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REMEDIAL ACTION PLAN BUILDING 425 NS MAYPORT FL

7/12/2001

TETRA TECH

Remedial Action Plan
for
Building 425

at

Naval Station Mayport
Mayport, Florida

Southern Division
Naval Facilities Engineering Command
Contract Number N62467-94-D-0888
Contract Task Order 0123

July 2001

Rev. 1
07/12/01

REMEDIAL ACTION PLAN
FOR
BUILDING 425

NAVAL STATION MAYPORT
MAYPORT, FLORIDA

CONPREHENSIVE LONG-TERM
ENVIRONMENTAL ACTION NAVY (CLEAN) CONTRACT

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

Submitted by:
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CONTRACT NUMBER N62467-94-D-0888
CONTRACT TASK ORDER 0123

JULY 2001

PREPARED UNDER THE SUPERVISION OF:

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The professional opinions rendered in this decision document identified as Remedial Action Plan for Building 425, Naval Station Mayport, Mayport, Florida were developed in accordance with commonly accepted procedures consistent with applicable standards of practice. Decision documents were prepared under the supervision of the signing engineer and are based on information obtained from others. If conditions are determined to exist differently than those described in this document, then the undersigned professional engineer should be notified to evaluate the effects of any additional information on the project described in this document.

7/6/01

Gregory S. Root, P.E.
Professional Engineering Number 55842
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ACRONYMS

AFVR	Aggressive Fluid Vapor Recovery
API	American Petroleum Institute
ASME	American Society of Mechanical Engineers
AST	Aboveground Storage Tank
BTEX	Benzene, Toluene, Ethylbenzene, Xylenes
bls	Below Land Surface
BOQ	Bachelor Officer's Quarters
cfm	Cubic feet per minute
CTO	Contract Task Order
DOT	Department of Transportation
DPT	Direct Push Technology
DSCFM	Dry Standard Cubic Feet Per Minute
°F	Degree Fahrenheit
FAC	Florida Administrative Code
FDEP	Florida Department of Environmental Protection
FID	Flame Ionization Detector
FOTW	Federally Owned Treatment Works
ft	feet (foot)
GCTLs	Groundwater Cleanup Target Levels
Hg	Mercury
KAG	Kerosene Analytical Group
lb/hr	Pounds Per Hour
mg	Milligrams
MTBE	Methyl Tertiary Butyl Ether
Navy	United States Navy
NCDENR	North Carolina Department of Environment and Natural Resources
NS	Naval Station
O&M	Operations & Maintenance
OVA	Organic Vapor Analyzer
PID	Photo Ionization Detector
PMR	Phase Mass Removal
ppm	Parts per Million
°R	Degree Rankin

ACRONYMS (CONTINUED)

RAP	Remedial Action Plan
RPM	Remedial Project Manager
SAR	Site Assessment Report
SCTL	Soil Cleanup Target Level
STP	Standard Temperature and Pressure
TPH	Total Petroleum Hydrocarbons
T&D	Transport and Disposal
TtNUS	Tetra Tech NUS, Inc.
USEPA	United States Environmental Protection Agency
VOC	Volatile Organic Compounds

EXECUTIVE SUMMARY

Tetra Tech NUS, Inc. (TtNUS) has completed a Remedial Action Plan (RAP) for Building 425 at Naval Station (NS) Mayport in accordance with the requirements of Chapter 62-770, Florida Administrative Code (FAC). This Plan is being submitted to to the Florida Department of Environmental Protection (FDEP) for approval.

TtNUS performed the following tasks during the preparation of the RAP:

- Reviewed past remedial activities for relevant technologies from sites at NS Mayport.
- Utilized the information provided by the Site Assessment Report (SAR) (TtNUS, 2000), approved by the FDEP on February 22, 2001.
- Evaluated remedial alternatives to remove the free product located in the source area monitoring well and under Building 425.
- Prepared a RAP to remediate the free product and provide remedial equipment specifications.
- Specified a monitoring plan to track the remediation status of the site.
- Specified a system start-up, operations, and maintenance plan to operate the system.

This RAP identified aggressive fluid vapor recovery (AFVR) as the selected remedial alternative to remove the free product from the site. The system was selected based on the success of this technology in removing free product from other sites and bases. It is expected to require approximately three months to remove the free product once the first AFVR event is initiated. During this time, operation and maintenance requirements will include free product thickness measurements to verify that it is operating as expected.

1.0 INTRODUCTION

1.1 PURPOSE AND SCOPE

This RAP was prepared by TtNUS for the United States Navy (Navy), Southern Division Naval Facilities Engineering Command under Contract Task Order 0123, for the Comprehensive Long-term Environmental Action Navy, Contract Number N62467-94-D-0888. The RAP was prepared to recommend removal options for the free product at Building 425 at NS Mayport. The FDEP Facility Identification Number is 16862008.

The SAR conducted for Building 425 was submitted to the FDEP in December 2000. In this document, two separate petroleum impacted areas were identified at Building 425. In an FDEP letter dated February 22, 2001 (Appendix A), Area 1 was issued a no further assessment necessary, and Area 2 required the preparation of a RAP.

The purpose of this RAP is to select a remedial alternative that would serve to remove the free product in accordance with the requirements of Chapter 62-770 of the FAC. As a result of the findings of the SAR and subsequent conversations with the FDEP, this RAP only addresses the removal of free phase hydrocarbons. Fixed-base laboratory confirmation analyses of soils and groundwater yielded no results in excess of FDEP soil and groundwater contamination target levels [Soil Cleanup Target Level (SCTL) and Groundwater Cleanup Target Level (GCTL)] concentrations. This RAP addresses free product for the area of concern by evaluating applicable alternatives that protect human health and the environment, reduce free product (source area), and retard further migration of free product to downgradient areas. The RAP will also provide a conceptual design for the selected remedial alternative that will offer the best assurance of remediating the site in a timely manner.

1.2 SITE DESCRIPTION

NS Mayport is located in eastern Duval County, approximately 16 miles east-northeast of downtown Jacksonville, Florida. NS Mayport is located in Township 1 South, Range 29 East, Section 38, as shown on the Mayport, Florida United States Geological Survey Quadrangle (7.5 Minute Series) presented in Figure 1-1. Building 425 is located within the northeast portion of the base. The building is the Bachelor Officer's Quarters (BOQ) for the base. Figure 1-2 and Figure 1-3 illustrate the site vicinity and site map, respectively.

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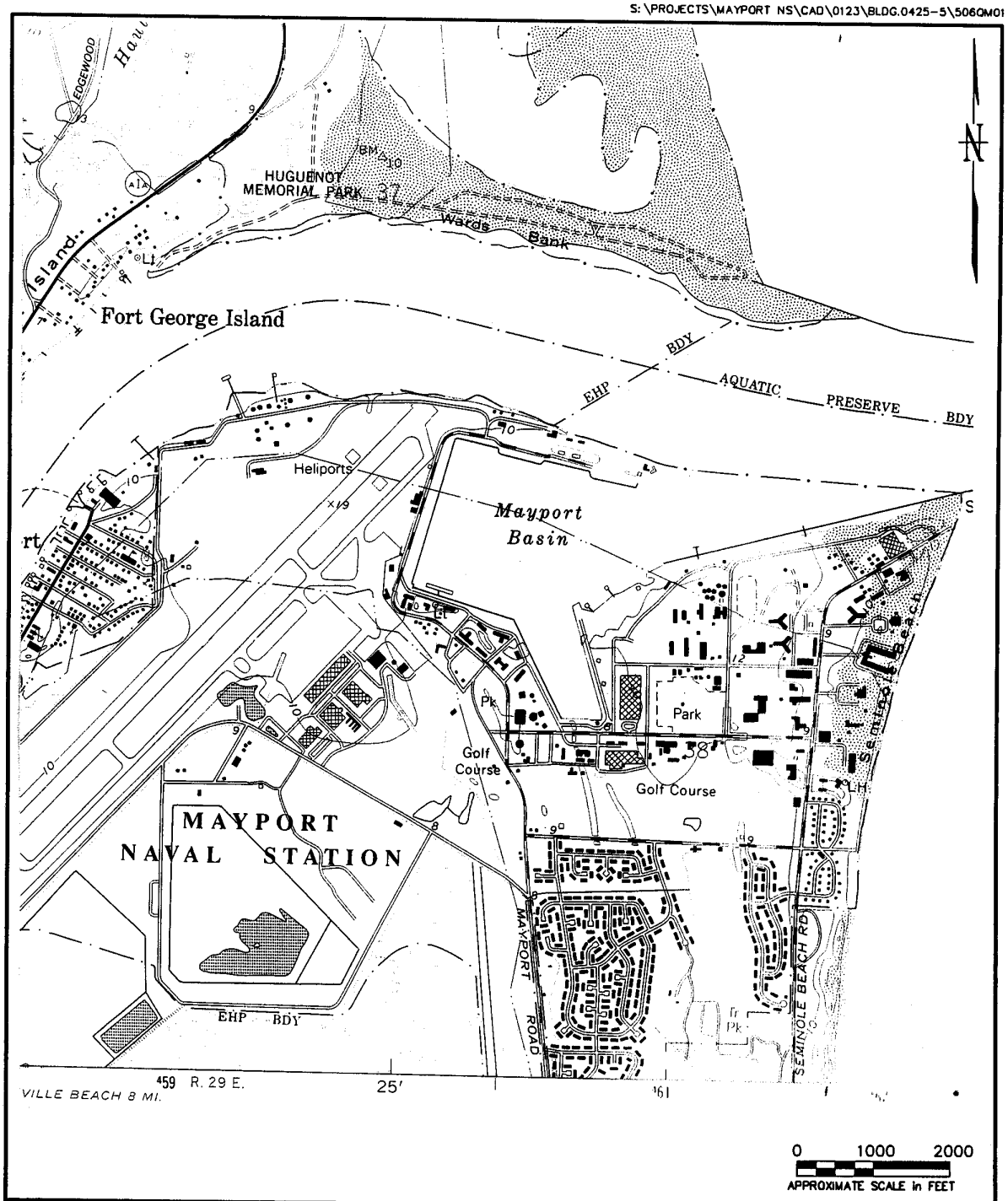

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COST/SCHED-AREA			APPROVED BY DATE
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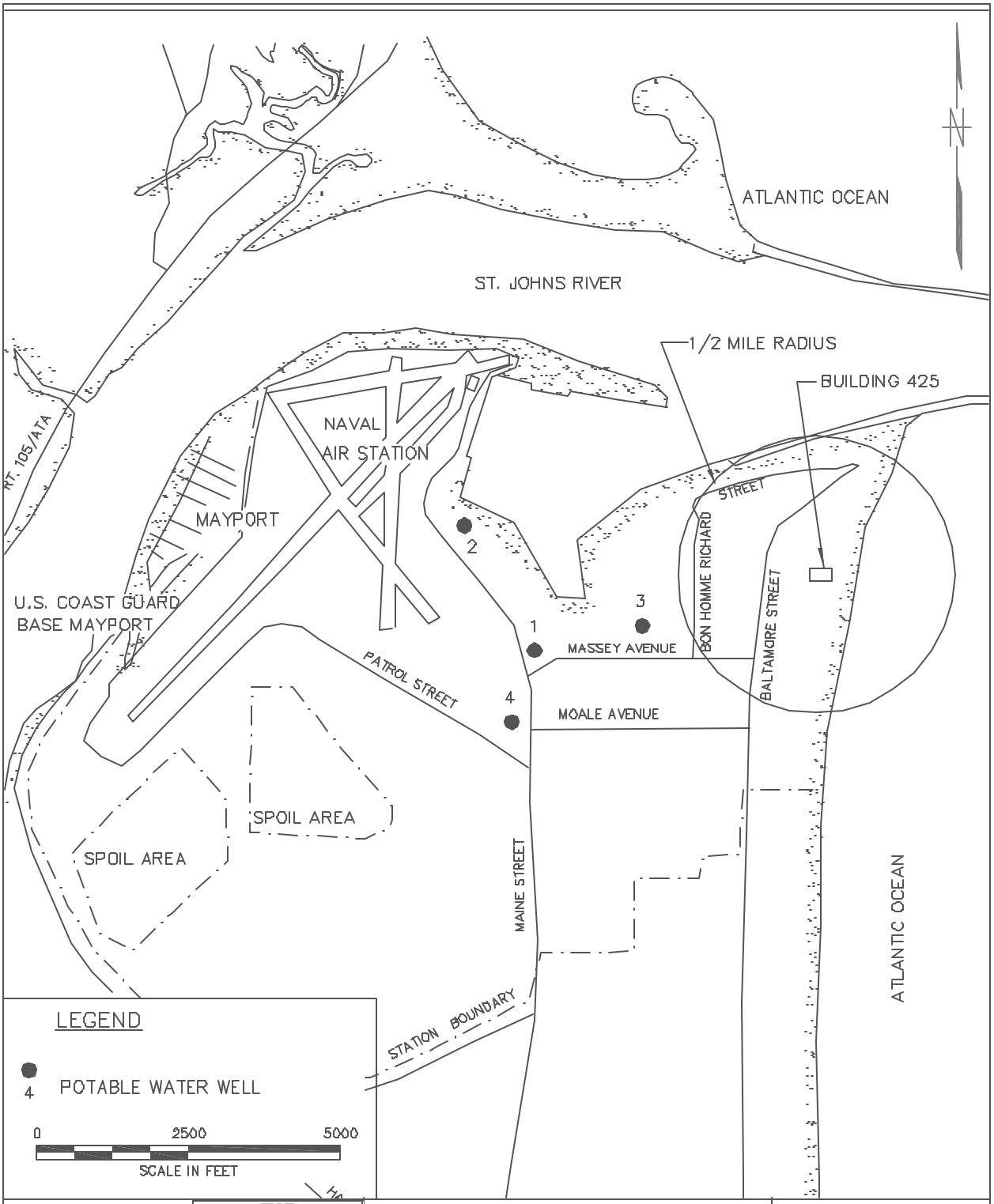
Source: USGS Mayport, Florida 7.5-Minute Topographic Quadrangle, 1964 (Photo-revised 1992)



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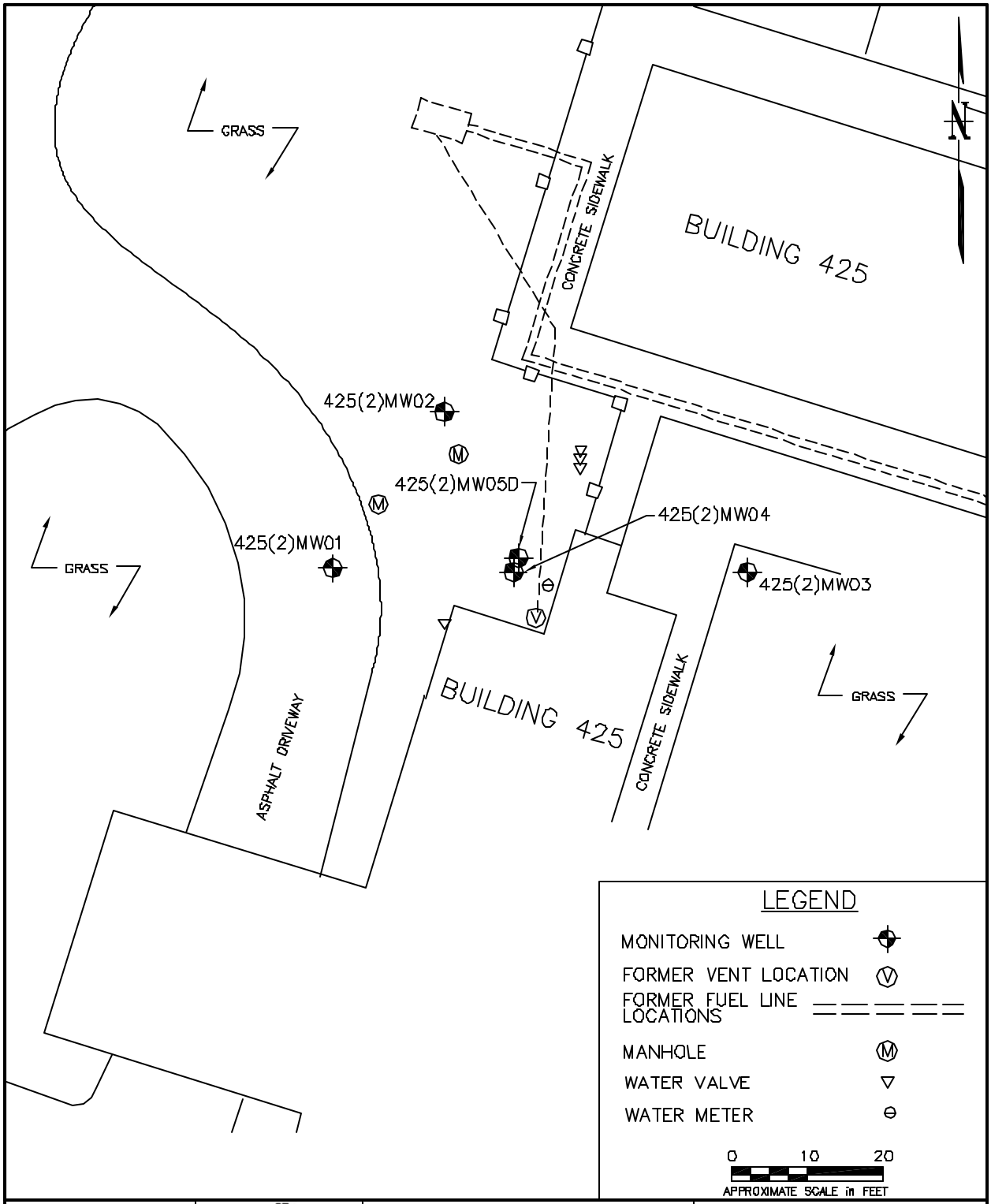

DRAWN BY LLK DATE 5/23/01		AREA 2-SITE MAP BUILDING 425 U.S. NAVAL STATION MAYPORT MAYPORT, FLORIDA	CONTRACT NO. 0506
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SCALE AS NOTED			DRAWING NO. FIGURE 1-3 REV. 0

FORM CADD NO. SDIV_AV.DWG - REV 0 - 1/20/98

1.3 SITE HISTORY

Building 425 is the location of two separate releases involving a single 1000-gallon fuel oil aboveground storage tank (AST). A release of 750 gallons of fuel reportedly occurred in Area 1 when a contractor severed a product line. The Area 2 release reportedly occurred when a faulty float valve in a day tank associated with a boiler, malfunctioned causing the tank to overfill and fuel to travel through the vent pipe which was connected to the 1000-gallon AST. The Area 1 release occurred due north of Building 425 while the Area 2 release was located in a corner on the west side of Building 425. It was estimated that approximately 700 gallons of heating oil was released at Area 2. After the release, approximately 60 cubic yards of hydrocarbon impacted soil was removed during an initial remedial action at Area 2. However, due to the close proximity to the foundation of the building, all impacted soil was not removed.

The SAR, submitted to the FDEP in December 2000, recommended that no further action be granted for Area 1, and recommended that a RAP be prepared for Area 2. A RAP was recommended for Area 2 because of the presence of free phase hydrocarbons (free product). The FDEP letter dated February 22, 2001 (Appendix A), and titled SAR for Building 425, NS Mayport, Florida accepted no further assessment necessary for Area 1 and requested the preparation of a RAP for Area 2. However, the FDEP letter requested the RAP be prepared for the petroleum contaminated soil at Area 2. Due to the discrepancy between the SAR recommendation and the FDEP's request, subsequent conversations were made between the FDEP and TtNUS to determine what the remedial goals of the RAP would be. Since analytical results of soil samples at Area 2 were below SCTLs, it was decided between the FDEP and TtNUS that free product removal would be the only remedial objective in the RAP.

1.4 REPORT ORGANIZATION

This report is organized into nine sections. Below is a list of the sections and a brief description of their purpose:

- Section 1: Introduction. Presents the report's purpose, scope, site information, and report organization.

- Section 2: SAR Findings and Conclusions. Reviews the approved SAR and summarizes the SAR's findings and conclusions.

- Section 3: RAP Goals. Establishes the treatment objectives for the remedial system/plan.

- Section 4: Contaminant Distribution. Estimates the volume of free product at Building 425.

- Section 5: Remedial Alternative Technology Screening. Presents the alternatives for remediation, determines the suitability to the site, and develops budgetary costs for each, and selects preferred alternative.

- Section 6: Remedial System Design. Presents all of the assumptions made and provides the detailed design of the preferred remedial alternative.

- Section 7: Operation & Maintenance (O&M) and Monitoring. Establishes start-up and O&M procedures and provides a monitoring plan for the remediation system as well as sampling frequencies to evaluate the system's effectiveness.

- Section 8: The Responsibility Assignment Matrix. Establishes the potential roles and responsibilities of individuals involved in the remedial action process.

- Section 9: References. Lists all references used.

2.0 SAR FINDINGS AND CONCLUSIONS

A site assessment for Building 425 was conducted between May and December 2000 by TtNUS to determine the extent of soil and groundwater contamination at the site. The site assessment focused on two separate areas at Building 425, Area 1 and Area 2. The findings of the SAR recommended that no further action status be granted for Area 1 and that a RAP be prepared for Area 2. The SAR was submitted to FDEP in December 2000. FDEP granted the no further action status for Area 1 and requested that a RAP be prepared for soil contamination for Area 2. The following is a summary of the findings of the SAR for Area 2 at Building 425 for which this RAP was prepared.

2.1 LITHOLOGIC FINDINGS

The subsurface at Building 425 consists of a medium to fine-grained fill material and sand to 5 feet (ft) below land surface (bls). From 5 to 30 ft, the lithology consists of a naturally occurring medium grained light brown well-sorted sand. No confining layers were encountered to a depth of 30 ft.

2.2 GROUNDWATER AND AQUIFER CHARACTERISTICS

The depth to groundwater across the entire Building 425 study area ranged from approximately 6.45 to 9.05 ft bls. The groundwater flow direction of the groundwater was generally to the north-northwest. Table 2-1 presents the groundwater elevation and monitoring well construction data for Building 425, Area 2. Figure 2-1 presents the groundwater potentiometric surface map. The following aquifer parameters were estimated in the SAR (TtNUS, 2000).

Hydraulic conductivity	K	=	4.34 ft/day
Hydraulic gradient	i	=	0.002 ft/ft
Seepage velocity	Vs	=	0.02 ft/day
Effective porosity	n_e	=	0.30 (unitless)

Table 2-1
Water Table Elevation and Monitoring Well Construction Data

Remedial Action Plan for Building 425
Naval Station Mayport
Mayport, Florida

Well Number	Total Well Depth (feet, bls)	Screened Interval	Top of Riser Elevation (feet msl)	June 2000	
				Depth to Water below Top of Riser (feet)	Water Elevation (feet msl)
Area 2					
425(2)MW01	15.00	5-15	12.57	8.77	3.80
425(2)MW02	15.00	5-15	12.67	8.90	3.77
425(2)MW03	15.00	5-15	12.86	9.05	3.81
425(2)MW04	15.00	5-15	12.57	Free Product	
425(2)MW05D	30.00	25-30	12.69	8.94	3.75

Notes:

Source of Table - Table 3-1 from TtNUS, 2000

bls = below land surface.

msl = mean sea level.

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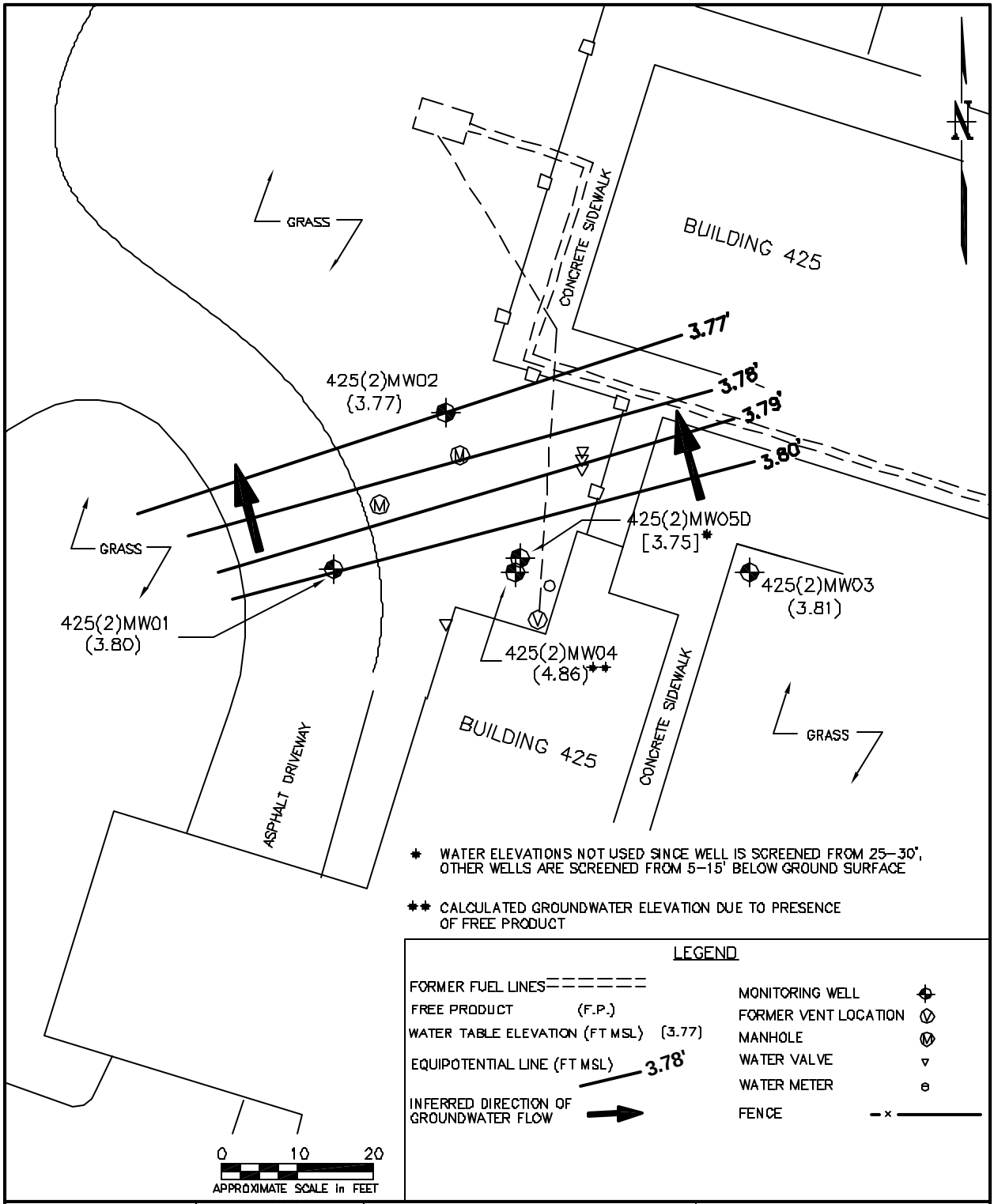

* WATER ELEVATIONS NOT USED SINCE WELL IS SCREENED FROM 25–30', OTHER WELLS ARE SCREENED FROM 5–15' BELOW GROUND SURFACE

** CALCULATED GROUNDWATER ELEVATION DUE TO PRESENCE OF FREE PRODUCT

LEGEND

FORMER FUEL LINES ======
FREE PRODUCT (F.P.)
WATER TABLE ELEVATION (FT MSL) (3.77)
EQUIPOTENTIAL LINE (FT MSL) 3.78'
INFERRED DIRECTION OF GROUNDWATER FLOW

MONITORING WELL
FORMER VENT LOCATION
MANHOLE
WATER VALVE
WATER METER
FENCE

DRAWN BY CW	DATE 8/23/00	AREA 2–GROUNDWATER CONTOUR MAP BUILDING 425 JUNE 13, 2000 U.S. NAVAL STATION MAYPORT MAYPORT, FLORIDA	CONTRACT NO. 0506
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2.3 CONTAMINATED SOIL ASSESSMENT

The vertical and horizontal extent of petroleum impacted soil in the vadose zone was assessed through soil head-space analysis performed during the direct-push field investigation and monitoring well installation described in the SAR (TtNUS, 2000). Soils exhibiting an organic vapor analyzer (OVA) response of greater than 50 parts per million (ppm) were considered "excessively contaminated" as defined by Chapter 62-770.200, FAC. Readings above 50 ppm were detected in three borings at Building 425, Area 2. Soil head-space screening results are presented in Table 2-2 and soil boring locations and head-space readings are depicted on Figure 2-2.

Soil samples from three elevated head-space (low, medium, high) direct-push technology (DPT) borings were collected and sent to a fixed-base laboratory for confirmation. The three soil samples were analyzed for the Kerosene Analytical Group (KAG). Analytical results from the soil samples indicated that no KAG parameters were present above detection limits, including the sample from 425(2)TW04 that had an OVA result of 1000 ppm. A summary of soil sample analytical results is presented in Table 2-3. Since no detections were noted, there does not appear to be a direct correlation of OVA readings to petroleum impacted soil at Building 425.

2.4 CONTAMINATED GROUNDWATER ASSESSMENT

Fourteen groundwater samples were collected from soil borings during the DPT investigation between May 2 and 3, 2000. The samples were analyzed for benzene, toluene, ethylbenzene, xylenes (BTEX); methyl tertiary-butyl ether (MTBE); and naphthalene by a mobile analytical laboratory. Hydrocarbon constituents were detected in nine of the groundwater samples collected from borings at Area 2. BTEX and naphthalene concentrations exceeded target levels in six [425(2)TW01 through 425(2)TW06] of the nine groundwater samples. MTBE was not detected in any groundwater samples collected from Area 2. Temporary well point locations with analytical results for Area 2 can be found on Figure 2-3. A table summarizing analytical results from temporary well point locations for Area 2 can be found on Table 2-4.

Five permanent monitoring wells were installed at Building 425, Area 2 during the site assessment, and on June 13, 2000 groundwater samples were collected from these monitoring wells. The groundwater samples were analyzed for the KAG. One monitoring well at Area 2 [425(2)MW04] was not sampled due to the presence of free phase hydrocarbons (free product). KAG results were not detected above method detection limits in the groundwater samples collected from Area 2. A few parameters

Table 2-2
Soil Head-Space Screening Summary

Remedial Action Plan for Building 425
Naval Station Mayport
Mayport, Florida

AREA 2				
Sample		**OVA Headspace results in ppm**		
Location	**Date**	**Unfiltered**	**Filtered**	**Total**
425(2)TW01	5/3/2000	<1	<1	<1
425(2)TW02	5/3/2000	<1	<1	<1
425(2)TW03	5/3/2000	<1	<1	5.00
425(2)TW04	5/3/2000	1000.00	<1	1000.00
425(2)TW05	5/3/2000	750.00	<1	750.00
425(2)TW06	5/3/2000	<1	0.00	<1
425(2)TW07	5/3/2000	7.00	<1	<1
425(2)TW08	5/3/2000	<1	<1	<1
425(2)TW09	5/3/2000	<1	<1	<1
425(2)TW10	5/3/2000	<1	<1	<1
425(2)TW11	5/3/2000	<1	1.00	<1
425(2)TW12	5/3/2000	<1	<1	<1
425(2)TW13	5/3/2000	55.00	<1	55.00
425(2)TW14	5/3/2000	<1	<1	<1

Notes:
Source: Table 3-2 TtNUS, 2000
ppm = parts per million

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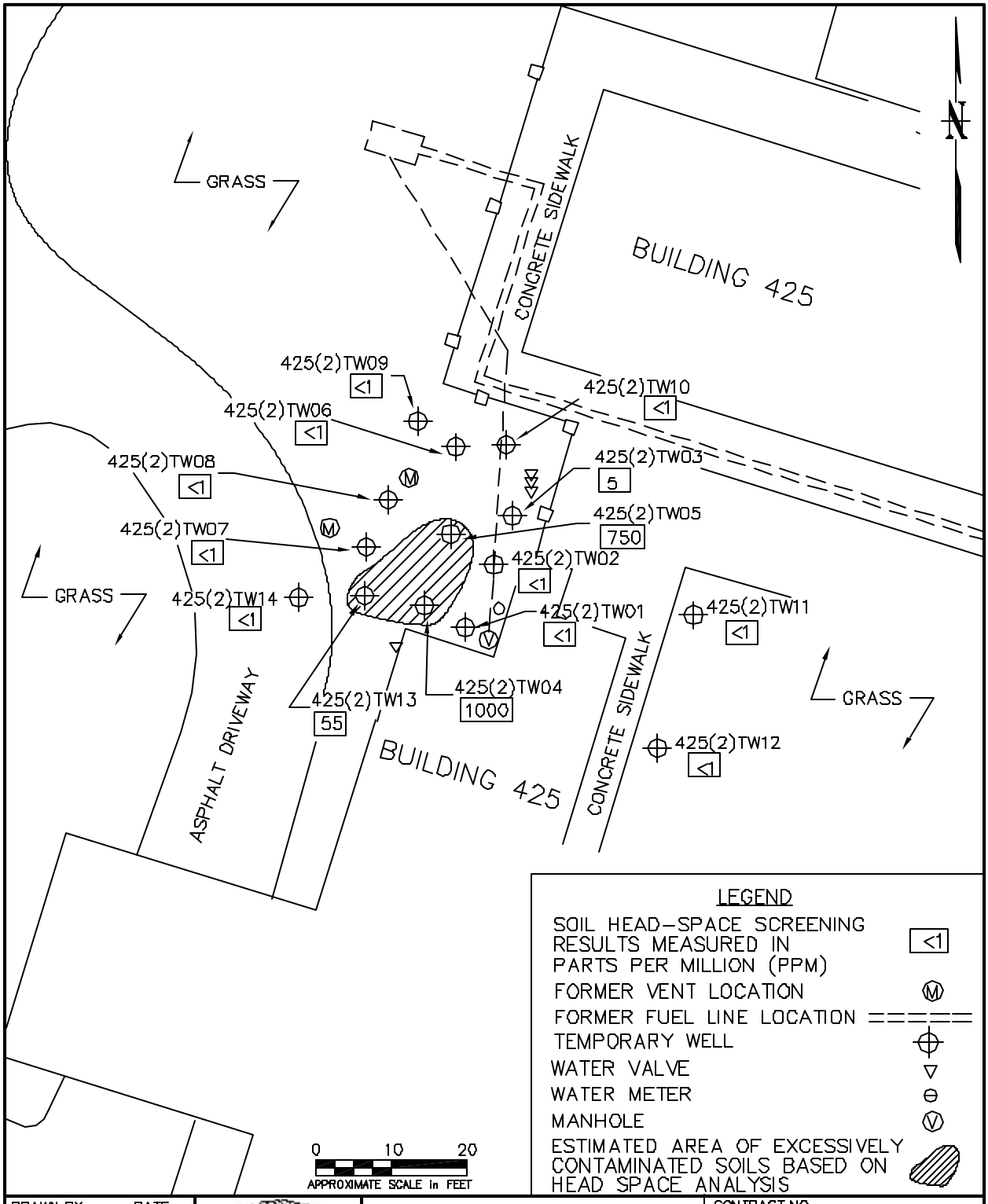

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Table 2-3
Analytical Summary of Soil Samples - Fixed Base Laboratory

Remedial Action Plan for Building 425
Naval Station Mayport
Mayport, Florida

Compound	Residential Direct Exposure SCTLs	Leachability Standards for Groundwater	425(2)-SS-SB02-05	425(2)-SS-SB04-05	425(2)-SS-SB11-05
			5/2/2000	5/2/2000	5/2/2000
Volatile Organic Aromatics USEPA Method 8260B (µg/kg)					
Benzene	1.1	7.0	<1.0	<1.0	<1.0
Toluene	380	500	0.64J	0.65J	1.3J
Ethylbenzene	1100	600	0.46J	<1.0	<1.0
Xylenes (total)	5900	200	1.7J	<1.0	1
Polynuclear Aromatic Hydrocarbons USEPA Method 8310 (µg/kg)					
1-Methylnaphthalene	68,000	2,200	<54	<55	<56
2-Methylnaphthalene	80,000	6,100	<54	<55	<56
OTHER (mg/kg)					
TRPH- FL PRO	340	340	<100	<100	<100
TOC	NA	NA	NS	NS	0
Arsenic	0.8	29.0	0.52	0.61	**1.0**
Cadmium	75.0	8.0	<0.03	<0.03	<0.03
Chromium	210.0*	38.0	1.8	1.6	2.8
Lead	400.0	**	0.85	1.1	1.4

Notes:

Source: Table 3-3 of TtNUS, 2000

* value for hexavalent chromium

** leachibility values only derived on a site specific basis

< = below laboratory detection limit

µg/kg = micrograms per kilogram

mg/kg = milligrams per kilogram

NS = not sampled

J = estimated below practical quantitation limit

SCTLs = Soil Cleanup Target Levels

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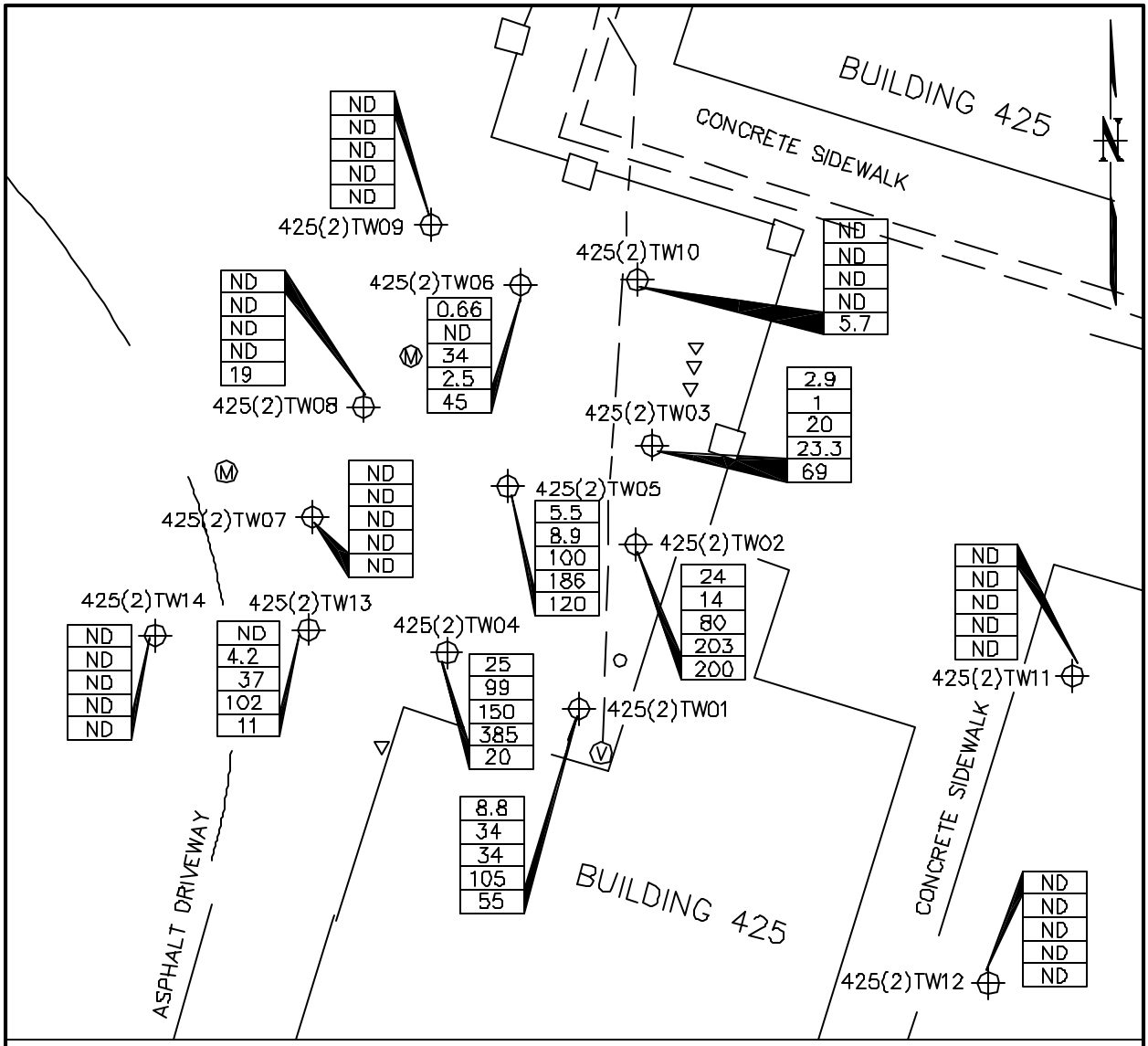

LEGEND

BENZENE	25
TOLUENE	99
ETHYLBENZENE	150
XYLENE	385
NAPHTHALENE	20
NOT DETECTED	ND

CONCENTRATIONS REPORTED IN MICROGRAMS PER LITER (µg/L)

FORMER VENT LOCATION Ⓥ

FORMER FUEL LINE LOCATION ====

TEMPORARY WELL ⊕

WATER VALVE ▽

WATER METER ⊖

MANHOLE Ⓜ

0 5 10

APPROXIMATE SCALE IN FEET

DRAWN BY CW DATE 9/7/00		AREA 2 TEMPORARY WELL LOCATIONS AND MOBILE LABORATORY RESULTS MAY 2, 2000 BUILDING 425 U.S. NAVAL STATION MAYPORT MAYPORT, FLORIDA	CONTRACT NO. 0506
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Table 2-4
Groundwater Analytical Results - Mobile Laboratory for Area 2

Remedial Action Plan for Building 425
Naval Station Mayport
Jacksonville, Florida

Compound	GCTLs[1]	425(2)TW01	425(2)TW02	425(2)TW03	425(2)TW04	425(2)TW05	425(2)TW06	425(2)TW07
		5/3/2000	5/5/2000	5/5/2000	5/5/2000	5/4/2000	5/4/2000	5/3/2000
USEPA Method 8260B (µg/L)								
Benzene	1	**8.8**	**24**	**2.9**	**25**	**5.5**	0.66	ND
Toluene	40	34	14	1	**99**	8.9	ND	ND
Ethylbenzene	30	34	**80**	20	**150**	**100**	**34**	ND
Xylenes (total)	20	**105**	**203**	**25.3**	**385**	**186**	2.5	ND
MTBE	50	ND	ND	ND	ND	ND	ND	ND
Naphthalene	20	**55**	**200**	**69**	**20**	**120**	**45**	ND

Compound	GCTLs[1]	425(2)TW08	425(2)TW09	425(2)TW10	425(2)TW11	425(2)TW12	425(2)TW13	425(2)TW14
		5/5/2000	5/5/2000	5/5/2000	5/4/2000	5/4/2000	5/3/2000	5/3/2000
USEPA Method 8260B (µg/L)								
Benzene	1	ND	ND	ND	ND	ND	ND	ND
Toluene	40	ND	ND	ND	ND	ND	4.2	ND
Ethylbenzene	30	ND	ND	ND	ND	ND	37	ND
Xylenes (total)	20	ND	ND	ND	ND	ND	102	ND
MTBE	50	ND	ND	ND	ND	ND	ND	ND
Naphthalene	20	19	ND	5.7	ND	ND	11	ND

Notes:
Source: Table 3-4 of TtNUS, 2000
[1]Groundwater Clean-up Target Levels [FAC 62-777]
ND = non detect
USEPA = United States Environmental Protection Agency
µg/L = micrograms per liter

not included in the KAG were reported as estimated concentrations below method detection limits. Levels for all detected constituents were below GCTLs. Monitoring well locations with analytical results can be found on Figure 2-4. A summary of the groundwater results is shown on Table 2-5.

2.5 FREE PRODUCT

On June 13, 2000, 2 inches of free product was detected in monitoring well 425(2)MW04. Free product was not encountered in the other wells or temporary well points installed or sampled during the site assessment investigation.

A pre-RAP site visit was conducted on April 4, 2001. On April 4, 2001 a free product water level interface probe was used to detect 5 inches of free product in well MW04.

2.6 SAR CONCLUSIONS

The SAR concluded that the site is underlain by the Surficial aquifer comprised of fill material and sand. No confining layers were encountered within the upper 30 ft of the Surifical aquifer. The Surficial aquifer qualifies as a G-II aquifer. The direction of groundwater flow is to the north-northwest at Area 2. The calculated velocity of the Surficial aquifer is 0.02 ft/day at Area 2.

Free product was detected in source monitoring well 425(2)MW04 during the course of the site assessment. The location of the release and the presence of free product in the well, which is adjacent to the building, suggests that impacted soil and/or free product may be located in close proximity beneath the building.

“Excessively contaminated” soil as defined by soil gas results was detected in three borings at the site during the investigation. Analytical results collected from the same borings with elevated headspace results, however, were below the direct exposure residential cleanup target levels referenced in Chapter 62-777, FAC, Table II.

DPT groundwater investigation results indicated the presence of petroleum hydrocarbon constituents above GCTLs in 6 borings at the site. Dissolved hydrocarbon constituents of the KAG were not detected above GCTLs in groundwater samples collected from Area 2 monitoring wells.

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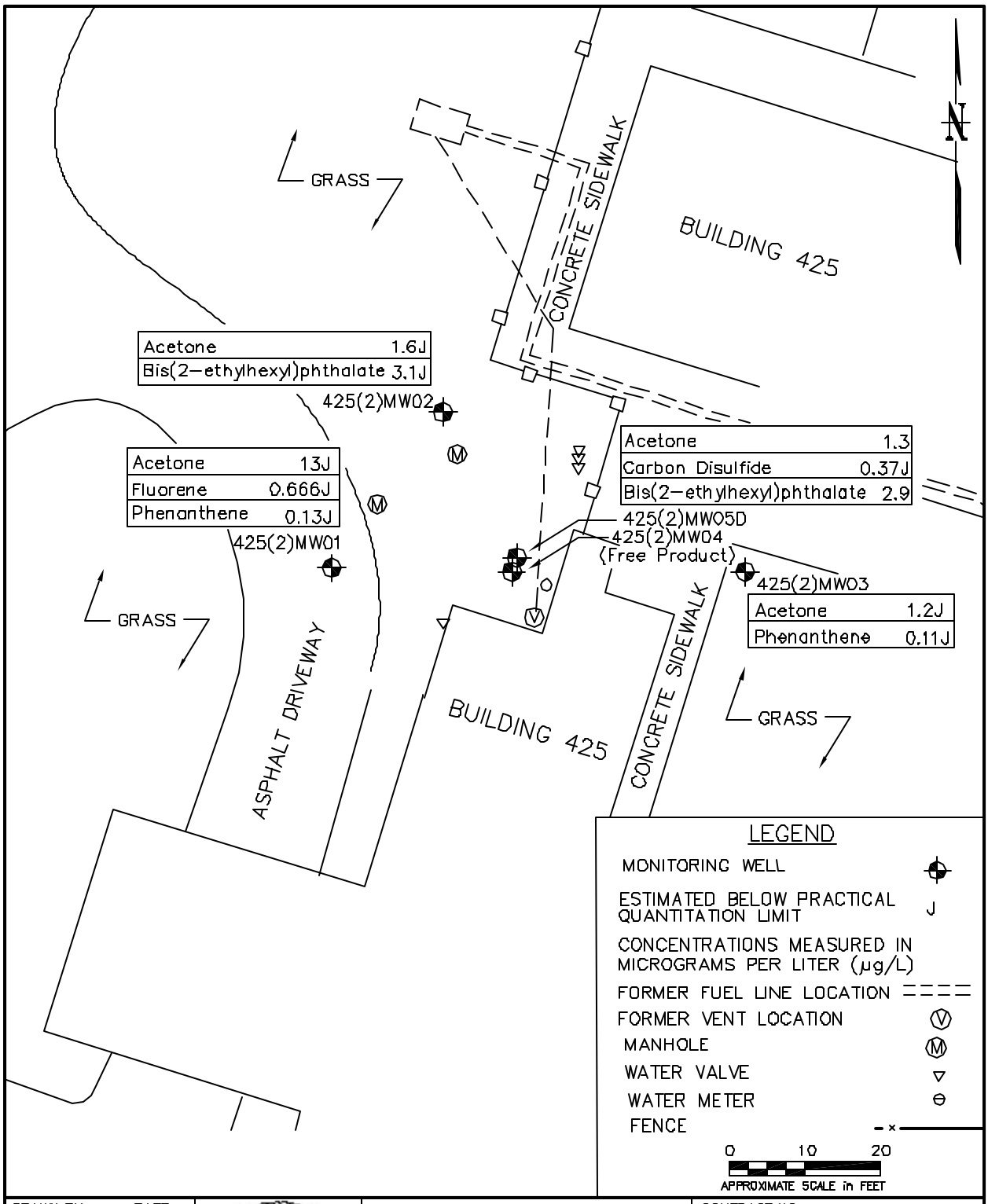

DRAWN BY CW DATE 8/23/00		AREA 2 MONITORING WELL LOCATIONS AND ANALYTICAL RESULTS BUILDING 425 JULY 2000 U.S. NAVAL STATION MAYPORT MAYPORT, FLORIDA	CONTRACT NO. 0506
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Table 2-5
Groundwater Results - Fixed Base Laboratory

Remedial Action Plan for Building 425
Naval Station Mayport
Jacksonville, Florida

Compound	GCTLs	425(2)MW01	425(2)MW02	425(2)MW03	425(2)MW04	425(2)MW05D
		6/13/2000	6/13/2000	6/13/2000	6/13/2000	6/13/2000
Detected Volatile Organic Aromatics (USEPA Method 8260B) (µg/L)						
Acetone	**700**	1.3J	1.6J	1.2J	NS	1.3J
Carbon Disulfide	**63**	<1	<1	<1	NS	0.37J
Semivolatile Organic Compounds (µg/L)						
Bis(2-Ethylhexyl)phthalate	**210**	<10	3.1J	<10	NS	2.9J
Polynuclear Aromatic Hydrocarbons (µg/L)						
Fluorene	**280**	0.666J	<1	<1	NS	<1
Phenanthrene	**20**	0.13J	<1	0.11J	NS	<1
1- Methylnaphthalene	**20**	<1	<1	<1	NS	<1
2- Methylnaphthalene	**20**	<1	<1	<1	NS	<1
Inorganics (µg/L)						
Lead	**15**	<1.7	<1.7	<1.7	<1.7	<1.7
Total Recoverable Petroleum Hydrocarbons (µg/L)						
TRPH - FL Pro	**5000**	<100	<100	<100	NS	<100
Natural Attenuation Parameters (mg/kg)						
Nitrate/Nitrite	NA	NS	NS	1.9	NS	NS
Sulfate	NA	NS	NS	87	NS	NS
Sulfide	NA	NS	NS	<1	NS	NS
Methane	NA	NS	NS	<1	NS	NS

Notes:
Source: Table 3-5 (TtNUS, 2000)
J = Estimated
NS = Not Sampled
µg/L = micrograms per liter
mg/kg = milligrams per kilogram
GCTLs = Groundwater Cleanup Target Levels [FAC 62-777]
NA = Not Applicable

The SAR concluded that based on the results of the investigation, which indicated the presence of free phase hydrocarbons (free product), a RAP be prepared for Area 2 in accordance with Chapter 62-770.700, FAC.

2.7 SAR SUMMARY FOR TRANSITION TO REMEDIAL ACTION

In summary, 700 gallons of heating oil was reportedly released at Building 425 Area 2. The interim remedial action at the site removed approximately 60 cubic yards of hydrocarbon-impacted soil, but all impacted soil was not removed due to the close proximity of the building. The SAR indicated that elevated organic vapor readings from soil were not confirmed by fixed-base laboratory results. Free product was present in one monitoring well [425(2)MW04], and groundwater samples collected from the other permanent monitoring wells did not indicate the presence of dissolved phase petroleum hydrocarbons above GCTLs.

Free product is located adjacent to and possibly under Building 425. The SAR recommended a RAP be prepared to address the free phase hydrocarbons. The recommendations of the SAR were accepted by the FDEP (Appendix A), although the FDEP requested the preparation of a RAP to remediate petroleum-impacted soil. As a result of subsequent conversations with the FDEP, and since the analytical results of soil was below regulatory criteria, it was agreed that only free phase hydrocarbons would be addressed in the RAP.

3.0 RAP GOALS

The objective of this RAP is to present a reliable and cost-effective method to remove free product from the source area. In accordance with the SAR recommendations, and discussions with the FDEP, this RAP only addresses the removal of free product at Building 425, Area 2. This RAP does not address hydrocarbon constituents within the groundwater matrix (dissolved) or soil matrix.

The goals and expected accomplishments of the RAP include:

- Identify a remediation technology to perform free product recovery.

    - Which will result in the reduction of free product while considering the use of Building 425 as the installation's BOQ.

    - Which will not compromise the numerous underground utilities in the surrounding area and the structural stability of Building 425.

3.1 FREE PRODUCT TARGET LEVELS

Chapter 62-770, FAC defines free product as petroleum or petroleum product in excess of 0.01 ft in thickness, measured at its thickest point, floating on surface water or groundwater. As a result of this definition, the remedial action goal for free product removal at Building 425 will be to remove free product in excess of 0.01 ft.

3.2 RESTRICTIVE SITE CHARACTERISTICS

Building 425 is the BOQ for NS Mayport, and several officers quarters are located in close proximity to the source area. Continuous loud and/or obtrusive remedial equipment adjacent to the living quarters of the building inhabitants is undesirable. Additionally, there are numerous utilities located in the northwest corner of the building (source area), and a 13.5-ft eave overhangs Building 425. These restrictions may reduce the remedial options available for Building 425.

4.0 CONTAMINANT DISTRIBUTION

4.1 ESTIMATED AMOUNT OF FREE PRODUCT

Building 425 is the location of a 1,000-gallon fuel oil AST. The release of concern for this RAP (Area 2) occurred as a result of a vent line attached to the northwest corner of Building 425 (Figure 2-4). The failure of a float valve in a day tank associated with a boiler caused heating oil to be pumped through a vent line and discharge along the northwestern corner of the building and adjacent to the building foundation. Approximately 700 gallons of heating oil was released. Information provided in the SAR stated that although 60 cubic yards of soil were removed during the initial remedial action, all impacted soil was not removed due to the close proximity of the foundation of Building 425.

The SAR for Building 425 stated that 2 inches of free product was detected in the source area monitoring well 425(2)MW04 during the course of the assessment. An additional site visit in April 2001 confirmed the presence of free product in this well at a thickness of 5 inches. Additionally, as indicated in the SAR the location of the release and the presence of free product in the well adjacent to the building suggest that the impacted soil and/or free product may be located in close proximity beneath the building (TtNUS, 2000).

Due to the nature of the release the close proximity of the building and the presence of several utilities, wells could not be placed completely around the plume during the site investigation. As a result, assumed lateral limits of the free product plume have been defined as depicted in Figure 4-1. The assumed lateral limits were based on the product release location, the free product located in well 425(2)MW04, and the groundwater flow direction. Based on the assumed lateral limits of the free product plume and specific site characteristics, the total volume of free product is estimated at approximately 37 gallons based on the Hall equation. Free product volume calculations are provided in Appendix B. The equation used to determine the amount of free product is one of several equations provided in “How to Effectively Recover Free Product at Leaking Underground Storage Tank Sites” [United States Environmental Protections Agency (USEPA), 1996].

Calculating the volume of free product in the subsurface is an estimate, and actual product volumes can vary significantly. The contaminant distribution estimate is based on data obtained during the SAR, which did not include soil sampling from beneath the building. Therefore, even though the plume appears to be

limited, since investigative efforts could not be performed underneath the building, actual contaminant quantities are uncertain.

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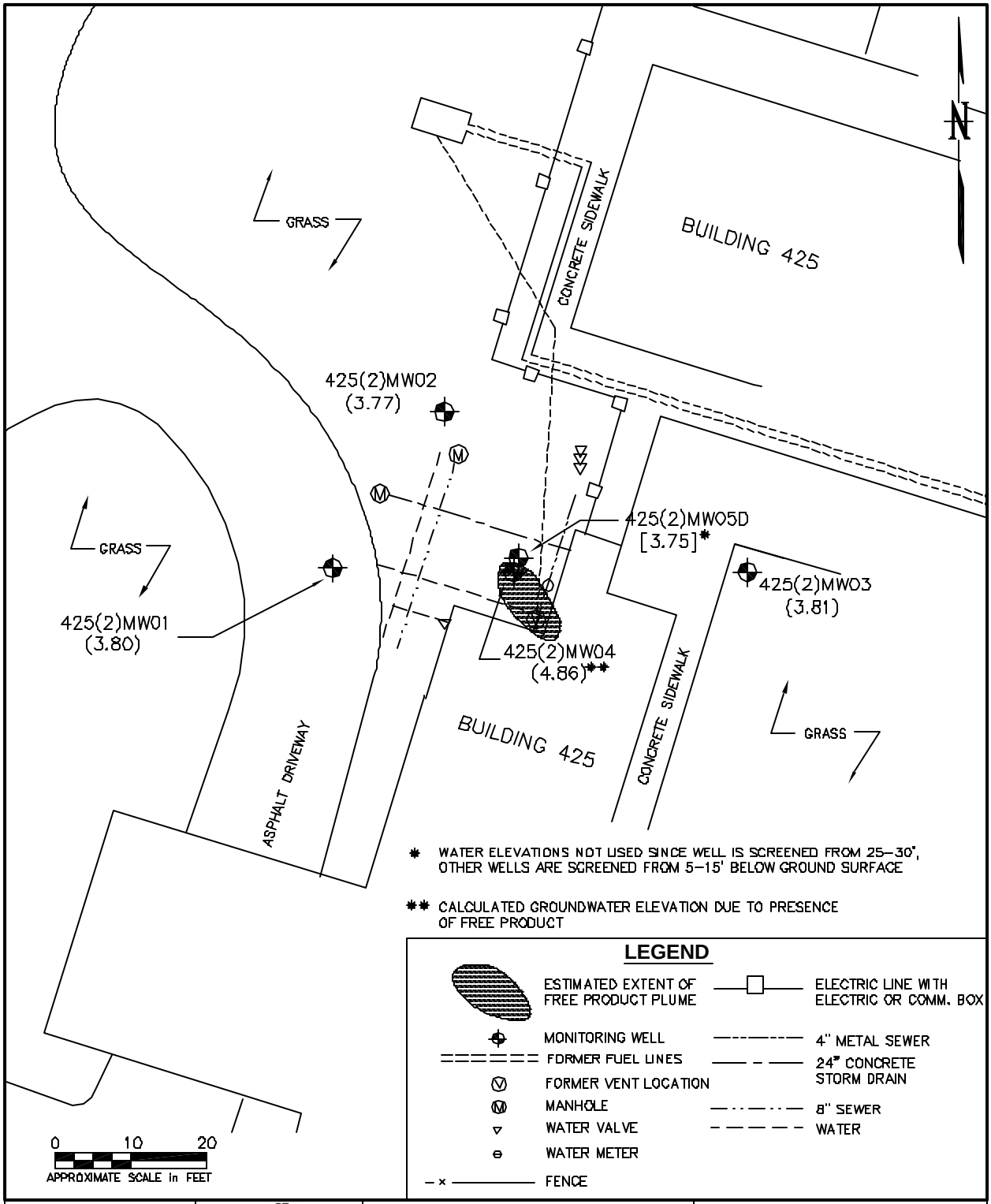

* WATER ELEVATIONS NOT USED SINCE WELL IS SCREENED FROM 25–30', OTHER WELLS ARE SCREENED FROM 5–15' BELOW GROUND SURFACE

** CALCULATED GROUNDWATER ELEVATION DUE TO PRESENCE OF FREE PRODUCT

LEGEND

- ESTIMATED EXTENT OF FREE PRODUCT PLUME
- MONITORING WELL
- FORMER FUEL LINES
- FORMER VENT LOCATION
- MANHOLE
- WATER VALVE
- WATER METER
- FENCE
- ELECTRIC LINE WITH ELECTRIC OR COMM. BOX
- 4" METAL SEWER
- 24" CONCRETE STORM DRAIN
- 8" SEWER
- WATER

DRAWN BY LLK DATE 5/24/01		AREA 2–ESTIMATED EXTENT OF FREE PRODUCT PLUME BUILDING 425 JUNE 13, 2000 U.S. NAVAL STATION MAYPORT MAYPORT, FLORIDA	CONTRACT NO. 0506
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5.0 REMEDIAL ALTERNATIVE TECHNOLOGY SCREENING

TtNUS conducted a screening of available technologies in order to determine the best remedial alternative for the subject site. Potential remedial technologies and process options for the free product removal have been identified and evaluated based on their ability to meet clean-up objectives (effectiveness), applicability based on site conditions, feasibility of implementation, reliability, anticipated duration, and cost. It should be noted that typically a treatability study is performed prior to implementation of a RAP. Although contaminant mass was estimated, since there was no investigation performed under or directly adjacent to the building, contaminant mass estimates are only an approximation based on available data.

The analytical results of the SAR for Building 425 determined that soil and groundwater concentrations were below regulatory criteria. The SAR determined that free product and soil contamination was localized to a small area in the northwest corner of the building and potentially located under the building.

5.1 EVALUATION OF FREE PRODUCT RECOVERY ALTERNATIVES

Based on the SAR data, total volume of approximately 37 gallons of free product is potentially located in the subsurface at Building 425 over an estimated surface area of 96 square ft. It should be noted that this is only an estimate since groundwater and soil was not investigated underneath or directly adjacent to the building. Actual free product concentrations may differ significantly from this estimate. TtNUS has investigated various methods for the removal of free product from the site. The following methods have been identified for removal of free product and will be evaluated in this RAP:

- Free product removal/skimming systems.
- Free product recovery with water table depression.
- Dual-phase recovery.

The following sections briefly discuss each of these free product removal actions with respect to their suitability for implementation at this site.

5.1.1 Free Product Removal/Skimming Systems

Skimming systems are typically used to collect free product with little or no recovery of water. In general this approach involves using skimming devices to remove product floating on the water table (USEPA, 1996).

Free product removal using skimming equipment is applicable in settings where long-term hydraulic control of the dissolved hydrocarbon plume is not required. In most settings skimmer operations will not control the liquid hydrocarbon plume. The most common use of these systems is inclusion in an interim action where free product has entered open excavations. In general, skimming systems are applicable to settings in which the amount of free product is small and exists in permeable conduits such as utility bedding or buried underground structures. The hydraulic conductivity should be greater than 10± centimeters per second to ensure a sufficient influx of free product to the skimmer. Skimmers may also be used in conjunction with other free product removal programs such as in monitoring and extraction wells used for water table depression methods (USEPA, 1996).

For long-term operations, skimmers are placed in wells and gravel-filled trenches with sumps. Recovery may be enhanced by the use of hydrophobic gravel packs in wells. Field studies have shown that gravel packs constructed from hydrophobic materials allow for free product to enter wells and sumps more rapidly. Recovery rates for long-term operations are generally very low.

The selection of skimming equipment is based primarily on the size of the recovery installation (well, trench) and expected rate of recovery of free product. Two types of skimming equipment are available. Mechanical skimming equipment actively extracts free product from recovery initiation, whereas passive skimming equipment accumulates free product over time. Mechanical skimming systems rely on pumps (either surface mounted or within the well) or other motors to actively extract free product from the subsurface. Mechanical skimming systems are more often used where larger volumes of free product are present. Passive skimming systems do not actively pump free product; instead they slowly accumulate it over time. There are two basic forms of passive skimmers, filter canisters, and absorbent socks.

Based on the thin free product layer (less than 5 inches) at Building 425, a passive skimming system would likely be used. It is expected that due to the small quantities of free product measured in well 425(2)MW04 a mechanical skimming system would be inefficient since it would most likely operate for a short period of time before shutting down and then activate again several hours later. This cycle would result in a very small amount of time where the system would actively be removing the free product.

Site conditions at Building 425 restrict the use of skimming systems at the site. The location of utilities in the area would make the installation of a trench more difficult than installing recovery wells. To capture the free product plume, as it migrates away from the building, filter canisters would be placed in well 425(2)MW04, and a new well would be installed adjacent to well 425(2)MW04. It is anticipated that the two wells would capture the free product plume as depicted in Figure 4-1. The filter canisters would be checked, emptied, and adjusted on a weekly basis.

Since groundwater seepage velocity for the site was calculated at 10.56 ft/year, preliminary calculations indicate a free product recovery time of 1 to 2 years. However, this time calculation does not include desorption factors. Experience with passive skimming systems at sites with similar lithology and similar fuel oil contaminants indicate that adsorbed petroleum hydrocarbons within saturated zone soils continually leach into groundwater prolonging remedial time periods. This leaching process cannot be predicted accurately. In addition, since the free product is likely under the building the free product flow may also be retarded. Therefore, the use of the 1 to 2 years for free product recovery is considered to be optimistic. Cost calculations therefore were prepared using a more conservative remedial time period of 5 years for the passive skimming system. An estimated cost for installation of a passive skimming system and 5 years of operation is presented in Table 5-1 and Appendix C, Table C1.

5.1.2 Free Product Recovery With Water Table Depression

This method of recovery creates a depression in the water table so that free product is directed toward pumping wells within the plume area. This system may help remove the free product potentially retained around the building footers. Both free product and groundwater are extracted during recovery operations as the pump removes free product and water from the subsurface. The design of these systems is constrained by the need to minimize drawdown of the water table because minimizing drawdown will reduce both the volume of co-produced water as well as the smearing of free product along the drawdown surface.

Product recovery systems using water table depressions are most applicable when hydraulic control of the hydrocarbon plume is necessary. These systems can operate in a wide range of permeability values and geologic media. Typically, free product recovery with water table depression is used in long-term operations of greater than 1 year (USEPA, 1996). The primary constraints on the design of this system include the need to minimize pumping rates and drawdowns but still provide hydraulic control of the free product.

Table 5-1
Free Product Remedial Alternatives Cost Summary

Remedial Action Plan for Building 425
Mayport Naval Station
Jacksonville, Florida

ALTERNATIVE	CAPITAL COST	ANNUAL O&M	ESTIMATED YEARS OF OPERATION	O&M PRESENT WORTH	TOTAL PRESENT WORTH
Passive Skimming	$688	25147*	5	$103,108	$103,796
Free Product Recovery with Groundwater Depression	$33,721	$25,560	1**	$25,560	$59,281
AFVR	$11,853	$13,940	6 Months	$13,940	$25,793

* Cost includes annual groundwater sampling of five monitoring wells.
** Costs for 1 year of operation, time may vary.
Note: See Appendix C for detailed cost estimates for the free product remediation alternatives.

To accomplish free product removal with groundwater depression a specialized pump would be installed in well 425(2)MW04. No additional wells would be installed. The free product and groundwater would be removed from well 425(2)MW04, where the free product would be stored in drums on site and the groundwater treated and discharged. Free product recovery using groundwater depression can generate large quantities of co-produced groundwater. Two options for the disposal of recovered groundwater include Federally Owned Treatment Works (FOTW) discharge or treatment and recharge to the water-bearing geologic formation. Because of the cost of treating contaminated groundwater, discharging it to the FOTW is preferred (provided the facility will accept discharges). Some pretreatment, such as phase separation, may be required before discharging to the sanitary sewer. Operational time to remediation using groundwater depression was estimated at 1 year. An operational time of 1 year was used for cost purposes only, due to the uncertainties associated with the actual free product concentrations that may be present adjacent to and under the building. Actual removal times may vary significantly. The estimated costs for free product recovery with water table depression for 1 year of operation are presented in Table 5-1 and Appendix C, Table C2.

5.1.3 Dual-Phase Recovery/AFVR

The approach of dual-phase recovery is to extract free product and vapor by vacuum enhanced pumping techniques. Dual-phase systems recovers free product and facilitates vapor-based unsaturated zone clean-up through each well point (USEPA 1996). This approach has several benefits compared to other free product recovery methods. A cone of depression is not formed at the air/oil interface or the air/water interface therefore, smearing of the free product zone is minimized. Vapor-phase hydrocarbons and mobile free product are collected simultaneously.

There are two main conceptual approaches to dual-phase recovery, although they differ only in the vertical positioning of the pump intake. 1) Recovery of free product and water by a single vacuum/liquids pump. 2) Extraction of free product, air, and water with a single pump and a vacuum extraction point set at the air/product interface. This technology is commonly referred to as “bioslurping.”

Dual phase extraction can be applied using either an in-situ system or via specialized mobile vacuum trucks. The use of mobile vacuum trucks is a variation of multi-phase extraction/dual-phase extraction, and also known as AFVR, mobile multi-phase extraction, or mobile dual-phase extraction (MDES). For the RAP this technology will be referred to as AFVR. Permanent dual-phase extraction systems typically involve large capital costs for equipment and installation. Permanent dual-phase recovery systems are also typically used for long-term operations. AFVR allows sites with small amounts of free product to be remediated via dual-phase extraction with low capital cost. AFVR is the proposed dual-phase extraction

technology for Building 425 due to these factors, the site constraints listed in section 3.2 and reduced costs. A mobile vacuum truck equipped for AFVR would eliminate the need for an on-site remedial system. The vacuum pressures provided by the vacuum truck may provide a large radius of influence, thereby effecting the potential product beneath the building footers. Phone conversations were made between TtNUS and an AFVR subcontractor to determine what radius of influence can be obtained with the use of AFVR. An AFVR contractor reported that the radius of influence for sites can range from 20 ft to 200 ft. However, the contractor stated that with the site conditions present a Building 425 the radius of influence would most likely range from 40 to 50 ft from the extraction point.

Dual-phase recovery systems are most applicable in medium to low permeability media or thin (less than 0.5 ft) saturated thicknesses, with water table depths of 5 to 20 ft, settings in which conventional pumping approaches or trenches are inappropriate or ineffective, and free product plumes are located under paved or sealed surfaces (USEPA, 1996).

To accomplish free product removal with AFVR, monitoring well 425(2)MW04 would be used as the extraction well. No addition wells or a trench would be installed. Based upon the use of AFVR at similar sites in Northeast Florida and moderate free product levels, it is estimated that free product recovery may be achieved with three or less AFVR events. The estimated time duration of this remedial technology was estimated at 6 months. An estimated cost of AFVR implementation with 6 months of O&M is presented in Table 5-1 and Appendix C.

5.2 COST COMPARISON AND RATIONALE FOR SELECTION

The goal of the remedial system is to remove free product from the site. The free product plume at the site was estimated at 96 square ft, with a total volume of 37 gallons.

A table comparing the estimated cost of removing free product using each evaluated alternative is provided in Table 5-1. Based on a review of the advantages, disadvantages, costs, and TtNUS project experience at sites with similar conditions, TtNUS recommends the use of AFVR to remediate the free product at this site.

The primary advantage of using passive skimmers is the low capital cost. The disadvantage with passive skimming systems is fuel oil contaminants adsorbed to soils within saturated zone soils continually leach into groundwater, prolonging remedial time periods. This leaching process cannot be accurately predicted and may take several years, and there is no hydraulic containment of the free product.

The primary advantage of free product recovery with water table depression is the shorter time duration compared to passive skimming and enhanced plume containment. Free product can be removed fairly quickly compared to other methods (USEPA, 1996). However, at Building 425, groundwater in surrounding wells is typically below GCTLs and plume containment is not the primary concern. Additionally, the free product is from heating oil, which has a high viscosity, and the free product will take longer to remove than for lighter fuels. This will result in a prolonged remedial time and large quantities of groundwater that requires treatment and disposal. This alternative is eliminated from further consideration due to these concerns, higher costs, and permitting associated with discharging the generated water. This type of system has the potential to generate excess noise and the presence of equipment and separator tanks next to BOQ living quarters would be undesirable.

Past uses of AFVR have provided a high degree of overall protection to human health and the environment by providing quick reductions of free product. AFVR will promote in-situ biodegradation and volatilization of hydrocarbon constituents within the soil matrix. The equipment and controls needed for AFVR are reliable, easily operated, commonly available, and systems typically require low capital and minimal O&M cost. Minimal permitting is required for the implementation and operation of AFVR.

The use of a AFVR is a preferred alternative based on: 1) low capital and O&M costs, 2) low impact on surrounding site conditions, 3) limited operations effecting residents of the BOQ 4) proven effectiveness, and 5) it is expected that AFVR will also provide a shorter duration to achieve cleanup standards and goals compared to the other alternatives. Table 5-2 summarizes the advantages and disadvantages of each remedial alternative.

Table 5-2

Summary of Remedial Alternatives

Alternative	Advantages	Disadvantages
Passive Skimmer System	- Focused on free product - Low capital costs - Small disposal quantities	- Not active - Longer time duration - Intensive O&M
Groundwater Depression	- Controls dissolved plume - Large radius of influence	- High capital costs - Requires continuous water treatment and disposal - On-site system required - Noise and aesthetic impairment for BOQ - Groundwater depressed
AFVR	- Low costs and O&M - Permanent system installation not required - Large radius of influence - Vapor phase and mobile free product removed simultaneously	- Disposal of removed product and groundwater - Multiple events required

6.0 REMEDIAL SYSTEM DESIGN

The preferred remedial alternative presented in this RAP was selected based on low capital and O&M costs, low impact on surrounding site conditions, proven effectiveness, and time to achieve clean-up. The potential remedial technologies and process options for free product removal were identified and screened, and the results were presented in Section 5.0. The selected alternative is dual phase extraction by AFVR.

6.1 AFVR DESIGN SPECIFICATIONS

AFVR is a technology that is used for rapid recovery of free product and is often the most cost-effective approach for product recovery (NCDNR, 1998). AFVR uses a vacuum to recover both fluids (groundwater/free product) and vapor phase hydrocarbons from monitoring/recovery wells. AFVR uses vacuum trucks that will generate high vacuum and airflow rates.

The application of AFVR for the site was chosen based on knowledge of site lithology and soil permeability and based on AFVR applications at other sites with similar soil conditions. Based on discussions with AFVR vendors and the use of this technology at other sites in Northeast Florida, it is expected that three AFVR events will remove free product from the site. AFVR guidance material indicates that each AFVR event should be performed for eight hours, or until the vacuum truck is full. The following subsections provide the specifications and outline the components for the AFVR remedial system.

The vacuum truck selected should meet the following specifications. These specifications are taken from the North Carolina Department of Environment and Natural Resources (NCDENR) guidance, due to the absence of FDEP guidance:

- The vacuum truck tank should have a minimum storage capacity of 2000 gallons.

- The vacuum tank should meet all requirements of Section VII Division 1 of the American Society of Mechanical Engineering (ASME) Boiler and Pressure Vessel Code. Design pressure should be 25 pounds per square inch and registered with the National Board. The tank should be designed and constructed in full compliance with Department of Transportation Specification (DOT) DOT 407/DOT 412.

- The vacuum pump or blower shall be capable of running continuously for 8 to 12 hours without overheating.

- The pump or blower of the vacuum truck shall be capable of operating continuously at vacuum pressures between 24 and 27 inches of mercury (Hg) and the airflow at those vacuum pressures shall be at least 400 cubic feet per minute (cfm) (i.e., 400 cfm @ 24 inches of Hg). "Free Air" specifications shall not be accepted. High vacuum pressures increase recovery of hydrocarbons. High flow rates (cfm) will likely result in quicker recovery of free product and fewer site visits. Request pump curves for the vacuum truck (preferably from the pump manufacturer) to verify capacity.

- According to the American Petroleum Institute's (API) Publication 2219*, Safe Operating Guidelines for Vacuum Trucks in Petroleum Service* (1986), it is stated that "pneumatic-conveyor (blower) equipment operates on a high-airflow principle and is not suitable for hydrocarbon service." It is strongly recommended that the safety guidelines presented in the API Publication 2219 are followed. Examples of some of these safety measures include placing the exhaust stack downwind from the truck as far as practicable and ensuring that the gases do not accumulate in a confined space or in any area that has the potential for auto-ignition. It is also recommended that the exhaust stack be elevated to enhance the dispersion of emissions.

- Each AFVR event shall be conducted for an 8 to 12 hour period or until the vacuum truck tank is full of product and groundwater. The vacuum truck shall be equipped with a 4-inch or 6-inch diameter recovery hose, which is connected to the well containing free product [425(2)MW04]. The monitoring well completion log for well 425(2)MW04 is included as Figure 6-1. Place inside well 425(2)MW04 the 1-inch to 1.5 inch Stinger pipe with the inlet positioned approximately 12 inches below the static water level. The Stinger pipe shall then be sealed to the well head to prevent vacuum loss. A schematic showing the proper placement of the Stinger pipe inside the well is shown as Figure 6-2.

6.1.1 Treatment Recovered Liquids and Vapors

All free product and water recovered from the location shall be stored in the tank of the vacuum truck. After completion of the each event the Subcontractor shall be responsible for disposing of the waste at an appropriate licensed location with prior approval from the Navy.

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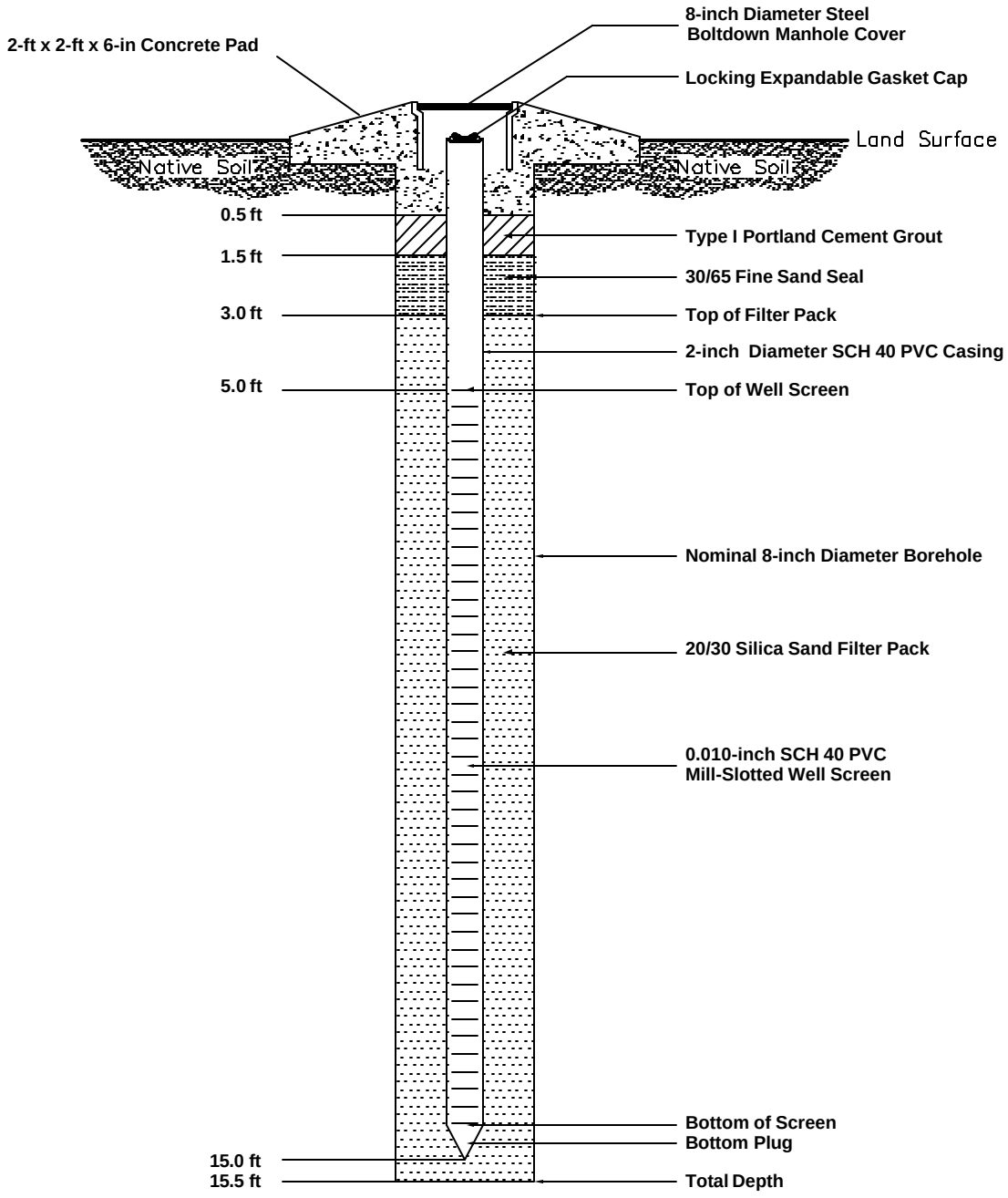

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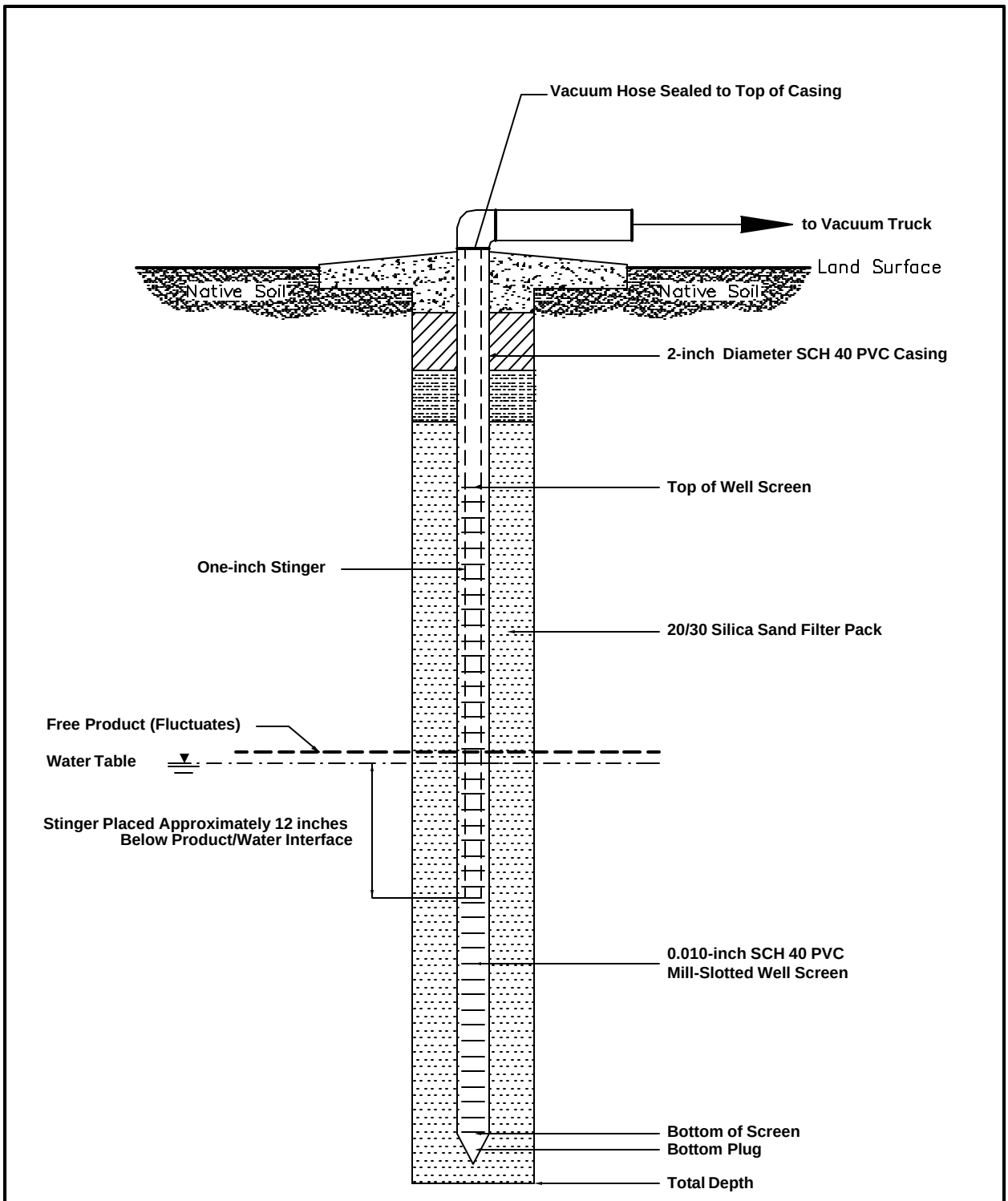

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6.1.2 Limitations

Similar to other vapor extraction technologies, AFVR is most effective when free product plumes are located under paved or sealed surfaces, which reduces the possibility of "short circuiting" the high vacuum pressure. The area where AFVR will be performed is a grassy area and the water table ranges from 7 to 8 feet bls. Typically, a pilot study would be performed to determine if "short-circuiting" is a factor; however, the costs and application of the study would be similar to one AFVR event. Therefore, it is suggested that the first AFVR event conducted at the site be used to determine if "short-circuiting" is a factor. If it is determined during the first AFVR event that "short circuiting" is occurring and is reducing the removal of free product, then modifications or a different technology may be necessary. Options for modifications may include sealing the surface with asphalt or some other covering or installing additional wells, which may be horizontal or vertical.

6.2 AFVR ACTIVITIES

The primary goal of AFVR is to rapidly remove free product from the groundwater and capillary fringe. The amount of free product in the well will be measured before the initial recovery attempt. After the recovery attempt, the amount of free product will be measured. Recovery attempts shall continue if the free product removal is determined to be effective. Based on free product estimates, similar experience in Northeast Florida, and discussions with vendors the number of recovery attempts is estimated at three or less. Free product thickness measurements and vapor measurements shall be obtained during AFVR activities. In general, the following apply.

- Because of high vacuum pressures, an actual increase in product thickness may occur after the first event. This is not unusual since the vacuum forces water, product, and air to the vacuum wells. Each AFVR event shall be performed as long as possible (8 or more hours per event) in order to maximize effectiveness.

- The radius of influence was not assumed for this RAP, and shall be determined by the water levels and vacuum pressures in nearby wells when it measured during the first AFVR event. This information may also be useful for system optimization.

The following text below describes what measurements and actions shall be performed during the AFVR events.

- When the AFVR truck arrive onsite, a safety check of all equipment shall be performed. The vacuum truck tank shall be inspected to verify that the tank is free of any residual petroleum.

- Prior to the AFVR event, free product and groundwater measurements shall be obtained from the proposed vacuum well (MW04) and all other wells at the site.

- Install AFVR to well and begin operation.

- During the AFVR operation the parameters listed below shall be collected at 15-minute intervals for the first 2 hours, and at 30-minute intervals thereafter.

    - Vacuum pressures pre blower or pump and on nearby wells (non-AFVR wells).

    - Water levels and free product measurements at nearby wells (non-AFVR wells).

    - Use an Anemometer or Pitot Tube to collect air velocity rates from the center of the stack or discharge outlet.

    - Temperature from the stack or discharge outlet (dry bulb and wet bulb or dry bulb and relative humidity).

    - Use an OVA-Flame Ionization Detector (FID) to measure the Total Petroleum Hydrocarbons (TPH) concentrations (ppm) from the stack or discharge outlet and provide the inside diameter dimension of the stack. A FID that has a range of 0-10,000 ppm or an FID with a range of 0-100,000 ppm is an approved instrument for determining TPH concentrations. Do not use a Photo Ionization Detector (PID). When recovering high boiling point hydrocarbons (e.g., heating oil), expect low TPH concentrations from the discharge stack of the truck.

- After the completion of the event, free product and groundwater measurements shall be collected from the AFVR well [425(2)MW04] and the volume of free product recovered in the vacuum truck tank shall also be determined.

- Disconnect system and demobilize

- Measure for the presence of free product in all wells two weeks after the AFVR event. If free product is present in wells at the site, schedule another AFVR event. If free product is not present in any well after the two-week measurement, continue to measure for free product every two weeks until two months have past since the day of the AFVR event. If no free product is present at this time post-active remediation monitoring shall be implemented.

- The above measurements (velocity, temperature, TPH concentrations, and diameter of stack) will be used to calculate a mass vapor phase removal rate [pounds per hour (lb/hr)] by using the equations below. From the emission calculations, convert the units from pounds to gallons removed. To arrive at a total gallons removed, add the gallons (from emission calculation) to the total gallons of free product measured in the tank of the vacuum truck. All measurements and calculations for each event shall be incorporated into a "Free Product Recovery Status Letter". The equations necessary for the vapor phase mass removal rates are:

Equation to Determine Flow as Dry Standard Cubic Feet Per Minute (DSCFM):

B_{ws} = (B_{wsw}/18 lb-mole H_2O)/ [1/28.84 lb-mole dry air) + (B_{wsw}/18 lb-mole H_2O)]

Q_{std} = (60 sec/min) (1-B_{ws}) (V) (A) (528 R^o / T_s)

Where:

Q_{std} = flow at DSCFM
B_{wsw} = lb. of water per lb. of dry air (use high temperature psychrometric chart for air-water vapor mixtures in Perry's Chemical Engineers' Handbook)
B_{ws} = water vapor % by volume
V = velocity in ft/sec [obtain with hot wire anemometer or pitot tube (use average value)]
A = cross sectional area of discharge stack in sq. ft. at sampling location
T_s = stack temperature in degrees Rankin (R^o), R^o = degrees Fahrenheit (F^o) + 460 (use average value)

Equations to determine Vapor Phase Mass Removal rate (PMR_h):

$ppm_w = ppm_{measured}$
ppm_d = (ppm_w) / (1-B_{ws})
ppm_c = (ppm_d) (K)
$C_{c:m} = ppm_c$ (M_c/K_3)
$C_c = C_{c:m}$ ($62.43x10^{-9}$ lb-m^3/mg-ft^3)
$PMR_c = C_c$ (Qstd) (60 min/hr)
PMR_h = (PMR_c) (M_h/M_{ch})

Where:
ppm_w = "wet" concentration

$ppm_{measured}$ = obtained directly from OVA (use average value)

ppm_d = "dry" concentration

K = number of carbons in calibration gas (methane K=1, propane K=3, hexane K=6)

$ppm_c = ppm_v$, volumetric concentration of volatile organic compounds (VOC) emissions as carbon, dry basis, at standard temperature and pressure (STP)

$C_{c:m}$ = mg/dsm^3, mass concentration of VOC emissions as carbon

M_c = 12.01 mg/mg-mole, molecular weight of carbon

K_3 = 24.07 $dsm^3/10^6$ mg-mole, mass to volume conversion factor at STP

C_c = lb/dscf, mass concentration of VOC emissions as carbon, dry basis, at STP

PMR_c = lb/hr, pollutant mass removal rate of VOCs as carbon

PMR_h = lg/hr, pollutant mass removal rate of VOCs as heating oil

M_h = mg/mg-mole, molecular weight. of heating oil

M_{ch} = mg/mg-mole, weight of carbon in heating oil molecule

7.0 MONITORING PLAN AND PROJECT CLOSEOUT

The following section establishes procedures for system implementation, routine O&M between AFVR events, and final reporting and monitoring after the completion.

7.1 MONITORING REMEDIATION PROGRESS

The performance-monitoring program will be evaluated after each AFVR event and will be modified as necessary to maximize the effectiveness of the remediation. During AFVR events, three phases of petroleum will be removed: the free product, the dissolved phase contained in the groundwater, and the vapor phase, which is discharged in the exhaust. Evaluating the following data and modifying the process as necessary should enhance the overall effectiveness of the proposed remediation and cleanup progress:

- The mass rate of hydrocarbons removed by the AFVR system in comparison with the estimated mass present. After each AFVR event a brief status letter shall be submitted providing the information stated in Section 6.0 and recommendations. The status letters are discussed in further detail in subsection 7.3.

- The presence of free product in monitoring well 425(2)MW04. The free product will be measured immediately after the AFVR event and again two weeks later. If free product is present at that time the next AFVR event, shall be scheduled. The AFVR events shall be scheduled at an interval to allow for free product monitoring for two weeks and to allow submission of status reports, to determine if an additional AFVR event is necessary.

- The trend of free product thickness as the remediation progresses. If the trend in free product thickness indicates the technology is effective in remediating the area, the additional events shall be performed. If after the first or second AFVR event the AFVR events are determined to be unsuccessful, then the AFVR events shall be discontinued and modification or an alternate approach shall be considered.

This monitoring data will be used to determine if the objectives of the RAP and standards of the design criteria are being met (i.e., free product thickness is less than 0.01 feet). The remediation will be modified

if the monitoring data indicates that the cleanup goals can be met earlier or cannot be met in the time frame as specified in the RAP. Modifications of the remedial action will be based on the site-specific monitoring data.

7.2 REMEDIATION COMPLETION

If the AFVR events are successful in removing the free product from the site, and free product is not present (i.e., free product is less than 0.01 feet) two months after an AFVR event, then the Post-Active Remediation monitoring in 62-770.750, FAC shall be implemented.

7.3 STATUS LETTERS

During the implementation and operation of the remedial system described in this RAP, status letters shall be prepared and submitted to the Navy after each AFVR event. The reports will summarize all remedial activities and shall contain at a minimum the following information:

- AFVR application date.
- Estimated volume of free product recovered.
- Hydrocarbon constituent concentrations in recovered vapors.
- Cumulative mass of hydrocarbon removed by the AFVR system.
- Free product measurements in monitoring well before and after AFVR event.
- Summary of system operational data.
- Conclusions as to the effectiveness of the AFVR event, and recommendations for further monitoring and operation.

8.0 RESPONSIBILITY ASSIGNMENT MATRIX

Table 8-1 presents the Responsibility Assignment Matrix for the remedial actions at Building 425.

Table 8-1

Roles, Responsibilities, and Authorities of Individuals Assigned to the Contract Task Order (CTO)

Remedial Action Plan for Building 425
Naval Station Mayport
Mayport, Florida

Role	Responsibility	Authority
RAC, Project Manager	• Management and technical direction of work • Communication with Southern Division Remedial Project Manager (RPM) and NTR • Overview subcontractor performance • Select CTO staff • Develop CTO Work Plan and supporting plans • Meet CTO performance objectives • Prepare status reports	• Approve subcontractor selection • Approve invoices to Southern Division • Approve CTO baseline schedule • Stop work at the site for any reason • Approve payment to vendors and suppliers • Approve payment to subcontractors
RAC, Site Superintendent	• Responsible for all site activities • Provide direction to subcontractors • Act for Project Manager • Provide status reports • Prepare CTO Work Plan • Conduct safety meetings • Review subcontractor qualifications • Stop work for unsafe conditions or practices	• Stop work for subcontractors • Approve corrective action for site work-arounds • Approve materials and labor costs for site operations • Resolve subcontractor interface issues • Approve daily and weekly status reports

Table 8-1 (Continued)

Role	Responsibility	Authority
Resident Engineer	• Monitor and oversee subcontractor compliance with scope of work • Review requests for changes in scope of work • Review technical qualifications of subcontractors • Prepare Field Change Requests • Respond to Design Change Notices • Recommend improvements in work techniques or metrics • Recommend work-around to Site Superintendent	• Approve Field Change Requests below ceiling amount • Complete daily compliance report
Field Accountant	• Provide project scheduling coordination • Responsible for site cost tracking and reporting • Maintain record of site purchases • Maintain government property records	• Approve payables for disposable items
Transportation and Disposal Coordinator	• Develop site specific procedures for transport and disposal (T&D) practices • Plan and coordinate the transport and disposal of waste • Review subcontractor qualifications • Audit T&D subcontractors compliance with contract requirements	• Approve subcontractors daily report of waste material removed from the site • Approve corrective action plans from T&D subcontractor
Project Assistant	• Maintain CTO files and correspondence • Coordinate CTO schedule and monitor deliverables • Maintain change management records • Maintain Action Tracking System log	• Submit Action Tracking System log • Assign correspondence log numbers
QC Inspector(s)	• Monitor and report on subcontractor quality and quantities • Audit subcontractors offsite fabrication • Maintain Submittal Register • Participate in Continuous Improvement Team • Stop work for non-compliant operations • Maintain Lessons Learned Log	• Stop work for non-compliant operations • File daily quantities report • File Lessons Learned Log Sheet • Approve resumption of work for resolved quality issues
Site Health and Safety Specialist	• Monitor and report on subcontractor safety and health performance • Record and report safety statistics • Conduct needed site safety and health orientation • Maintain Environmental Log • Stop work for unsafe practices or conditions	• Stop work for unsafe practices or conditions • Approve subcontractor site specific health and safety plan • Set weekly safety objectives • Approve resumption of work for resolved safety issues
Subcontract Specialist	• Prepare bid packages • Purchase disposable materials • Maintain subcontract log	

REFERENCES

FDEP (Florida Department of Environmental Protection), 1999. Petroleum Contamination Site Cleanup Site Criteria, Florida Administrative Code, Chapter 62-770. August.

North Carolina Department of Environment and Natural Resources, 1998. *Groundwater Section Guidelines for The Investigation and Remediation of Soil and Groundwater,* Vol. II Petroleum Underground Storage Tanks*,* Appendix A – Remediation Technologies, January 2, 1998.

TtNUS (Tetra Tech NUS, Inc.), 2000. *Site Assessment Report, Mayport Naval Station Jacksonville, Florida*. Prepared for Southern Division, Naval Facilities Engineering Command, South Charleston, South Carolina. December.

USEPA (U.S. Environmental Protection Agency)*, 1996. How To Evaluate Alternative Recover Free Product at Leaking Underground Storage Tank Sites, A Guide For State Regulators*, USEPA 510-R-96-001. September.

APPENDIX A

FDEP LETTER DATED FEBRUARY 22, 2001

Department of Environmental Protection

Jeb Bush
Governor

Twin Towers Building
2600 Blair Stone Road
Tallahassee, Florida 32399-2400

David B. Struhs
Secretary

February 22, 2001

Ms. Beverly Washington
Department of the Navy, Southern Division
Naval Facilities Engineering Command
2155 Eagle Drive, PO Box 190010
North Charleston, SC 29419-9010

file: 425sar1.doc

RE: Site Assessment Report for Building 425, Naval Station, Mayport, Florida

Dear Ms. Washington:

I have reviewed the above document dated December 2000 (received December 14, 2000). The site was divided into two subsites, Area 1 and Area 2. Documentation contained in the report confirmed that no further assessment is necessary for Area 1. Additional documentation contained in the report pertaining to Area 2 confirms that the requirements of Chapter 62-770.600, F.A.C. have been met. Please prepare a Remedial Action Plan for the petroleum-contaminated soil at Area 2.

If you need further clarification or any additional information, please feel free to contact me at 850-921-4230.

Sincerely,

JAMES H. CASON LICENSE No. 00193 PROFESSIONAL GEOLOGIST STATE OF FLORIDA

James H. Cason, P.G.
Remedial Project Manager

Feb. 22, 2001
Date

CC: Randy Bishop, NAVSTA Mayport
Terry Hansen, TetraTech, Tallahassee

TJB JJC for ESN

APPENDIX B
FREE PRODUCT CALCULATIONS

Estimating Thickness of Free Product in the Subsurface

Method of Hall, et al. (1984)

$$H_f = H_o - F$$

H_f = thickness of mobile hydrocarbon in the adjacent formation

H_o = hydrocarbon thickness measured in well

F = formation factor

"This method depends upon a "formation factor" (F), which is apparently empirical, and not related to any other type of formation factor (e.g., those found in petroleum literature) (Ballestero et al., 1994). For fine sand, F is equal to 12.5 cm; for a medium sand F is equal to 7.5 cm; and for a coarse sand, F is equal to 5 cm. The principal weakness of this method is in selecting an appropriate value for F, especially when the soil is either not one of the three types mentioned above or is layered."

Where:

H_o = 5 inches or 12.7 cm

F = 7.5 cm

H_f = 12.7cm - 7.5 cm

H_f = 5.2 cm

5.2 cm*0.0321 feet/cm = 0.17 feet

Estimated Volume of Total Free Product in Subsurface

Estimated area of free product from Figure 4-1 = 96 ft^2

0.171 ft * 96 ft^2 = 16.4 ft^3

16.4 ft^3*.30 effective porosity = 4.91 ft^3
(.30 effective porosity from TtNUS 2000)

4.91 ft^3 * 7.4794 gallons/ft^3 = 36.7 gallons

Total volume of free product in subsurface = **36.7 gallons**

APPENDIX C
REMEDIAL ALTERNATIVE COST ESTIMATES

Table C-1

Free Product by Passive Skimming

INITIAL COSTS	Quantity	Unit	Unit Cost	Total Cost
Free Product Removal/Skimming System				
Skimmer, 1" Diameter, 47" L, 0.10 gal capacity	2	ea	$367	$734
Materiel Storage Building (for storage of drums & equipment)	1	ea	$3,038	$3,038
Labor				
1 Technician	8	hrs	$35	$280
1 Jr. level engineer	8	hrs	$45	$360
Sub-total for skimming system				$4,412
Additional Well Installation				
Mob/demob	1	ea	$500	$500
2" PVC Monitoring well installation	15	ft	$22	$334
IDW (1 drum each for soil cuttings and well development)	2	ea	$150	$300
Well completion	1	ea	$65	$65
Labor				
1 Technician (well installation)	8	hrs	$35	$280
1 Jr. level engineer (well installation)	8	hrs	$45	$360
1 Technician (well development)	8	hrs	$35	$280
sub-total for well installation				$1,339
Sub-total for initial costs				$5,751
Labor OH (30%)				$1,725
Engineering and Design (20%)				$1,150
Total for Initial Costs				**$8,626**
TREATMENT SYSTEM O&M (annual)				
System Maintenance				
Labor:				
Technician, 30 hrs per month	360	hrs	$30	$10,800
Sr. Engineer, 2 hours per month	24	hrs	$90	$2,160
Project Mgr, 2 hrs per month	24	hrs	$100	$2,400
Purchase Drum for product storage	4	ea	$50	$200
Recovered Product Drum Disposal, 1 per year	1	ea	$150	$150
Truck ($50 each trip, 4 trips a month or 48 trips a year)	48	ea	$50	$2,400
Misc. equipment (gloves, tools, etc.0	1	ls	$200	$200
Total Annual O&M				**$18,310**

Groundwater Monitoring	Quantity	Unit	Unit Cost	Total Cost
Assumptions:				
1 event annually to monitor groundwater, due to no plume containment with this alternative				
Use of 5 existing wells onsite				
LABOR: (1 technician, 1 geologist, 2 days)	40	hrs	$75	$3,000
Truck	2	ls	$25	$50
Field:				
Rental of Horiba U-22 meter for conductivity, Oxidation-Reduction Potential, pH, dissolved oxygen, turbidity, and temperature.	2	days	$60	$120
Lab:				
TLC Volatile Organics, Method 8260, assume 5 wells, 1QC	6	ea	$80	$480
PAHs, Method 8310, assume 5 wells, 1 QC	6	ea	$135	$810
Total Analysis:				$1,410
EXPENDABLES AND EQUIPMENT RENTAL:				
Gloves (2 boxes per event)	2	box	$10	$20
Teflon tubing (200 feet per event)	200	ft	$1.45	$290
Silicon tubing (50 feet per event)	50	ft	$1.55	$78
Shipping and supplies (tape, bubble wrap, ice)	1	ls	$250	$250
Pumps for purging wells, 2 pumps, 2 days rental	4	days	$35	$140
First Aid kit	1	ls	$50	$50
Drum for purge water	1	ea	$50	$50
Water level indicator, 2 @ 2 days rental	4	days	$25	$100
Total Expendables and Equipment Rental:				$978
DISPOSAL OF PURGE WATER, assume nonhaz., 1 drums	4	ls	$150	$600
Total cost for groundwater monitoring				**$8,425**
Quarterly Status Reports				
(assume four status reports)				
1 Jr. Level Geologist 16 hrs	64	hrs	$45	$2,880
1 Senior Geologist 4 hrs	16	hrs	$80	$1,280
Technical Expert 2 hrs	8	hrs	$75	$600
CAD Technician	8	hrs	$40	$320
Production:	1	ls	$100	$100
word processing 8 hrs	32	hrs	$35	$1,120
editor 2 hrs	8	hrs	$60	$480
Total				**$6,780**
Total Initial Costs				$8,626
Total annual O&M for one year				$33,515
Present worth of O&M costs for Five years (years = 5, I = 7%, payment = $31,865)				($137,418)
Total costs (indirect costs+present worth costs of 5 years O&M)				**$146,044**

Table C-2

Free Product Recovery by Groundwater Depression

INITIAL COSTS	Quantity	Unit	Unit Cost	Total Cost
Free Product Recovery with Water Table Depression				
Pneumatic Product Recovery Pump	1	ea	$602	$602
80 Gallon Air Compressor	1	ea	$4,942	$4,942
20 gpm Oil/Water Separator	1	ea	$9,199	$9,199
Air Supply and Exhaust Hose	100	ft	$2	$200
Hydrocarbon Discharge Line	100	ft	$2	$200
Electrical site usage	12	mo	$240	$2,880
15 gpm, 1/2 HP, Transfer Pump with motor valves and piping	1	ea	$1,128	$1,128
4,000 Polyethylene Aboveground Holding Tank	1	ea	$1,500	$1,500
Materiel Storage Building (for storage of drums & equipment)	1	ea	$3,038	$3,038
Totalizing flow meter	1	ea	$300	$300
Flow indicator	1	ea	$100	$100
Pressure gauge	1	ea	$100	$100
Sewer connection fee	1	ea	$2,150	$2,150
Piping	200	ft	$2	$400
GAC 15 GPM Liquid Adsorption Drum (Assume two drums)	2	ea	$700	$1,400
Electrical to system	1	ls	$5,000	$5,000
Misc. supplies (fittings, tools, etc.)	1	ls	$500	$500
Truck	5	day	$50	$250
Labor				
1 Technician, 1 week @ 50 hrs/wk	50	hrs	$35	$1,750
1 Jr. level engineer, 1 week @ 50 hrs/wk	50	hrs	$45	$2,250
1 Sr. engineer, 16 hours	16	hrs	$90	$1,440
Sub-total for initial costs				$39,329
Labor OH (30%)				$11,799
Engineering and Design (20%)				$7,866
Total for Initial Costs				**$58,994**
TREATMENT SYSTEM O&M (annual)				
System Maintenance				
Labor:				
Jr. Engineer, 16 hrs per month, system operating data, control	192	hr	$45	$8,640
Sr. Engineer, 2 hours per month	24	hr	$90	$2,160
Technician, 24 hrs per month	288	hr	$30	$8,640
Project Mgr, 2 hrs per month	24	hr	$100	$2,400
Electrician, 16 hours per year	16	hr	$60	$960
Truck ($50 per trip, 4 trips per month or 48 trips a year)	48	ea	$50	$2,400
Analytical analysis of groundwater (assume 1 sample per month)	12	ea	$90	$1,080
Sewer Charge (assume $100 a month)	12	ea	$100	$1,200
Electrical Charge (assume $50 a month)	12	ea	$50	$600
Total Treatment System 0&M				**$28,080**
Annual Status Report				
1 Jr. Level Geologist	64	hrs	$45	$2,880
1 Senior Geologist	16	hrs	$80	$1,280
Technical Expert	8	hrs	$75	$600

CAD Technician	8 hrs	$40	$320
Production:	1 ls	$100	$100
word processing	32 hrs	$35	$1,120
editor	8 hrs	$60	$480
Total			**$6,780**

Initial Costs	$58,994
Annual O&M Costs (Annual report + O&M)	$34,860
Total Costs (Initial Costs + O&M + Annual Report)	**$93,854**

Table C-3

Free Product Recovery by AFVR

DIRECT COSTS	Quantity	Unit	Unit Cost	Total Cost
Free Product Recovery Via Mobile Enhanced Multi-Phase Extraction				
8 hour AFVR event	3	ea	$3,165	$9,495.00
Off-gas Treatment	3	ea	$1,500	$4,500.00
Over Time	3	hrs	$450	$1,350
Oily Water Removal, 3 events @ 2100 gal/event	6300	gal	$0.16	$1,008
Sub-total for initial costs				$16,353
Labor OH (30%)				$4,906
Engineering and Design (20%)				$3,271
Total Direct Costs				**$24,530**
AFVR Costs for Oversight and Free Product Monitoring				
Oversight by Staff Engineer during AFVR event (10 hrs per event)	30	hrs	$45	$1,350
Free Product Monitoring by Technician	36	hrs	$30	$1,080
(Assume 4 hrs once every two weeks for 6 month project duration)				
Rental of free product interface probe	30	day	$25	$750
Truck	30	ea	$50	$1,500
Total				**$4,680**
Status letter Reports				
(assume two reports, one after the first event and one after the second event)				
1 Jr. Level Geologist 16 hrs	32	hrs	$45	$1,440
1 Senior Geologist 4 hrs	8	hrs	$80	$640
Technical Expert 2 hrs	4	hrs	$75	$300
CAD Technician	4	hrs	$40	$160
Production:	1	ls	$100	$100
word processing 8 hrs	16	hrs	$35	$560
editor 2 hrs	4	hrs	$60	$240
Total				**$3,440**
REPORTING, Final Site Activities/System Operation Report:				
1 Jr. Level Geologist	100	hrs	$45	$4,500
1 Senior Geologist	16	hrs	$80	$1,280
Technical Expert	6	hrs	$75	$450
Production:				
word processing	12	hrs	$35	$420
editor	8	hrs	$60	$480
CADD operator,	8	hrs	$40	$320
reproduction: 100 pgs @ 20 copies	2000	pg	$0.10	$200
shipping/binding: 20 reports	20	ea	$20	$400
Total report cost:				**$8,050**
Direct Costs				$29,210
Annual O&M Costs (status letter reports + Final Report)				$11,490
Total Costs (Direct + Indirect costs)				**$40,700**

ECOVAC SERVICES

www.ecovacservices.com

April 18, 2001

Mr. Alan Pate
TetraTech
7018 A.C. Skinner Parkway
Suite 250
Jacksonville, Florida 32256

Subject: Proposal to Provide Enhanced Fluid Recovery (EFR®) Services
Mayport Naval Station
Jacksonville, Florida

Dear Mr. Pate:

EcoVac Services is pleased to team with TetraTech to provide innovative and cost effective environmental solutions to your clients. Attached a brief description of the EFR® technology that the principals of EcoVac Services have conducted in various hydrogeologic regimes throughout the United States and Puerto Rico. This technology is a mobile variation of multi-phase extraction/dual-phase extraction. EFR® is widely recommended by a number of states. The allure of this technology is its effectiveness, cost, regulatory approval, and it allows the departure from continued assessment to remediation with little or no additional study or engineering.

EFR® is a proprietary technology developed by the principals of EcoVac Services that allows the simultaneous removal of multiple phases (i.e. dissolved, vapor, adsorbed, and liquid phases) of volatile organic compounds (VOCs) utilizing high flow rates and vacuum pressures. EcoVac Services is the world leader in mobile dual-phase/multi-phase extraction, having conducted well over 3,500 EFR® events throughout the United States and Puerto Rico. EcoVac Services only provides EFR® services and, hence, is not in competition with environmental consulting firms. Our firm has provided EFR® services to over 150 environmental consulting firms, as well as to several major and independent oil companies.

Our experience with treatment of EFR® offgases dates back over five years, including having complied with the stringent VOC emission requirements in southern California (including the Los Angeles basin). We have achieved an average VOC destruction efficiency of 99.94%, with an average emission of 0.38 pound of VOCs per eight hour EFR® extraction event.

The following summarizes components of the "EcoVac difference" as it pertains to our application of this technology:

- Protection from infringement of seven patents relating to this process, or components of this process (5,050,676; 5,172,764; 5,197,541; 5,358,357; 5,400,858; 5,441,365; 5,452,765). Without documented experience in implementing this technology prior to 1990, or having

secured a licensing agreement, practitioners of this process are potentially in violation of these patents.

- EcoVac Services is the world leader in mobile dual-phase/multi-phase extraction, having conducted well over 3,500 EFR® events throughout the United States and Puerto Rico. Other providers generally have very limited EFR® experience and typically have other limitations, such as the number of wells that they can simultaneously extract from (we can extract from as many as eight wells simultaneously), the depth from which they can extract well fluids (we have performed EFR® at sites where groundwater existed at depths greater than 100 feet), etc.

- EcoVac has extensive experience in dealing with regulatory authorities on the state and federal level, to the extent that we have assisted state agencies in drafting technical guidance documents relative to the implementation of this technology.

EcoVac Services typically collects the following data during the course of EFR®, which is then summarized in tables and a concise letter format report:

- VOC removal rate and total removal (mass and volume)
- Flow rates
- Extraction well vacuum pressures
- Offgas concentrations (influent and effluent)
- Groundwater and free product recoveries
- Groundwater/product levels (before and after EFR®)
- Limited vacuum influence and groundwater level drawdown data

Our lump sum cost per event to perform an eight hour EFR® extraction event at the subject site is $3,165.00 (excluding the use of offgas treatment) if EFR® at this site is conducted during a scheduled mobilization to Florida or south Georgia, subject to those assumptions contained in Attachment A. This cost will increase by $1,030.00 if a special mobilization is required.

Thank you once again for the opportunity to team with TetraTech in serving the environmental needs of your clients.

Sincerely,

EcoVac Services

Nick Athens

ATTACHMENT A
ASSUMPTIONS UTILIZED IN DEVELOPING
ECOVAC SERVICES' LUMP SUM COSTS (4/18/01)
TetraTech
Mayport Naval Station
Jacksonville, Florida

- The cost estimate contains no contingencies for costs or delays that may result from adverse weather conditions (heavy rain, snow, electrical activity, extreme heat or cold, or high winds), client or regulatory delays, or any other conditions beyond the control of EcoVac Services. Cancellation or postponement of the project without five business days notice may incur a cancellation fee.

- Payment terms are net 30 days. The invoice will be submitted in lump sum format (i.e. no time and material back up provided) upon completion of the field work. This quotation is valid for a period of 30 days. Level D personal protective equipment (PPE) will be utilized in the field. TetraTech will be responsible for making the proper state and local notifications, if any, as well as securing any and all necessary regulatory permits. The extraction wells are assumed to be two or four inch schedule 40 PVC monitor wells. The cost of the replacement of any fittings or equipment damaged by a patron or employee of this facility will be charged to Parsons Engineering Science.

- Disposal of the fluids recovered during EFR® is not included in the lump sum cost. Recovered fluid is assumed to be characterized and disposed as a non-hazardous, non-regulated waste at IWS (Jacksonville, Florida) at a rate of $0.16/gallon (includes EcoVac Services' markup). Any increase in the cost of disposal and transportation, including if the recovered fluids are disposed at a different facility (e.g. if the recovered fluid is determined to be hazardous, etc.) will be passed on to Parsons Engineering Science. TetraTech will fully profile and characterize the site. Any potential present or future liability relating to any and all wastes generated during this investigation is the sole responsibility of TetraTech and your client. As with any disposal facility we utilize, EcoVac Services does not audit nor advocate the respective facility and by contracting our services, TetraTech and your client indemnifies EcoVac Services from any claims that may result from disposal of EFR® fluids disposed at the subject facility. TetraTech or your client will execute the manifest. One trip (per site) to the disposal facility is assumed. The vacuum truck has a legal weight capacity of approximately 2,100 gallons.

- EFR® will be conducted for 8 hours or until the legal weight limit of the vacuum truck is attained (i.e. approximately 2,100 gallons), whichever is the earlier time period. The full lump sum cost will be charged in the event that EFR® is discontinued prior to eight hours of extraction due to these conditions, or if the event is discontinued due to the type of delays prescribed in the first bulleted item. Two additional hours are allocated per event for set-up, break-down and gauging, as well as offloading to the onsite container. Any additional field will be charged at a rate of $450/hour. Extraction time beyond 8 hours must be coordinated in advance of the event.

- TetraTech will provide monitoring well locking cap keys, if necessary, as well as the other items listed in the attached EFR® Request Form. Site access and any off site access will be coordinated by or through Parsons Engineering Science.

- EcoVac Services will provide TetraTech with our standard letter format report containing data sheets (i.e. a summary of the data collected during the event, as well as any cumulative data graphed and tabulated). The report will be forwarded in final form only (i.e. a draft report will not be generated) in approximately 30 days following completion of the event.

EFR® Request Form

Client name:_____
Client project manager and alternate:_____
Type of facility:_____
Client facility ID No.:_____
State facility ID No.:_____
Site address/location:_____
Objective(s) of EFR®:

- **Remove free product?:**_____
- **Remediate soils?:**_____
- **Reduce dissolved phase concentrations?:**_____

Type of contaminant(s):_____
EFR® extraction point(s):_____
Depth to water and product thickness:_____
Monitoring well construction (assumed to be flush mounted PVC wells):

- **Well diameter(s):**_____
- **Total depth(s):**_____
- **Special well cap or vault keys required?**_____
- **Required advanced contact (and phone number):**
- **Client:**_____
- **Facility:**_____

Restrictions on performing EFR® (i.e. time of day, etc.):_____
Is the site active?:_____
Current facility name (and phone no. if known):_____
Other known site constraints:_____
Duration of EFR® (if <or> 8 hours):_____
Requested date(s):_____
Waste disposal site:_____
Drums on site requiring content removal?

- **Contents and volume:**_____
- **Drum location:**_____
- **Keys required?**_____

Comments/other:_____

PLEASE ALSO ATTACH THE FOLLOWING:

- **Updated site map**
- **Gauging reports**
- **Health and safety plan**
- **Dissolved phase plume map(s)**
- **Free product plume map**
- **Geologic cross-section(s)**
- **Subcontractor agreement or contract**
- **Directions to the site (or site vicinity map)**
- **Suspected release point(s) (if known)**
- **Water table elevation map**
- **Adsorbed phase (soil) plume map**
- **Closure or monitoring only criterion**

ENHANCED FLUID RECOVERY®

Enhanced Fluid Recovery® (EFR®) is an innovative and cost effective remediation method that utilizes high vacuum pressures and flow rates to remove multiple phase (i.e. vapor, adsorbed, dissolved, and free phase) volatile organic compounds (VOCs) from the subsurface. This proprietary technology was developed by the principals of EcoVac Services and is a variation of what is commonly referred to as dual-phase extraction, multi-phase extraction, and vacuum enhanced recovery. The principals of EcoVac Services have conducted and/or have provided technical oversight of over 3,500 individual EFR® events throughout 35 states and Puerto Rico.

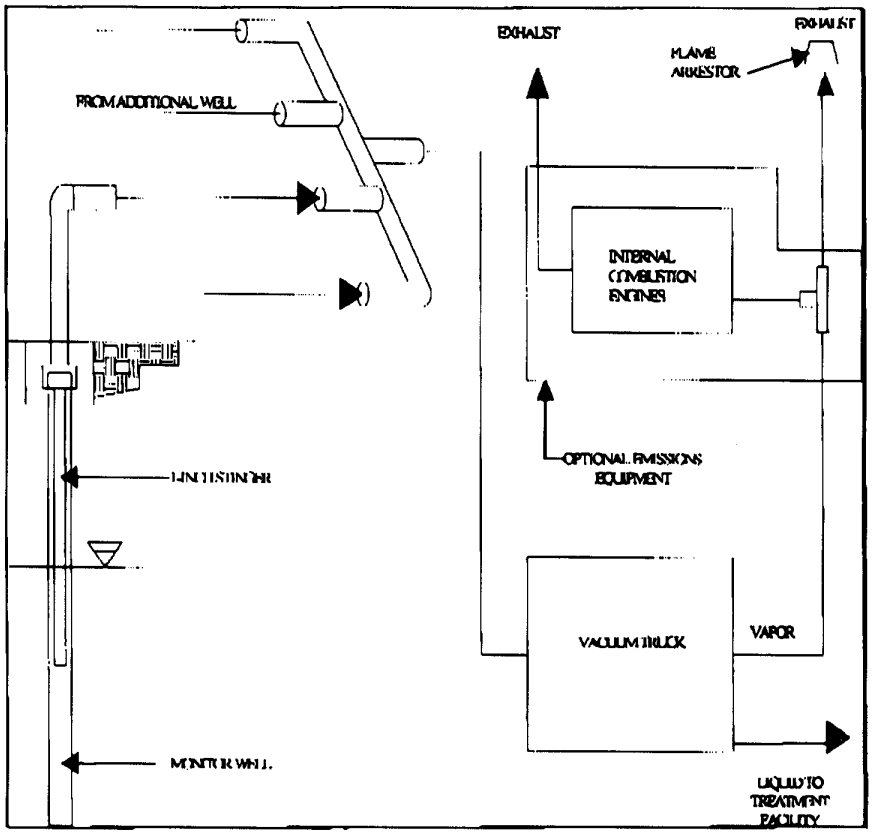
EFR® is a process for treatment of soils and groundwater containing multi-phase VOCs. EFR® is a simple and cost effective mobile system that is particularly effective in the removal of free floating petroleum hydrocarbons (gasoline and diesel). EFR® utilizes high vacuum and high flow rates simultaneously connected to as many as eight or more monitoring or recovery wells. EFR® is normally conducted for an eight hour period per event. EFR® has removed as much as 2,000 equivalent gallons of gasoline or diesel during a single eight hour event.

EFR® simultaneously removes vapors, free product, and groundwater from the subsurface. It volatilizes adsorbed and free phase VOCs through a process similar to soil vapor extraction, but with a much higher vacuum and radius of influence. EFR® is also very unique in that it can treat adsorbed phase VOCs existing within the "smear zone" (i.e the zone of seasonal or climatic groundwater fluctuation) that act as a source for dissolved phase VOCs by dewatering and exposing this zone to the effects of "high rate" soil vapor extraction. As such, EFR® has also been documented to be effective in the reduction of dissolved phase concentrations. Importantly, EFR® also introduces oxygen to the vadose zone and saturated zones, thereby enhancing aerobic biodegradation.

EFR® is an important tool, particularly for source removal. As such, it is an excellent compliment to risk based corrective action (RBCA) since adsorbed and free phase VOCs can be removed, thereby potentially allowing a risk based decision to then be rendered resulting in "monitoring only," or a reduced size remediation system. EFR® is also applicable at sites where rapid remediation is necessary (e.g. real estate transfers, off-site plume migration, emergency response, etc.)

The principals of EcoVac Services are David M. Goodrich, P.G. and Nick Athens, who collectively have over 30 years of broad range experience in the environmental and energy fields. Mr. Goodrich originated the technology in California in 1989. EcoVac Services only provides EFR® services and, hence, is not in competition with environmental consultants. EcoVac Services' staff consists of a multidisciplinary group of geologists, engineers, and scientists that have conducted over 3,500 EFR® events at underground storage tank sites, terminals, refineries, air fields, industrial facilities, and chemical plants for over 200 major oil companies, environmental consulting firms, independent oil companies, and other clients.

EFR® is a "pay as you go" remediation method that involves no capital cost investment or operation and maintenance (O&M) and is recognized and recommended by numerous state agencies.



EFR® RESULTS SUMMARY BY SITE TYPE

	Number of Sites	Number of Events	Equiv. Gal./ Event	Cost/ Eq.Gal.
FREE PRODUCT - Gasoline	448	1,855	117	**$26**
FREE PRODUCT - Diesel	90	255	145	**$22**
FREE PRODUCT - Gas/Diesel	68	213	66	**$45**
DISSOLVED PHASE - Gas	197	508	34	**$90**
DISSOLVED PHASE - Gas/Diesel	29	66	12	**$241**
DISSOLVED PHASE - Diesel	17	46	26	**$107**
ALL SITES	849	2,943	98	**$31**

ECOVAC SERVICES

(888) 4ECOVAC

ENHANCED FLUID RECOVERY PROJECT SUMMARIES

Client: Environmental Consulting Firm
Type of Facility: Service Station
Location: Atlanta, Georgia

EcoVac Services was contacted by a state trust fund contractor to initiate EFR® on an emergency response basis. High levels of gasoline vapors were detected in a sanitary sewer line near downtown Atlanta and approximately two city blocks were partially evacuated (including a nursing home) as a precautionary measure. EFR® was implemented at seven monitor wells, which resulted in the gasoline vapors being completely removed from the sanitary sewer within hours. Consequently, the 24 hour police and fire department surveillance was discontinued. In excess of an estimated 2,700 equivalent gallons of gasoline were recovered during the initial 47 hours of EFR® at a cost of approximately $17,173. A calculated total of 8,997 equivalent gallons of gasoline were removed from the site.

Client: Trucking Company
Type of Facility: Former Trucking Facility
Location: Jackson, Mississippi

An estimated total of 5,670 equivalent gallons of diesel were removed during a single 8 hour EFR® event. Separate phase diesel exists in four monitor wells at a maximum thickness of 6 feet. An estimated total of 22,869 equivalent gallons of diesel have been removal during EFR®, which has been implemented at a cost of $48,152 (including a significant cost for disposal), or $2.11 per removed gallon of diesel. A surfactant was introduced into the subsurface several months prior to the initial EFR® event, which appears to have dramatically enhanced the diesel recovery volumes.

Client: Major Oil Company
Type of Facility: Refinery
Location: Puerto Rico

EcoVac Services was retained to conduct a feasibility study to assess the efficacy of free product removal by EFR®. This site is under U.S. EPA administrative order. Pilot testing was conducted at various locations throughout the refinery. The site did not appear to be an ideal candidate for EFR® due to a shallow water table and the lack of an impervious surface cover. Offgas concentrations >100,000 ppm were prevalent during most of the pilot test period and >9,200 pounds of VOCs were removed over a 54 hour pilot testing period. On the basis of the results of the feasibility study, the client is purchasing a vacuum truck and an internal combustion engine (to treat the offgases) and EFR® was subsequently implemented as a corrective action measure at this site. Initial results indicate that product is being removed at a cost of approximately $0.96/gallon.

Client: National Environmental Consulting Firm
Type of Facility: Service Station (Major Oil Company)
Location: Stone Mountain, Georgia

EcoVac Services was contacted regarding a significant subsurface release of gasoline. EcoVac Services arrived at the site within three hours and initially performed EFR® for a thirty hour period. In excess of 2,200 equivalent gallons of gasoline was recovered during this 30 hour period. EcoVac Services mobilized to the site four additional times during the following week and recovered an additional >3,900 equivalent gallons of gasoline.

Client: Environmental Consulting Firm
Type of Facility: Service Station Sites
Location: Marietta, Holly Springs and Conyers, Georgia

A total of eight 8-hour EFR® events were conducted at three active gas stations during a six week period. A total of five monitor wells at the three sites contained between 0.17 to 3.31 feet of free product. Free product was no longer present at any of the three sites following these EFR® events. The total cost of EFR® at the three sites was $24,323.

Client: Environmental Consulting Firm
Type of Facility: Snack Food Manufacturing Facility
Location: Gentry, Arkansas

A single 8 hour EFR® event was conducted at a site where diesel fuel had persisted in three monitor wells at a thickness of 0.07 to 0.20 feet. Free product was removed from the site and was absent one year after this extraction event, which was conducted at a cost of $3,560. Site closure was obtained for the site.

Client: Environmental Consulting Firm
Type of Facility: Service Station
Location: Knoxville, Tennessee

EcoVac Services was contacted to address an "emergency response" action, which was prompted by the threat of a third party lawsuit. EcoVac personnel mobilized to the site the same evening and conducted EFR® at three existing wells for a period of ten hours. Groundwater sampling was conducted prematurely (i.e. 5 days following the event) and dissolved phase concentrations actually increased in some of the wells. Sampling was then conducted 30 days later and the laboratory data indicated reductions in dissolved phase concentrations as much as 99%. Consequently, "monitoring only" status was requested following this single event since the dissolved phase concentrations were well below the site specific standard established for the site. Total cost for EFR® (inclusive of disposal) was only $3,916. (fax)

Client: Passenger Bus Line Company
Type of Facility: Former Terminal
Location: Charleston, South Carolina

A former bus line terminal in the historic district of Charleston, South Carolina was slated for development as a high rise hotel. Four EFR® events (total of 36 hours of extraction) were conducted at the site which had shallow groundwater conditions (<5 feet below surface) and as much as 0.63 feet of diesel product in two monitor wells. The separate phase product was completely removed following the four EFR® events, which was confirmed by a subsequent subsurface investigation (conducted by the purchaser), as well as verified during foundation excavation at the site. A no further action (NFA) letter was issued. The total EFR® cost was $15,113.

Client: Environmental Consulting Firm
Type of Facility: Carpet Mill
Location: Lafayette, Georgia

A sheen to 0.04 feet of diesel existed in three monitor wells under shallow water table conditions (i.e. 5 to 10 feet below surface). Five 8 hour EFR® events were conducted at a cost of $15,713 (including disposal), after which the separate phase diesel was removed and dissolved phase benzene was reduced to 10 ppb in one well and <5 ppb in all of the other site monitor wells. (mw)

Client: Environmental Consulting Firm
Type of Facility: Service Station
Location: Memphis, Tennessee

Two events of EFR® were performed at a site where an active groundwater pump and treatment system had been operating for a period of years. Very good vacuum influence and recovery of petroleum hydrocarbons were achieved at the site. Not only were the two treatments successful in removing the free product (as much as 0.08 feet), EFR® also significantly reduced dissolved phase TPH-GRO to "monitoring only" limits of <1,000 ppb (compared to >100,000 ppb prior to EFR®) and benzene to <70 ppb. The client did not think that these closure limits were achievable at this site with any technology, given the challenging hydrogeologic conditions at the site. The client has since requested "monitoring only" and discontinued operation of the remediation system. Total cost for EFR® was only $5,074. (pvl)

Client: Environmental Consulting Firm
Type of Facility: Service Station
Location: Jackson, Tennessee

EcoVac Services teamed with a small environmental consulting firm to reduce dissolved phase petroleum hydrocarbon concentrations at a former auto repair shop / service station from greater than 20 ppm to below "monitoring only" criteria (i.e. <1 ppm). Two EFR® events were conducted and the environmental consulting firm also employed oxygen release compound (ORC) in the monitor wells. Dissolved phase petroleum hydrocarbon concentrations were successfully reduced to beneath the "monitoring only" criteria. The cost to implement EFR® was $7,208. (emc2)

Client: Major Oil Company
Type of Facility: Service Station
Location: Memphis, Tennessee

Over 10 feet of free product was discovered in a downgradient monitor well located at an active service station site. Four EFR® events were performed (within a period of 45 days) at an approximate cost of $10,000 and the free product was reduced to 0.00 feet. (a767)

Client: Environmental Consulting Firm
Type of Facility: Apartment Complex
Location: Washington, D.C.

A single EFR® event was conducted at a former fuel oil UST site at which free product was unsuccessfully addressed by prior remedial efforts. The site was widely known within the environmental community as a result of the prior unsuccessful efforts. The site posed particular logistical challenges, for example, having to perform EFR® on multiple levels of a parking garage. Offgas treatment was implemented and the fuel oil free product was removed from all four monitor wells following a single nine hour EFR® event.

Client: National Environmental Consulting Firm
Type of Facility: Service Stations
Location: Chattanooga, Tennessee

Separate phase kerosene and degraded gasoline existed at two different active gasoline stations owned by a major oil company. A total of nine and five 8-hour EFR® events were conducted at the kerosene and gasoline free product sites, respectively, at a total cost of $39,153 for both sites. Although only 0.20 to 0.25 feet of product existed at the site, the low mobility of the kerosene and degraded gasoline posed a challenge. Free product was successfully removed from both sites. (e42075/90)

Client: Major Oil Company
Type of Facility: Former Service Station
Location: Fort Valley, Georgia

EcoVac Services was retained to conduct two EFR® events at a former UST site where a small amount of free product existed. After two EFR® events not only was the free product removed, but the dissolved phase concentrations were significantly reduced, to the extent that site closure was requested by the client. A total of approximately $5,000 was expended for EFR®. (w978)

Client: Environmental Consulting Firm
Type of Facility: Petroleum Bulk Storage Facility
Location: Bainbridge, Georgia

Dissolved phase petroleum hydrocarbon concentrations existed in a UST tankfield where free product is believed to have previously existed. A total of 12 monitor wells were utilized as extraction wells during a single eight hour EFR® event, conducted at a cost of $3,441. The dissolved phase contamination was successfully removed following the single treatment, after which the USTs were excavated. The site subsequently received closure.

Client: Major Oil Company
Type of Facility: Former Service Station
Location: Battle Creek, Michigan

A single EFR® event was conducted at a closed service station site where two monitor wells contained 0.37 to 0.45 feet of product. Approximately 213 equivalent gallons of gasoline were removed and product was not present in the monitor wells during subsequent gauging events. The cost to implement EFR® was $2,456, including product and groundwater disposal. (w316)

Client: Major Oil Company
Type of Facility: Service Station
Location: Waynesville, North Carolina

A single eight hour EFR® event was conducted at an active service station site as an emergency response action. A release of approximately 2,000 gallons of unleaded gasoline via an overfill/overspill was documented. Approximately 1,000 gallons were removed prior to implementation of EFR®. Offgas concentration exceeded 100,000 ppm during the initial five hours of the event and an estimated 998 equivalent gallons of gasoline were removed at a total cost of $3,272, inclusive of the cost to dispose of product and groundwater. (e8134)

Client: Environmental Consulting Firm
Type of Facility: Active Service Station
Location: Columbia, South Carolina

Two EFR® events were conducted at a dissolved phase site, achieving "monitoring only" status after a cost of only $6,540. The dissolved phase benzene concentrations in the downgradient wells were reduced to nondetect (ND) from 30 to 100 ppb. EFR® was conducted at the site after 11 p.m. to minimize interruption to facility operations. (emw)

Client: Environmental Consulting Firm
Type of Facility: Service Station (Independent Oil Company)
Location: Summerville, South Carolina

EcoVac Services was contacted to perform an "emergency response" action, prompted by a 1,000-gallon gasoline release near the tankfield. A 0.5 ft. layer of product was measured in three tankpit monitor wells. A 25 hour EFR® event was conducted at a total cost of $7,860 and removed over an estimated 700 equivalent gallons of gasoline. Free product was not detected during the following month and a second EFR® event was performed one month later to reduce dissolved phase petroleum hydrocarbons.

Client: Independent Oil Company
Type of Facility: Petroleum UST Site
Location: Ft. Wayne, Indiana

Free phase gasoline existed in one recovery well and two tank pit observation wells at a thickness of as much as 0.6 feet. Four 6-hour EFR® events were conducted at a cost of less than $10,000. Free product was no longer detected at the site 9 months following the final EFR® event. (66147)

Client: Environmental Consulting Firm
Type of Facility: Service Station
Location: Brookhaven, Mississippi

A fixed remediation system had been installed at an active convenience store and had recovered only approximately 100 gallons of product over a 36 month period. Free product remained in the four monitor and recovery wells and approximately $200,000 was expended in capital, installation, and operation/maintenance costs. EFR® was performed at the facility and removed 60 equivalent gallons of product during the initial 6.5 hour event at a cost of approximately $3,500.

Client: Environmental Consulting Firm
Type of Facility: Convenience Store
Location: Acworth, Georgia

A pump and treat system was previously installed at this site at a total cost of >$200,000, which reportedly recovered only ~200 gallons of gasoline. Over 3 feet of product persisted onsite and >1.5 feet of product existed offsite (across a highway) near a creek. Five 8 hour EFR® events have been implemented at the site utilizing offgas treatment. A calculated total of 203 gallons of product have been removed at a total cost of $14,822. Product in the onsite well (which has been subjected to three of the five EFR® events) has been reduced from 3.31 feet to 0.06 feet and in the offsite well (two EFR® events) from 1.65 feet to 0.19 feet.

Client: National Environmental Consulting Firm
Type of Facility: Service Station
Location: Charlotte, North Carolina

Free product (0.5 feet of gasoline) existed in a single monitor well, which was screened in a clayey to sandy silt surficial aquifer. Free product was absent after two 8 hour EFR® events which were conducted at a total cost of $6,326. (633004)

Client: Independent Oil Company
Type of Facility: Service Station
Location: Hopkinsville, Kentucky

Separate phase gasoline was present in five monitor wells at an active gasoline station at a maximum thickness of 1.7 feet. Separate phase product was absent following three 8 hour EFR® events, which were conducted at a cost of $8,415. A fourth EFR® event was subsequently conducted to further reduce dissolved phase concentrations.

Client: Environmental Consulting Firm
Type of Facility: Car Rental Facility
Location: Alcoa, Tennessee

A small amount of separate phase gasoline (0.16 feet) existing in a single monitor well was removed after a single 8 hour EFR® event at a cost of $2,778. Two additional EFR® events were conducted to reduce dissolved phase concentrations. The client is initiating a modeling effort to take the site to "monitoring only" status.

Client: Environmental Consulting Firm
Type of Facility: Service Station
Location: Bristol, Tennessee

A small amount of free product (i.e. 0.01 feet of gasoline) existed at a country convenience store. EFR® was conducted at two monitor wells during a single 8 hour EFR® event (approximate total cost of $3,200). Dissolved phase TPH-GRO was reduced from ~20 ppm to ≤10 ppm. (empc)

Client: Environmental Consulting Firm
Type of Facility: Cemetery (former UST site)
Location: Memphis, Tennessee

A single monitor well at a cemetery/funeral home property previously contained free product. Two 8 hour EFR® events were conducted at a cost of $4,900. Free product was absent and dissolved phase benzene was reduced to 15 ppb and TPH to 5.9 ppm (from 431 ppm). Based upon the success of EFR® at the site, a site specific standard is being sought by the client to allow the site to transition to "monitoring only."

Client: Environmental Consulting Firm
Type of Facility: Truck Stop
Location: Commerce, Georgia

A pump and treat/soil vapor extraction system was implemented at the site, which was unsuccessful in fully removing free product from three monitor wells. As much as >1 feet of free product persisted at the site. Three EFR® events were conducted at the site at a cost of $7,961, after which free product was no longer detected.

Client: Environmental Consulting Firm
Type of Facility: Service Station
Location: Atlanta, Georgia

EFR® has been implemented at a state trust fund site with as much as two feet of free phase gasoline in fourteen monitor wells. As many as eight wells have been simultaneously utilized for extraction. An estimated total of over 5,257 equivalent gallons of gasoline have been recovered during 16 EFR® events at a cost of $49,680 (i.e. ~$9.50 per equivalent gallon). (jackson)

Client: Major Oil Company
Type of Facility: Service Station
Location: Columbus, Georgia

Free product had persisted at two service station sites in south Georgia for a long period of time. The objective at the sites was to remove free product (as much as 0.25 to 0.55 feet was present), as well as to reduce dissolved phase petroleum hydrocarbon concentrations, in an effort to move the site towards risk based closure. Measurable free product was removed from both sites after a total of six EFR® events at a total cost of approximately $17,172 for both sites. (91012/3)

Client: Major Oil Company
Type of Facility: Service Station
Location: Birmingham, Alabama

EFR® was implemented at an active service station site as an immediate response action due to nuisance gasoline odors present in an adjacent fast food restaurant. EcoVac Services was mobilized to the site the day following the initial contact by the client, inclusive of negotiating a first time contract with this major oil company. The site conditions did not qualify it as an ideal candidate due to a shallow water table (1 to 6 feet below ground surface), known manmade subsurface conduits, and a land surface partially lacking an impervious cover. Nearly 2,000 pounds of petroleum hydrocarbons (an estimated 310 equivalent gallons of gasoline) were recovered during the initial eight hour EFR® event and EcoVac Services personnel were successful in determining the conduit for the nuisance odors present at the adjacent restaurant (i.e. a breach in a sanitary sewer line that serviced the restaurant). The amount of free product was significantly reduced after the initial EFR® event in terms of the thickness of free product, as well as the number of wells which contained free product. A second event of EFR® was performed ten days later, after which an interim (fixed) remediation system was installed. (24292)

Client: Major Oil Company
Type of Facility: Service Station
Location: Memphis, Tennessee

As much as 0.53 feet of product was detected in two monitor wells adjacent to the dispenser islands and diesel USTs at a closed service station property. Product was absent following the second EFR® event, although a rise in the water table may have contributed to the absence of product. A total of $11,350 was expended for EFR®, inclusive of recovered fluids disposal. (24424)

Client: Major Oil Company
Type of Facility: Service Station
Location: Memphis, Tennessee

As much as 2.5 feet of product was detected in four monitor points at a former service station. The monitor wells used for extraction were located at, and downgradient to, the former UST area. Four EFR® events were conducted over a 16 month period at a cost of $11,350. Product was absent prior to the fourth event, however, a climatic rise in the water table may have contributed to the absence of product. (23578)

Client: Major Oil Company
Type of Facility: Service Station
Location: Memphis, Tennessee

Two EFR® events were conducted at a former service station site to address a sheen of product and dissolved phase petroleum hydrocarbons, at a cost of $5,750. The sheen was removed and dissolved phase TPH-GRO/DRO and benzene were reduced by a minimum of 50% to as much as nondetect (ND) levels. (24362)

Client: Environmental Consulting Firm
Type of Facility: Casino/Restaurant (Former Service Station)
Location: Latta, South Carolina

Over 2 feet of free phase gasoline existed at a former petroleum UST site, which had been converted to a gambling facility. Despite shallow groundwater conditions (2.5 to 6 feet below surface), the product was completely removed following a single eight hour EFR® event at a cost of only $3,495.

Client: Environmental Consulting Firm
Type of Facility: Truck Stop
Location: Sweetwater, Tennessee

A groundwater pump and treat system operated at a site for over three years and pumped over 1,200,000 gallons of groundwater. Approximately 6 and 23 equivalent gallons of benzene and TPH-GRO, respectively, were removed by pump and treat during this three year period. A sheen of separate phase product existed on the top of the water table, which existed at 5 to 7 feet below ground surface. A single 8 hour EFR® event was conducted at the site at a cost of $2,863, during which a calculated 33 equivalent gallons of gasoline (233 pounds of vapor phase petroleum hydrocarbons) were removed. The client reported that a >90% reduction in dissolved phase TPH-GRO (i.e. from 25-30 ppm to 2 ppm) and dissolved phase benzene (i.e. from 2,000-3,000 ppb to ~200 ppb) was achieved.

Client: Environmental Consulting Firm
Type of Facility: Service Station Site
Location: Little Rock, Arkansas

A single eight hour EFR® event was conducted at a petroleum UST site that had historically contained about 2 inches of free phase product. The product was removed after the single event, at a cost of less than $3,500, and the site is expected to be "closed out" after going to a site specific (dissolved phase) standard. (efwill)

Client: Environmental Consulting Firm
Type of Facility: Army National Guard Facility
Location: Greeneville, Tennessee

An armory had a monitor well, screened to the underlying shale bedrock, with over 1.5 feet of free phase diesel. Diesel was no longer present in the monitor well following four 8-hour EFR® extraction events, conducted at a cost of $12,690.

Client: Environmental Consulting Firm
Type of Facility: Trucking Facility
Location: Nashville, Tennessee

A small amount (0.04 feet) of separate phase diesel was present in a single monitor well under shallow water table conditions (i.e. 5 feet below surface). The product was removed following a single 8 hour EFR® event, conducted at an approximate cost of $2,936. (nst)

Client: Environmental Consulting Firm
Type of Facility: Service Station
Location: Memphis, Tennessee

Nine 8-hour EFR® events were conducted at an active gasoline station during a three year period. Separate phase gasoline initially existed in six monitor wells at a thickness of as much as 2.5 feet. Free product was removed from the monitor wells at this site. A total of $23,911 was expended for EFR®. (1227n)

Client: Environmental Consulting Firm

Type of Facility: Service Station
Location: Nashville, Tennessee

Two 8-hour EFR® events successfully removed 0.25 feet of product. A third extraction event was conducted to reduce the dissolved phase concentrations, which was successful and the site currently is in "monitoring only" phase. Total cost for EFR® was $10,115. (628)

Client: Environmental Consulting Firm
Type of Facility: Electrical Contractor
Location: Memphis, Tennessee

Groundwater existed at a depth of 75 feet below surface at a site where 0.34 feet of free product existed. Two 8 hour events were conducted (at an approximate cost of $4,800) after which the free product was successfully removed. The site went to a site specific standard and is currently in the "monitoring only" phase prior to site closure. (summer)

Client: Environmental Consulting Firm
Type of Facility: Service Station
Location: Memphis, Tennessee

EcoVac Services conducted two EFR® events at an active retail gasoline dispensing facility during a three month period. Free floating product existed in six monitor wells (ranging from a sheen to >1 feet). A sheen (i.e. <0.01 feet) existed in only two monitor wells following these two EFR® events.

Client: Environmental Consulting Firm
Type of Facility: Service Station
Location: Chattanooga, Tennessee

The EFR® process was suggested by state regulators to be implemented at an active service station. A maximum of 0.20 feet of free product existed in six monitor wells at this site. EFR® was performed four times (8 hour events) at a cost of $12,532 and free product was thereafter absent in the monitor wells. (mpre)

Client: Major Oil Company
Type of Facility: Service Station
Location: Memphis, Tennessee

EFR® was implemented at an active service station, under which a free product plume existed entirely across the site at a thickness as much as 1.9 feet of product. EFR® was conducted at night and involved placing hoses over the top of the car wash (to allow access to one of the extraction wells), so as to minimize interruption to customer fueling and service bay operations. Approximately 3,000 pounds of petroleum hydrocarbons (500 equivalent gallons of gasoline) were removed during the four EFR® events conducted over a period of 14 months. Product was not present prior to the fifth EFR® event and a total of $13,400 was expended for these EFR® treatments.

Client: Environmental Consulting Firm
Type of Facility: Building Supply
Location: Memphis, Tennessee

Five EFR® events were conducted during a two year time period, which successfully removed minor amounts of gasoline/diesel free product from three monitor wells. Dissolved phase TPH was also reduced from 350 ppm to 57 ppm in the primary extraction well. A site specific (dissolved phase) standard is being sought by the client to transition the site into "monitoring only" status. (owm)

Client: Major Oil Company
Type of Facility: Service Station

Location: Ypsilanti, Michigan

EFR® was implemented for four events (total of 24 hours of extraction) at a site at which four monitor wells contained as much as 2.3 feet of free product. Offgas concentrations exceeding 100,000 ppm were recorded during the initial 18 hours of extraction. An estimated total of 3,040 pounds of petroleum hydrocarbons (approximately 550 equivalent gallons of gasoline) was removed at a total cost of $6,416. (2361)

Client: Major Oil Company
Type of Facility: Service Station
Location: Memphis, Tennessee

As much as 1.3 feet of product was present in eight monitor wells entirely across a site (the monitor wells with product were as much as 110 feet by 100 feet apart) that is now a family style restaurant. Seven EFR® events were conducted over a 12 month time period at a cost of $20,225, during which 11,500 pounds of petroleum hydrocarbons (over 1,900 equivalent gallons of gasoline) were removed. A maximum of 0.15 feet of product was present prior to the seventh event. (2443)

Client: National Environmental Consulting Firm
Type of Facility: Snack Food Distribution
Location: Chamblee, Georgia

As much as 6 feet of a diesel and gasoline free product mixture existed in 4 monitor wells. EFR® was implemented utilizing offgas control, consisting of trailer mounted dual internal combustion engines (ICEs). A total of 443 equivalent gallons of gasoline/diesel were removed during the initial EFR® event, and a 99.99% vapor emission destruction efficiency was achieved by the ICEs. Four subsequent eight hour EFR® events were conducted. A total of over 1,500 equivalent gallons of gasoline/diesel have been removed at a cost of $20,562, including the cost of offgas treatment. (P.L)

Client: Environmental Consulting Firm
Type of Facility: Active Truck Stop/Service Station
Location: Doraville, Georgia

EFR® was implemented at a site impacted by diesel, which was present in four tankpit wells at a thickness of ~0.25 feet. An estimated total 1,400 gallons of diesel were removed during two 8-hour EFR® event at a cost of $8,130, inclusive of the cost to dispose of free product and groundwater. Treatment of the offgases was achieved through the use of a computer controlled dual internal combustion engine (ICE). A total of only 0.26 pound of VOCs was emitted during the two events. (qt)

Client: Environmental Consulting Firm
Type of Facility: Service Station
Location: Caro, Michigan

EFR® was conducted for a total of 30 hours over a two week period at a site in east central Michigan. Free product levels were reduced by approximately one-half following three EFR® events (24 hours of extraction) and a calculated total of over 1,200 equivalent gallons of gasoline were removed.

Client: Independent Oil Company
Type of Facility: Service Station
Location: Richmond, Indiana

Seven EFR® events were performed at a site containing as much as 0.75 feet of free product in two wells, after which free product was removed from the site. The cost of the cleanup was $23,905.

Client: Environmental Consulting Firm
Type of Facility: New Car Dealership
Location: Linwood, Michigan

Hydraulic oil was released from hydraulic lifts at a dealership. As much as 2 feet of free phase hydraulic oil existed in three monitor wells. The hydraulic oil was removed from the site following only four EFR® events conducted at a total cost of only $10,953.

Client: Environmental Consulting Firm
Type of Facility: Wastewater Treatment Plant
Location: Bay City, Michigan

Diesel fuel was present in a single monitor well at a measured thickness of 0.40 feet. The diesel was removed following only three EFR® events performed at a total cost of $8,295.

Client: Environmental Consulting Firm
Type of Facility: Service Station
Location: Jackson, Tennessee

0.25 feet of gasoline was present in a single monitor well. The product was removed after a single EFR® event. Over 120 equivalent gallons of gasoline were removed and vacuum influence in excess of 10 inches of water and groundwater drawdown of 0.35 feet were recorded over 80 feet away from the extraction. Total cleanup cost was $2,921. (hw14)

Client: Environmental Consulting Firm
Type of Facility: Naval Air Station
Location: Millington, Tennessee

This site containing a sheen of gasoline was treated with two EFR® events at a total cost of $4,554. The sheen was removed and the dissolved phase concentrations were reduced to the extent that site closure was obtained at the site. (flyclub)

Client: Environmental Consulting Firm
Type of Facility: Naval Air Station
Location: Millington, Tennessee

A site containing as much as 0.28 feet of fuel oil in a single monitor well was subjected to four EFR® events at a cost of $9,108. The fuel oil was removed and site closure was subsequently obtained. (mel flms)

Client: Environmental Consulting Firm
Type of Facility: Former Grocery Store
Location: Decatur, Tennessee

A bank had taken a piece of property in lien of foreclosure that was subsequently found to contain elevated dissolved phase gasoline. The bank had spent hundreds of thousands of dollars in assessment and unsuccessful remedial efforts. Four EFR® events were conducted at a total cost of only $10,721. The dissolved phase concentrations were reduced dramatically and the site is currently awaiting closure.

Client: Environmental Consulting Firm
Type of Facility: Tire Store
Location: Campbellsville, Kentucky

A single EFR® event was conducted at a cost of $2,950 at a site containing 0.20 feet of mixed gasoline and diesel fuel product. Free product was successfully removed from the site and dissolved phase concentrations were reduced below the groundwater standard of 0.4 ppm.

Client: Environmental Consulting Firm
Type of Facility: Service Station
Location: Clay City, Kentucky

Dissolved phase concentrations were reduced by 85% at this site after conducting a single EFR® event at a total cost of $2,950.

Client: Environmental Consulting Firm
Type of Facility: School Bus Fueling Area
Location: Memphis, Tennessee

Fifteen EFR® events removed an estimated 1,854 equivalent gallons of diesel fuel at a total cost of $39,104. As much as 2.8 feet of free product was present in two monitor wells, which was completely removed by EFR®.

Client: Environmental Consulting Firm
Type of Facility: Service Station
Location: Evans, Georgia

Thirteen EFR® events were performed at a cost of $47,392, removing an estimated 2,273 equivalent gallons of gasoline. SPH was reduced to 0.03 feet. The state regulatory agency directed the consultant to install a fixed system, at a capital cost of about $80,000 (excluded installation, design, and O&M costs). The fixed system failed in removing the SPH and EcoVac was called back out to the site to complete the clean up. (Hill)

Client: Environmental Consulting Firm
Type of Facility: Former Service Station
Location: Chamblee, Georgia

Five EFR® events were conducted at a cost of $16,774. SPH was successfully removed from the site monitor wells, and dissolved phase concentrations also decreased. A total of 334 equivalent gallons (2,025 pounds) of vapor phase gasoline were removed from the site, of which only 1.95 pounds were emitted to the atmosphere following offgas treatment (i.e. a 99.9% destruction efficiency was achieved).

Client: Environmental Consulting Firm
Type of Facility: Service Station
Location: Smithville, Tennessee

SPH was removed from this site after a single EFR® event conducted at a total cost of $2,597. (broadus)

Client: Environmental Consulting Firm
Type of Facility: Service Station
Location: LaVergne, Tennessee

Four EFR® events, conducted at a total cost of $11,157, were all that was required to remove all measurable SPH at this site. As much as ____ feet of SPH had previously existed at this site.

Client: Environmental Consulting Firm
Type of Facility: Service Station
Location: Sewanee, Tennessee

This site containing dissolved phase gasoline had been monitored and sampled for four years in an unsuccessful attempt at closing the site by natural alternation. Four EFR® events were performed at a cost of $10,200 which reduced dissolved benzene concentrations from 600 ppb to 70 ppb (the site specific standard was 200 ppb) and decreased TPH-GRO from 2.5 ppm to 0.3 ppm.

Client: Major Oil Company
Type of Facility: Service Station
Location: Memphis, Tennessee

As much as 1.8 feet of SPH existed at this site in three monitor wells, which was reduced to 0.00 feet after eight EFR® events performed at a cost of $18,941. (34202-24365)

Client: Environmental Consulting Firm
Type of Facility: Service Station
Location: Memphis, Tennessee

Six monitor wells contained as much as nearly 4 feet of SPH, which was completely removed after eleven EFR® events. Cost for EFR® was $24,111. (2260)

Client: Environmental Consulting Firm
Type of Facility: Former Service Station
Location: Memphis, Tennessee

As much as 6 feet of SPH was contained in two monitor wells. Nine EFR® events were conducted at a cost of $20,888, which removed all measurable SPH. (rogers)

Client: Environmental Consulting Firm
Type of Facility: Service Station
Location: Maryville, Tennessee

Only three EFR® events, performed at a cost of $7,677, were required to remove as much as 8 feet of SPH that existed in two monitor wells. (DM411)

Client: Environmental Consulting Firm
Type of Facility: Fire Station
Location: Lansing, Michigan

Four EFR® events were conducted at an active fire station site containing elevated dissolved phase BTEX. Benzene was reduced from 2,000 ppb to 100 ppb; toluene from 3,900 ppb to 53 ppb; ethyl benzene from 2,400 ppb to 550 ppb; and total xylenes from 4,000 ppb to 1,600 ppb. EFR® cost was $13,249.

Client:
Type of Facility: Former Bus Company Facility
Location: Tallahassee

A single EFR® event was conducted at this facility at a cost of $3,580.00. Free product was completely removed and dissolved phase petroleum hydrocarbon were reduced to nondetect (ND). An NFA has been requested at the site.

Client:
Type of Facility: Trucking Facility
Location: Jacksonville

A single EFR® event was conducted at this facility at a cost of $4,104.00. Dissolved phase petroleum hydrocarbons were reduced by as much as to nondetect (ND).

Client:
Type of Facility: Former Trucking Facility
Location: Orlando Area

Minimal details are revealed regarding this site due to ongoing litigation. A single eight hour EFR® event was conducted at a cost of $4,498.00 which resulted in a >99% reduction in dissolved phase concentrations, according to the client.

Client: Environmental Consulting Firm
Type of Facility: Service Station
Location: Bushnell, Florida

Four EFR® events removed all measurable SPH at a site where state regulators were exerting pressure since SPH had "lingered" for many years. Total cost for EFR® was only $14,993.

Client: Major Oil Company
Type of Facility: Service Station
Location: Chickasha, Oklahoma

Only two EFR® events, conducted at a cost of $6,240 were required to remove ≤1.15 feet of SPH from seven monitor wells. (9/15)

Client: Power Company
Type of Facility: Power Plant
Location: Gentry, Arizona

A single EFR® removed all measurable diesel from this site at a cost of only $3,390. Diesel SPH had existed at this site for a long period of time.

Client: Petroleum Pipeline Co.
Type of Facility: Storage Terminal
Location: Newington, Virginia

A single EFR® event removed the measurable diesel SPH at this site at a cost of only $3,686, after which the state regulatory agency agreed to close down the investigation.

APPENDIX D
REMEDIAL ACTION PLAN SUMMARY

Remedial Action Plan Summary

DEP Form # 62-770.900(4)
Form Title: Remedial Action Plan Summary
Effective Date: September 23, 1997

Site Name Building 425
Location Naval Station Mayport
Media Contaminated: ☑ Groundwater ☑ Soil

FDEP Facility ID No. _____
Current Date 7 / 12 / 1
Date of Last GW Analysis 6 / 13 / 0

Type(s) of Product(s) Discharged:
☐ Gasoline Analytical Group
☑ Kerosene Analytical Group (Diesel)
- Estimated Petroleum Mass (lbs):
  Groundwater FP
  Saturated Zone Soil _____
  Vadose Zone Soil FP
- Area of Plume 96 (ft^2)
- Thickness of Plume 0.17 (ft)

Groundwater Recovery and Specifications:
- No. of Recovery Wells 1
  ☑ Vertical ☐ Horizontal
- Design Flow Rate/Well NA (gpm)
- Total Flow Rate NA (gpm)
- Hydraulic Conductivity 4.34 (ft/day)
- Recovery Well Screen Interval 5-15 (ft)
- Depth to Groundwater 8 (ft)

Method of Groundwater Remediation:
☐ Pump-and-Treat
  ☐ Air Stripper
    ☐ Low Profile ☐ Packed Tower
  ☐ Diffused Aerator
  ☐ Activated Carbon
    ☐ Primary Treatment ☐ Polishing
☐ In Situ Air Sparging
- No. of Sparge Points _____
  ☐ Vertical ☐ Horizontal
- Pressure _____ (psi)
- Design Air Flow Rate/Well _____ (cfm)
- Total Air Flow Rate _____ (cfm)

☐ Biosparging
- No. of Sparge Points _____
  ☐ Vertical ☐ Horizontal
- Design Air Flow Rate/Well _____ (cfm)

☐ Bioremediation
  ☐ In Situ ☐ Ex Situ
☑ Other Dual Phase Extraction Via AFVR for FP

Method of Groundwater Disposal:
☐ Infiltration Gallery ☐ Sanitary Sewer
☐ Surface Discharge/NPDES ☐ Injection Well
☑ Other Disposal at Treatment Facility

Free Product Present: ☑ Yes ☐ No
- Estimated Volume 37 (gal)
- Maximum Thickness 5 (in)
- Method of Recovery (check all that apply):
  ☐ Manual Bailing ☐ Skimming Pump
  ☑ Other Aggresive Fluid Vapor Recovery

Method of Soil Remediation:
☐ Excavation
  Volume to be Excavated _____ (yds^3)
  ☐ Thermal Treatment ☐ Land Farming On Site
  ☐ Landfill ☐ Bioremediation
  ☐ Other _____
☐ Vapor Extraction System (VES)
- No. of Venting Wells _____
  ☐ Vertical ☐ Horizontal
- VES - Applied Vacuum _____ (wg)
- Design Air Flow Rate _____ (cfm)
- Design Radius of Influence _____ (ft)
- Air Emissions Treatment
  ☐ Thermal Oxidizer ☐ Catalytic Converter
  ☐ Carbon ☐ Other _____

☐ Soil Bioventing
- No. of Venting Wells _____
  ☐ Vertical ☐ Horizontal
- Design Air Flow Rate _____ (cfm)

☐ In Situ Bioremediation
☑ Other Dual Phase Extraction Via AFVR for FP

Natural Attenuation:
- Method of Evaluation
  ☐ Rule 62-770.690(1)(e), F.A.C.
  ☐ Rule 62-770.690(1)(f), F.A.C.

Estimated Time of Cleanup: 183 (days)
- Method of Estimation
  ☐ Pore Volumes (no. of pore vols. = _____)
  ☐ Exponential Decay (Decay Rate) ____ (day^{-1})
  ☐ Groundwater Model
  ☑ Other Historical use at other sites

Estimated Cost:
- Est. Capital Cost (incl. install.) $ 29,210.00
- Est. O & M Cost (per year) $ 11,490.00
- Est. Total Cleanup Cost $ 40,700.00