Report No. CG-D-16-96

Remediation of Contaminated Media at U.S. Coast Guard Facilities

Suresh R. Kikkeri
Edward P. Hagerty

Woodward-Clyde Federal Services
200 Orchard Ridge Drive, Suite 101
Gaithersburg, MD 20878

Eric R. Ness
Michele Fitzpatrick

U.S. Coast Guard
Research and Development Center
1082 Shennecossett Road
Groton, CT 06340-6096

William J. Halloran
John P. McGuiggin

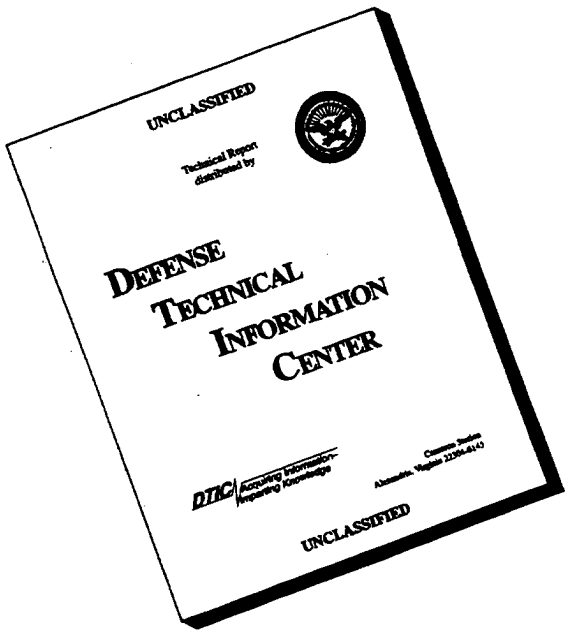
Department of Transportation
Volpe National Transportation Systems Center
Kendall Square
Cambridge, MA 02142

FINAL REPORT
June 1996

Prepared for:

U.S. Department of Transportation
United States Coast Guard
Office of Research and Development
Washington, DC 20593-0001

DISCLAIMER NOTICE



THIS DOCUMENT IS BEST QUALITY AVAILABLE. THE COPY FURNISHED TO DTIC CONTAINED A SIGNIFICANT NUMBER OF PAGES WHICH DO NOT REPRODUCE LEGIBLY.

NOTICE

This document is disseminated under the sponsorship of the Department of Transportation in the interest of information exchange. The United States Government assumes no liability for its contents or use thereof.

The United States Government does not endorse products or manufacturers. Trade or manufacturers' names appear herein solely because they are considered essential to the object of this report.

The contents of this report reflect the views of the Coast Guard Research & Development Center. This report does not constitute a standard, specification, or regulation.

G.T. Gunther
Commanding Officer
United States Coast Guard
Research & Development Center
1082 Shennecossett Road
Groton, CT 06340-6096

Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
CG-D-16-96		

4. Title and Subtitle	5. Report Date
Remediation of Contaminated Media at U.S. Coast Guard Facilities	June 1996
	6. Performing Organization Code
7. Author(s) Suresh R. Kikkeri, Eric R. Ness, Michele Fitzpatrick, William J. Halloran, John P. McGuiggin, Edward P. Hagerty	8. Performing Organization Report No. R&DC 16/96
9. Performing Organization Name and Address	10. Work Unit No. (TRAIS)
Woodward-Clyde Federal Services 200 Orchard Ridge Drive Suite 101 Gaithersburg, MD 20878	U.S. Coast Guard Research and Development Center 1082 Shennecossett Road Groton, Connecticut 06340-6096
	11. Contract or Grant No.
	13. Type of Report and Period Covered Final Report
9. Performing Organization Department of Transportation Volpe National Transportation Systems Center, Kendall Square Cambridge, MA 02142	12. Sponsoring Agency Name and Address Department of Transportation U.S. Coast Guard Office of Research and Development Washington, D.C. 20593-0001
	14. Sponsoring Agency Code Commandant (G-SEC) USCG Headquarters Washington, D.C. 20593-0001

15. Supplementary Notes

The R&D Center's technical point of contact is LCDR Michele Fitzpatrick, 860-441-2859.

16. Abstract

This document summarizes data, in tabular form, of remediation technologies practiced at U.S. Coast Guard (USCG) facilities. Abbreviated information concerning the site, media treated, contaminants, matrix characteristics, operating parameters, cost, and other pertinent information is organized by technology type as identified in the Remediation Technologies Screening Matrix and Reference Guide (EPA/542/B-94/013). The document structure matches that of Tables 3-4 through 3-16 in Section 3 of the Guide, and review of USCG data should be done using the Guide as a companion/reference text.

17. Key Words	18. Distribution Statement
USCG, U.S. Coast Guard, remediation projects, remediation, cleanup, treatment, projects, environmental remediation, treatment	Document is available to the U.S. public through the National Technical Information Service, Springfield, Virginia 22161

19. Security Classif. (of this report)	20. SECURITY CLASSIF. (of this page)	21. No. of Pages	22. Price
UNCLASSIFIED	UNCLASSIFIED		

Form DOT F 1700.7 (8/72) Reproduction of form and completed page is authorized

METRIC CONVERSION FACTORS

Approximate Conversions to Metric Measures

Symbol	When You Know	Multiply By	To Find	Symbol
	LENGTH			
in	inches	* 2.5	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
	AREA			
in^2	square inches	6.5	square centimeters	cm^2
ft^2	square feet	0.09	square meters	m^2
yd^2	square yards	0.8	square meters	m^2
mi^2	square miles	2.6	square kilometers	km^2
	acres	0.4	hectares	ha
	MASS (WEIGHT)			
oz	ounces	28	grams	g
lb	pounds	0.45	kilograms	kg
	short tons (2000 lb)	0.9	tonnes	t
	VOLUME			
tsp	teaspoons	5	milliliters	ml
tbsp	tablespoons	15	milliliters	ml
fl oz	fluid ounces	30	milliliters	ml
c	cups	0.24	liters	l
pt	pints	0.47	liters	l
qt	quarts	0.95	liters	l
gal	gallons	3.8	liters	l
ft^3	cubic feet	0.03	cubic meters	m^3
yd^3	cubic yards	0.76	cubic meters	m^3
	TEMPERATURE (EXACT)			
°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C

*1 in = 2.54 (exactly).

Approximate Conversions from Metric Measures

Symbol	When You Know	Multiply By	To Find	Symbol
	LENGTH			
mm	millimeters	0.04	inches	in
cm	centimeters	0.4	inches	in
m	meters	3.3	feet	ft
m	meters	1.1	yards	yd
km	kilometers	0.6	miles	mi
	AREA			
cm^2	square centimeters	0.16	square inches	in^2
m^2	square meters	1.2	square yards	yd^2
km^2	square kilometers	0.4	square miles	mi^2
ha	hectares (10,000 m^2)	2.5	acres	
	MASS (WEIGHT)			
g	grams	0.035	ounces	oz
kg	kilograms	2.2	pounds	lb
t	tonnes (1000 kg)	1.1	short tons	
	VOLUME			
ml	milliliters	0.03	fluid ounces	fl oz
l	liters	0.125	cups	c
l	liters	2.1	pints	pt
l	liters	1.06	quarts	qt
l	liters	0.26	gallons	gal
m^3	cubic meters	35	cubic feet	ft^3
m^3	cubic meters	1.3	cubic yards	yd^3
	TEMPERATURE (EXACT)			
°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F

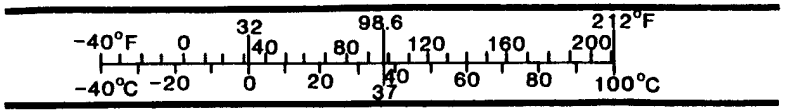


TABLE OF CONTENTS

LIST OF ACRONYMS

AST	Aboveground Storage Tank
AVDET	Aviation Detachment
bgs	below ground surface
BTEX	Benzene, Toluene, Ethylbenzene, Xylene
CAP	Contamination Assessment Plan
CAR	Contamination Assessment Report
CEC	Cation exchange capacity
CARA	Contamination Assessment Report Addendum
CEU	Civil Engineering Unit
cfm	cubic feet per minute
cm	centimeter
cp	centipoise
DCE	Dichloroethane
DEQ	Department of Environmental Quality
DRMO	Defense Reutilization and Marketing Office
DRO	Diesel Range Organics
EPH	Extractable Petroleum Hydrocarbons
FD & CC	Facility Design and Construction Center
GAC	Granular Activated Carbon
gpd	gallons per day
gpm	gallons per minute

gw	groundwater
H	Henry's Law Constant
HC	Hydrocarbon
Hg	Mercury
hp	horsepower
IRA	Initial Remedial Action/Interim Remedial Action
ISC	Integrated Support Command
K	Hydraulic conductivity
kg	kilogram
L	liter
LANT	Atlantic
LDPE	Low Density Polyethylene
Lorsta	LORAN Station
mg	milligram
mm Hg	millimeters of Mercury
MPN	Most Probable Number
NAPL	Non-aqueous Phase Liquid
ND	Not Detected
NSFO	Naval Special Fuel Oil
O&M	Operations and Maintenance
PAC	Pacific
PAH	Polyaromatic Hydrocarbons

PCB	Polychlorinated biphenol
PCE	Polychloroethene
PES-31	Proprietary Nutrient Supplement
PNUM	Project Number
POTW	Public-Owned Treatment Works
ppb	parts per billion
ppm	parts per million
psi	pounds per square inch
RAP	Remedial Action Plan
RPM	revolutions per minute
RTC	Reserve Training Center
S	Storativity
scfm	standard cubic feet per minute
SVE	Soil Vapor Extraction
STA	Station
SVOC	Semi-Volatile Organic Compound
T	Transmissivity
TBD	To Be Determined
TCE	Trichloroethane
TCLP	Toxicity Characteristic Leaching Procedure
TDS	Total Dissolved Solids
TKN	Total Kjeldahl Nitrogen
TOC	Total Organic Carbon

TPH	Total Petroleum Hydrocarbons
Tracen	Training Center
TRPH	Total Recoverable Petroleum Hydrocarbons
UST	Underground Storage Tank
UV	ultraviolet
VOA	Volatile Organic Aromatic
VOC	Volatile Organic Compound
VP	Vapor Pressure
W	Watt
°C	degrees Celsius
°F	degrees Fahrenheit

[BLANK]

1.0
INTRODUCTION

This document, *Remediation of Contaminated Media at USCG Facilities*, was developed by the United States Coast Guard (USCG) Research and Development Center (RDC) in conjunction with the John A. Volpe National Transportation Systems Center (Volpe Center) and their consultant Environmental Transportation Consultants (ETC). This document summarizes information pertaining to remediation technologies practiced at USCG facilities and is intended to be used as a companion document to the *Remediation Technologies Screening Matrix and Reference Guide* (EPA/542/B-94/013).

1.1 PURPOSE

The *Remediation Technologies Screening Matrix and Reference Guide*, prepared by the Federal Remediation Technologies Roundtable, is intended to be used to screen and evaluate candidate cleanup technologies for contaminated installations and waste sites in order to assist remedial project managers in selecting a remedial alternative. While the Federal document gives a detailed description of remedial technologies being practiced at various federal installations, it does not provide specific information on USCG facilities. *Remediation of Contaminated Media at USCG Facilities* summarizes the USCG's remediation experience and provides a point of contact for future follow up.

The main purpose of this document is to provide USCG personnel with summarized information regarding the past, current and planned remedial technologies that are located at USCG facilities. This summarized information can help USCG personnel when making decisions regarding the selection of appropriate remediation technologies. A companion document, *Engineering Parameters for Environmental Remediation Technologies* includes a collection of engineering design parameters.

1.2 ORGANIZATION

This document has three sections. Section 1.0 is an introduction. Section 2.0 explains the methods used to gather the data on various projects at the USCG facilities. Section 3.0 summarizes information of various remedial technologies at the USCG facilities. The data provided is organized to follow the technology identifying number and title as given in the *Remediation Technologies Screening Matrix and Reference Guide*. The structure matches that of Tables 3-4 through 3-16 in Section 3 of the Guide.

2.0
DATA COLLECTION METHODOLOGY

Data pertaining to the remediation technologies at USCG facilities were collected through telephone interviews and personal site visits.

Telephone Interviews: Initially, the USCG - RDC contacted the CEUs, Facilities Design and Construction Centers (FD&CC); and Headquarter Unit Facilities Engineering Divisions and explained the intent of this document. This initiation by the USCG led to an understanding of the existence or non-existence of technologies at the USCG facilities. The Volpe Center and ETC prepared a checklist of technologies and two sets of data collection forms, Data Collection Form - I (to collect the general information of the site and the technology) and Data Collection Form - II (to collect specific information on engineering parameters for the technology in question). Copies of the Data Collection Form - I were mailed to the facilities mentioned above and information about the remediation technologies was obtained prior to the site visits.

Site Visits and Personal Interviews: The first site visit was conducted at CEU Providence, RI. This visit was the prototype and was followed by a workshop to determine the best approach for the remaining site visits. The RDC, Volpe Center and ETC participated in this site visit during which information on various technologies was collected by going through the various project related files and personal interviews. Information thus collected was reviewed during the workshop session along with the remaining data collection process.

Following the prototype site visit, site visits were conducted by the RDC and/or the Volpe Center/ETC at various USCG facilities that had available data pertaining to remediation technologies. Relevant information on the technologies was collected by going through the project related files located at each of these facilities and by conducting personal interviews. Information collected is presented in Section 3.0.

3.0
REMEDIAL TECHNOLOGIES AT USCG FACILITIES

Information about remedial technologies at USCG facilities is summarized and presented in this section. The information is summarized under the following headings:

- **Site Name/Contact** - This column provides the name of the facility, location of the site, USCG project number (PNUM) (where available), the dates projects began and/or were being performed, and the name of the contact person along with their telephone numbers.

- **Technology/Vendor** - The type of technology and the vendor who designed and/or installed it is mentioned here.

- **Media Treated** - This column explains what the type of media was treated.

- **Contaminants Treated** - Under this heading, the treated contaminants are mentioned.

- **Matrix Characteristics** - Some of the important characteristics such as soil type, and hydraulic conductivity are identified.

- **Operating Parameters** - Available operating parameters are listed in this column. More details can be found in the other document *Engineering Parameters for Environmental Remediation Technologies.*

- **Materials Handling** - Where applicable, materials handling issues are included.

- **Residuals Management** - Many technologies did not include residuals management. Where applicable, methods of residuals management are included.

- **Cost/Comments** - Any comment on the technology and/or the cost to operate this technology are included in this column.

4.1 Biodegradation (In-Situ and Ex-Situ)

Site Name/ Contact	Technology/ Vendor	Media Treated	Contaminants Treated	Matrix Characteristics
Army Diesel UST PNUM F4055 ISC Kodiak Kodiak, AK July 1997 FD&CC Mike Bowlus (206) 220-7370	**Biodegradation In-Situ**	soil 1,300 yd^3	DRO: 3,000 - 26,000 pp TPH: 43 - 2,100 ppm cleanup level: 100 ppm	silty, gravelly sand grain size: 0.1 - 20 mm bedrock: 15 - 25' bgs K: 0.002 cm/s moisture: 22.3 - 58.1% depth to gw: 5.7 - 6.7' bgs gw gradient: 0.08 ft/ft pH: 5.8 - 6.7 water data: iron: 18.7 - 521 ppm manganese: 1.2 - 19.4 ppm sulfate: 3.5 - 6.4 ppm TKN: 22.7 - 69.0 ppm phosphorus: 15 - 24.4 ppm TOC: 2.1 - 12.0% heterotrophic plate count: 28,100 col/g oil degrading bacteria: 2,510 MPN
PNUM 1836 Air Station Sitka Sitka, AK June 1994 CEU Juneau Bob Deering (970) 463-2440	**Biodegradation In-Situ**	soil 5,000 yd^3	petroleum HC's JP-5 fuel TPH: 150 - 10,350 ppm cleanup level: 1,000ppm	shot rock with granular soil bedrock: 5 - 12' bgs O_2: 5 - 21% CO_2: 0.05 - 9.1%
PNUM 33-X 3762 Aviation Hill Housing ISC Kodiak Kodiak, AK 1996 - 1997 FD&CC John Vogel (206) 220-7387	**Biodegradation Ex-Situ**	Soil 8,000 yd^3	heating fuel oil DRO: 3.1 - 5600 ppm BTEX: 0.043 - 11.29 pp TPH: 220 - 28,000 ppm cleanup level: 200 ppm	silty sandy gravel bedrock: 5' - 9' bgs depth to gw: 1.5' - 11.5 ' bgs air permeability: 10 E-7 - 10 E-8 cm^2

4.1 Biodegradation (In-Situ and Ex-Situ)

Operating Parameters	Materials Handling	Residuals Management	Cost/Comments
			$85,955 Release investigation. Pilot test planned for 1997.
estimated cleanup time: 3 yr semi-annual soil gas monitoring (O_2, CO_2) to track biological activity. hand broadcast fertilizer: 10 - 15 lb/1000 ft^2 every 3 months. (21% N, 3% P, 5% potash)			$76,000 Release investigation $10,210/yr Semi-annual samples
2 cells 50' x 180' x (7'-8") 50' x 225' x (7'-8") 2% slope for runoff drainage 30 mil liner 12" sand above liner soaker hoses -H_2O and nutrients on top microbe mix PES - 31 added aeration pipes at bottom of pile leachate control recycles liquid to pile 10 mil top cover field capacity to be kept @ 75% Rotron blower - 100 cfm @ 10" of H_2O Ops @ 29-36 cfm @ 10" of H_2O	4,300 yd^3/pile before movement to biocell.		$70,000 Construct 2 cells $50,000 Excavation

4.1 Biodegradation (In-Situ and Ex-Situ)

Site Name/ Contact	Technology/ Vendor	Media Treated	Contaminants Treated	Matrix Characteristics
Bio Cell PNUM F4046 Nymans Peninsula ISC Kodiak Kodiak, AK August 1995 FD&CC PAC John Vogle (206) 220-7387	**Biodegradation Ex-Situ**	soil 500 yd^3	diesel	
RTC Yorktown Yorktown, VA March 3, 1996 RTC Yorktown Lynn Daniels (804) 898-2390	**Biodegradation Ex-Situ** and/or thermal treatment Cherokee Environmental Group	soil 536 tons	diesel	
Bio cell PNUM J1170 Potato Point Valdez, AK 1993 - ongoing CEU Juneau Bob Deering (907) 463-2440	**Biodegradation Ex-situ**	soil 1,400 yd^3	petroleum HC's diesel TPH: 650 - 59,700 ppm	coarse gravelly sand (gravel: up to 2") peaty top soil: 3 - 4' depth to gw: 8 - 10' bgs

4.1 Biodegradation (In-Situ and Ex-Situ)

Operating Parameters	Materials Handling	Residuals Management	Cost/Comments
cell 100' x 50' x 6' soil ht: 3' temp: > 40°F moisture content: 17 - 22% dry wt blower: 2 - 2 psi piping: 6" dia 2 levels: at bottom on top of surface sand base: 18 - 24" single sump; base @ 2 - 3% slope estimated soil cycle time: 6 months			$ 27,646 O&M (1yr.) $ 95,000 Construction
Process of heating waste to 1,700 °F for 12 hours.			$30.50/ton Disposal cost Cost would have been a lot higher if material had to be shipped to a non-local site. ($25,000) Vendor acceptance criteria: no metals.
regenerative blower: 1 hp 107 scfm max 57" of H_2O max pressure 52" of H_2O max vacuum 75' x 50' x 11' cell air supply: 1.25" dia pipe (2 levels) leachate collection: 4" dia pipe 5' on center spacing 4' vertical separation	monitoring every 2 weeks.		$89,637 Construction of biocell.

4.1 Biodegradation (In-Situ and Ex-Situ)

Site Name/ Contact	Technology/ Vendor	Media Treated	Contaminants Treated	Matrix Characteristics
Bio cell PNUM 17-J5492 AVDET Cordova Cordova, AK 1995 CEU Juneau Bob Deering (907) 463-2440	**Biodegradation** **Ex-situ**	soil 160 yd^3 120 yd^3 placed in on site biocell.	petroleum HC's JP-5: 75 - 100 gallons (released)	depth to gw: 6' bgs

4.1 Biodegradation (In-Situ and Ex-Situ)

Operating Parameters	Materials Handling	Residuals Management	Cost/Comments
blower: 130 scfm moisture added: every 3 - 5 months biocell construction: pit w/ 20 mil liner and cover 24" contaminated soil pile 36' of 4" vent line 5' of 4" PVC as riser (surface penetration for bioventing system) excavation: 384' x 14' x 7' weekly inspection: blower, piping, cover, pressure, vacuum, temp. semi-annual soil gas, CO_2 O_2, and HC's.			$ 6,200 Spill response/Biocell construction $ 3,000 Annual monitoring $ 2,000 Future site closure and sampling $ 11,200 Total This is an on going project. Respiration rate will be determined in late spring.

4.2 Bioventing

Site Name/ Contact	Technology/ Vendor	Media Treated	Contaminants Treated	Matrix Characteristics
Site 6A - MOGAS PNUM F4016 ISC Kodiak Kodiak, AK July 1995 FD&CC Mike Bowlus (206) 220-7370	**Bioventing**	soil 27,200 ft^2 closed as landfill	JP-5, used oil waste solvents TPH: 14,200 ppm PCE: 3,500 ppb contaminants > background levels	sand, gravelly with silt (0.5 - 1.0" dia) 1' organic soil overlay fractured bedrock:17 - 21' bgs K: 4.2 E-4 - 8.7 E-3 cm/s porosity assumed: 0.12 void volume: 48,000 ft^3 gw gradient: 0.02 - 0.88 ft/ft
PNUM 33-X 3762 Aviation Hill Housing ISC Kodiak Kodiak, AK 1996-1997 FD&CC John Vogel (206) 220-7370	**Bioventing**	soil 8,000 yd^3	heating fuel oil DRO: 3.1 - 5600 ppm BTEX: 0.043 - 11.29 pp TPH: 220 - 28,000 ppm cleanup sampling: 1 every 200 yd^2 surface area. cleanup level: 200 ppm	silty, sandy gravel bedrock: 5 - 9' bgs depth to gw: 1.5' - 11.5 ' bgs air permeability 10 E-7 - 10 E-8 cm^2
PNUM 09-C0882 Air Station Traverse City, Traverse City, MI 1992 CEU Cleveland Frank Blaha (216) 522-3368 ext. 368	**Bioventing** Reclamation Pilot Program Traverse Group 2525 Aeropark Drive Traverse City, MI	soil	petroleum HC's aviation gasoline fuel carbon: 100 - 900 ppm plume: 1,100' x 250' plots: 30' x 50'	beach sand: 0 - 50' bgs glacial silty clay: > 50' bgs moisture content: 3.5 - 23% depth to gw: 16' bgs water fluctuation: 2.5' (up to 6 - 8') treatment area: 30' x 50' temp: 3 - 21 °C
PNUM 0095 Air Station San Diego, San Diego, CA 1988 - 1995 CEU Oakland Dave Stalters or Joseph Sabel (510) 535-7239 Ref# TCN 0095-09	**Bioventing** To be implemented in mid 1996. Design completed by; Tetra Tech, Pasadena, CA Vendor: unknown	soil 185 yd3	petroleum HC's JP-5 TPH(gas): 3,500 ppm TPH(diesel): 39,100 pp benzene: 15 ppb toluene: 8 ppb ethylbenzene: 5 ppb xylene: 83 ppb naphthalene: 65 ppm	silty sand moisture content: 2.5 - 50.1% air permeability: 751 - 20,000 millidarcies pH: 6.9 - 8.4 HC oxidizing population: < 10 - 11,000 MPN/g ammonia nitrogen: 0.7 - 4.6 ppm nitrate nitrogen: 1.2 - 1.8 ppm orthophosphate: 3.5 - 12.2 ppm

4.2 Bioventing

Operating Parameters	Materials Handling	Residuals Management	Cost/Comments
bioventing 1.25" dia pipe regeneration blower (2ea) 35 CFM @ 50" H_2O 1.5 hp 10 - 25' pipe, 5 per side (perforated pipe)			$ 97,262 Design $ 12,583 Design review $ 824,788 Construction $ 92,873 UST liquid collection and disposal $ 11,000 Const Insp Svcs $ 358,251 Preclosure gw monitoring (1yr)
well spacing 25 - 35 ft intervals regenerative blowers 20 - 30 scfm 2" dia pipe			$ 100,000 Construction $ 12,000 Operation
air flow rate design: 5 - 63 cfm (actual 3 - 58 cfm) design radius of influence: 10' extraction pressure: 4 - 6" Hg injection pressure: 4 psi re-injection pressure: 6 psi	N, P, K added by sprinklers.	Oily residue is entrapped in capillary pores below water table preventing sufficient exposure to removal process.	$ 50 Cost/ton $50,035 Total (not including research) Objective of pilot test (1 yr study) evaluate 2 systems: 1) injection system only, and 2) injection/ extraction/reinjection. Both performed satisfactory. Aviation gas still below water table.
min O2/lb HC: 13 lb of atm air blower capacity: 30 scfm at 60" H2O (max 92 scfm) flow: 2.5 scfm (injection wells) air temp: 25 - 120 °F discharge pressure: 30 - 50" H2O operation speed: 3,450 rpm max hp: 1 inlet filter: 10 u air filter (dry)	In-situ	1988: 430 yd3 excavated and disposed.	$122,000 Original total cost $ 75,000 Low bid original cost break down: $ 6,000 Work plan $ 20,000 12 soil vent wells $ 40,000 Inf. trench $ 15,000 Water nutrient and blower system $ 8,000 Closure report $ 75,000 Estimated rem. cost

4.2 Bioventing

Site Name/ Contact	Technology/ Vendor	Media Treated	Contaminants Treated	Matrix Characteristics
Tank 191 ISC Kodiak Kodiak, AK December 1994 CEU Juneau Bob Deering (907) 463-2440	**Bioventing** (1 yr pilot test) Parsons Engineering Sciences, Inc. Denver, CO	soil	petroleum HC's TRPH max: 3,400 ppm (18 - 19' bgs) benzene: ND toluene: ND ethylbenzene: 1,900 ppb (3 - 5' bgs) xylene: 6,200 ppb (3 - 5' bgs)	glacial deposits (silt/clay glacial tills) overlie slate bedrock; glacial deposits covered by post-glacial peats and organic soils that have been overlain by multiple volcanic layers. depth to gw: 15' bgs gw gradient: 0.14 ft/ft NW
Building T-2 PNUM J1833 ISC Kodiak Kodiak, AK May 95 - May 97 CEU Juneau Bob Deering (907) 463-2440	**Bioventing** Ex-situ	soil	petroleum HC's EPH: 244 - 1060 ppm EPH soil: 550 - 2500 pp EPH gw: 44 ppm avg cont: 800 ppm	sandy gravel and gravelly sands with < 10% fines K: 500 - 4000 gpd/ft^2 depth to gw: 5' bgs gw gradient: 0.001 ft/ft gw velocity: 0.45 - 3.6 ft/d
Building T-2 PNUM J1833 ISC Kodiak Kodiak, AK May 95 - May 97 CEU Juneau Bob Deering (907) 463-2440	**Bioventing** In-situ	soil	HC contamination levels nearly 2,500 ppm	sandy gravel and gravelly sands with < 10% fines K: 500 - 4000 gpd/ft^2 depth to gw: 5' bgs gw gradient: 0.001 ft/ft gw velocity: 0.45 - 3.6 ft/d

4.2 Bioventing

Operating Parameters	Materials Handling	Residuals Management	Cost/Comments
designed radius of venting influence around central sir injection well: 30 - 40' (expected to exceed 90' in deeper soils). diameter of vent well: 4" (40 PVC) with 15' screen of 0.04" slot set at 5 - 20 ' bgs blower: 2.5 hp air flow rate: 26 scfm air permeability: 154 darcies radius of influence: 50' from vent well O_2 loss rates (mod): 0.0084%/min - 0.037%/min based on O_2 estimate 1,200 - 2,100 mg fuel/kg soil can be degraded. air field porosity: 0.3 lt/kg soil; 3.5 mg O_2/mg fuel.	soil samples taken from 35' radius and up to 90'.		There is no PNUM because there is no cost to the USCG. Soil gas: (total volatile HC's) reduction from 400 to 140 ppm (in monitoring well) TVPH in soil after 1 yr reduced to ND limits. Respiration tests: initial biodegradation rate: 1,180 - 5,210 mg TPH/kg soil/yr 6 month biodegradation rate: 180 - 550 mg TPH/kg soil/yr 12 month biodegradation rate: 170 - 830 mg TPH/kg soil/yr
2 - 20 slot PVC horizontal pipes run the length of the material placed 8' deep. longest radius of influence: 15' across the pit regenerative blower: 160 cfm (rated at 145 scfm at 0" H_2O vacuum as installed 1,125 scfm at 20")	excavation: 43' x 30' x 12' periodic monitoring for the system performance.	system includes air filter to remove particles.	$ 95,378 Release investigation $ 6,756 CAP $ 102,134 Total
Converted monitoring well receiving 70 cfm ambient air from Gaast R4 regenerative blower (rated at 88 scfm at 0" H_2O; installed at 66 scfm at 21"). Weekly monitoring of blower performance: vacuum, pressure, temp.		system includes an air filter to remove particulates.	Cost part of bioventing ex-situ costs listed above.

4.2 Bioventing

Site Name/ Contact	Technology/ Vendor	Media Treated	Contaminants Treated	Matrix Characteristics
Former Fuel Farm PNUM C3801 Air Station Elizabeth City Elizabeth City, NC 1992 CEU Cleveland Frank Blaha (216) 522-3368 ext. 368	**Hybrid of Vapor Extraction and Bioventing**	soil and gw	petroleum HC's JP-4 release at fire station	dense clayey silt or silty clay: 0 - 5' medium fine silty sand or silty sand: 5 - 50' dense clay: 50 - 75' K: 0.0003 - 0.01 cm/s depth to gw: 5 - 6' bgs gw gradient: 0.01 - 0.03 ft/ft gw velocity: 10.5 ft/yr pH: 5.5 - 8.5 temp: 20 - 40 °C

4.2 Bioventing

Operating Parameters	Materials Handling	Residuals Management	Cost/Comments
air injection: 4.5 psig 85 scfm per well 1,800 scfm blower with 75 hp motor vapor extraction: 35 - 50 scfm/well 800 scfm vacuum pump with 30 hp motor typical system: 1 to 3 psi 3 to 30" H_2O vacuum	Visibly stained soil and water removed with fuel tank removal. O_2, CO_2, temp, TPH monitored on extracted air to monitor biodegradation and volatilization rate.	Pulsing done every 3 months by using injection wells for extraction and extraction for injection.	$ 250,000 Construction $ 94,600 O&M (2 yrs) $ 33,800 System removal Designed to lower water table to expose contaminated soil. Clean TPH level < 100 ppm. Monitoring and evaluation support provided by EPA.

4.6 (In-Situ) and 4.18 (Ex-Situ) Soil Vapor Extraction

Site Name/ Contact	Technology/ Vendor	Media Treated	Contaminants Treated	Matrix Characteristics
Site 3-laundry A PNUM F4020 ISC Kodiak Kodiak, AK July 1996 FD&CC PAC Mike Bowlus (206) 220-7387	**Soil Vapor Extraction**	Soil 65,600 ft^3	PCE: 0.02 - 1,700 ppm TCE : 0.065 - 0.380 pp 1,2-DCE: 0.190 ppm vinyl chloride: 0.22 ppm chlorethylene: 1.1 ppm TPH: 60 - 260 ppm	sandy silt & poorly graded gravel 0 - 5' bgs fractured bedrock 5' - 15' bgs K: 0.02 - 3.86 cm/s porosity: 0.12 void volume: 7,900 ft^3 depth to gw: 2' - 3.86' bgs perched aquifer TOC: < .21 - 1.1% CEC: 3930 - 8750 mg/kg
Site 7A Barrel Storage 1 PNUM F4201 ISC Kodiak Kodiak, AK July 1996 FD&CC PAC Mike Bowlus (206) 220-7387	**Soil Vapor Extraction**	Soil: area 27,000 ft^2	JP-5, FS-6, TCE 1-1-1 TCE carbon tetrachloride methylene chloride paint wastes, PCE TPH: 43-91,000 ppm Lead: 7.2 - 93.5 ppm 1,2 - DCE: 10,000 ppb TCE: 12-1,600 ppb	fibrous peat 0 - 1' poorly sorted gravel 1' - 8' gravelly clay >8' K: 3.5 E-6 - 3.5 E-4 cm/s depth to gw: 5' - 14.5' bgs pH: 5.9 - 9.1 temp: 1-15.3° C yearly hardness: 59 - 515 mg/L O_2 : 1.2 - 5.5 mg/L TOC: 1.0 - 24.6 mg/L iron : 25.9 - 277 mg/L Mg: 0.96 - 10.9 mg/L Conductance: 35 - 210 umhos/cm
Fuel Farm PNUM M1055 Base Miami Beach Miami, FL 1996/97 FD&CC LANT Jim Lewis (804) 858-6230 ext. 255	**Soil Vapor Extraction**	Soil	TPH (diesel): 27,500 ppm max. 2,750 ppm avg. est. VOC: 1,534 gal. depth of contaminant: 20'	sand, fine silty sand K (vadose zone): 0.011 cm/s K: 7.1E-5 cm/s effective porosity: 0.25 soil density: 1.4 ton/yd^3 permeability: 3.8E-6 - 1.0E-4 ft/s depth to gw: 3' - 9' bgs (tidal Influence) gw flow towards bay aquifer thickness: 15' pH: 7.5 - 8.1 transmissivity: 3,366 gpd/ft

4.6 (In-Situ) and 4.18 (Ex-Situ) Soil Vapor Extraction

Operating Parameters	Materials Handling	Residuals Management	Cost/Comments
16 extraction air chimneys 12" dia, 8 'x 8' spacing 1 extraction well 2" dia 8' x 8' spacing 8" SVE pipe in porous med. above chimney under cap operates @ 610 cfm extraction fan 650 cfm @ 41 " H_2O		SVE filters (air): 4 ea. - 750 #GAC units in series bed area: 7.5 ft^2 (ea.) Q: 750 cfm 6" H_2O drop per drum water scrubber: 000#GAC 30 lb/ cu. ft. pellets 8 x 30 mesh filters liquid from knockout tank (55 gal drum)	
SVE 2" dia. pipe centrifugal blower: 2400 scfm @ 40" H_2O vacuum 5,500 RPM, 50 HP, 3" dia 55 wells: approx. 10' x 10' spacing		knockout pot tank (38.5 cu ft) water processed through 2 GAC filters in series then returned in air sparging GAC 4000# each 51#/cu. ft. 60% active 4 x 8 mesh size	$ 89,770 Debris removal $ 163,368 Soil removal (1st closure attempt) $ 5,033 Project oversight -soil removal $ 66,000 Design $ 850,000 Construction (estimated)
Air flow rate 400 cfm Vacuum 37 in water (60) Typical depth of extraction well: 4 ft (pilot) Treatment required for air emissions thermal oxidizer 4 horizontal wells Radius of influence: 15 ft			$194,000 capital (est) $290,000 O&M

4.6 (In-Situ) and 4.18 (Ex-Situ) Soil Vapor Extraction

Site Name/ Contact	Technology/ Vendor	Media Treated	Contaminants Treated	Matrix Characteristics
Fuel Farm PNUM M1055 Base Miami Beach Miami, FL July 92 -Sept. 95 CEU Miami Sonia Reyes/ Rob Kappel (305) 278-6700	**Soil Vapor Extraction**	Soil 1,163 yd^3	petroleum HC's gas diesel	sand, fine silty sand K(vadose zone): 0.011 cm/s K: 7.1E-5 cm/s effective porosity: 0.25 soil density: 1.4 ton/yd^3 permeability: 3.8E-6 - 1.0E-4 ft/s depth to gw: 3'-9' bgs aquifer thickness: 15' pH: 7.5 - 8.1 transmissivity: 3,366 gpd/ft
SARDET Holland PNUM C9125 Holland, MI Jan. 1991 - Feb. 1992 CEU Cleveland Denise Hancsak (216) 522-3934 (ext.267)	**Soil Vapor Extraction** The Traverse Group, Inc. 3772 Plaza Dr. Suite 5 Ann Arbor, MI 48108 (313) 747-9300 Ann Markstrom	soil	petroleum HC's diesel fuel waste oil BTEX PNA oil & grease TPH	medium, fine sand 0 - 9' bgs silty layers below 9' bgs depth to gw: 8' bgs
PNUM C0860 Base Milwaukee Milwaukee, WI Feb. 1996 CEU Cleveland Denise Hancsak (216) 522-3834	**Soil Vapor Extraction**	soil	Petroleum HC's gasoline diesel Soil: DRO Water: BTEX ethylbenzene DRO	clay to silty clay 1-7 ft bgs silty sand below 7' bgs K: 6.9E-4 cm/sec depth to gw: 5'-10' bgs
PNUM 09-C0805 STA Little Creek Norfolk, VA 1992 CEU Cleveland Denise Hancsak (216) 522-3934 ext.267	**Soil Vapor Extraction** EA Engineering Science and Technology 15 Loveton Circle Sparks, MD 21152 (410) 771-4950	soil	petroleum HC's BTEX	K: 0.66 - 3.11 cm/s porosity: 25% depth to gw: 8' - 10' bgs gw flucuation: 0.3' - 1.3' gw gradient: 1.2E-3 ft/ft perched gw: 5' - 8' bgs gw linear velocity: 1.6E-2 - 7.4E-2 ft/day transmissivity: 107 -505 ft^2/day aquifer thickness: 15'

4.6 (In-Situ) and 4.18 (Ex-Situ) Soil Vapor Extraction

Operating Parameters	Materials Handling	Residuals Management	Cost/Comments
4 wells air flow rate: 100 - 400 cfm radius of influence: 15'	In situ In conjunction with pump and treat system.	SVE gas will be filtered and vented to the atmosphere first 2 months thermal oxidation of vapor	See pump and treat for total project costs, pg 3-61
SVE vacuum: 0.4"-1.6" of H_2O blower avg: 42 scfm sparging radius of influence: 6' SVE radius of influence: 10'	biweekly monitoring: BTEX PNAs O_2 OVM readings	Off gas treatment GAC canisters 441 ft^3 of soil landfilled	\$75.00/ yd^3 disposal cost (unit)
2 extraction wells 2" dia.	in situ		\$ 50,000 site assessment \$ 81,000 remedial design \$130,000 install remedial system \$ 56,000 O&M/testing (1yr)
blower: 30 cfm at 80" H_2O	in situ	carbon adsorption system for air	passive skimmer device is proposed under Phase III assessment.

4.6 (In-Situ) and 4.18 (Ex-Situ) Soil Vapor Extraction

Site Name/ Contact	Technology/ Vendor	Media Treated	Contaminants Treated	Matrix Characteristics
Former Fuel Farm PNUM C3802 Air Station Elizabeth City Elizabeth City, NC CEU Cleveland Jim Vardy (919) 335-6847	**Soil Vapor Extraction -** Wind driven turbines Engineering-Science, Inc One Harrison Pk 401 Harrison Oaks Blvd., Suite 305 Cary, NC 27513 (919) 677-0080 Donald Boyle	soil in situ	Petroleum HC's Fuel (POL), JP-5 TPH, BTEX, VOAs, SVOAs TPH: 50.8-6490mg/kg VOA: >10 ppm SVOA: >40 ppm free product levels: 0.5'-4.5' (est. several 100,000 gallons) cont. area: 3.4 acres	clay, silty loam 0 - 5' bgs silty fine sand 5'-67' bgs K: 0.02 - 1.28 cm/s porosity: 25% moisture 16.4-25.3% depth to gw: 8'-9' bgs gradient 1.0E-3-5.0E-3 ft/ft pH 4.6-7.0 temp 10.9-16.6 °C O_2: 0.45-3.3 mg/l horiz. perm. 4.5E-10
Lorsta St. Paul PNUM J3866 Saint Paul, AK May 1995 CEU Juneau Bob Deering (907) 463-2440	**Soil Vapor Extraction** Arctic Slope Consulting Group	soil: 500 yd^3	Petroleum HC's, Fuel Oil, JP-5, Heating Oils most contaminant: 0 -5' bgs BTEX: ND-7.7ppm EPH: ND-7380 ppm B: ND-0.042 ppm	soil: 1-3ft boulders in fine grained matrix with dense silt lenses depth to gw: 5' - 15' bgs
Fire Station PNUM C3801 Air Station Elizabeth City Elizabeth City, NC 1992-1993 CEU Cleveland Jim Vardy (919) 335-6847	**Soil Vapor Extraction**	soil	petroleum HC's JP-4 product found @: 3.5' to 9' bgs	Sand with silt and clay (stiff to loose) K: 2 ft/day gw gradient: 0.01-0.03 ft/ft

4.6 (In-Situ) and 4.18 (Ex-Situ) Soil Vapor Extraction

Operating Parameters	Materials Handling	Residuals Management	Cost/Comments
1 riser every 150 ft of horizontal pipe 12" wind turbine on 4" dia. pipe turbine flow 4-61 cfm each (16 turbines) 8- 320' trench radius of influence: 25' - 30'	in situ	passive vapor extraction: straight off gas air monitoring required	$ 100,000 construction $ 31,600 annual maintenance
	in situ		$ 76,000 assessment report soil vapor extraction proposed testing to begin summer 1996
8- 320' trenches operable pressure: 4.5 psi Min. reliable flow rate: 87 cfm (5" dia. pipe).	in situ	straight off gas	operation stopped due to high water table resulting from antecedent rainfall events. removed > 400 lb hydrocarbons.

4.6 (In-Situ) and 4.18 (Ex-Situ) Soil Vapor Extraction

Site Name/ Contact	Technology/ Vendor	Media Treated	Contaminants Treated	Matrix Characteristics
Lorsta Pt. Clarence PNUM J1831 Port Clarence, AK August 1995 CEU Juneau Bob Deering (907) 463-2440	**Soil Vapor Extraction**	soil	petroleum HC's diesel Fuel EPH: 780-14,000 ppm BTEX: 2.26-25.90 ppm	Gravelly sand, gravel 0.5" -1.0 dia. permafrost: 10' - 15' bgs depth to gw: 10' - 15' bgs (thin layer of gw above permafrost)
PNUM C0882 Air Station Traverse City Traverse City, MI 1990-1992 CEU Cleveland Frank Blaha (216) 522-3368	**Soil Venting System - Vacuum Extraction** Traverse Group, Inc. 2525 Aeropark Dr Traverse City, MI	soil: 2 feet above gw table 2 feet below gw table	petroleum HC's aviation gas max. conc.: 10,000 mg/kg 15,000-17,000 gal. in plume	Uniform beach sand to gray glacial silty clay K: 30.5 cm/s

4.6 (In-Situ) and 4.18 (Ex-Situ) Soil Vapor Extraction

Operating Parameters	Materials Handling	Residuals Management	Cost/Comments
wells: 5 injection 5 extraction air flow: 60 - 65 scfm vacuum: 4" - 10" H_2O temp.: 43° F CO_2: 1-4% O_2: 13-21% air injection: all year vapor extraction: only in summer. Thermistor strings to monitor permafrost.		vented to atmosphere	$ 48,492 investigation $ 89,506 CAP $ 22,388 SVE/biovent system Well placement constrained by existing structures and utilities set at 100 ft radii.
sys. flow rate: 150 cfm Inj. flow rate: 209 scfm (avg.) injection blower pressure: 1.25-1.5 psi vacuum for withdrawal blower <2 in to 7 in temp.: 40°F radius of influence: 50'-73' daily monitoring		GAC bed to treat off gas Carbon usage 5.5lb of carbon per pd of contamination. Extracted vapors incinerated using re-fitted torvex catalytic incinerator	$ 8,789 incinerator cost $ 112,607 carbon usage $ 168,910 carbon for entire project soil venting system removed 425 gallons contamination in 5 years

4.10 Composting

Site Name/ Contact	Technology/ Vendor	Media Treated	Contaminants Treated	Matrix Characteristics
Tracen Petaluma Contract No. DTCG49-94-RQEN0 Delivery Order #7 Petaluma, CA July 1996 Tracen Petaluma Patrick Nelligan (707) 765-7225	**Composting** PES Environmental Inc. 1682 Novato Blvd. Suite 100 Novato, CA 94947 (415) 899-1600	soil 1,000 yd^3	TPH: 80 - 740 ppm cleanup target: 200 ppm	20% rock sandy clay, silty sand gw gradient: 0.006 ft/ft pH: 4.3 - 8.1

4.10 Composting

Operating Parameters	Materials Handling	Residuals Management	Cost/Comments
windrow pile length: 1000' windrow size: 6' H x 12' W additives 250 - 300 yd^3 compost (lawn clippings & wood chips) 25 - 30 yd^3 (manure) nutrients added inlifts central 4" dia drain pipe nitrogen target 20 ppm phosphorus 5 ppm 20 mil bottom liner w/ 6" native soil cover 1.5' perimeter berm 10 mil cover recycle leachate through drip irrigation system moisture: 50-60% saturation windrow to be periodically turned windrow temp: 50 - 55 °C monitor conditions monthly	front end loader		$ 25,616 Remediation plan design (includes soil sampling) $ 10,000 Composting $ 5,000 Pile spreading after composting Plan approval by regulators pending.

4.12 Landfarming

Site Name/ Contact	Technology/ Vendor	Media Treated	Contaminants Treated	Matrix Characteristics
Aviation Hill Housing PNUM ISC Kodiak Kodiak, AK FD&CC John Vogel (206) 220-7387	**Landfarming** (In-Situ)	soil	petroleum HC's	
Fuel Farm Air Station Miami PNUM M0091 Opa Locka, FL 1990 - 1995 CEU Miami Zonia Reyes (305) 278-6700	**Absorbent Collection and Excavation (Landfarm)** Law Environment (607) 698-3400	soil 145 yd^3	petroleum HC's TRPH: 228 ppm	depth to gw: 4 - 5' bgs fluctuation: 1' K: 63.0 - 66.5 cm/s gw gradient: 0.0001 ft/ft gw flow: NW
Former Fuel Farm PNUM C3802 Air Station Elizabeth City Elizabeth City, NC CEU Cleveland Jim Vardy (919) 335-6847	**Landfarming** Engineering-Science, Inc. One Harrison Park 401 Harrison Oaks Blvd suite 305 Cary, NC 27513 (919) 677-0080 Donald Boyle	soil	petroleum HC's fuel (POL) JP-5 BTEX VOA's TPH: 50.8 - 6,490 pp contaminated area: 3.4 acres (> 10 ppm VOA, > 40 ppm SVOA) free product levels: 0.5 - 4.5' (estimate several hundred thousand gallons)	clay, silty loam: 0 - 5' bgs silty fine sand: 5 - 67' bgs K: 0.001 - 0.018 cm/s moisture content: 16.4 - 25.3% porosity: 25% depth to gw: 8 - 9' bgs gw gradient: 0.001 - 0.005 ft/ft pH: 4.6 - 7.0 temp: 10.9 - 16.6 °C dissolved O_2: 0.45 - 3.3 mg/L horiz perm: 4.5 x 10 E-10 radius of influence: 25 - 30'
PNUM P 1813 Air Station Brooklyn Brooklyn, NY 1990 completed 7/8/94 CEU Providence Rachel Marino (401) 736-1746	**Landfarming** Texto, Inc. 40 Stone Castle Rd. Rock Terem, NY 12575	soil 384 yd^3	petroleum HC's JP-4 fuel TPH: ND - 2,800 ppm (avg 534 ppm)	moisture content: 60 - 70% pH: 7 - 9.9 CEC: 5.2 meq/100 g

4.12 Landfarming

Operating Parameters	Materials Handling	Residuals Management	Cost/Comments
			$190,000 Tank removals $ 30,000 Landfarm
contaminated soil was spread out on visquene sheets to volatilize the residual fuel content.	initial cleanup: absorbent collection and excavation (145 yd^3)	Intrinsic remediation for gw.	
single 4" lift over 3.7 acres bi-annual composite sampling at 8 locations cleanup level: 10 ppm VOA 40 ppm SVOA project duration: 2 yrs	tilling 1, 2, 6, 6, etc., months wood chips added for bulking	veg cover in 60 days	$ 18,200 Spreading and tilling $ 5,000 Sampling every 6 months until clean
soil lifts: 18" area: 220' x 220' nutrient ratio: 300:15:1 pH: 6.5 - 8 maintained endpoint: TPH 100 ppm	Monitoring of pH, moisture and nutrients. Weekly tilling. Monthly monitoring of TPH	Used as a cover for a MSW landfill.	$148,000 Lump sum contract, (1990).

4.12 Landfarming

Site Name/ Contact	Technology/ Vendor	Media Treated	Contaminants Treated	Matrix Characteristics
PNUM J5492 AVDET Cordova Cordova, AK 1993 CEU Juneau Bob Deering (907) 463-2440	**Landfarming**	soil 60 yd^3	petroleum HC's heating oil TPH: 11,600 ppm	glacial till with rocks > 2"

4.12 Landfarming

Operating Parameters	Materials Handling	Residuals Management	Cost/Comments
soil spread out on 20 mil liner: 1' x 50' x 50'	tilling once a week		Completed

4.21 (High) and 4.24 (Low) Temperature Thermal Desorption

Site Name/ Contact	Technology/ Vendor	Media Treated	Contaminants Treated	Matrix Characteristics
Fire Fighting School PNUM 2081 RTC Yorktown Yorktown, VA March 3, 1996 RTC Yorktown Lynn Daniels (804) 898-2390	**Thermal Desorption** Rickmond Enviro	soil: 336 yd^3 stone: 224 yd^3	diesel	
Peanut Island PNUM M1045/46 Sta. Lake Worth Inlet Riviera Beach, FL May 1995 CEU Miami Zonia Reyes (305) 278-6700	**Low Temperature Thermal Desorption** Tanktek 14512 N. Nebraska Suite 104 Tampa, FL 33613 Mr. Jack Keiser (813) 971-4664	soil: 107 ton 93 yd^3	bilge H_2O/oily waste petroleum HC's TPH: 50 - 1,000 pp PAH: 12 - 37,000 pp VOA: < 1 - 6,100 pp TRPH: 4,500 - 42,000 ppm	fine sand with rubble soil size: < 2" depth to gw: 3.5 - 4' bgs (tidal influence) pH: 7.6 - 7.8 smear zone: 1.5'
PNUM M4321 Sta. Destin Destin, FL May 1993 CEU Miami Zonia Reyes (305) 278-6700	**Thermal Desorption** Falcon Industries Rte. 4, Box 348 Brewton, AL 36426	soil: 31.3 tons 3,413 ft^3	petroleum HC's diesel fuel	fine-med sand depth to gw: 1.4 - 4.3' bgs (tidal influence) gw gradient: 0.004 ft/ft TDS: 380 - 460 mg/L
Sta. Fort Myers PNUM M1388 Fort Myers, FL Feb 1993 CEU Miami Zonia Reyes (305) 278-6700	**Thermal Desorption** South Florida Thermal Services 1 Formoor Lane P.O. Box 309 Moore Haven, FL (813) 946-3300	soil: 80 tons 1530 yd^3	petroleum HC's waste oil BTEX: 2951 ug/L	fine-med sand K (@12' bgs): 5 -7 cm/s K (@33' bgs): 9 cm/s porosity: 0.30 (clean sand) depth to gw: 5 - 6' bgs gw gradient: horiz: 0.03 ft/ft vert: 0.04 - 0.23 ft/ft pH: 6.78 - 8.27 TDS: 550 - 9,000 mg/L

4.21 (High) and 4.24 (Low) Temperature Thermal Desorption

Operating Parameters	Materials Handling	Residuals Management	Cost/Comments
			Most costs and volumes were below the government estimates of $60,000.
backhoe excavation	barge transport off island truck to off site STTF (treat. fac.)	<50 ppm residual is clean for gasoline group	$ 60,000 Assessment $ 20,862 Removal and gw monitoring $ 24,960 Excavation and treatment
	ex-situ		$ 27,000 CAR $ 45/ton Thermal treatment
	ex-situ		$46,689 CAR $11,583 Monitoring plan $ 3,711 Initial assessment $5,407/yr qrtly monitoring

4.21 (High) and 4.24 (Low) Temperature Thermal Desorption

Site Name/ Contact	Technology/ Vendor	Media Treated	Contaminants Treated	Matrix Characteristics
Lorsta Pt. Clarence PNUM J1831 Pt. Clarence, AK August 1995 CEU Juneau Bob Deering (907) 463-2440	**Low Temperature Thermal Desorption** portable rotary kiln	soil: 360 yd^3	petroleum HC's diesel fuel EPH: 780 - 14,000 ppm BTEX: 2.3 - 25.9 ppm	gravelly sand w/ gravel: 0.5 - 1" depth to gw: 10 - 15' bgs (thin layer of gw on top of permafrost) depth to permafrost: 10 - 15' bgs
Lorsta Tok PNUM J1884 Tok, AK June 1995 CEU Juneau Bob Deering (907) 463-2440	**Low Temperature Thermal Desorption** portable rotary kiln	soil 200 yd^3	petroleum HC's No. 1 fuel oil TPH: 210 - 2,400 ppm	sand: 3 - 7' bgs sandy gravel 7 - 9' bgs gravel with cobbles: 9 - 20' bgs depth to gw: 86 - 100' bgs gw gradient: 0.001 ft/ft depth to permafrost: 8 - 15' bgs
PNUM J1836 Air Station Sitka Sitka AK February 1993 CEU Juneau Bob Deering (907) 463-2440	**Low Temperature Thermal Desorption** portable rotary kiln	soil: 610 yd^3	petroleum HC's JP-5 fuel TPH: 5,000 ppm	
PNUM M4336 Sta. Panama City Panama City, FL July 1994 CEU Miami Zonia Reyes (305) 278-6700	**Thermal Treatment** Kleensoil International 13838 Harlee Road Palmetto, FL 43221 (800) 926-9677	soil 25.39 yd^3 32.54 tons	petroleum HC's diesel: 300 - 400 ppm PAHs: 5,261 ppb VOAs: 1,400 ppm	med-fine silty sand depth to gw: 2.5 - 6.5' bgs (tidal influence) pH: 5.4 - 6.9 temp: 22 - 28 °C

4.21 (High) and 4.24 (Low) Temperature Thermal Desorption

Operating Parameters	Materials Handling	Residuals Management	Cost/Comments
operating temp: 600 °F after burner: propane or natural gas temp: 800 - 1,200 °F soil treated: max size: 3" max vol dry: 8 yd^3/day max vol wet: 4 yd^3/day max contam. soil processed: 5,000 ppm TPH	ex-situ treatment of 7 yd^3/day for 51 days.	vented to atmosphere after treatment soil reused on site @ TPH < 50 ppm	Test burned samples every 100 yd^3.
operating temp: 600 °F after burner: propane or natural gas temp: 800 - 1,200 °F soil treated: max size: 3" max vol dry: 8 yd^3/day max vol wet: 4 yd^3/day max contam. soil processed: 5,000 ppm TPH	ex-situ treatment	after treatment: TPH < 50 ppm	$26,936 Investigation rpt. $ 6,160 Sampling
operating temp: 600 °F after burner: propane or natural gas temp: 800 - 1,200 °F soil treated: max size: 3" max vol dry: 8 yd^3/day max vol wet: 4 yd^3/day max contam. soil processed: 5,000 ppm TPH	treated 7 yd^3 of soil per day and sampled every 100 yd3.	after treatment: soil returned to excavation site TPH < 50 ppm	$40,000 Kiln operation $ 2,553 Soil sampling
	ex-situ		$24,290 IRA (soil removal) $ 6,140 Groundwater and soil sampling

4.23 Incineration

Site Name/ Contact	Technology/ Vendor	Media Treated	Contaminants Treated	Matrix Characteristics
Lorsta Martha's Vineyard Gay Head, MA 1995 CEU Providence Rachel Marino (401) 736-1746	**Incineration** SI: Keyes Assoc., Lincoln, RI and Franklin Env. Services Wrentham, MA Disposal Facility: Chem. Waste Management Port Arthur, TX	soil 100 yd^3	PCBs: 0.28 - 8,000ppm	

4.23 Incineration

Operating Parameters	Materials Handling	Residuals Management	Cost/Comments
	Excavation and off site incineration.	All residuals tested after incineration: < 5 ppm	$2,500 - $3,000/yd^3 (unit price)

4.29 (Soil) and 4.50 (Water) Natural Attenuation

Site Name/ Contact	Technology/ Vendor	Media Treated	Contaminants Treated	Matrix Characteristics
UST Soil Contract No: DTCG49-94-RQEN001 Delivery Order #7 July 1996 Tracen Petaluma Patrick Nelligan (707) 765-7225	**Natural Attenuation** Ex-Situ	Soil 10,400 yd^3	TPH: 0-180 ppm (avg. 50 ppm)	sandy clay, silty sand, 20% rock gw gradient: 0.006 ft/ft pH: 4.3 - 8.1
PNUM X3809 Station Port Isabel S. Padre Island, TX March 1996 FD&CC LANT Jim Lewis (804) 858-6230 x225	**Natural Attenuation**	soil 100 yd^3	gasoline diesel TPH: 13,200 pp contamination depth: 0-4' bgs	dredge spoil silt and clay moisture content: 31% soil bulk density wet: 1810 g/cm^3 dry: 1.622 g/cm^3 Effective porosity: 0.446 Depth to gw: 5' bgs Organic carbon content 0.082 g/g
Boiler Plant, UST Bldg #15 PNUM Y4043 Baltimore, MD March 26, 1996 CG Yard Howard Galliford (410) 636-7070	**Natural Attenuation**	Soil	Heavy HC's #6 heating oil TPH: 3,900 ppm	Sand, silt, clay and backfill Depth to groundwater: 14' @ UST 3' @ sump
PNUM M1052 Airstation Miami Opa Locka, FL Feb. 27, 1996 CEU Miami Steve Avallone (305) 278-6700	**Natural Attenuation** Parsons Engineering 8100 Oak Lane, Suite 301 Miami Lakes, FL 33016 Catherine McMullen (305) 558-3002	Water	Petroleum HC's Benzene: 6 ug/l Tot. PAH: 83 ug/l Tot. NAPHs: 4,300 ug/l Tot. lead: 50 ug/l	K: 66 cm/sec depth to gw: 4'-5' bgs gw fluctuation: 1' gw flow: northwest gw gradient: 1.0E-4 ft/ft

4.29 (Soil) and 4.50 (Water) Natural Attenuation

Operating Parameters	Materials Handling	Residuals Management	Cost/Comments
in-situ	soil okay for landfill but hauling costs are 4 -5 times the cost of onsite relocation		$ 57,000 stockpile spreading $ 10,055 stockpile maintenance soil sat from 1992 to 1995 naturally degrading. plan approval by regulators pending
in situ	in situ		no free product or offsite migration groundwater not impacted
in situ	in situ		In-house, not monitored
in situ	in situ		$ 33,000 total cost 4 quarters of groundwater monitoring and an intrinsic remediation demonstration will be performed.

4.29 (Soil) and 4.50 (Water) Natural Attenuation

Site Name/ Contact	Technology/ Vendor	Media Treated	Contaminants Treated	Matrix Characteristics
Isle of Shoal Light Sta. Portsmouth NH CEU Providence Rachel Marino (401) 736-1746	**Natural Attenuation**	Soil	Petroleum HC's TPH: 84,000 ppm	loamy sand/bedrock depth of soil pile: 6"
Burnt Island Light Station Southport, ME CEU Providence Rachel Marino (401) 736-1746	**Natural Attenuation**	Soil	Petroleum HC's TPH: 81,000 ppm	sandy loam/bedrock
Fog Signal Station Manana Island, ME February 1995 CEU Providence Rachel Marino (401) 736-1746	**Natural Attenuation**	Soil	Petroleum HC's VOC: 171 ppm as of Feb. 1995	fractured bedrock
West Quoddy Head Light Station Lubec, ME October 1992 CEU Providence Rachel Marino (401) 736-1746	**Natural Attenuation**	Soil	Petroleum HC's VOC: 164 ppm as of Oct. 1992	silty soil, black clay silt/bedrock depth soil pile: 1-1.5 ft
Nauset Light House Eastham, MA CEU Providence Rachel Marino (401) 736-1746	**Natural Attenuation**	soil	Petroleum HC's Gasoline VOC: 2,500 ppm	bedrock (mostly)

4.29 (Soil) and 4.50 (Water) Natural Attenuation

Operating Parameters	Materials Handling	Residuals Management	Cost/Comments
In situ	In situ	In situ	No cost bedrock located very near ground surface isolated area
In situ	In situ	In situ	No cost bedrock very close to ground surface isolated area
In situ	In situ	In situ	No cost bedrock very close to ground surface isolated area reduction in VOCs: 24 - 44 ppm as of Nov. 1995
In situ	In situ	In situ	No cost bedrock very close to ground surface isolated area reduction in VOCs: 0.8 - 1.9 ppm as of Sept. 1995
In situ	In situ	In situ	No cost bedrock very close to ground surface isolated area

4.29 (Soil) and 4.50 (Water) Natural Attenuation

Site Name/ Contact	Technology/ Vendor	Media Treated	Contaminants Treated	Matrix Characteristics
Former Fuel Farm PNUM C3801 Air Station Elizabeth City Elizabeth City, NC 1992 CEU Cleveland Frank Blaha (216) 522-3934	**Natural Attenuation**	soil and water	Petroleum HC's JP-4 release	dense clay/silt and silty clay 0-5' bgs silty sand 5'-50' bgs dense clay 50'-75' bgs K: 2.7E-4 - 1.0E-3 cm/sec depth to gw: 5'-6' bgs pH 5.5-8.5 gw gradient: 0.01-0.03 ft/ft gw velocity: 10.5 ft/yr temp.: 20-40 °C

4.29 (Soil) and 4.50 (Water) Natural Attenuation

Operating Parameters	Materials Handling	Residuals Management	Cost/Comments
In situ fate & transport of gw BTEX modeled using Bioplume II	In situ	In situ	$61,600 remed. modeling $15,000/year O&M Heavy contamination removed with tank hybrid system used for 2 years. System removed except for monitoring points. Complete remediation expected in 8- 12 years.

4.34 Air Sparging

Site Name/ Contact	Technology/ Vendor	Media Treated	Contaminants Treated	Matrix Characteristics
Barrel Storage 1 Site 7A PNUM F4021 ISC Kodiak Kodiak, AK July 1996 FD&CC PAC Mike Bowlus (206) 220-7370	**Air Sparging**	water	JP-5, FS-6, TCE, 1-1-1 TCE, carbon tet methylene chloride paint wastes, PCE TPH: 43-91,000 ppm Lead: 7.2 - 93.5 ppm 1,2-DCE: 10,000 ppb TCE: 12-1,600 ppb	fibrous peat: 0 - 1' bgs poorly sorted gravel: 1' - 8' bgs gravelly clay: >8' bgs K: 3.5 E-6 - 3.5 E-4 cm/sec depth to gw: 5' - 14.5' bgs pH: 5.9 - 9.1 temp: 1-15.3° C yearly O_2: 1.2 - 5.5 mg/L Conductance: 35 - 210 umhos/cm hardness: 59 - 515 mg/L TOC: 1.0 - 24.6 mg/L iron: 25.9 - 277 mg/L Mg: 0.96 - 10.9 mg/L
Laundry Loc. A Site 3 PNUM F4020 ISC Kodiak Kodiak, AK July 1996 FD&CC PAC Mike Bowlus (206) 220-7370	**Air Sparging**	water	PCE: 3,000 ppb TCE: 71 ppb 1,2-DCE: 83 ppb Vinyl chloride: 440 ppb Methylene chloride: 5.5 ppb Xylene: 5.0 ppb	sandy silt, poorly graded gravel fractured bedrock: 5' - 15' bgs K: 0.02 - 3.9 cm/sec assumed porosity: 0.12 void volume: 7,900 cu. ft. depth to gw: 2' - 12' bgs perched aquifer TOC: < .21 - 1.1% CEC: 3,930 - 8,750 mg/kg
Fuel Farm PNUM M1055 Base Miami Beach Miami, FL 1996/97 FD&CC LANT Jim Lewis (804) 858-6230	**Air Sparging** in conjunction with pump and treat (recommended for gw)	water	diesel VOA's: 108 ppm Naph: 680 ppm	silty sand K: 6.1 cm/sec Depth to gw: 5' (tidal fluctuation) Temp: approx 70° F Depth to contaminants 15 ft TDS: 17,102 mg/L Product VP 2.12 - 26.4 mm Hg

4.34 Air Sparging

Operating Parameters	Materials Handling	Residuals Management	Cost/Comments
2" dia pipe 4 scfm/well @ 15 psi 55 wells total (495 scfm) positive displacement pump 495 scfm @ 15 psi 60 HP, 3" dia 2950 RPM approx. 10' x 10' spacing			$ 89,770 Debris removal $ 163,368 Soil removal (1st closure attempt) $ 5,033 Project oversight-soil removal $ 66,000 Design $ 850,000 Construction (estimated)
17 sparge wells - 2" dia pipe 2 return well - 2" dia wells spaced @ 9'x10' interval blower: 150 scfm			$ 66,561 Design $ 45,186 Design rvw-GAC filter $ 40,073 Construction monitoring $ 565,451 Construction $ 153,828 GW monitoring (1yr)
Air flow rate: 7 cfm per well Operating pressure: 11.4 psi Depth of sparging wells: 15' Radius of influence: 15'		Treatment of vapors: SVE - thermal oxidation	$ 194,000: Total capital costs for Air Sparging, free prod. recovery, and SVE Anticipated cleanup time for air sparging: 1.5 yrs.

4.34 Air Sparging

Site Name/ Contact	Technology/ Vendor	Media Treated	Contaminants Treated	Matrix Characteristics
PNUM C9125 SARDET Holland Holland, MI Jan. 1991 - Feb. 1992 CEU Cleveland Denise Hancsak (216) 522-3934	**Air Sparging with SVE** The Traverse Group, Inc. 3772 Plaza Dr. Suite 5 Ann Arbor, MI 48108 Ann Markstrom (313) 747-9300	water 70' x 60' are	petroleum HC's diesel fuel/waste fuel BTEX PNA Oil & grease TPH	medium fine sand: 0 - 9' bgs silty layers: > 9' bgs depth to gw: 8' bgs
Fuel Farm PNUM M1055 Base Miami Beach Miami, FL July 1992 - Sept. 1995 CEU Miami Zonia Reyes Rob Kappel (305) 278-6700	**Air Sparging**	soil 1,163 yd^3	Petroleum HC's Gas and Diesel	fine to very fine silty sand K: 6.1 cm/sec permeability: 1.2E-4 - 3.0E-3 cm/sec depth to gw: 3' - 9' bgs pH: 7.5 - 8.1 transmissivity: 3,366 gpd/ft storativity: 0.25
Pilot Study PNUM 09-C0882 Air Station Traverse City Traverse City,MI 1982 CEU Cleveland Frank Blaha (216) 522-3368	**Air Sparging Pilot Program**	soil	petroleum HC's aviation gas	uniform beach sand to gray glacial silty clay K: 0.3 cm/sec

4.34 Air Sparging

Operating Parameters	Materials Handling	Residuals Management	Cost/Comments
wells: 2 observation 1 monitoring 5 sparging ave. sparge pressure: 84" H_2O initial DO: 0.8 ppm ave. DO: 3.4 ppm bi-weekly monitoring of: BTEX PNA organic volatiles O_2		off gas treatment GAC drums	$10,180 site assessment $36,030 remed. design, Constr,. and sampling $75/yd soil disposal
wells: 5 air sparging wells air flow rate: 7 cfm injection depth: 20'	in-situ in conjunction with pump and treat syst.		See pump and treat for total project cost.
well dia.: 2" well spacing: 30' intervals flow rate: 100 ft^3/min pressure: 5 psig blower rate: 10 ft^3/min			$3,600 Estimated cost

4.37 Free Product Recovery

Site Name/ Contact	Technology/ Vendor	Media Treated	Contaminants Treated	Matrix Characteristics
Navy NSFO Site RTC Yorktown Yorktown, VA March 1996 RTC Yorktown Lynn Daniels (804) 898-2390	**Free Product Recovery** aided by steam injection (Navy plans)	soil: 200,000 yd^3 water	NSFO TPH in gw NSFO-soil: 0.11 - 8.8 ppm	sand, coarse to fine with some silt K: 0.4 cm/sec permeability: 1.0 E-2 cm/s depth to gw: 13' - 24' bgs gw gradient: 0.03 ft/ft gw velocity: 7.6 E-2 ft/day gw flows southwest to west 0.5' - 9.8' floating hydrocarbon lens
Boiler Plant, UST bldg #15 PNUM Y4043 Baltimore, MD March 26, 1996 CG Yard Howard Galliford (410) 636-7070	**Free Product Recovery** with sorbent pads In-house	water	heavy HC's BTEX: 65 ppb BTEX: 58 ppb BTEX: 11 ppb TPH: 4 ppm NAPL sheen to 1"	depth to groundwater: 14' @ UST 3' @ sump gw flow is southeast
Fuel Farm PNUM - M1055 Base Miami Beach July 1992-Sept. 1995 CEU Miami Zonia Reyes/ Rob Kappel (305) 278-6700	**Free Product Recovery**	water	petroleum HC's gas and diesel	fine-very fine silty sand K: 6.1 cm/sec permeability: 3.8 E-6 - 1E-4 ft/sec depth to gw: 3'-9' bgs (tidal influence) gw flow toward bay pH: 7.5-8.1 Transmissivity: 3366 gpd/ft Aquifer thickness: 15'
Fuel Farm PNUM C3802 Air Station Elizabeth City Elizabeth City, NC CEU Cleveland Jim Vardy (919) 335-6847	**Free Product Recovery** Engineering-Science,Inc One Harrison Park 401 Harrison Oaks Blvd., Suite 305 Cary, NC 27513 (919) 677-0080 Donald Boyle	water: 3.2 acres (area)	Petroleum HC's Fuel (POL), JP-5 TPH, BTEX, VOAs, SVOAs TPH: 51-6490 mg/kg VOA: >10 ppm SVOA: >40 ppm free product levels: est. several thousand gal.	clay, silty loam 0 - 5' bgs silty fine sand 5' - 67' bgs grain size: 0.074-2.0mm K_{avg}: 0.4 cm/sec moisture content: .16-.25 permeability: .25 horiz. perm. 4.5 E-10 depth to gw: 8'-9' bgs gw gradient 0.001-0.005 ft/ft pH 4.6-7.0 temp 10.9-16.6 °C

4.37 Free Product Recovery

Operating Parameters	Materials Handling	Residuals Management	Cost/Comments
above ground oil/water separators - planned by Navy. disposal of product- recycling planned disposal method of water - on site UV/Oxidation (Navy)			The RTC Site is a small part of a large Navy spill, remediation of RTC's segment will depend on what the Navy does.
free product removal with sorbent pads in-house monitored	in-house	disposed as used oil.	
free product recovery in conjunction with pump and treat system oil/water separator is connected to a sump tank.			See pump and treat for total project costs.
in well skimmers recovery well every 100' pipe gravity flow to sumps drain pipes at water/product interface rad. of infl.: 25'-30' product recovery: 60 gal/day			$350,000 construction $ 30,000 maint. & monitoring $500,000 demolition & removal of fuel farm

4.37 Free Product Recovery

Site Name/ Contact	Technology/ Vendor	Media Treated	Contaminants Treated	Matrix Characteristics
PNUM C0805 Sta. Little Creek, Norfolk, VA 1992 Cleveland CEU Denise Hancsak (216) 522-3934 x.267	**Free Product Recovery** EA Engineering, Science and Technology 15 Loveton Circle Sparks, MD 21152 (410) 771-4950	water	petroleum HC's BTEX	K: 0.7-3.1 cm/sec porosity: 0.25 depth to gw: 8'-10' bgs gw fluctuations: 0.3'-1.3' gw velocity: 0.02-0.07 ft/day gw gradient: 0.0012 ft/ft transmissivity: 800-3700 gpd/ft perched groundwater: 5' - 8' bgs aquifer thickness: 33'

4.37 Free Product Recovery

Operating Parameters	Materials Handling	Residuals Management	Cost/Comments
in line filter remove 8-10 micron particle at efficiency of 97-98% 1 soil sample annually for BTEX and TPH 1 gw sample quarterly for BTEX and TPH			

4.44 Air Stripping

Site Name/ Contact	Technology/ Vendor	Media Treated	Contaminants Treated	Matrix Characteristics
Fuel Farm PNUM - M1055 Base Miami Beach Miami, FL July 1992- Sept. 1995 CEU Miami Zonia Reyes/ Rob Kappel (305) 278-6700	**Air Stripping**	groundwater soil: 1,163 yd^3	petroleum HC's gas and diesel	fine,very fine silty sand K: 6 cm/sec permeability: 3.8 E-6 - 1.0 E-4 ft/sec depth to gw: 3'-9' bgs (tidal influence) gw flows toward bay pH: 7.5-8.1 transmissivity: 3,366 gpd/ft Aq. thickness: 15'
PNUM P1813 Air Station Brooklyn Brooklyn, NY 1987-1994 CEU Providence Rachel Marino (401) 736-1746	**Air Stripping** Tyree Brothers Environmental	groundwater	petroleum HC's aviation Fuel VOCs	K: 1.3 E-4 - 4.3E-4 cm/sec porosity: 0.35 - 0.36 depth to gw: 7' - 11' bgs gw flow rate: 36 ft/year product thickness: 0-3.47'
PNUM P1813 Air Station Brooklyn Brooklyn, NY 1991-1992 CEU Providence Rachel Marino (401) 736-1746	**Air Stripping** H&GCL, Inc. 300 Metro Center Blvd. Warwick, RI	Groundwater	Petroleum HC's JP-4 TPH: 0.28-1.26 mg/l Benzene: 5-260 ug/l Toluene: 5-12 ug/l Ethylbenzene: 5-140 ug/l Xylene: 5-520 ug/l	depth to gw: 6.7'-12.0' bgs tidal fluctuation: 0.4' product thickness: 3.23'
PNUM C0860 Base Milwaukee Milwaukee, WI Feb. 1996 CEU Cleveland Denise Hancsak (216) 522-3934 (ext.267)	**Air Stripping**	air from soil vapor extraction operation	petroleum HC's gasoline/diesel Soil: DRO Water: BTEX ethylbenzene DRO	clay to silty clay 1'-7' bgs silty sand >7' K: 6.9xE-4 cm/sec depth to gw: 5'-10' bgs

4.44 Air Stripping

Operating Parameters	Materials Handling	Residuals Management	Cost/Comments
air stripper: temp.: 70° F air flow: 600 cfm water flow: 12 gpm	in situ - in conjunction with pump and treat system.		see pump and treat for total project costs, pg 3-61.
in situ capacity of airstripper: 30 gpm pump rate: 2.75 hp	free product recovery using petropurge pump water pumped using a submersible hydropurge pump	product recovery tanks no off gas treatment	$3,350/month O&M
air stripper influent: 13-33 gpm radius of influence: 30'-60'	recovery: 100,000 gal. of JP-4	off gas treated with carbon.	
air stripper: max flow rate: 10 gpm	in situ		

4.47 (Liquid) and 4.55 (Vapor) Phase Carbon Adsorption

Site Name/ Contact	Technology/ Vendor	Media Treated	Contaminants Treated	Matrix Characteristics
Taxiway C spill PNUM O1499 Air Station San Francisco San Francisco, CA January 1995 CEU Oakland Joseph Sabel (510) 535-7239	**Liquid Phase Carbon Adsorption** WCC Oakland, CA Carrie Austin (510) 893-3600	groundwater	petroleum HC's gasoline/jet fuel Soil Contamination: TPH: 1100 mg/kg Toluene: 360 ug/kg Ethylbenzene: 5.7 ug/kg Xylene: 6100 ug/kg groundwater: jet fuel 23,000 ug/l	stiff clay and sand depth to gw: sea level near shore inland up to 5ft bgs
Fuel Farm PNUM - M1055 Base Miami Beach Miami, FL July 1992- Sept. 1995 CEU Miami Zonia Reyes/ Rob Kappel (305) 278-6700	**Carbon Adsorption**	groundwater	petroleum HC's gas and diesel	fine,very fine silty sand K: 6 cm/sec permeability: 3.8 E-6 - 1.0 E-4 ft/sec depth to gw: 3'-9' bgs (tidal influence) gw flows toward bay pH: 7.5-8.1 transmissivity: 3,366 gpd/ft Aq. thickness: 15'

4.47 (Liquid) and 4.55 (Vapor) Phase Carbon Adsorption

Operating Parameters	Materials Handling	Residuals Management	Cost/Comments
avg.groundwater pumping: 3600 gal/d air supply: 8-10 psig; collection/interceptor trench: thickness: 9' trench bottom 3ft below water table. transfer pump flow: 10 gpm 2-1000lb carbon vessels	replacement carbon vessels annually breakthru monitoring: every 2wks for 3 mo. monthly thereafter analyze TPH, VOA	GAC treated water discharged to industrial waste line.	$101,369: total cost $2.25/lb carbon replacement work scheduled to be completed 9/30/96.
Loading rate for GAC: 1.89 gpm/ft^2 used in conjunction with pump and treat system	6 GAC canisters: 200 lbs each used in conjunction with pump and treat system	Treated groundwater will be discharged to stormwater system. NPDES permit required.	See pump and treat for total project costs.

Asphalt Cap

Site Name/ Contact	Technology/ Vendor	Media Treated	Contaminants Treated	Matrix Characteristics
Barrel Storage 1 Site 7A PNUM F4021 ISC Kodiak Kodiak, AK July 1996 FDCC PAC Mike Bowlus (206) 220-7370	Asphalt Cap	Soil 27,000 ft^2	JP-5, FS-6, TCE, 1-1-1 TCE carbon tet methylene chloride paint wastes, PCE. TPH: 43-91,000 ppm Lead: 7.2-93.5 ppm 1,2-DCE: 10,000 ppb TCE: 12-1,600 ppb	fibrous peat 0 - 1' bgs poorly sorted gravel 1' - 8' bgs gravelly clay >8' bgs K: 3.5 E-6 - 3.5 E-4 cm/sec depth to gw: 5' - 14.5' bgs pH: 5.9 - 9.1 temp: 1 - 15.3° C yearly O_2: 1.2 - 5.5 mg/L TOC: 1.0 - 24.6 mg/L iron: 25.9 - 277 mg/L Mg: 0.96 - 10.9 mg/L Conductance: 35 - 210 umhos/cm hardness: 59 - 515 mg/L
Site 6A - MOGAS PNUM F4016 ISC Kodiak, AK Kodiak, AK July 1995 FDCC PAC Mike Bowlus (206) 220-7370	Asphalt Cap	Soil 27,200 ft^2	JP-5, used oil, waste solvents contaminants > background levels TPH: 14,200 ppm PCE: 3,500 ppb	organic soil 0-1' bgs sand, gravelly with silt 1'-17' bgs (.5" - 1.0" dia) fractured bedrock @ 17' - 21' K: 4.2E-4 - 8.7E-3 cm/sec porosity assumed: 0.12 void volume: 48,000cu. ft. gw gradient: .02 - .88 ft/ft
Laundry Loc. A Site 3 PNUM F4020 ISC Kodiak Kodiak, AK July 1996 FDCC PAC Mike Bowlus (206) 220-7370	Asphalt Cap	Soil 5,400 ft^2	PCE: 0.02-1700 ppm TCE: 0.065-0.380 pp 1,2-DCE: 0.190 ppm TPH: 60-260 ppm vinyl chloride: 0.22 ppm chloroethylene: 1.1 ppm	sandy silt, poorly graded gravel 0 - 5' bgs fractured bedrock 5' - 15' bgs K: 0.2 - 3.9 cm/sec void volume: 7,900 ft^3 assumed porosity: 0.12 depth to gw: 2' - 12' bgs perched aquifer TOC: < .21 - 1.1% CEC: 3,930 - 8,750 mg/kg

Asphalt Cap

Operating Parameters	Materials Handling	Residuals Management	Cost/Comments
asphalt cap design: area: 27,800 ft^2 seal coat cover asphalt: 3" base course: 4" subbase: 6" geotexile geomembrane geotexile 11" controlled fill for slope drainage (2%) SVE piping		Perimeter trench drains (6" dia)	SVE, air sparging, and asphalt cap were used on this project. The following costs are total costs for all three technologies: $ 66,000 Design $ 5,033 Project oversight -soil removal $ 89,770 Debris removal $ 163,368 Soil removal (1st closure attempt) $ 850,000 Construction (estimated)
asphalt cap design: seal coat cover asphalt: 3" base course: 4" subbase: 6" geomembrane (60 mil, LDPE) 5" controlled fill for slope drainage (1.5-3.0%) 6" under drain collection pipe		6" under drain collection pipe	Bioventing and asphalt cap were used on this project. The following costs are total costs for both technologies: $ 907,661 well installation @ MOGAS and laundry
asphalt cap design: seal coat cover asphalt: 3" base course: 4" subbase: 6" geomembrane (60 mil LDPE) 11" controlled fill for 3% slope	collection sump is pumped to 1,200 gal. AST	8" under drain collection pipe Collection sump is pumped to 1,200 AST	SVE, air sparging, and asphalt cap were used on this project. The following costs are total costs for all three technologies: $ 66,561 Design $ 45,186 Design rvw-GAC filter $ 565,451 Construction $ 40,073 Const. monitoring $ 153,828 GW monitoring (1yr)

Excavation

Site Name/ Contact	Technology/ Vendor	Media Treated	Contaminants Treated	Matrix Characteristics
Drum & Barrel Disposal Area Site 24 PNUM F4046 ISC Kodiak Kodiak, AK July 1996 FDCC PAC Mike Bowlus (206) 220-7370	**Excavation**	soil: 166 yd^3	TPH: 100-100,000 pp cleanup level 200 ppm	clayey and silty gravel depth to gw: 10' - 12' bgs
Quartermaster Gas Station Site 14 PNUM F4036 ISC Kodiak Kodiak, AK July 1996 FDCC PAC Mike Bowlus (206) 220-7370	**Excavation**	soil: 460 yd^3	2,250 gal. of product	gravel fill 0 - 4' bgs coarse sand/gravel 4'-19' bgs depth to gw: 11'-12' bgs 200 ft from river
Projects 4007 & 4008 RTC Yorktown Yorktown, VA March 1996 RTC Yorktown Lynn Daniels (804) 898-2390 Roger West (804) 898-2148	**Excavation**	soil: 5 yd^3	DDT: <1ppm DDE: <10ppm	

Excavation

Operating Parameters	Materials Handling	Residuals Management	Cost/Comments
	1,000 lb of removed vegetation was landfilled soil stockpiled for future remediation by Nyman's Biocell	1,000 lb of removed vegetation was landfilled	$ 25,000 Debris removal $ 24,174 Drum removal $140,164 Soil removal
15 - 5,000 gal UST cleaned, cut, and disposed (56 tons)	soil sampled every 10 - 15 cu yd (truckload) soil piles segregated by contamination levels: > 2,200 ppm TPH < 2,200 ppm TPH < 400 ppm TPH	6,075 gal liquid waste req. hazardous waste disposal 665 gals (10 drums) solid hazardous waste. 50,000 gals water filtered for POTW disposal filtration: 1st thru 10 micron filter 2nd 110 GAC filter 3rd 110 gallon ion exchange unit (metal)	$ 93,333 site investigation $ 6,567 liquids disposal $649,317 construction $ 43,873 gw monitoring
	3 - 55 gal drums to DRMO 14000 lb contaminated soil		$55,000 total cost

Excavation

Site Name/ Contact	Technology/ Vendor	Media Treated	Contaminants Treated	Matrix Characteristics
UST Removal PNUM X0819 Sta. Chincoteague Chincoteague, VA FDCC LANT Jim Lewis (804) 858-6230	**Excavation** Recycling Alternatives - Chance Constr. Co.	soil: 26 yd^3	diesel #2 heating oil: 32 - 800 ppm	sediment sandy silt
PNUM X3400 Sta. Clearwater Clearwater, FL FDCC LANT Jim Lewis (804) 858-6230	**Excavation**	soil: 1,580 tons	gasoline BTEX: 40 ppm	sand
Boiler Plant, UST Bldg #15 PNUM Y4043 Baltimore, MD March 1996 CG Yard Howard Galliford (410) 636-7070 Fax: (410) 636-7692	**Excavation** (partial)	soil	heavy HC's TPH: 3,900 ppm	sand, silt, clay and backfill Depth to gw: 14' @ UST 3' @ sump
15 Mohegan Ave. PNUM 7057B Contract No.: DTCG39-91-B USCG Academy Groton, CT USCG Academy LTJG Tim Opstrup (860) 444-8233 Fax: (860) 444-8219	**Excavation** Pollution Solutions of Vermont, Inc.	soil: 90 tons gw: potentially	waste oil solvents BTEX: 16-200 ppm tetrachloroethylene: 113 ppm 111-trichloroethylene: 67 ppm	coarse sand and gravel fractured bedrock groundwater flows east
PNUM M1583 Sta. Venice Venice, FL 1994 CEU Miami Zonia Reyes (305) 278-6700	**Excavation and Disposal** Vaughn Companies (504) 436-0808 Mr. Vaughn Rubark Env. Services (504) 944-9965	soil water	petroleum HC's diesel fuel	medium to fine sand

Excavation

Operating Parameters	Materials Handling	Residuals Management	Cost/Comments
	recycled/thermal treatment - 560 tons		$80 - $133 /cu yd cost included: excavation treatment backfill
	soil disposed as contaminated fill.	1,000 tons of contaminated soil remained on site.	$75 / ton unit cost
523 tons contaminated soil removed to date			$90/ton disposal and transport
90 tons soil excavated in 1991 add. sampling underway			$1,272/ton unit cost
	cont. soil: placed in drums for haz. waste disposal	monthly monitoring	$ 17,000 CAR $ 70,000 Phase I & II $118,800 CARA

Excavation

Site Name/ Contact	Technology/ Vendor	Media Treated	Contaminants Treated	Matrix Characteristics
UST Leak PNUM - M0190/M1049 Base Mayport Mayport, FL CEU Miami Zonia Reyes (305) 278-6700	Phase I Remediation - **Excavation and Disposal** Phase II remediation planned for 1997 Technology Unknown	soil; 750 ton 540 yd^3 (phase I)	petroleum HC's diesel fuel free product TPH: 1,490 mg/kg	fine-med silty sand K: 0.7 cm/sec porosity: 0.25 depth to gw: 3'-4' bgs (tidal influence: 0.1'-.2' bgs) pH: 6.9-8.7 gw gradient: 0.02 ft/ft pore water vel.: 1.02 ft/day temp.: 25.4-28.4 °C transmissivity: 102.2 ft^2/day

Excavation

Operating Parameters	Materials Handling	Residuals Management	Cost/Comments
	Ex situ		Phase I costs: $23,200 CAR $6,000 CAP

Pump and Treat

Site Name/ Contact	Technology/ Vendor	Media Treated	Contaminant Treated	Matrix Characteristics
Fuel Farm PNUM - M1055 Base Miami Beach Miami, FL July 1992 -Sept. 1995 Miami CEU Zonia Reyes/ Rob Kappel (305) 536-6722	**Pump and Treat** Air Stripper with GAC IRA: Barrington Petroleum Contractors CAR: Gehraghty & Miller RAP: PSI: Remediation: TBD	groundwater	Petroleum HC's Gas and Diesel	fine, very fine silty sand K: 6 cm/sec permeability: 4.0 E-6 -1.0 E-4 ft/s depth to gw: 3'-9' bgs (tidal influence) gw flow toward bay pH: 7.5 - 8.1 Transmissivity: 3366 gpd/ft Aquifer thickness: 15 ft

Pump and Treat

Operating Parameters	Materials Handling	Residuals Management	Cost/Comments
Recovery wells: screen length: 15' drawdown: 1.5' Q_{air}: 600 cfm Q_{water}: 12 gpm Loading rate for GAC: 1.89 gpm/ft^2	6 GAC canisters of 200 lbs each Oil/water separator is connected to a sump tank in conjunction with soil vapor extraction	Treated groundwater will be discharged to stormwater system. NPDES permit required	$200,000 construction $280,000 O&M 4 yrs. $278,000 CARA $110,000 power $240,000 fuel $ 16,000 IRA $ 75,000 CAR $ 33,250 RAP $ 8,000 CAP