that a till is composed mainly of sand and gravel is the presence of a gravel pit in an area the Maine Geological Survey has mapped as till.

5. Again silt or clay will usually be obvious when you see it. Some of these deposits may have a few sand grains or scattered pebbles mixed in but if you collect a moist, hand sized sample from any part of the deposit it will be very cohesive when pressed together. The best published sources showing the distribution of this material at the ground surface are surficial geologic maps. Map units representing deposits composed of these materials are lacustrine (lake), alluvial (stream), swamp, and fine grained glaciomarine deposits. The Presumpscot Formation, a widespread marine unit which was deposited up to about 60 miles inland from the present coastline following the last glacial period, is composed primarily of silt and clay sized particles. If silt or clay deposits contain numerous, possibly interconnected layers or lenses of sand and/or gravel, then the material should be treated as a sand or gravel for the purpose of setting clean-up goals.

6. There should be at least 10 feet of homogeneous silt and clay separating the contaminated zone from the top of underlying more permeable deposits such as till, sand and gravel, or bedrock. The depth from the contaminated zone to the top of these materials may be determined from boring logs or by measuring the depth of overburden in the excavation. If you don't have hard data on the depth you should assume that it is less than 10 feet. The thickness of overburden can vary greatly over short distances and there can be substantial variability even in areas where fairly thick surficial deposits are mapped.

7. If you have water level elevations from 3 nearby water table wells you can use the data to calculate the water table gradient. The wells should be screened or otherwise open (uncased) across the water table surface. Both dug and drilled wells may be used for this purpose although some dug wells may intersect a perched water table rather than the true water table. Most drilled water supply wells will not give an accurate representation of the water table elevation because they are not screened across the water table or they extend too far below the water table. Data from such wells must be used very carefully.

If you do not have water table data you will have to estimate the gradient based on the topographic gradient. This is possible because in many cases the water table gradient follows the

topographic gradient although the water table gradient is generally less steep. To use this method compare the difference in elevation between the leak site and the nearest substantial water body such a lake or year round stream. This is necessary because the area of the leak site may appear flat but the water table may slope toward a lake or stream which cannot be seen directly from the leak site. It is possible that geologic conditions at the site may greatly reduce the accuracy of this estimation method. For this reason it should be used conservatively. The investigator should also be aware that pumping of wells may draw down the water around the well and/or in the intersected fracture systems. This can change or even reverse natural gradients.

8. The water table is the top of the saturated zone. Maine state law defines a "significant groundwater aquifer" as "a porous formation of ice contact and glacial outwash sand and gravel or fractured bedrock that contains significant recoverable quantities of water which is likely to provide drinking water supplies." Obviously, the aquifers of most concern to us are sand and gravel deposits and bedrock. Approximate locations of many sand and gravel aquifers have been mapped by the Maine Geological Survey and published on Significant Aquifer or Sand And Gravel Aquifer maps. Bedrock must be protected because (1) it is typically the major source of drinking water in rural areas, (2) it can be extremely hard to remediate once contaminated, and (3) there is potential for high yield wells (for public or commercial purposes) in bedrock even though there has been very little exploration for them and few have been developed in Maine.

If the water table is always above the top of the sand and gravel deposit or bedrock surface then floating contaminants such as hydrocarbons are less likely to contaminate the aquifer. This is particularly true if the water table surface is horizontal. In Maine the water table does not usually fluctuate more than 10 feet throughout the year so if you can determine that the water table is more than 10 feet above top of an aquifer when you are at a site you can probably conclude that it is always above the top of the aquifer. (In general the water table fluctuation at most sites will be less than 5 feet).

9. This may be determined by questioning people or businesses within the area or by contacting the municipal government or other public water supply organization. Be aware that there are some sites where businesses or individuals may have their own water supply systems even though public water is available.

10. The potential for vapor problems exists wherever there is a source for vapor generation (free product, contaminated soil, contaminated water, etc.); a pathway to transport the vapors (porous soils, utility line backfill, etc.); and, a trap to collect vapors (such as a basement, manhole, etc.). Vapor

problems can occur indirectly when heavily contaminated water is pumped into a building or directly when vapors enter through cracks or other openings in foundations. Many developed areas will have potential for vapor problems. Structures with low probability of vapor problems include buildings on slabs, especially if they have continuously operated ventilation systems.

11. A non-attainment zone, for the purpose of these guidelines only, is an area from which groundwater will not be withdrawn for human use because of environmental and/or institutional factors. Non-attainment zones are defined by the criteria listed in 11A, 11B, or 11C below.

11A. The zone is in an urban or other heavily developed area made up predominantly of dense commercial or industrial land uses, OR dense residential (1/2 acre lots or less) development with subsurface waste water disposal, and where no water quality testing data is available. In addition the area must meet all the following criteria as well:

1. The area within 2000 feet downgradient and 1000 feet upgradient of the leak or spill must be served by public water; **and**,
2. No private drinking water supply wells are located within 1000 feet of the discharge; **and**
3. The site of the leak or spill must not be within 2000 feet of a public water supply well or within the wellhead protection zone of a public water supply well.

OR

11B. Local or state laws or regulations which prohibit human consumption of the area's ground water because of poor natural water quality, prior documented pollution or high potential for pollution due to past or present land uses. The existence and applicability of such local ordinances may be confirmed by the town planning board, code enforcement officer, town manager or selectmen. (NOTE: No State ground water classification or other laws currently exist which rule out areas of the State for drinking water).

OR

11C. Previous hydrogeological studies or water quality testing data demonstrate to the Department's satisfaction that, due to the presence of contaminants other than oil or of other pre-existing contaminant sources, groundwater in the area is unfit for human consumption due to violation of the State's maximum exposure guidelines (primary standards)

or Federal maximum contaminant levels for one or more contaminants.

12. The purpose of this goal is to prevent or remediate contamination of groundwater and prevent or correct vapor and confined space explosion hazards. Where this goal is applied it is assumed that groundwater is needed or may later be used for human consumption. Final groundwater and soil clean-up levels may have to be determined based on knowledge of technical limitations of remediation techniques and site specific environmental factors since each media may contaminate ( and re-contaminate) the other.

13. The purpose of this goal is to prevent further groundwater contamination and allow for natural groundwater clean-up by physical processes, biotic and abiotic degradation, or by all three. An additional purpose is to eliminate confined space explosion hazards and decrease the potential for human exposure to hydrocarbon vapors. Where this standard is applied it is assumed that the groundwater will not be used for human consumption in the immediate future. In this classification the clean-up goal for soil may not be immediately attainable if groundwater contamination is high. The reason for this is that heavily contaminated groundwater may re-contaminate clean soil as new equilibrium concentrations in the two media are established.

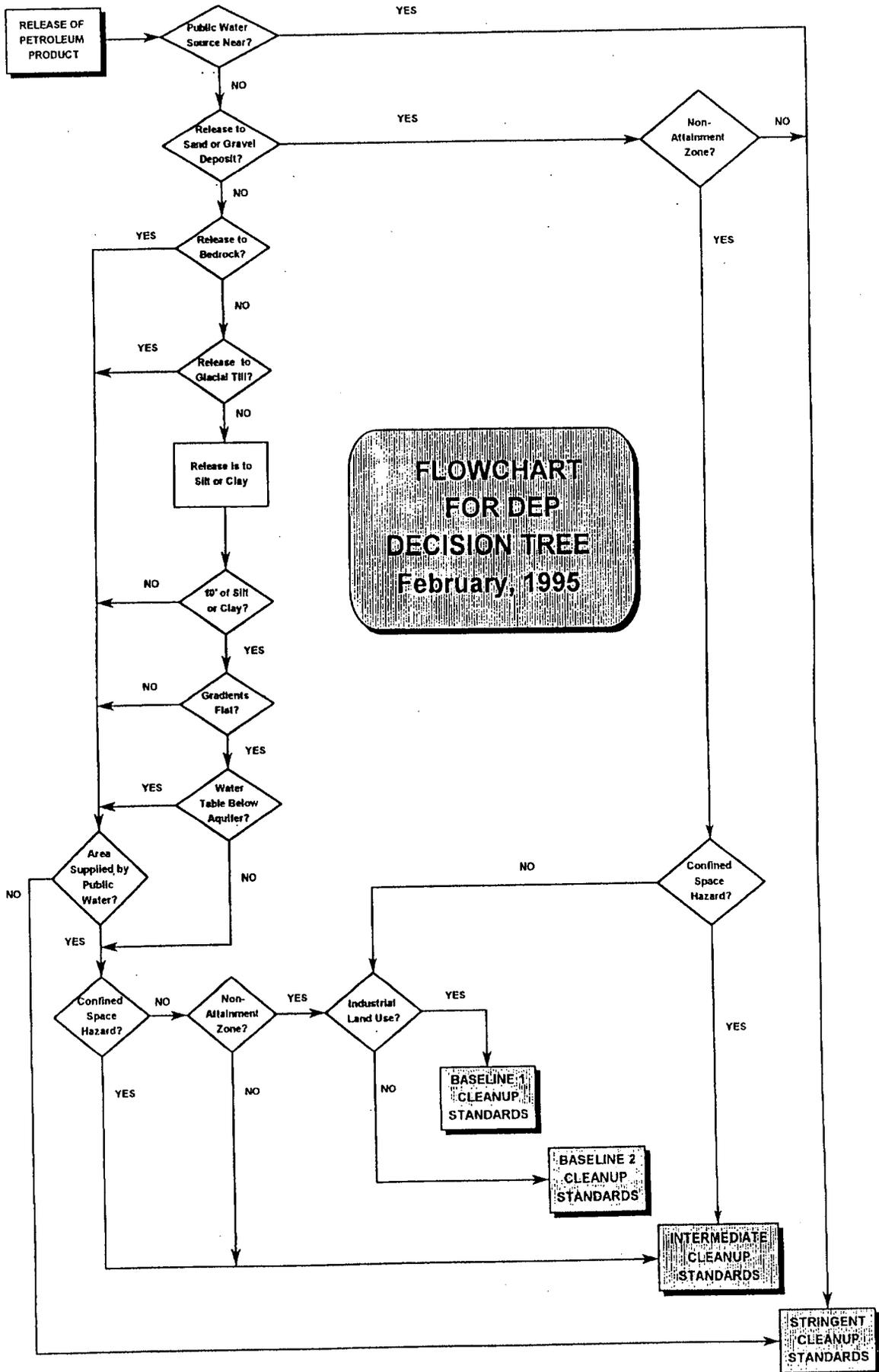
14. The purpose of this goal is to remove free product that may be mobile in the environment. If sufficient product is present in soils at a site it could potentially move in response to gradients and contaminate a larger area. The presence of free product also creates severe vapor explosion and exposure hazards. After removal of free product, residual contamination left in the soil may be a source for dissolved contamination in groundwater and may generate hydrocarbon vapors. Where this goal is applied it is assumed that the groundwater will not be used for human consumption and will not discharge to the surface until significant natural attenuation of the contamination has occurred. It is also assumed that no vapor conduits or traps which could cause health or safety hazards are present in the contaminated area.

The term "saturated" is used to describe soils which contain mobile product. It does not necessarily mean that the soils are truly saturated. "Saturation" may be identified by placing a handful of soil in a clear container and submerging it in water. The soil should then be stirred to break up any clumps. If product droplets or a product layer forms on the water, the soil can be considered "saturated". The presence of a sheen does not indicate "saturation". It may be easier to see the product if the water is decanted into a narrow container such as a VOA vial (40 ml.). It may also be necessary to let silty or clayey

materials settle for a few minutes in order to determine if product is present.

Baseline sites have been subdivided into two categories to reflect current and historical land use, Baseline-1 (BL1) for industrial areas and Baseline-2 (BL2) for other land uses. The BL1 category is for large, current or former known industrial sites, where the contamination and its affects are in all likelihood restricted to the industrial site itself or to other surrounding industrial lands. Common examples would include railroad yards, oil terminals, paper mills, other large manufacturing facilities and former coal gasification sites. BL2 sites include all other non-industrial properties, such as downtown urban areas, commercial strips, and other densely developed residential and commercial areas where the ground water is not currently used nor is it likely to be used in the future. The primary reason for the more stringent BL2 soil standards is the unacceptability of leaving gross soil contamination in residential and commercial areas, ultimately resulting in vapor or other problems in the future, requiring the Department and the responsible party(ies) to return to the site to undertake costly further remediation which could have been easily avoided.

To accomodate the variety of sites that fall into the BL2 category and the Guidelines' reliance on field analytical methods, a range of acceptable soil remediation standards is provided for greater flexibility with which to better match the remediation standard to the conditions that exist at that specific site. Bureau remediation program staff may choose to select an individual numeric standard, or to establish an objective for a given site to simply attain levels of residual contamination anywhere within the BL2 range.



**TABLE 1**  
**SUMMARY OF REMEDIATION STANDARDS**  
**FOR OIL CONTAMINATED SOIL & GROUND WATER**

CLEAN UP STANDARD	Free Product Removal	CONTAMINATED SOIL STANDARDS					DISSOLVED PHASE PRODUCT				
		Saturated Soil	Gasolines	Test Mthd	Fuel Oils/Kero. (1)	Test Mthd	Gasolines	MTBE	Benzene	Fuel Oil(1)	Test Mthd
ST	yes	yes	5 mg/kg	Lab (2)	10 mg/kg	Lab (2)	50 ppb	50 ppb	5 ppb	50 ppb	Lab (4)
IN	yes	yes	5 mg/kg	Lab (2)	10 mg/kg	Lab (2)	None	None	None	None	NA
BL2	yes	yes	500-1000 ppm (3)	Field Hdspace	200-400 ppm (3)	Field Hdspace	None	None	None	None	NA
BL1	yes	yes	None	NA	None	NA	None	None	None	None	NA

**Footnotes:**

- (1) Does not include heavy oils that are heated while being stored. Heavy oil clean-up standards are decided on a case by case basis. Includes #2 heating oil, diesel fuel, kerosene and heating oils other than heavy oils as well as a waste oil that is not a hazardous waste.
- (2) Laboratory methods for gasoline in soil and fuel oil in soil are DEP 4.2.3 and DEP 4.1.2, respectively. These DEP SOPs will be superseded by methods certified by the Maine Bureau of Health in upcoming laboratory certification regulations, adopted by that agency.
- (3) If laboratory analysis is used, the cleanup standards 50-100 mg/kg for each gasolines and fuel oils, as determined by methods in Note 2.
- (4) Laboratory methods for testing water are DEP Standard Operating Procedures 4.2.1 or 4.2.14P for gasoline and 4.1.1 for fuel oil and waste oil. Upon adoption of hydrocarbon lab method certification regulations by the Maine Bureau of Health lab methods certified by those rules will supersede the DEP SOPs.

## **Appendix B**

### **1999 Direct-Push Data, Gas Chromatography Field Analysis, and Photoionization Detector/ Flame Ionization Detector Headspace Readings**

**APPENDIX B**

**1999 DIRECT-PUSH DATA, GAS CHROMATOGRAPHY FIELD ANALYSIS, AND  
PHOTOIONIZATION DETECTOR/FLAME IONIZATION DETECTOR  
HEADSPACE READINGS**

Sample ID	Date Analyzed	Interval Sampled (ft bgs)	Benzene ( $\mu\text{g}/\text{kg}$ )	Toluene ( $\mu\text{g}/\text{kg}$ )	Ethylbenzene ( $\mu\text{g}/\text{kg}$ )	Total Xylenes ( $\mu\text{g}/\text{kg}$ )	Total BTEX ( $\mu\text{g}/\text{kg}$ )	PID <sup>(a)</sup> (ppm <sub>v</sub> )	FID <sup>(a)</sup> (ppm <sub>v</sub> ) (or %)
FF-DP-1	08/09/99	4-6	TRACE	69	TRACE	TRACE	69	270	2,800
FF-DP-2	08/09/99	4-6	---	---	---	---	---	580	15.82
FF-DP-3	08/09/99	4-6	BDL	TRACE	BDL	BDL	TRACE	5.2	96
FF-DP-4	08/09/99	5-7	60	290	52	240	642	95	3,400
FF-DP-5	08/09/99	4-6	30	350	TRACE	62	442	170	1,900
FF-DP-6	08/09/99	4-6	---	---	---	---	---	600	3.1%
FF-DP-7	08/09/99	4-6	---	---	---	---	---	700	3.2%
FF-DP-8	08/09/99	4-6	---	---	---	---	---	310	5,200
FF-DP-9	08/09/99	4-6	70	210	170	1,100	1500	250	3,400
FF-DP-10	08/09/99	4-6	BDL	BDL	BDL	BDL	BDL	0.3	32
FF-DP-10 DUP	08/09/99	4-6	BDL	BDL	BDL	BDL	BDL	NA	NA
FF-DP-11	08/09/99	5-7	11	110	65	2,300	2,486	160	980
FF-DP-12	08/09/99	4-6	---	---	---	---	---	720	3.9%
FF-DP-13	08/09/99	4-6	TRACE	110	TRACE	TRACE	110	12	167
FF-DP-14	08/20/99	10-12	BDL	38	TRACE	TRACE	38	47	1,100
FF-DP-15	08/09/99	4-6	---	---	---	---	---	410	1.2%
FF-DP-16	08/09/99	4-6	---	---	---	---	---	470	5,500
FF-DP-17	08/09/99	4-6	BDL	BDL	BDL	BDL	BDL	0.48	19
FF-DP-18	08/09/99	5-7	BDL	150	40	300	490	92	2,400
FF-DP-19	08/09/99	4-6	TRACE	190	TRACE	TRACE	190	41	1,600
FF-DP-20	08/10/99	4-6	TRACE	35	TRACE	80	115	72	(b)
FF-DP-21	08/10/99	4-6	TRACE	TRACE	TRACE	TRACE	TRACE	1.1	(b)
FF-DP-22	08/16/99	0-2	BDL	TRACE	BDL	BDL	TRACE	10	190
FF-DP-22 DUP	08/16/99	0-2	BDL	TRACE	BDL	BDL	TRACE	NA	NA
FF-DP-22	08/10/99	4-6	---	---	---	---	---	1,300	F.O.
FF-DP-22	08/16/99	6-8	BDL	310	75	85	470	9	110
FF-DP-23	08/10/99	4-6	---	---	---	---	---	360	5200
FF-DP-24	08/10/99	4-6	TRACE	TRACE	TRACE	54	54	36	420
FF-DP-25	08/09/99	5-7	---	---	---	---	---	700	1.66%
FF-DP-26	08/10/99	3-5	---	---	---	---	---	480	22.7%
FF-DP-27	08/10/99	3-5	TRACE	TRACE	BDL	TRACE	TRACE	4.5	150
FF-DP-28	08/10/99	3-5	TRACE	TRACE	BDL	BDL	TRACE	1.8	1,200
FF-DP-28 DUP	08/10/99	3-5	BDL	TRACE	BDL	BDL	TRACE	NA	NA
FF-DP-29	08/10/99	3-5	---	---	---	---	---	520	F.O.
FF-DP-30	08/10/99	3-5	---	---	---	---	---	700	11%
FF-DP-31	08/10/99	3-5	BDL	TRACE	TRACE	170	170	99	1,300
FF-DP-32	08/09/99	4-6	---	---	---	---	---	320	3,800
FF-DP-33	08/10/99	4-6	---	---	---	---	---	600	22.7%
FF-DP-34	08/10/99	3-5	BDL	330	58	290	678	120	600
FF-DP-35	08/10/99	3-5	TRACE	89	TRACE	TRACE	89	60	1,200
FF-DP-36	08/10/99	3-5	BDL	BDL	BDL	BDL	BDL	0.38	290

(a) Field headspace screening performed with Foxboro TVA-1000 photoionization detector/flame ionization detector (PID/FID).

(b) FID ran out of hydrogen gas before sample could be screened.

NOTE: BTEX = Benzene, toluene, ethylbenzene, and total xylenes.

ppm<sub>v</sub> = Parts per million in soil vapor.

TRACE = Benzene (<20  $\mu\text{g}/\text{kg}$ ), toluene (<20  $\mu\text{g}/\text{kg}$ ), ethylbenzene (<40  $\mu\text{g}/\text{kg}$ ), and total xylenes (<40  $\mu\text{g}/\text{kg}$ ).

BDL = Below detection limit (benzene (2  $\mu\text{g}/\text{kg}$ ), toluene (2  $\mu\text{g}/\text{kg}$ ), ethylbenzene (2  $\mu\text{g}/\text{kg}$ ), and total xylenes (2  $\mu\text{g}/\text{kg}$ )).

DUP = Duplicate sample.

NA = Not applicable/not analyzed.

F.O. = Flame out.

Interval sampled in ft below ground surface (bgs).

Dashes indicate (---) sample not analyzed for benzene, toluene, ethylbenzene, and total xylene compounds.

**APPENDIX B (Continued)**

Sample ID	Date Analyzed	Interval Sampled (ft bgs)	Benzene (µg/kg)	Toluene (µg/kg)	Ethylbenzene (µg/kg)	Total Xylenes (µg/kg)	Total BTEX (µg/kg)	PID <sup>(a)</sup> (ppm <sub>v</sub> )	FID <sup>(a)</sup> (ppm <sub>v</sub> ) (or %)
FF-DP-37	NS	NS	NS	NS	NS	NS	NS	NS	NS
FF-DP-38	NS	NS	NS	NS	NS	NS	NS	NS	NS
FF-DP-39	08/09/99	4-6	BDL	BDL	BDL	BDL	BDL	1.7	5.6
FF-DP-40	08/10/99	3-5	---	---	---	---	---	530	22.7%
FF-DP-41	08/10/99	3-5	---	---	---	---	---	640	22.7%
FF-DP-42	08/10/99	3-5	TRACE	160	74	310	544	85	1,300
FF-DP-43	08/10/99	3-5	BDL	TRACE	TRACE	TRACE	TRACE	34	790
FF-DP-44	08/10/99	3-5	BDL	TRACE	BDL	BDL	TRACE	0.51	410
FF-DP-45	08/10/99	3-5	BDL	TRACE	BDL	BDL	TRACE	0.65	240
FF-DP-46	08/09/99	4-6	BDL	BDL	BDL	BDL	BDL	1.5	52
FF-DP-47	08/10/99	3-5	BDL	TRACE	BDL	BDL	TRACE	1.2	5.1
FF-DP-47DUP	08/10/99	3-5	BDL	TRACE	BDL	BDL	TRACE	NA	NA
FF-DP-48	NS	NS	NS	NS	NS	NS	NS	NS	NS
FF-DP-49	NS	NS	NS	NS	NS	NS	NS	NS	NS
FF-DP-50	NS	NS	NS	NS	NS	NS	NS	NS	NS
FF-DP-51	NS	NS	NS	NS	NS	NS	NS	NS	NS
FF-DP-52	NS	NS	NS	NS	NS	NS	NS	NS	NS
FF-DP-53	08/09/99	4-6	BDL	TRACE	BDL	BDL	TRACE	5.2	36
FF-DP-54	NS	NS	NS	NS	NS	NS	NS	NS	NS
FF-DP-55	08/10/99	3-5	---	---	---	---	---	670	(b)
FF-DP-56	08/10/99	3-5	---	---	---	---	---	660	2.5%
FF-DP-57	08/10/99	3-5	BDL	TRACE	BDL	BDL	TRACE	3.9	(b)
FF-DP-58	08/11/99	3-5	BDL	BDL	BDL	BDL	BDL	0.60	520
FF-DP-59	08/11/99	3-5	BDL	BDL	BDL	BDL	BDL	1.6	420
FF-DP-60	08/11/99	3-5	BDL	BDL	BDL	BDL	BDL	2.4	620
FF-DP-61	08/11/99	3-5	BDL	TRACE	BDL	BDL	TRACE	3.4	38
FF-DP-61DUP	08/11/99	3-5	BDL	TRACE	BDL	BDL	TRACE	NA	NA
FF-DP-62	08/11/99	3-5	---	---	---	---	---	610	4.6%
FF-DP-63	08/11/99	3-5	BDL	BDL	BDL	BDL	BDL	1.3	60
Method Blank	08/09/99	---	BDL	BDL	BDL	BDL	BDL	NA	NA
Method Blank	08/10/99	---	BDL	BDL	BDL	BDL	BDL	NA	NA
Method Blank	08/11/99	---	BDL	BDL	BDL	BDL	BDL	NA	NA
FF-DP-64	08/11/99	3-5	---	---	---	---	---	650	21%
FF-DP-65	08/16/99	2-4	BDL	TRACE	BDL	BDL	TRACE	7	27
FF-DP-65	08/11/99	3-5	---	---	---	---	---	770	2.5%
FF-DP-65	08/16/99	6-8	BDL	42	BDL	BDL	42	0	21
FF-DP-66	08/11/99	3-5	TRACE	23	BDL	BDL	23	11	800
FF-DP-67	08/11/99	3-5	BDL	BDL	BDL	BDL	BDL	0.5	1.0
FF-DP-68	08/11/99	3-5	BDL	BDL	BDL	BDL	BDL	0.6	1.9
FF-DP-69	08/11/99	3-5	BDL	20	BDL	BDL	20	5.6	51
FF-DP-70	08/11/99	3-5	BDL	250	TRACE	TRACE	250	25	240
FF-DP-71	08/11/99	3-5	BDL	BDL	BDL	BDL	BDL	0.74	93
FF-DP-72	08/11/99	3-5	TRACE	64	TRACE	160	224	190	800
FF-DP-73	08/11/99	3-5	BDL	TRACE	BDL	BDL	TRACE	10	720
FF-DP-74	08/11/99	3-5	BDL	BDL	BDL	BDL	BDL	1.9	1,300
FF-DP-75	08/11/99	3-5	BDL	BDL	BDL	BDL	BDL	0.32	6.0
FF-DP-76	08/12/99	3-5	BDL	BDL	BDL	BDL	BDL	6.4	2.5
FF-DP-77	08/12/99	3-5	BDL	BDL	BDL	BDL	BDL	4.6	0.7
FF-DP-78	08/12/99	3-5	BDL	BDL	BDL	BDL	BDL	2.4	0.3
FF-DP-79	08/12/99	3-5	BDL	TRACE	BDL	BDL	TRACE	3	17
FF-DP-80	08/12/99	3-5	BDL	BDL	BDL	BDL	BDL	1	1.4
FF-DP-81	08/12/99	3-5	BDL	BDL	BDL	BDL	BDL	1.3	37
FF-DP-82	08/12/99	3-5	BDL	BDL	BDL	BDL	BDL	0.6	0.5
FF-DP-83	08/12/99	3-5	BDL	BDL	BDL	BDL	BDL	3.0	30
FF-DP-84	08/12/99	3-5	BDL	BDL	BDL	BDL	BDL	1.6	2.6
FF-DP-85	08/12/99	3-5	BDL	BDL	BDL	BDL	BDL	1.3	0.28
FF-DP-86	08/12/99	3-5	---	---	---	---	---	1,200	2.3%
FF-DP-87	08/12/99	3-5	BDL	27	BDL	BDL	27	19	77
FF-DP-87DUP	08/12/99	3-5	BDL	TRACE	BDL	BDL	TRACE	NA	NA
FF-DP-88	08/12/99	3-5	BDL	BDL	BDL	BDL	BDL	1.7	4.6
FF-DP-89	08/12/99	3-5	BDL	BDL	BDL	BDL	BDL	6.6	17

NOTE: NS = Not sampled due to utility obstruction.

**APPENDIX B (Continued)**

Sample ID	Date Analyzed	Interval Sampled (ft bgs)	Benzene (µg/kg)	Toluene (µg/kg)	Ethylbenzene (µg/kg)	Total Xylenes (µg/kg)	Total BTEX (µg/kg)	PID <sup>(a)</sup> (ppm <sub>v</sub> )	FID <sup>(a)</sup> (ppm <sub>v</sub> ) (or %)
FF-DP-90	08/12/99	3-5	---	---	---	---	---	1,300	5.2%
FF-DP-91	08/12/99	3-5	BDL	58	BDL	BDL	58	2.0	10
FF-DP-92	08/12/99	3-5	BDL	TRACE	BDL	BDL	TRACE	4.1	21
FF-DP-93	08/12/99	3-5	BDL	390	BDL	BDL	390	32	360
FF-DP-94	08/11/99	3-5	---	---	---	---	---	580	21.1%
FF-DP-95	08/11/99	2-4	BDL	TRACE	BDL	BDL	TRACE	10	140
FF-DP-96	08/11/99	2-4	TRACE	880	TRACE	TRACE	880	200	2,000
FF-DP-97	08/11/99	2-4	TRACE	110	TRACE	TRACE	110	72	(b)
FF-DP-98	08/11/99	3-5	BDL	BDL	BDL	BDL	BDL	1.3	(b)
FF-DP-99	08/12/99	3-5	BDL	BDL	BDL	BDL	BDL	17	2.2
Method Blank	08/12/99	---	BDL	BDL	BDL	BDL	BDL	NA	NA
FF-DP-100	08/12/99	3-5	---	---	---	---	---	1,100	2.1%
FF-DP-101	08/12/99	3-5	---	---	---	---	---	870	6,900
FF-DP-102	08/12/99	3-5	---	---	---	---	---	1,100	19.4%
FF-DP-102	08/20/99	8-10	BDL	1,700	TRACE	270	1,970	23	240
FF-DP-103	08/13/99	3-5	---	---	---	---	---	700	18.1%
FF-DP-104	08/13/99	3-5	BDL	BDL	BDL	BDL	BDL	5.2	17
FF-DP-105	08/13/99	3-5	BDL	BDL	BDL	BDL	BDL	3.2	2.5
FF-DP-105DUP	08/13/99	3-5	BDL	BDL	BDL	BDL	BDL	NA	NA
FF-DP-106	08/13/99	3-5	BDL	35	BDL	BDL	35	23	91
FF-DP-107	08/13/99	3-5	BDL	620	TRACE	TRACE	620	28	320
FF-DP-108	08/13/99	3-5	BDL	150	BDL	BDL	150	66	430
FF-DP-108DUP	08/13/99	3-5	BDL	160	BDL	BDL	160	NA	NA
FF-DP-109	08/13/99	3-5	---	---	---	---	---	720	14%
FF-DP-110	08/13/99	3-5	BDL	37	BDL	BDL	37	24	227
FF-DP-111	08/13/99	3-5	---	---	---	---	---	720	12%
FF-DP-112	08/13/99	3-5	BDL	40	BDL	230	270	110	520
FF-DP-113	08/13/99	3-5	---	---	---	---	---	820	7,800
FF-DP-114	08/13/99	3-5	BDL	BDL	BDL	BDL	BDL	1.6	1.0
FF-DP-115	08/13/99	3-5	---	---	---	---	---	360	2,100
FF-DP-116	08/13/99	3-5	BDL	600	BDL	41	641	166	1,000
FF-DP-116DUP	08/13/99	3-5	BDL	1,500	BDL	51	1,551	NA	NA
FF-DP-117	08/13/99	3-5	---	---	---	---	---	390	3,200
FF-DP-118	08/13/99	3-5	---	---	---	---	---	810	8,100
FF-DP-119	08/13/99	3-5	BDL	31	BDL	BDL	31	9.1	36
FF-DP-119DUP	08/13/99	3-5	BDL	35	BDL	BDL	35	NA	NA
FF-DP-120	08/13/99	3-5	BDL	BDL	BDL	BDL	BDL	1.1	5.6
FF-DP-121	08/13/99	3-5	BDL	100	BDL	BDL	100	24	130
FF-DP-122	08/13/99	3-5	TRACE	230	BDL	BDL	230	0.9	2.6
FF-DP-123	08/13/99	3-5	---	---	---	---	---	430	3,200
FF-DP-124	08/13/99	3-5	BDL	TRACE	BDL	BDL	TRACE	0.90	4.3
Method Blank	08/13/99	---	BDL	BDL	BDL	BDL	BDL	NA	NA
FF-DP-125	08/13/99	3-5	---	---	---	---	---	440	3,400
FF-DP-126	08/16/99	3-5	BDL	TRACE	BDL	BDL	TRACE	1.7	5.7
FF-DP-127	08/16/99	3-5	BDL	TRACE	BDL	BDL	TRACE	3.1	21
FF-DP-128	08/16/99	3-5	BDL	190	BDL	BDL	190	49	560
FF-DP-129	08/16/99	3-5	BDL	41	TRACE	BDL	41	18	600
FF-DP-130	08/16/99	3-5	BDL	TRACE	BDL	BDL	TRACE	0.6	27
FF-DP-131	08/16/99	3-5	BDL	170	BDL	TRACE	170	110	570
FF-DP-132	08/16/99	3-5	BDL	130	BDL	TRACE	130	58	480
FF-DP-133	08/16/99	3-5	BDL	TRACE	BDL	BDL	TRACE	1.4	8.2
FF-DP-134	08/16/99	3-5	BDL	180	BDL	TRACE	180	39	420
FF-DP-135	08/16/99	3-5	BDL	TRACE	BDL	BDL	TRACE	1.0	4.7
FF-DP-136	08/17/99	3-5	BDL	BDL	BDL	BDL	BDL	1.3	0.0
FF-DP-136DUP	08/17/99	3-5	BDL	BDL	BDL	BDL	BDL	NA	NA
FF-DP-137	08/16/99	3-5	BDL	86	BDL	BDL	86	19	100
FF-DP-138	08/16/99	3-5	BDL	37	TRACE	BDL	37	21	740
FF-DP-139	08/16/99	3-5	TRACE	410	BDL	TRACE	410	98	820
FF-DP-140	08/16/99	3-5	BDL	41	BDL	BDL	41	22	320
FF-DP-141	08/16/99	3-5	BDL	630	BDL	42	672	89	620
Method Blank	08/16/99	---	BDL	BDL	BDL	BDL	BDL	NA	NA
FF-DP-142	08/17/99	3-5	BDL	490	BDL	TRACE	490	24	180

**APPENDIX B (Continued)**

Sample ID	Date Analyzed	Interval Sampled (ft bgs)	Benzene (µg/kg)	Toluene (µg/kg)	Ethylbenzene (µg/kg)	Total Xylenes (µg/kg)	Total BTEX (µg/kg)	PID <sup>(a)</sup> (ppm <sub>v</sub> )	FID <sup>(a)</sup> (ppm <sub>v</sub> ) (or %)
FF-DP-143	08/17/99	3-5	TRACE	BDL	BDL	BDL	TRACE	5.6	47
FF-DP-144	08/17/99	3-5	BDL	TRACE	BDL	BDL	TRACE	1.4	1,100
FF-DP-145	08/17/99	3-5	BDL	1,200	BDL	TRACE	1,200	100	710
FF-DP-146	08/17/99	3-5	BDL	360	TRACE	TRACE	360	18	360
FF-DP-147	08/17/99	3-5	BDL	1,100	BDL	110	1,210	220	1,500
FF-DP-148	08/17/99	3-5	BDL	BDL	BDL	BDL	BDL	2	15
FF-DP-149	08/17/99	3-5	---	---	---	---	---	350	4,200
FF-DP-150	08/17/99	3-5	32	1,200	TRACE	41	1,273	85	1,000
FF-DP-150DUP	08/17/99	3-5	46	2,600	60	63	2,769	NA	NA
FF-DP-151	08/17/99	3-5	TRACE	370	BDL	BDL	370	91	870
FF-DP-152	08/17/99	3-5	BDL	BDL	BDL	BDL	BDL	3.6	2.4
FF-DP-153	08/17/99	3-5	---	---	---	---	---	660	8.2%
FF-DP-154	08/17/99	3-5	---	---	---	---	---	720	3.0%
FF-DP-155	08/17/99	3-5	BDL	2,400	TRACE	170	2,570	130	800
FF-DP-156	08/17/99	3-5	---	---	---	---	---	>600	F.O.
FF-DP-157	08/17/99	3-5	---	---	---	---	---	450	2,900
FF-DP-158	08/17/99	3-5	BDL	BDL	BDL	BDL	BDL	3.6	330
FF-DP-159	08/17/99	3-5	---	---	---	---	---	700	16.2%
FF-DP-160	08/17/99	3-5	---	---	---	---	---	720	13%
FF-DP-161	08/17/99	3-5	BDL	BDL	BDL	BDL	BDL	0.10	41
FF-DP-162	08/17/99	3-5	BDL	TRACE	BDL	BDL	TRACE	0.52	420
FF-DP-163	08/17/99	3-5	---	---	---	---	---	>470	F.O.
FF-DP-164	08/17/99	3-5	---	---	---	---	---	>480	F.O.
FF-DP-165	08/17/99	3-5	---	---	---	---	---	>500	F.O.
FF-DP-166	08/17/99	3-5	BDL	TRACE	BDL	BDL	TRACE	4.5	18
FF-DP-167	08/17/99	3-5	BDL	TRACE	M.E.	M.E.	M.E.	220	1,100
FF-DP-168	08/17/99	3-5	BDL	TRACE	M.E.	M.E.	M.E.	299	1,300
FF-DP-169	08/17/99	3-5	BDL	BDL	BDL	BDL	BDL	19	75
Method Blank	08/17/99	---	BDL	BDL	BDL	BDL	BDL	NA	NA
FF-DP-170	08/18/99	3-5	BDL	BDL	BDL	BDL	BDL	50	200
FF-DP-171	NS	NS	NS	NS	NS	NS	NS	NS	NS
FF-DP-172	08/17/99	3-5	BDL	180	TRACE	TRACE	180	140	2,000
FF-DP-172DUP	08/18/99	3-5	BDL	104	BDL	TRACE	104	NA	NA
FF-DP-173	08/18/99	3-5	BDL	TRACE	BDL	BDL	TRACE	29	14
FF-DP-174	08/18/99	7-9	BDL	TRACE	M.E.	M.E.	M.E.	280	1,200
FF-DP-175	08/18/99	3-5	BDL	TRACE	M.E.	M.E.	M.E.	200	1,400
FF-DP-176	08/18/99	3-5	BDL	BDL	BDL	BDL	BDL	6.5	0.60
FF-DP-177	08/18/99	3-5	BDL	BDL	BDL	BDL	BDL	4.4	410
FF-DP-178	08/18/99	3-5	BDL	TRACE	BDL	BDL	TRACE	5.9	10
FF-DP-179	08/18/99	3-5	BDL	TRACE	BDL	BDL	TRACE	6.7	310
FF-DP-180	08/18/99	3-5	BDL	TRACE	BDL	BDL	TRACE	6.7	17
FF-DP-181	08/18/99	3-5	BDL	BDL	BDL	BDL	BDL	4.4	13
FF-DP-182	08/18/99	3-5	BDL	BDL	BDL	BDL	BDL	1.4	1.8
FF-DP-183	08/18/99	3-5	BDL	BDL	BDL	BDL	BDL	0.40	0.45
FF-DP-184	08/18/99	3-5	BDL	160	TRACE	TRACE	160	200	1,100
FF-DP-184DUP	08/18/99	3-5	BDL	260	TRACE	TRACE	260	NA	NA
FF-DP-185	08/18/99	3-5	---	---	---	---	---	>800	F.O.
FF-DP-186	08/18/99	3-5	BDL	BDL	BDL	BDL	BDL	1.8	3.3
FF-DP-187	08/18/99	3-5	---	---	---	---	---	>600	F.O.
FF-DP-188	08/18/99	3-5	BDL	120	M.E.	M.E.	M.E.	120	640
FF-DP-189	08/18/99	3-5	BDL	BDL	BDL	BDL	BDL	4.3	29
FF-DP-190	08/18/99	3-5	---	---	---	---	---	850	17.6%
FF-DP-191	08/18/99	3-5	---	---	---	---	---	820	17.1%
FF-DP-192	08/18/99	3-5	---	---	---	---	---	500	4,300
FF-DP-193	08/18/99	3-5	BDL	BDL	BDL	BDL	BDL	2.3	5.7
Method Blank	08/18/99	---	BDL	BDL	BDL	BDL	BDL	NA	NA
FF-DP-194	08/19/99	3-5	BDL	TRACE	BDL	BDL	TRACE	6.9	15
FF-DP-195	08/19/99	3-5	BDL	BDL	BDL	BDL	BDL	3.2	1

NOTE: M.E. = Matrix effect caused by heavy hydrocarbons; component concentration not determined.

**APPENDIX B (Continued)**

Sample ID	Date Analyzed	Interval Sampled (ft bgs)	Benzene ( $\mu\text{g}/\text{kg}$ )	Toluene ( $\mu\text{g}/\text{kg}$ )	Ethyl-benzene ( $\mu\text{g}/\text{kg}$ )	Total Xylenes ( $\mu\text{g}/\text{kg}$ )	Total BTEX ( $\mu\text{g}/\text{kg}$ )	PID <sup>(a)</sup> (ppm <sub>v</sub> )	FID <sup>(a)</sup> (ppm <sub>v</sub> ) (or %)
FF-DP-196	08/19/99	3-5	BDL	69	TRACE	210	279	53	400
FF-DP-196DUP	08/19/99	3-5	BDL	22	BDL	TRACE	22	NA	NA
FF-DP-197	08/19/99	3-5	---	---	---	---	---	690	18%
FF-DP-198	08/19/99	3-5	BDL	TRACE	BDL	BDL	TRACE	7.2	38
FF-DP-199	08/19/99	3-5	---	---	---	---	---	600	18%
FF-DP-200	08/19/99	3-5	BDL	59	TRACE	TRACE	59	49	340
FF-DP-200DUP	08/19/99	3-5	BDL	62	BDL	TRACE	62	NA	NA
FF-DP-201	08/19/99	3-5	BDL	BDL	BDL	BDL	BDL	1.1	3.1
FF-DP-202	08/19/99	3-5	BDL	160	BDL	BDL	160	61	1,700
FF-DP-203	08/19/99	3-5	BDL	39	BDL	TRACE	39	23	210
FF-DP-204	08/19/99	3-5	BDL	53	BDL	BDL	53	12	150
FF-DP-205	08/19/99	3-5	BDL	50	BDL	BDL	50	9.9	1,000
FF-EQ BLANK	08/19/99	---	BDL	BDL	BDL	BDL	BDL	NA	NA
FF-DP-206	08/19/99	3-5	BDL	TRACE	BDL	BDL	TRACE	2.6	200
FF-DP-207	08/19/99	3-5	BDL	110	BDL	TRACE	110	21	1,600
FF-DP-208	08/19/99	3-5	---	---	---	---	---	>600	F.O.
FF-DP-209	08/19/99	3-5	BDL	BDL	BDL	BDL	BDL	1.6	5.2
FF-DP-210	08/19/99	3-5	BDL	BDL	BDL	BDL	BDL	3.8	170
FF-DP-211	08/19/99	3-5	---	---	---	---	---	840	3.7%
FF-DP-212	08/19/99	3-5	---	---	---	---	---	700	F.O.
FF-DP-213	08/19/99	3-5	---	---	---	---	---	870	18%
FF-DP-214	08/19/99	3-5	BDL	BDL	BDL	BDL	BDL	1.4	2.6
FF-DP-215	08/19/99	3-5	BDL	BDL	BDL	BDL	BDL	17	8,500
FF-DP-216	08/19/99	3-5	---	---	---	---	---	>700	F.O.
FF-DP-217	08/19/99	3-5	---	---	---	---	---	>680	F.O.
FF-DP-218	08/19/99	3-5	BDL	BDL	BDL	BDL	BDL	1.6	2.8
FF-DP-219	08/19/99	3-5	BDL	BDL	BDL	BDL	BDL	8.8	82
FF-DP-220	08/19/99	3-5	BDL	BDL	BDL	BDL	BDL	1.1	83
FF-DP-221	08/19/99	3-5	BDL	BDL	BDL	BDL	BDL	1.4	73
FF-DP-222	08/19/99	3-5	BDL	TRACE	BDL	BDL	TRACE	8.8	82
FF-DP-223	08/19/99	3-5	BDL	BDL	BDL	BDL	BDL	1.2	520
FF-DP-224	08/19/99	3-5	10	97	TRACE	230	337	190	2,300
Method Blank	08/19/99	---	BDL	BDL	BDL	BDL	BDL	NA	NA
FF-DP-225	08/20/99	3-5	BDL	31	TRACE	TRACE	31	2.9	2,200
FF-DP-226	08/20/99	3-5	BDL	TRACE	BDL	BDL	TRACE	1.9	550
FF-DP-227	08/20/99	3-5	BDL	TRACE	BDL	BDL	TRACE	3.1	2,100
FF-DP-228	08/20/99	3-5	BDL	BDL	BDL	BDL	BDL	2.3	0.5
FF-DP-229	08/20/99	3-5	BDL	300	M.E.	M.E.	M.E.	140	690
FF-DP-230	08/20/99	3-5	BDL	BDL	BDL	BDL	BDL	1.2	11
FF-DP-231	08/20/99	3-5	BDL	BDL	BDL	BDL	BDL	1.7	1.4
FF-DP-232	08/20/99	3-5	BDL	TRACE	BDL	BDL	TRACE	33	350
FF-DP-232 DUP	08/20/99	3-5	BDL	TRACE	BDL	BDL	TRACE	NA	NA
FF-DP-233	08/20/99	3-5	---	---	---	---	---	1.9	2.7
FF-DP-234	08/20/99	2-4	BDL	110	BDL	TRACE	110	18	440
FF-DP-235	08/20/99	2-4	BDL	93	M.E.	M.E.	M.E.	250	2,900
FF-DP-236	08/20/99	2-4	BDL	TRACE	BDL	BDL	TRACE	4.7	2,800
FF-DP-237	08/20/99	2-4	BDL	22	M.E.	M.E.	M.E.	15	1,700
FF-DP-237DUP	08/20/99	2-4	BDL	57	M.E.	M.E.	M.E.	NA	NA
FF-DP-238	08/20/99	2-4	NA	NA	NA	NA	NA	0.7	1.0
FF-DP-239	08/20/99	2-4	NA	NA	NA	NA	NA	0.54	0.27
FF-DP-240	08/20/99	2-4	BDL	TRACE	M.E.	M.E.	M.E.	20	740
FF-DP-241	08/20/99	2-4	BDL	TRACE	BDL	BDL	TRACE	2.7	1,400
FF-DP-242	08/20/99	3-5	NA	NA	NA	NA	NA	2.6	36

## **Appendix C**

### **Calibration Set Points for Photoionization and Flame Ionization Detectors Used in Field Headspace Determinations at Maine Underground Storage Tank and Leaking Underground Storage Tank Sites**




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## Calibration Set Points For Photoionization (PIDs) and Flame Ionization Detectors (FIDs) Used in Field Headspace Determinations at Maine UST and LUST Sites

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**DATE:** September 8, 1997

**TO:** All Persons Performing Site Assessments Pursuant To "Regulations for Registration, Installation, Operation & Closure of Underground Oil Storage Facilities (Appendix P of CMR, Chapter 691)

George Seel, Director

**FROM:** Division of Technical Services  
Bureau of Remediation & Waste Management

\*\*\*\*\*

The following table gives the set points for various PIDs and FIDs when calibrating with 100 ppm isobutylene span gas. Only the makes and models of instrument listed below may be used in Maine site assessments, where these are required by Chapter 691. The notification level using instruments adjusted to these set points is 100 ppm, regardless of the petroleum product being measured. Instruments calibrated to these set points may also be used to determine compliance with the cleanup standards at Baseline-2 (BL-2) sites, per the DEP Procedural Guidance For Establishing Standards For The Remediation Of Oil-Contaminated Soil And Groundwater In Maine ("Decision Tree").

Instruments may be made to read directly, either by entering the appropriate set point when the calibration routine requests the span gas concentration, or by adjusting the instrument's span until the set point reading is obtained. As an alternative, the instrument may be calibrated to the actual span gas concentration and readings are then multiplied by the set point divided by 100, producing the equivalent result. (e.g., a reading of 35 made with an HNu HW-101 at a gasoline site would be multiplied by 440/100 or 4.4 to produce a corrected reading of 154). Headspace concentrations obtained by either method should not be corrected to "benzene equivalents," as suggested by some instrument manufacturers.

If isobutylene span gas having a concentration other than 100 ppm is used, the set point should be adjusted proportionally (e.g., when calibrating a Thermo 580S using 250 ppm isobutylene, the set points should be multiplied by 250/100 or 2.5, producing set points of 637 and 800, respectively, for gasoline and fuel oil work).

This list is periodically updated as set points are established for additional instruments. For the most current listing, please contact the Division of Technical Services, Bureau of Remediation & Waste Management at (207) 287-2651.

A protocol is also available, whereby manufacturers of unlisted PID and FID instruments can

generate validation data for DEP's evaluation. For further information, please contact the Division of Technical Services.

<b>PID Instruments</b>	<b>Set Point for Gasoline Sites</b>	<b>Set Point for #2 Fuel Oil Sites</b>
<b>HNu PI-101, HW-101, ISPI-101, DL-101</b>	<b>440</b>	<b>520</b>
<b>MSA Photon Gas Detector</b>	<b>225</b>	<b>225</b>
<b>MSA Passport PID II OVM</b>	<b>210</b>	<b>355</b>
<b>MicroTIP MP-1000, HL-2000, IS-3000</b>	<b>225</b>	<b>225</b>
<b>Thermo OVM 580B, 580S</b>	<b>255</b>	<b>320</b>
<b>Environmental Technologies "Determinator"</b>	<b>255</b>	<b>320</b>
<b>Foxboro TVA-1000</b>	<b>265</b>	<b>330</b>
<b>FID Instruments</b>	<b>Set Point for Gasoline Sites</b>	<b>Set Point for #2 Fuel Oil Sites</b>
<b>Thermo OVM Model 680</b>	<b>80</b>	<b>45</b>
<b>Foxboro TVA-1000</b>	<b>90</b>	<b>60</b>

Posted 1/19/00

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**Appendix D**  
**Preliminary Cost Estimates**

**TABLE D-1 ALTERNATIVE 1: *IN SITU* CHEMICAL OXIDATION  
(Preliminary Cost Analysis)**

**A. CAPITAL COSTS**

Item No.	Cost Categories and Items	Description	Unit Cost	Quantity (#)	Total Cost
	<b><i>In-Situ</i> Chemical Oxidation (See NOTE 1)</b>				
1.1	Laboratory/Pilot Study	Includes a treatability study which would identify parameters such as water content, alkaline metals, and humus content in soil and total organic halides that could affect processing time and cost, followed by the implementation of a pilot program.	\$30,000.00	1	\$30,000
1.2	Injection System	Installation of delivery wells to distribute oxidizers, catalysts, mobility agents, viscosity enhancers, etc.	\$40,000.00	1	\$40,000
1.3	Chemical Injection/Diffusion	Generation of hydroxyl free radicals as oxidizing agents to destroy TPH compounds	\$100,000.00	3	\$300,000
1.4	Soil Confirmation Sampling Analysis	Samples collected every 2500 sf. and analyzed for BTEX, TPH-DRO and TPH-GRO with normal turnaround time	\$210.00	108	\$22,680
1.5	Ground-Water Confirmation Sampling Analysis	Samples collected every 2500 sf. and analyzed for BTEX, TPH-DRO and TPH-GRO with normal turnaround time	\$210.00	108	\$22,680
1.6	Geoprobe	Collection of soil and ground-water samples	\$4,000.00	3	\$12,000
1.7	Soil and Ground-Water Sampling (Labor)	Collection of soil and ground-water samples	\$55.00	96	\$5,280
	Subtotal				\$432,640
1.8	Contingency			20%	\$86,528
1.9	Reports	Outlining the results of the program	\$10,000	1	\$10,000
	Line Item Total				\$529,168
	<b>TOTAL CAPITAL COST</b>				<b>\$529,168</b>

**B. OPERATION AND MAINTENANCE (O&M) COSTS**

There are no operations and maintenance costs associated with *In Situ* Chemical Oxidation

**C. COST SUMMARY**

Cost Element	Cost (\$)
Capital Costs (Laboratory/Pilot Program)	\$529,168
Operation and Maintenance Costs (1 year)	\$0
<b>TOTAL PROJECT COSTS</b>	<b>\$529,168</b>

**NOTE**

1 It is impossible to estimate the total capital cost of site remediation with certainty prior to performance of the laboratory and pilot study. The capital costs reflected in Item Nos. 1.2 through 1.6 are contingent on a successful pilot study to determine site specific treatment requirements and are intended to be used for rough estimation purposes. If the laboratory/pilot study is unsuccessful, \$30,000 should be added to the remaining alternatives to reflect the capital cost of the unsuccessful laboratory/pilot study.

**ASSUMPTIONS**

- 1.1 Cost for laboratory/3 injection well pilot study based on conversations with ISOTECH
- 1.2 Assumes injection wells as required by Geocleanse. If injection trenches were utilized, a cost savings of \$15,000 would be realized
- 1.3 Assumes 3 oxidizing events to ensure that post-treatment soils meet site-specific PRG
- 1.4 Assumes 3 rounds of sampling (1 initial sampling event, 1 intermediate sampling event, and 1 final sampling event to confirm completed remediation)
- 1.5 Assumes 3 rounds of sampling (1 initial sampling event, 1 intermediate sampling event, and 1 final sampling event to document ground-water quality)

**TABLE D-2 ALTERNATIVE 2: EXCAVATION/OFFSITE ASPHALT BLENDING  
(Preliminary Cost Analysis)**

**A. CAPITAL COSTS**

Item No.	Cost Categories and Items	Description	Unit Cost	Quantity (#)	Total Cost
<b>1</b>	<b>Selective Excavation</b>				
1.1	Excavation, Transportation, Site Restoration	Includes mobilization, excavation, loading, and transport of 12,500 cy of soil to asphalt batch facility. Replace with 12,500 cy of common borrow, compaction to 90%, and level site to match existing grade.	\$34.00	12,500	\$425,000
1.2	PID Head Space Post Excavation Confirmation Sampling	Includes use of Foxboro TVA-1000 PID/FID in performing MEDEP Chapter 691 (Appendix Q) Field Determination of Soil Hydrocarbon Content by Jar/Poly Bag Headspace Technique	\$55.00	240	\$13,200
1.3	Fixed Laboratory Confirmation Sampling	Samples collected every 2500 sf. and analyzed for TPH-DRO and TPH-GRO with quick turnaround time	\$660.00	36	\$23,760
1.4	Health and Safety	S&H tailgate meetings, air monitoring, PPE, excavation safety, etc.	\$60.00	90	\$5,400
1.5	De-Watering	Sheet-piling and/or pump-and-treat	\$70,000.00	1	\$70,000
1.6	Engineering Design/Permitting	5% of excavation cost		5%	\$26,868
	Subtotal				\$564,228
1.7	Contingency			20%	\$112,846
1.8	Reports	Outlining the results of the program	\$10,000	1	\$10,000
	<b>Line Item Total</b>				<b>\$687,074</b>
<b>2</b>	<b>Offsite Asphalt Blending</b>				
2.1	Soil Recycling at Asphalt Batch Facility	Asphalt batch facility located in Scarborough, ME (tons)	\$28.50	18,750	\$534,375
2.2	Contingency			20%	\$106,875
	<b>Line Item Total</b>				<b>\$641,250</b>
	<b>TOTAL CAPITAL COST</b>				<b>\$1,328,324</b>

**B. OPERATION AND MAINTENANCE (O&M) COSTS**

There are no operations and maintenance costs associated with Excavation/Offsite Asphalt Blending

**C. COST SUMMARY**

Cost Element	Cost (\$)
Capital Costs	\$1,328,324
Operation and Maintenance Costs (1 year)	\$0
<b>TOTAL PROJECT COSTS</b>	<b>\$1,328,324</b>

**ASSUMPTIONS**

- 1.1 Unit cost includes 13% G&A and 5% award fee. Assumes \$8/yd common borrow. Screening of the excavated materials may reduce cost by eliminating construction debris.
- 1.2 Assumes 2 people (P2 and T3) for 3 weeks with 115% Overhead, 13% G&A, and 10% award fee
- 1.4 Assumes 1 person for 3 weeks with 115% Overhead, 13% G&A and 10% award fee
- 2.1 Material must be sufficiently dry as to not produce "free liquids" during transportation and the quoted price does not include clay material or other waste material mixed with the soil. Assumes procurement of a "spill letter" from MEDEP to eliminate the need to test for BTEX and lead per every 500 tons transported to the Unit cost on a per ton basis and includes 13% G&A and 5% award fee. Quantity assumes a 1 to 1.5 ratio for estimation purposes (12,500 cy x 1.5 ton/cy)

**TABLE D-3 ALTERNATIVE 3: EXCAVATION/ONSITE THERMAL DESORPTION  
(Preliminary Cost Analysis)**

**A. CAPITAL COSTS**

Item No.	Cost Categories and Items	Description	Unit Cost	Quantity (#)	Total Cost
<b>1</b>	<b>Selective Excavation</b>				
1.1	Excavation, Soil Handling, Site Restoration	Includes mobilization, excavation, screening, and loading of 12,500 cy of source soil into a mobile low temperature thermal Desorption unit. Utilize treated material for backfill with the addition of 625 cy of common borrow, compaction to 90%, and level site to match existing grade	\$28.00	12,500	\$350,000
1.2	PID Head Space Post Excavation Confirmation Sampling	Includes use of Foxboro TVA-1000 PID/FID in performing MEDEP Chapter 691 (Appendix Q) Field Determination of Soil Hydrocarbon Content by Jar/Poly Bag Headspace Technique	\$55.00	240	\$13,200
1.3	Fixed Laboratory Confirmation Sampling	Samples collected every 2500 sf. and analyzed for TPH-DRO and TPH-GRO with quick turnaround time	\$660.00	36	\$23,760
1.4	Health and Safety	S&H tailgate meetings, air monitoring, PPE, excavation safety, etc.	\$60.00	90	\$5,400
1.5	De-Watering	Sheet-piling and/or pump-and-treat	\$70,000.00	1	\$70,000
1.6	Engineering Design/Permitting	5% of excavation cost		5%	\$23,118
	Subtotal				\$485,478
1.7	Contingency			20%	\$97,096
1.8	Reports	Outlining the results of the program	\$10,000	1	\$10,000
	<b>Line Item Total</b>				<b>\$592,574</b>
<b>2</b>	<b>Mobile Thermal Desorption (See NOTE 1)</b>				
2.1	Low Temperature Thermal Desorption Unit		\$36.00	18,750	\$675,000
2.2	Contingency			20%	\$135,000
	<b>Line Item Total</b>				<b>\$810,000</b>
	<b>TOTAL CAPITAL COST</b>				<b>\$1,402,574</b>

**B. OPERATION AND MAINTENANCE (O&M) COSTS**

There are no operations and maintenance costs associated with Excavation/Onsite Thermal Desorption

**C. COST SUMMARY**

Cost Element	Cost (\$)
Capital Costs	\$1,402,574
Operation and Maintenance Costs (1 year)	\$0
<b>TOTAL PROJECT COSTS</b>	<b>\$1,402,574</b>

**NOTES**

1 Material must have a moisture content of less than 25%. If excavated soils are above 25%, additional de-watering costs/time will be realized.

**ASSUMPTIONS**

- 1.1 Unit cost includes 13% G&A and 5% award fee. Assumes \$8/yd common borrow and 95% reuse of treated soil.
- 1.2 Assumes 2 people (P2 and T3) for 3 weeks with 115% Overhead, 13% G&A, and 10% award fee
- 1.4 Assumes 1 person for 3 weeks with 115% Overhead, 13% G&A and 10% award fee
- 2.1 Unit cost on a per ton basis and includes 13% G&A and 5% award fee. Quantity estimate equals 12,500 cy x 1.5 ton/cy

**TABLE D-4 ALTERNATIVE 4: EXCAVATION/LAND FARMING OFFSITE  
(Preliminary Cost Analysis)**

**A. CAPITAL COSTS**

Item No.	Cost Categories and Items	Description	Unit Cost	Quantity (#)	Total Cost
<b>1</b>	<b>Selective Excavation</b>				
1.1	Excavation, Soil Handling, Site Restoration	Includes mobilization, excavation, screening of 12,500 cy of source material, transportation to an off-site facility, backfill with 12,500 cy common borrow, compaction to 90%, and level site to match existing grade	\$30.00	12,500	\$375,000
1.2	PID Head Space Post Excavation Confirmation Sampling	Includes use of Foxboro TVA-1000 PID/FID in performing MEDEP Chapter 691 (Appendix Q) Field Determination of Soil Hydrocarbon Content by Jar/Poly Bag Headspace Technique	\$55.00	240	\$13,200
1.3	Fixed Laboratory Confirmation Sampling	Samples collected every 2500 sf. and analyzed for TPH-DRO and TPH-GRO with quick turnaround time	\$660.00	36	\$23,760
1.4	Health and Safety	S&H tailgate meetings, air monitoring, PPE, excavation safety, etc.	\$60.00	90	\$5,400
1.5	De-Watering	Sheet-piling and/or pump-and-treat	\$70,000.00	1	\$70,000
1.6	Engineering Design/Permitting	5% of excavation cost		5%	\$24,368
	Subtotal				\$511,728
1.7	Contingency			20%	\$102,346
1.8	Reports	Outlining the results of the program	\$10,000	1	\$10,000
	Line Item Total				\$624,074
<b>2</b>	<b>Offsite Landfarming</b>				
2.1	Landfarming	Includes spreading of 12,500 cy of soil in 9 in. lift, runoff control, etc.	\$10.00	12,500	\$125,000
2.2	Contingency			20%	\$25,000
	Line Item Total				\$150,000
	<b>TOTAL CAPITAL COST</b>				<b>\$774,074</b>

**B. OPERATION AND MAINTENANCE (O&M) COSTS**

<b>3</b>	<b>Landfarm O&amp;M</b>				
3.1	Operations and Maintenance Program	Included periodic tilling and confirmatory sampling	\$10.00	12,500	\$125,000
3.2	Contingency			20%	\$25,000
	Line Item Total				\$150,000
	<b>TOTAL ANNUAL O&amp;M COSTS</b>				<b>\$150,000</b>

**C. COST SUMMARY**

Cost Element	Cost (\$)
Capital Costs	\$774,074
Operation and Maintenance Costs (1 year)	\$150,000
<b>TOTAL PROJECT COSTS</b>	<b>\$924,074</b>

**ASSUMPTIONS**

- 1.1 Unit cost includes 13% G&A and 5% award fee. Assumes \$8/yd common borrow.
- 1.2 Assumes 2 people (P2 and T3) for 3 weeks with 115% Overhead, 13% G&A, and 10% award fee
- 1.4 Assumes 1 person for 3 weeks with 115% Overhead, 13% G&A and 10% award fee

**TABLE D-5 ALTERNATIVE 5: EXCAVATION/BIOPILE CONSTRUCTED ONSITE  
(Preliminary Cost Analysis)**

**A. CAPITAL COSTS**

Item No.	Cost Categories and Items	Description	Unit Cost	Quantity (#)	Total Cost
<b>1 Selective Excavation</b>					
1.1	Excavation, Soil Handling, Site Restoration	Includes mobilization, excavation, screening of 12,500 cy of source material, and backfill with 12,500 cy common borrow, compaction to 90%, and level site to match existing grade.	\$30.00	12,500	\$375,000
1.2	PID Head Space Post Excavation Confirmation Sampling	Includes use of Foxboro TVA-1000 PID/FID in performing MEDEP Chapter 691 (Appendix Q) Field Determination of Soil Hydrocarbon Content by Jar/Poly Bag Headspace Technique	\$55.00	240	\$13,200
1.3	Fixed Laboratory Confirmation Sampling	Samples collected every 2500 sf. and analyzed for TPH-DRO and TPH-GRO with quick turnaround time	\$660.00	36	\$23,760
1.4	Health and Safety	S&H tailgate meetings, air monitoring, PPE, excavation safety, etc.	\$60.00	90	\$5,400
1.5	De-Watering	Sheet-piling and/or pump-and-treat	\$70,000.00	1	\$70,000
1.6	Engineering Design/Permitting	5% of excavation cost		5%	\$24,368
	Subtotal				\$511,728
1.7	Contingency			20%	\$102,346
1.8	Reports	Outlining the results of the program	\$10,000	1	\$10,000
	Line Item Total				\$624,074
<b>2 Temporary Biopile Construction (see NOTE 1)</b>					
2.1	Biopile Installation	Includes addition of bulking agents and nutrients (urea, ammonium phosphate, potassium sulfate, and super phosphate), mixing, and formation of 12,500 cy (plus 10% bulking agents) of soil into biopiles at the Old Fuel Farm (CY).	\$20.00	12,500	\$250,000
2.2	Contingency			20%	\$50,000
	Line Item Total				\$300,000
<b>TOTAL CAPITAL COST</b>					<b>\$924,074</b>

**B. OPERATION AND MAINTENANCE (O&M) COSTS**

Item No.	Cost Categories and Items	Description	Unit Cost	Quantity (#)	Total Cost
<b>3 Biopile O&amp;M</b>					
3.1	Operations and Maintenance Program		\$16.00	12,500	\$200,000
3.2	Contingency			20%	\$40,000
	Line Item Total				\$240,000
<b>TOTAL ANNUAL O&amp;M COSTS</b>					<b>\$240,000</b>

**C. COST SUMMARY**

Cost Element	Cost (\$)
Capital Costs	\$924,074
Operation and Maintenance Costs (1 year)	\$240,000
<b>TOTAL PROJECT COSTS</b>	<b>\$1,164,074</b>

**NOTE**

1 Treated soil could be reused as fill for ball fields resulting in economic savings of approximately \$125,000 (assuming \$10/yd).

**ASSUMPTIONS**

- 1.1 Unit cost includes 13% G&A and 5% award fee. Assumes \$8/yd common borrow.
- 1.2 Assumes 2 people (P2 and T3) for 3 weeks with 115% Overhead, 13% G&A, and 10% award fee
- 1.4 Assumes 1 person for 3 weeks with 115% Overhead, 13% G&A and 10% award fee
- 2.1 Costs taken from NFESC Technical Memorandum for Construction of Biopiles. Biopiles constructed with 40-mil HDPE bottom liner, 8-inch clean dirt or clay foundation, 4-inch flexible slotted drainage pipe, drainage pump and water collection tank/distribution system. Liquid phase activated carbon vessel to provide water treatment as needed. One of the existing AAS blowers retrofitted to provide aeration through slotted piping. Installation of thermocouple for temperature monitoring.
- 3.1 Costs taken from NFESC Technical Memorandum for Construction of Biopiles.

**TABLE D-6 ALTERNATIVE 6: EX SITU CHEMICAL OXIDATION  
(Preliminary Cost Analysis)**

**A. CAPITAL COSTS**

Item No.	Cost Categories and Items	Description	Unit Cost	Quantity (#)	Total Cost
<b>1 Selective Excavation</b>					
1.1	Excavation, Soil Handling, Site Restoration	Includes mobilization, excavation, screening of 12,500 cy of source material, and backfill with treated material, compaction to 90%, and level site to match existing grade	\$28.00	12,500	\$350,000
1.2	PID Head Space Post Excavation Confirmation Sampling	Includes use of Foxboro TVA-1000 PID/FID in performing MEDEP Chapter 691 (Appendix Q) Field Determination of Soil Hydrocarbon Content by Jar/Poly Bag Headspace Technique	\$55.00	240	\$13,200
1.3	Fixed Laboratory Confirmation Sampling	Samples collected every 2500 sf. and analyzed for TPH-DRO and TPH-GRO with quick turnaround time	\$660.00	36	\$23,760
1.4	Health and Safety	S&H tailgate meetings, air monitoring, PPE, excavation safety, etc.	\$60.00	90	\$5,400
1.5	De-Watering	Sheet-piling and/or pump-and-treat	\$70,000.00	1	\$70,000
1.6	Engineering Design/Permitting	5% of excavation cost		5%	\$23,118
	Subtotal				\$485,478
1.7	Contingency			20%	\$97,096
1.8	Reports	Outlining the results of the program	\$10,000	1	\$10,000
	<b>Line Item Total</b>				<b>\$592,574</b>
<b>2 Ex Situ Chemical Oxidation</b>					
2.1	Mobilization		\$65,000	1	\$65,000
2.2	Ex Situ Chemical Oxidation		\$35.00	12,500	\$437,500
2.3	Confirmation Sampling		\$10.00	12,500	\$125,000
	Subtotal				\$627,500
2.4	Contingency			20%	\$125,500
	<b>Line Item Total</b>				<b>\$753,000</b>
<b>TOTAL CAPITAL COST</b>					<b>\$1,345,574</b>

**B. OPERATION AND MAINTENANCE (O&M) COSTS**

There are no operations and maintenance costs associated with *Ex Situ* Oxidation

**C. COST SUMMARY**

Cost Element	Cost (\$)
Capital Costs	\$1,345,574
Operation and Maintenance Costs (1 year)	\$0
<b>TOTAL PROJECT COSTS</b>	<b>\$1,345,574</b>

**ASSUMPTIONS**

- 1.1 Unit cost includes 13% G&A and 5% award fee.
- 1.2 Assumes 2 people (P2 and T3) for 3 weeks with 115% Overhead, 13% G&A, and 10% award fee
- 1.4 Assumes 1 person for 3 weeks with 115% Overhead, 13% G&A and 10% award fee

## **Appendix E**

### **Quotations and Vendor Information**



EA ENGINEERING,  
SCIENCE, AND  
TECHNOLOGY, INC.

Project No.: 29600.35

COMMUNICATIONS RECORD FORM

Distribution: ( ) \_\_\_\_\_ ( ) \_\_\_\_\_  
 ( ) \_\_\_\_\_ ( ) \_\_\_\_\_  
 ( ) Author

Person Contacted: BRUCE PENN Date: 9/21/99

Title: SALESMAN

Affiliation: MIDWEST SOIL REMEDIATION

Address: (847) 742-4331

Type of Contact: QUOTE REQUEST

Person Making Contact: BART BOOZ

Communications Summary: MIDWEST HAS MULTIPLE MOBILE THERMAL  
DESORPTION UNITS THAT COME IN TWO SIZES. THE SMALLER  
UNIT IS FOR SITES LESS THAN 20,000 TONS; THE LARGER IS  
FOR GREATER THAN 20,000 TONS

- MIDWEST IS LOCATED IN ILLINOIS
- THERE IS LITTLE VOLUME REDUCTION IN THE THERMAL DESORPTION  
PROCESS

QUOTED PRICE = \$ 32 / TON ( DOES NOT INCLUDE EXCAVATION  
OR BACKFILL ) FOR SMALLER UNIT

Signature: Bart C Booz



# FAX TRANSMISSION

Date: 9/21/99 Time: \_\_\_\_\_

To: Barth Booz

From: Andrea Colby

FAX No: 798-4636

Number of Pages (Including This Cover): 1

Comments: Pricing for Old Fuel Farm Soil Excavation

Test	48hr	72hr	5 Day
GRO	\$ 165	\$ 150	\$ 120
DRO	\$ 225	\$ 200	\$ 150

Note: 48hr TAT available with prior scheduling and if lab capacity allows.

**From:** Katahdin Analytical Services, Inc.  
 340 County Road No. 5  
 P.O. Box 720  
 Westbrook, ME 04098  
 Tel: (207) 874-2400 Fax: (207) 775-4029

*The information contained in this facsimile transmission is privileged and confidential and intended for the use of the addressee named above. If the receiver of the following pages is not (one of) the above named recipients(s), you are hereby notified that any retention, dissemination, distribution, or copying of this facsimile is prohibited. If you received this facsimile in error, please notify us immediately by telephone. Thank you.*

"customized" by PERMAMORAL Inc. (800) 287-1616 • FAX (207) 783-0157

**Proposal**



THE FLEET THAT'S HARD TO BEAT

**RAY LABBE & SONS, INC.**

4 HIGHLAND ROAD  
BRUNSWICK, ME 04011-7212

☎ (207) 725-7336 or 725-5421  
Fax (207) 725-0796



ASSOCIATED CONSTRUCTORS  
OF MAINE, INC.

PROPOSAL SUBMITTED TO <i>E A Engineering 40 Bart</i>		PROPOSAL DATE <i>9-17-99</i>		Page No. <i>1</i> of <i>1</i> Pages	
STREET <i>P.O. Box 1305 #287</i>		PHONE <i>798-5977</i>	FAX <i>798-4636</i>	JOB PHONE	
CITY, STATE AND ZIP CODE <i>Brunswick, Me. 04011</i>		JOB NAME <i>Fuel Farm Clean up</i>			
ARCHITECT	DATE OF PLANS	JOB LOCATION <i>NH&amp;SB</i>			

We hereby submit specifications and estimates for:

- 1) Excavate down to water level as needed, screen, load, and transport 9,200 cy of contaminated soil to Commercial Paving in Scarborough, Me. for disposal by others, replace w/ 9,200 cy common borrow, compacted to 90%, Level site to match existing grades, @25.<sup>00</sup> per yd **\$230,000.<sup>00</sup>**  
\* price based on truck load measure, no more than 3' of over burden, no dewatering, no pipe system repair, no temporary facility, no disposal fees, no testing
- 2) Handle 9,200 yds on site, to feed burn plant, and place back on site, compacted 90% **\$188,000.<sup>00</sup>**  
no new import material

**We Propose** hereby to furnish material and labor — complete in accordance with above specifications, for the sum of:

dollars (\$ \_\_\_\_\_).

Payment to be made as follows:

**% Deposit Required With Balance In Full Due Upon Completion**

**TERMS:** There will be a **LATE CHARGE** of 2% per month (an **ANNUAL PERCENTAGE RATE** of 24%) applied to any balance which remains unpaid thirty day or more past completion date. Ray Labbe & Sons, Inc. shall be entitled to recover all costs incurred with the enforcement of this contract, including but not limited to reasonable attorney fees and waive any presentment, demand, protest, and any other notice from Ray Labbe & Sons, Inc. regarding this guarantee of payment.

All material is guaranteed to be as specified. All work to be completed in a workmanlike manner according to standard practices. Any alteration or deviation from above specifications involving extra costs will be executed only upon written orders, and will become an extra charge over and above the estimate. All agreements contingent upon strikes, accidents or delays beyond our control, Owner to carry fire, tornado and other necessary insurance. Our workers are fully covered by Workman's Compensation Insurance.

Authorized Signature

*Ray Labbe*  
(For The Company)

Note: This proposal may be withdrawn by us if not accepted within 30 days.

**Acceptance of Proposal** — The above prices, specifications and conditions are satisfactory and are hereby accepted. You are authorized to do the work as specified. Payment will be made as outlined above.

Signature X \_\_\_\_\_

Date of Acceptance: \_\_\_\_\_

Signature X \_\_\_\_\_

Commercial Recycling Systems  
2 Gibson Road  
Scarborough, ME 04074

Commercial Paving Co., Inc.  
2 Gibson Road  
Scarborough, ME 04074

FACSIMILE TRANSMITTAL

Date: September 15, 1999

To: Bart Booz  
E.A Engineering

Phone 207-798-5977  
Fax 207-798-4636

From: Bill Garland  
Vice President -- Operations

Phone: 207-883-3325  
Fax: 207-883-1121

Subject: Brunswick Naval Air Station, Tank Farm Clean Up, 9,200 cu yds

Page 1 of 2

Message: We thank you for your interest in our services. I understand that the material at this site is virgin gas and JP-5 jet fuel. As I indicated on the phone, your best option is to procure a "spill letter" from DEP. If the spill letter is not an option for you, we need to utilize the enclosed Pre-Qualification forms which require one set of tests per every 500 tons. You commented that borings indicated the material to be granular fill and sand, bordering on very limited amounts of clay soils and that the work will either be done this October/November or next spring.

Recycling at our facility in Scarborough will be \$24.00 per ton. We can also provide transportation at \$5.40 per ton. - AMENDED 4/15 Wm Garland

Should you require additional information I will be pleased to be of assistance.

*Note: Material must be sufficiently dry as to not produce "free liquids" during transportation and the quoted price does not include clay material or other waste material mixed with the soil.*

VISIT US ON THE WEB: <http://www.cpcrs.com>

**GENERATOR PRE-QUALIFICATION FORM**



**I TYPE OF WASTE:** GASOLINE CONTAINING SOIL  
(Virginia UST Sources)

**II AMOUNT OF WASTE:** +/- \_\_\_\_\_ Cu Yds +/- \_\_\_\_\_ Tons

**III GENERATOR INFORMATION:**

a) Generator \_\_\_\_\_ Contact \_\_\_\_\_  
 Address \_\_\_\_\_ Phone# \_\_\_\_\_  
 b) Process Generating the Waste \_\_\_\_\_  
 c) Site of Generation \_\_\_\_\_  
 d) Contracting Firm \_\_\_\_\_ Contact \_\_\_\_\_  
 Address \_\_\_\_\_ Phone# \_\_\_\_\_

**IV WASTE CHARACTERIZATION:** Analytical Method - See Table 1

PARAMETER	ANALYTICAL RESULTS		ACCEPTANCE CRITERIA	
	Total <sup>1</sup>	TCLP	Total	TCLP
a) Lead	_____ ppm	_____ ppm	<50 ppm	<5.0 ppm
b) % Solids		_____ %		no free liquids

**V GENERATOR CERTIFICATION:**

The undersigned agrees that to the best of his/her knowledge the materials to be processed by Commercial Recycling Systems do not contain any hazardous waste, hazardous substances, toxic substances, or toxic pollutants as those terms are used in the Resource Conservation and Recovery Act, the Comprehensive Environmental Response, Compensation and Liability Act, the Hazardous Materials Transportation Act, the Toxic Substances Control Act, the Clean Air Act and the Clean Water Act, or any similar state or local law, or any regulation promulgated pursuant thereto, or any other applicable law, except those materials expressly indicated above. Samples obtained by generator for pre-qualification of this material have been obtained in accordance with the requirements of Table 1 and CRS's Sampling and Analytical Plan.

\_\_\_\_\_  
 (Name Print/Type) \_\_\_\_\_  
 (Title)  
 \_\_\_\_\_  
 (Signature) \_\_\_\_\_  
 (Date)

**VI COMMERCIAL RECYCLING SYSTEMS ACCEPTANCE:**

CRS accepts this waste in accordance with requirements set forth in it's MDEP Solid Waste Facility Processing License #S-021243-WK-A-N.

\_\_\_\_\_  
 (Name Print/Type) \_\_\_\_\_  
 (Title)  
 \_\_\_\_\_  
 (Signature) \_\_\_\_\_  
 (Date)

<sup>1</sup> If analytical results for Total exceed the maximum acceptance criteria, TCLP analysis is required for that material.

**GENERATOR PRE-QUALIFICATION FORM**



**I TYPE OF WASTE:** **GASOLINE CONTAINING SOIL**  
**(Virgin Surface Sources)**

**II AMOUNT OF WASTE:** +/- \_\_\_\_\_ Cu Yds +/- \_\_\_\_\_ Tons

**III GENERATOR INFORMATION:**

a) Generator \_\_\_\_\_ Contact \_\_\_\_\_  
Address \_\_\_\_\_ Phone# \_\_\_\_\_  
b) Process Generating the Waste \_\_\_\_\_  
c) Site of Generation \_\_\_\_\_  
d) Contracting Firm \_\_\_\_\_ Contact \_\_\_\_\_  
Address \_\_\_\_\_ Phone# \_\_\_\_\_

**IV WASTE CHARACTERIZATION: Analytical Method - See Table 1**

PARAMETER	ANALYTICAL RESULTS		ACCEPTANCE CRITERIA	
	Total <sup>1</sup>	TCLP	Total	TCLP
a) Lead	_____ ppm	_____ ppm	<50 ppm	<5.0 ppm
b) TCLP Benzene	_____ ppm	_____ ppm	<5.0 ppm	<.5 ppm
c) % Solids	_____ %		no free liquids	

**V GENERATOR CERTIFICATION:**

The undersigned agrees that to the best of his/her knowledge the materials to be processed by Commercial Recycling Systems do not contain any hazardous waste, hazardous substances, toxic substances, or toxic pollutants as those terms are used in the Resource Conservation and Recovery Act, the Comprehensive Environmental Response, Compensation and Liability Act, the Hazardous Materials Transportation Act, the Toxic Substances Control Act, the Clean Air Act and the Clean Water Act, or any similar state or local law, or any regulation promulgated pursuant thereto, or any other applicable law, except those materials expressly indicated above. Samples obtained by generator for pre-qualification of this material have been obtained in accordance with the requirements of Table 1 and CRS's Sampling and Analytical Plan.

\_\_\_\_\_  
(Name Print/Type) \_\_\_\_\_ (Title)  
\_\_\_\_\_  
(Signature) \_\_\_\_\_ (Date)

**VI COMMERCIAL RECYCLING SYSTEMS ACCEPTANCE:**

CRS accepts this waste in accordance with requirements set forth in it's MDEP Solid Waste Facility Processing License #S-021243-WK-A-N.

\_\_\_\_\_  
(Name Print/Type) \_\_\_\_\_ (Title)  
\_\_\_\_\_  
(Signature) \_\_\_\_\_ (Date)

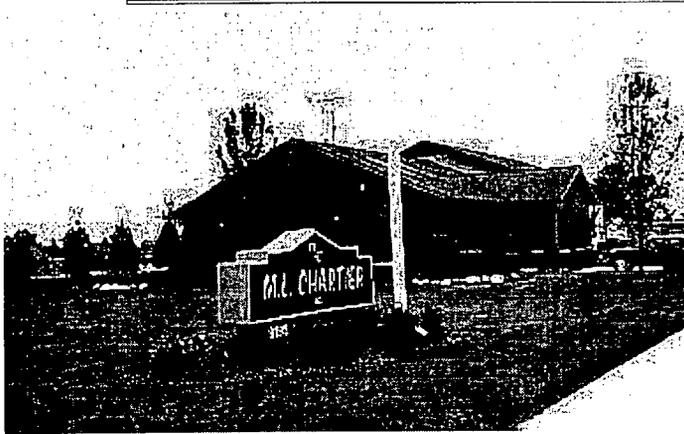
<sup>1</sup> If analytical results for Total exceed the maximum acceptance criteria, TCLP analysis is required for that material.



# CHARTIER

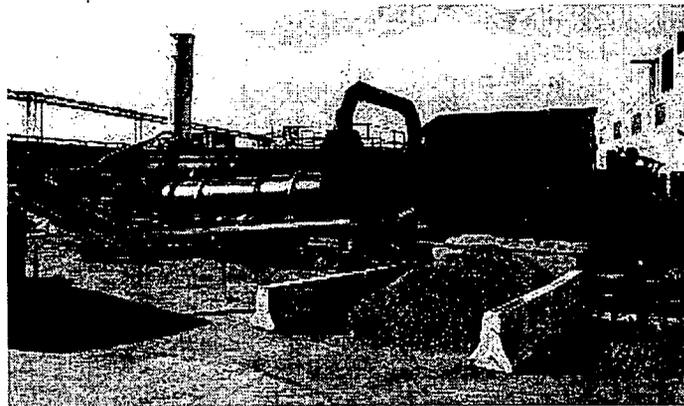
## Environmental Services

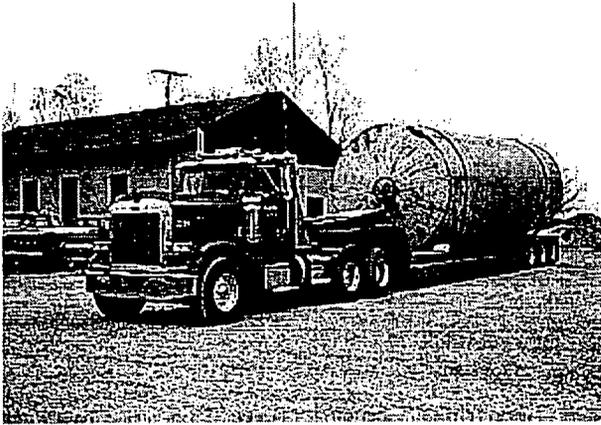
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Today, with environmental issues high on the global priority list, is in the forefront of the industry with its broad range of environmental services. Committed to providing environmentally Sound Solutions and helping to meet your environmental management objectives.

offers an alternative to landfilling petroleum contaminated soils through a transportable Medium Temperature Destruction Unit, The THERMINATOR. This method is a viable technique for reclaiming soil that has been contaminated with petroleum products.





Medium Temperature Thermal Desorption  
Restoration Of Environmentally Impacted  
Sites

Underground Storage Tank Management

Transportation and Disposal

Emergency Spill Response

Plant Decommissioning

Lagoon Closures

Exploratory Excavation

Environmental Drilling

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Company History

Equipment List

Project Summaries

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Since 1954, \_\_\_\_\_ has made a solid commitment to excellence in the environmental services we provide and in the professional team of employees we retain to provide these services. \_\_\_\_\_ has worked closely with petroleum companies, utilities and industry earning a successful reputation in site remediation and environmental decontamination projects. \_\_\_\_\_ has continually proven itself by consistently creating solutions and implementing innovative and safe corrective actions to hazardous waste problems.

**Excellent References Furnished Upon Request**

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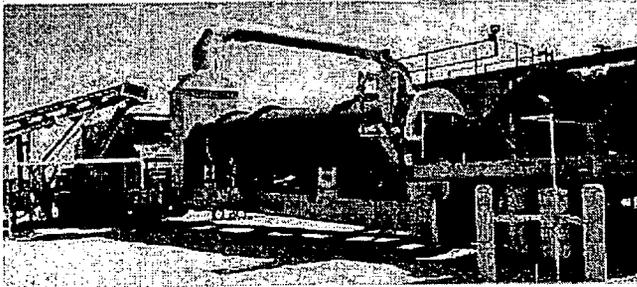
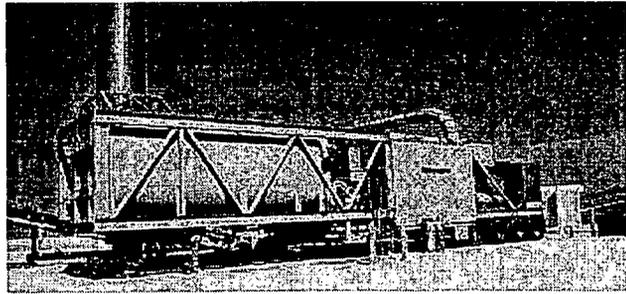
**Environmental Services  
9195 Marine City Hwy.  
Fair Haven, Michigan 48023**

**Phone (810) 725-8373  
FAX (810) 725-1450**

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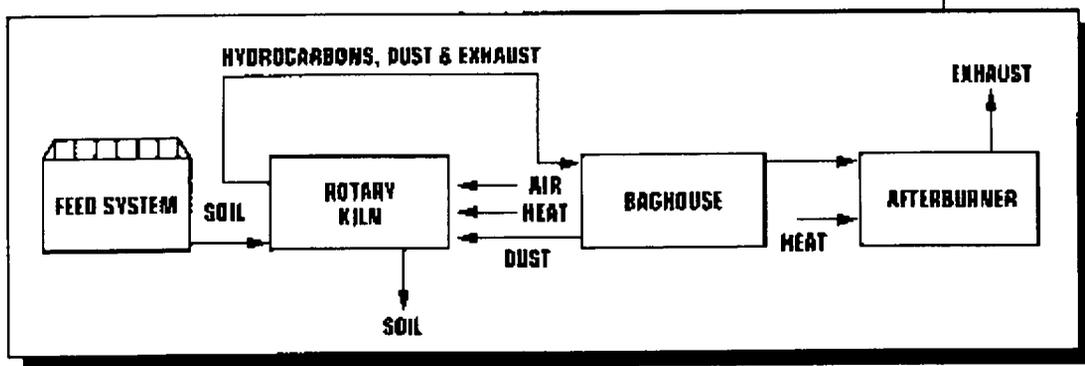
offers a soil treatment alternative which eliminates landfilling and the liabilities associated with it. Our medium temperature thermal desorption unit is a viable technology for reclaiming soil that has been contaminated with hydrocarbons. This unit is capable of processing 71 tons an hour under ideal conditions. M. L. Chartier's portable unit is transported on two chassis with a separate 10' X 24' control center.



The primary chassis contains a feed system which reduces soil material size to less than two inches. The soil is then carried into a drier where temperatures average 850 degrees F and hydrocarbons are forced to separate from the soil. Soil exits through a screw pugmill equipped with a quench unit to regain moisture content. Processed soil is then stockpiled, analyzed, and placed back into the excavated area, meeting even the most stringent cleanup criteria.

Hydrocarbons now released from the soil travel to the secondary treatment chassis into a baghouse where particulate fines are dropped out and carried back into the drier. Volatilized hydrocarbons continue into an afterburner, are heated to a maximum temperature of 1750 degrees F, and are retained for 1.4 seconds. Simultaneously, the gas stream carrying the vaporized petroleum hydrocarbons is oxidized. All air emissions are regulated by conditions set forth by an air quality permit. A separate control center allows for monitoring of processes and documentation through an automated recorder.

**The key to efficient soil remediation is material handling ability**



**FEED SYSTEM**

THE **THERMINATOR**'s heavy duty feed system allows even clay type materials to be processed with minimal effort.

Soils and debris that do not process easily through the two inch screening, move into a crusher and are reduced to uniform, ingestible sizes. This insures complete removal of hydrocarbons trapped in the soil because heat is evenly dispersed throughout the material. When soil is reduced into pieces under two inches, the appropriate temperatures are reached quickly and cost effectiveness is attained.

After material is reduced to the correct size it drops through the hopper and onto a feed conveyor. At this point the soil is weighed and fed to the drier.

## **DRIER**

Material under 2" in size is conveyed into the vaporizing drier. The delivered material is heated to an average temperature of 550 degrees F, creating a condition where remediation begins. When the hydrocarbons reach their boiling point they vaporize, separate from the soil, and are channeled to the baghouse. The soil, now clean, exits through a soil discharge chute.

## **SOIL DISCHARGE UNIT**

The soil exiting from the discharge chute travels through a reconstitution mixer and discharge conveyor. This unit injects and mixes an adequate amount of water to lower soil temperatures to approximately 212 degrees F, and control fugitive dust emissions.

A steam collection hood contains the steam created by injecting water into the reconstitution mixer. The particulate drop-out from the steam is reverted back into the filterhouse for secondary cleaning.

## **FILTERHOUSE**

The portable filterhouse receives the gas stream from the drier via insulated ductwork. The filterhouse contains 3,520 square feet of cloth providing a 3.5:1 air to cloth ratio. Filtering of airborne particulate is controlled by a pressure drop across the filterhouse from the clean side to the unclean side. Cleaning of the bags is accomplished by blowing pulsating jets of air through each row of bags on a timed cycle. Particulate dislodged from the filters during the cleaning cycle is collected on the floor of the filterhouse and pneumatically returned to, and re-introduced into the dryer. This process insures that all particulate matter is liberated of petroleum contamination.

## **THERMAL OXIDIZER**

The gas stream, after having passed through the clean side of the filterhouse, is channeled into the thermal oxidizer for the last stage of the cleaning process. Air entering into the thermal oxidizer is heated to a maximum temperature of 1600 degrees F and held in the heating chamber of the thermal oxidizer (afterburner) for a retention time of 1.4 seconds. This assures efficient destruction of the incoming gas stream carrying the vaporized petroleum hydrocarbons.

## CONTROL CENTER

In addition to housing the controls of the functions already discussed, the control center's recorder documents the material discharge temperature, drier gas discharge temperature, filterhouse inlet temperature, and thermal oxidizer outlet temperature.

- Portable night use lights allow for flex-time
  - Dual fuel system uses either propane or natural gas
  - If the area of the remediated site allows, a 24" x 50' stacking conveyor may be attached to the discharge conveyor for minimum handling when stockpiling.
  - This unit is cost comparable to landfilling jobs of 1,500 yards or greater. Sufficient room for operation requires a minimum construction area of 50' x 100'.
- 

Return to [M.L. Chartier](#) home page



Technological Fact Sheet

Enco-Tec Environmental

## **Low Temperature Thermal Desorption (LTTD)**

FA1-04-96

SITE DECONTAMINATION/RESTORATION

---

### **Description of the Technology**

As remediation specialists, Enco-Tec Environmental Technology Systems (EncoTec) offers a proven cost-effective solution to remediation of soil impacted with petroleum hydrocarbons.

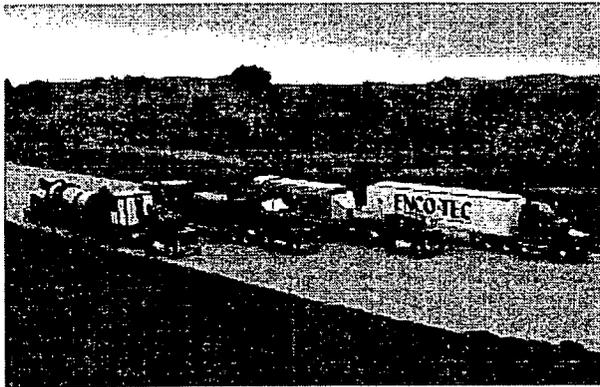
The company owns and operates a Mobile Low Temperature Thermal Desorption (LTTD) unit which is permitted in 9 of 10 provinces in Canada. The system is designed to safely and effectively treat soils, contaminated with a broad range of petroleum hydrocarbons. The system is designed to be both versatile and highly portable. System components include:

*Cold Feed System* - A front-end loader delivers soil to the feed hopper from where a conveyor system feeds soil to the unit. The feed rate is continually monitored by a belt scale and can be varied depending on the desired operating conditions.

*First Stage Primary Kiln* - Removal of the hydrocarbons from the soil occurs in this stage. The system is a counter-flow, direct-fired rotary drum type kiln, and provides heat directly to the soil. The soil is heated to the point where the moisture and hydrocarbons are volatilized and transferred to the gas phase. This separation technique leaves the soil characteristics generally unchanged. Treated soil exits the kiln and can be returned to the site as backfill.

*Baghouse* - The baghouse filters the dust particles from the air stream, prior to the second stage afterburner. The dust is periodically pulsed from the bags and combined with the treated soil discharge.

*Second Stage Afterburner* - The purpose of this unit is to provide thermal treatment (oxidation) of the hydrocarbons volatilized in the first stage rotary kiln. The afterburner is a parallel flow design and is lined with refractory brick to protect the exterior metal and provide a safe working environment. Exhaust gases (consisting primarily of CO<sub>2</sub> and H<sub>2</sub>O) are discharged directly to the atmosphere.



## Performance

The high efficiency thermal treatment process allows clients to achieve non-detectable trace results for even severely hydrocarbon impacted soils. This effectively eliminates future liability associated with the soil. The control system for the thermal plant employs state of the art technology allowing EncoTec office personnel to monitor all

aspects of remote thermal plant operations. On-line acquisition of current time or historical operating data improves EncoTec performance and adds value for the client.

The LTTD plant is versatile with regard to fuel supply and can operate using propane, butane, natural gas or diesel. Power requirements are supplied by an on-board generator. The plant is equipped with a continuous stack emission monitoring system which provides control input for safety and automatic shutdown features.

General performance information for the LTTD Unit is:

- Soil treatment at a rate of 30 tonnes per hour
- First Stage Rotary Kiln capable of 540<sup>0</sup>C (1000<sup>0</sup> F)
- Second Stage Afterburner capable of 1080<sup>0</sup>C (2000<sup>0</sup> F)



## Limitations

The first stage rotary kiln is limited to a temperature of 540<sup>0</sup>C. The equipment is designed to treat petroleum hydrocarbons, but is not intended for other hazardous wastes such as PCBs or heavy metals.

## Installation and Operation

The LTTD unit is generally transported to a source of hydrocarbon impacted soil. The unit requires approximately three days for set-up and the site must be accessible by tractor-trailer. The entire set-up requires a level area approximately 23 m x 30 m (75' x 100').

Once operational, the system provides soil treatment 24 hours per

day (subject to local permits) with a four person crew generally required during each shift. The system requires two days for disassembly and preparation for transport.



Workers are required to wear standard safety clothing and follow general safety procedures for the operation of large industrial equipment. Additional safety is provided by the plant control system with stack emission monitoring and automatic shutdown features.

### **Costs**

Soil treatment costs beginning at \$40 per tonne generally include excavation and backfilling. Costs will increase based on the nature and concentration of the hydrocarbons present in the soil.

### **Additional Information**

EncoTec is a privately held firm operating with 15 employees. Their LTTD unit is permitted in 9 canadian provinces and they also operate contaminated soil-receiving facilities in Atlantic Canada.

EncoTec Environmental provides expertise in a wide range of related fields. Prime target areas are the oil and gas industries, government, other industrial applications and the military.



For more information on the Low Temperature Thermal Desorption Unit, please contact:

John Morrissey, President

Enco-Tec Environmental Technology Systems Limited  
134 South Albion Street  
Amherst, Nova Scotia B4H 2X3  
Telephone: (902) 661-6890  
Fax: (902) 661-6892  
Email: [encotec@fox.nsnt.ca](mailto:encotec@fox.nsnt.ca)  
Website: <http://www.encotec.com/encotec>

---

The Enviro-Access technological fact sheets seek to explain the operating process and know-how of equipment developed for the benefit of the environmental sector.

These technological fact sheets are based on the information provided by the same organizations that have conceived and perfected the technologies. The dissemination of this information should by no means be perceived as an Enviro-Access guarantee.

The reproduction of these technological fact sheets and of their content is authorized only when the source is mentioned.

Enviro-Access invites organizations that have developed technologies for the environmental sector to share information about their products or processes.

Place Andrew-Paton  
85, Belvédère Nord, Suite 150  
Sherbrooke (Québec) J1H 4A7  
Telephone: (819) 823-2230 Fax: (819) 823-6632

**SHERBROOKE \* MONTRÉAL \* QUÉBEC \* MONCTON**

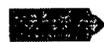
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[Up to factsheet index](#)



[Back to homepage](#)



[For further information, e-mail Enviro-Access](#)

Modified November 25, 1997  
Lysanne Larose, [enviro@enviroaccess.ca](mailto:enviro@enviroaccess.ca)  
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A **Low Temperature Thermal Desorption (LTTD)** unit is also an available option for the larger volumes of soil. The LTTD is shown here set up on site in northern Ontario where 6000 tonnes of hydrocarbon contaminated soil was remediated.

# Canadian Soil Remediation Services INC

Canadian Soil Remediation Services Inc.  
151 Frobisher Dr., Unit C211  
Waterloo, Ontario, Canada  
N2V 2C9

Business: (519) 886-2972  
Fax: (519) 886-3078  
E-Mail: [admin@cdnsoil.com](mailto:admin@cdnsoil.com)

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EA ENGINEERING,  
SCIENCE, AND  
TECHNOLOGY, INC.

Project No.: 29600.35

COMMUNICATIONS RECORD FORM

Distribution: ( ) \_\_\_\_\_ ( ) \_\_\_\_\_  
 ( ) \_\_\_\_\_ ( ) \_\_\_\_\_  
 ( ) Author

Person Contacted: ELLIOT THOMAS, C.G. Date: 9/20/99  
 Title: GEOLOGIST, DIRECTOR OF OPERATIONS  
 Affiliation: YARMOUTH ENVIRONMENTAL SERVICES  
 Address: PO BOX 898, YARMOUTH, ME 04096-0898  
 Type of Contact: QUOTE REQUEST  
 Person Making Contact: BART BOOZ

Communications Summary: REQUEST VERBAL QUOTE FOR INSTALLATION  
OF ADDITIONAL AIR SPANGING WELLS AT OLD FUEL FARM.

PRODUCTIVITY ESTIMATE = 10 WELLS / DAY  
2 PEOPLE @ \$1100 / DAY  
\$200 MOBILIZATION CHARGE  
\$95 / WELL MATERIALS

Signature: Bart C Booz