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REMEDIAL ACTION PLAN FOR TRUMBO POINT FUEL FARM NAS KEY WEST FL
8/1/1999
HARDING LAWSON ASSOCIATES

REMEDIAL ACTION PLAN

TRUMBO POINT FUEL FARM

NAVAL AIR STATION KEY WEST
TRUMBO POINT ANNEX, KEY WEST, FLORIDA

Unit Identification Code: N00213

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CERTIFICATION OF TECHNICAL
DATA CONFORMITY (MAY 1987)

The Contractor, Harding Lawson Associates, hereby certifies that, to the best of its knowledge and belief, the technical data delivered herewith under Contract No. N62467-89-D-0317/095 are complete and accurate and comply with all requirements of this contract.

DATE: December 15, 1999

NAME AND TITLE OF CERTIFYING OFFICIAL: Kathleen M. Hodak
Task Order Manager

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Project Technical Lead

(DFAR 252.227-7036)

KW-TPFF.RAP
FGW.08.99

FOREWORD

To meet its mission objectives, the U.S. Navy performs a variety of operations, some requiring the use, handling, storage, and/or disposal of hazardous materials. Through accidental spills or leaks, or as a result of conventional methods of past disposal, hazardous materials may have entered the environment in ways unacceptable by current standards. With growing knowledge of the long-term effects of hazardous materials on the environment, the Department of Defense initiated various programs to investigate and remediate conditions related to suspected past releases of hazardous materials at their facilities.

One of these programs is the Comprehensive Long-Term Environmental Action, Navy Underground Storage Tank (UST) program. This program complies with Subtitle I of the Resource Conservation and Recovery Act, and the Hazardous and Solid Waste Amendments of 1984. In addition, the UST program complies with all appropriate State and local storage tank regulations as they pertain to each naval facility.

The UST program includes the following activities:

- registration and management of Navy and Marine Corps storage tank systems,
- contamination assessment planning,
- site field investigations,
- preparation of contamination assessment reports,
- remedial (corrective) action planning,
- implementation of the remedial action plans, and
- tank and pipeline closures.

The Southern Division, Naval Facilities Engineering Command (SOUTHNAVFACENGCOM) manages the UST program, and the U.S. Environmental Protection Agency and the Florida Department of Environmental Protection oversee the Navy UST program at Naval Air Station (NAS) Key West.

Questions regarding this report should be addressed to the Commanding Officer, NAS Key West in Key West, Florida, or to SOUTHNAVFACENGCOM, Byas Glover, Code 18410, at (843) 820-5651.

EXECUTIVE SUMMARY

The purpose of this Remedial Action Plan (RAP) is to recommend a plan for remediation of petroleum and arsenic contamination at the Trumbo Point Fuel Farm (TPFF) area, including Piers D1, D2, and D3, at Naval Air Station Key West in Key West, Florida. A risk-based approach has been used to establish human health and ecological risk factors for the guidance of remedial efforts for the petroleum-related contamination in the soil and groundwater and arsenic in surface soil in accordance with the requirements of Chapter 62-770, Florida Administrative Code.

This RAP presents the rationale for the remedial actions recommended for implementation at the TPFF. This RAP includes a plan to accomplish the following tasks:

- reduce petroleum contaminant source(s) using multiphase extraction, passive product removal, and source area excavation;
- excavate all areas of arsenic contaminated surface soil which exceed the site-specific background concentration of 6.9 mg/kg; and
- natural attenuation monitoring of potential groundwater contaminant pathways so that appropriate measures can be taken if contamination threatens human or ecological receptors.

GLOSSARY

ABB-ES	ABB Environmental Services, Inc.
AST	aboveground storage tank
AVGAS	aviation gasoline
bls	below land surface
CA	contamination assessment
CAR	Contamination Assessment Report
CLEAN	Comprehensive Long-Term Environmental Action, Navy
FAC	Florida Administrative Code
FDEP	Florida Department of Environmental Protection
HLA	Harding Lawson Associates
JP	jet propellant
MTBE	methyl tert-butyl ether
$\mu g/\ell$	micrograms per liter
MOA	memorandum of agreement
MOGAS	motor gasoline
NAS	Naval Air Station
OVA	organic vapor analyzer
PAH	polynuclear aromatic hydrocarbons
PCA	preliminary contamination assessment
PCB	polychlorinated biphenyl
RAP	Remedial Action Plan
SOUTHNAV-FACENGCOM	Southern Division, Naval Facilities Engineering Command
TPFF	Trumbo Point Fuel Farm
TRPH	total recoverable petroleum hydrocarbons
USCG	U. S. Coast Guard
USEPA	U.S. Environmental Protection Agency
UST	underground storage tank
VOA	volatile organic aromatics
VOC	volatile organic compound

1.0 INTRODUCTION

The Trumbo Point Fuel Farm (TPFF) has been used as a fuel storage and distribution point by the Navy since 1942. The TPFF is the location of several aboveground storage tanks (ASTs), associated pipelines and various pump houses used to transport fuel to and from the ASTs. In addition to the various fuel pipelines, which are still active at the site, a large number of abandoned buried fuel pipelines are also present on the site. Fuels reported to have been stored and transported at the site include No. 6 fuel oil, Bunker C oil, diesel fuel, aviation gasoline (AVGAS), jet propellant (JP)-4 and JP-5 jet fuels, motor gasoline (MOGAS), waste oil, and hydraulic fluids. According to Navy personnel, the TPFF is currently used to store and dispense diesel fuel marine, JP-5 fuel, and MOGAS.

The land currently occupied by the U.S. Coast Guard (USCG) facility was previously owned and operated by Naval Air Station (NAS) Key West. The property was leased by the Navy to the USCG in 1983. The facility primarily consists of two concrete piers (D-2 and D-3) and various buildings used to house operational and support services (maintenance shops, administration offices, living quarters, etc.). Pier D-1, located west of Trumbo Road and adjacent to the USCG property, is currently owned and operated by NAS Key West. Ships docking at Pier D-2 off-load fuel for storage at the TPFF. Fuel dispensers on Piers D-2 and D-3 are used to support USCG operations.

Harding Lawson Associates (HLA) conducted a preliminary contamination assessment (PCA) in August 1993 to verify the findings of previous investigations and to assess soil and groundwater contamination in areas not well documented during the previous investigations. The HLA PCA was conducted from July through October 1993. At the request of the Navy, the area of investigation also included parts of the USCG facility west of the TPFF site. During the PCA, 101 soil borings were drilled and three vertical extent monitoring wells were installed. Soil samples were collected from soil borings and analyzed for volatile organic compounds (VOCs) by organic vapor analyzer (OVA) analysis. Groundwater samples were collected from monitoring wells (MWs) installed during previous investigations and from MWs and specific soil borings completed during the PCA.

From January 1996 to April 1996, HLA conducted a contamination assessment (CA) at the TPFF and USCG sites to collect data required to complete a contamination assessment report (CAR) for Florida Department of Environmental Protection (FDEP) approval and to obtain site-specific data to evaluate potential remedial technologies. During the CA, soil samples were collected from 139 additional soil borings and 103 additional MWs were installed and sampled. Soil samples were analyzed for VOCs by OVA analysis and, in some areas, for the Waste Oil Group parameters. Groundwater samples were analyzed for either the Kerosene Analytical Group (KAG) or Waste Oil Group parameters. Sediment and surface water samples were collected and analyzed for the KAG parameters.

In April of 1999, at FDEP's direction, additional samples were collected from surface soil locations in order to complete the site risk assessment. Samples were collected from 41 locations and analyzed for benzene, toluene, ethylbenzene, xylenes (BTEX), MTBE, PAHs, TRPH and metals. The surface soil sampling results indicated the presence of elevated concentrations of arsenic. The arsenic is presumed to be present due to past pesticide application practices.

1.1 PURPOSE. The purpose of this Remedial Action Plan (RAP) is to recommend a plan to address petroleum and arsenic contamination at the TPFF. The RAP presented herein is designed for implementation at the TPFF site. Risk-based reasoning has been used to establish human health and ecological risk factors for the guidance of remedial efforts for the arsenic and petroleum-related contamination in the soil and groundwater in accordance with the requirements of Chapter 62-770, Florida Administrative Code (FAC).

1.2 SCOPE. This RAP presents the rationale for the remedial actions recommended for implementation at the TPFF. This RAP will include recommendations for a plan to accomplish the following tasks:

- reduce petroleum contaminant source(s) using multiphase extraction, passive product removal, and source area excavation;
- excavate all areas of arsenic contaminated surface soil which exceed the site-specific background concentration of 6.9 mg/kg; and
- natural attenuation monitoring of potential groundwater contaminant pathways so that appropriate measures can be taken if contamination threatens human or ecological receptors.

2.0 BACKGROUND

2.1 SITE DESCRIPTION. NAS Key West is located approximately 150 miles southwest of Miami in Monroe County, Florida (Figure 2-1). NAS Key West, a complex located in several areas of the Lower Florida Keys, encompasses approximately 5,000 acres. The majority of the facility's operations and activities are concentrated on Boca Chica Key and Thomas Key. The mission of NAS Key West is to maintain and operate facilities and provide services and materials to support operations of aviation activities and units designated by the Chief of Naval Operations.

The TPFF and USCG sites are located along the northern shore of Key West, south of Fleming Key Cut. The TPFF and the USCG facilities are bordered on the north by Fleming Key Cut, on the west by Man of War Harbor, on the east by Mustin Street, and on the south by Whiting Avenue. Piers D-1, D-2, and D-3, located at the USCG facility, serve as fuel depots for ships.

The TPFF is the location of several ASTs, as well as associated piping and various pumphouses used to transport fuel from the ASTs. The site entrance is located along Trumbo Road near Building D-19. Building D-19 is used as an office and storage facility by site personnel. Buildings D-3A and D-22 through D-26 are pumphouses, which are now used or were formerly used to transport fuel from the site. The TPFF is surrounded by an 8-foot-high chain-link fence. A concrete seawall extends along the northern perimeter of the site. The seawall is approximately 1-foot thick and extends to a depth of approximately 15 to 20 feet below land surface (bls).

The area within the fuel farm has been leased by the Navy to several contractors for the supply and transportation of fuel. During the CA, contractors using the tanks within the fuel farm included Avantra and the Key West Pipeline Company. The northeastern portion of the fuel farm contained six ASTs in a bermed area that was leased by the Key West Pipeline Company. The southern and western portion of the fuel farm, operated by Avantra, contained several cut and cover storage tanks that have been removed. The only remaining tanks within the fuel farm area at this time are three large ASTs operating in the area leased by the Key West Pipeline Company.

The land currently occupied by the USCG facility was previously occupied by NAS Key West. The property was leased by the Navy to the USCG in 1983. The facility primarily consists of two concrete piers (D-2 and D-3) and various buildings used to house operational and support services (maintenance shops, administration offices, living quarters, etc.). Pier D-1, located west of Trumbo Road and adjacent to the USCG property, is currently owned and operated by NAS Key West. Ships docking at Pier D-2 off-load fuel for storage at the TPFF. Fuel dispensers on Piers D-2 and D-3 are used to support USCG operations.

Several aboveground and underground fuel pipelines are located at the site (see Figures 2-2 and 2-3). Diesel fuel marine (DFM) and JP-5 pipelines are used to transport fuel to the fuel farm from Pier D-2 at the USCG facility. Several unused fuel pipelines are present at the TPFF site. An abandoned DFM pipeline extends from pumphouse D-26 near DFM Tank D-4 to another abandoned DFM pipeline located along the west fenceline of the site. An abandoned underground Bunker C oil pipeline reportedly existed along the western fenceline of the TPFF parallel to the abandoned DFM pipeline (see Figure 2-3).

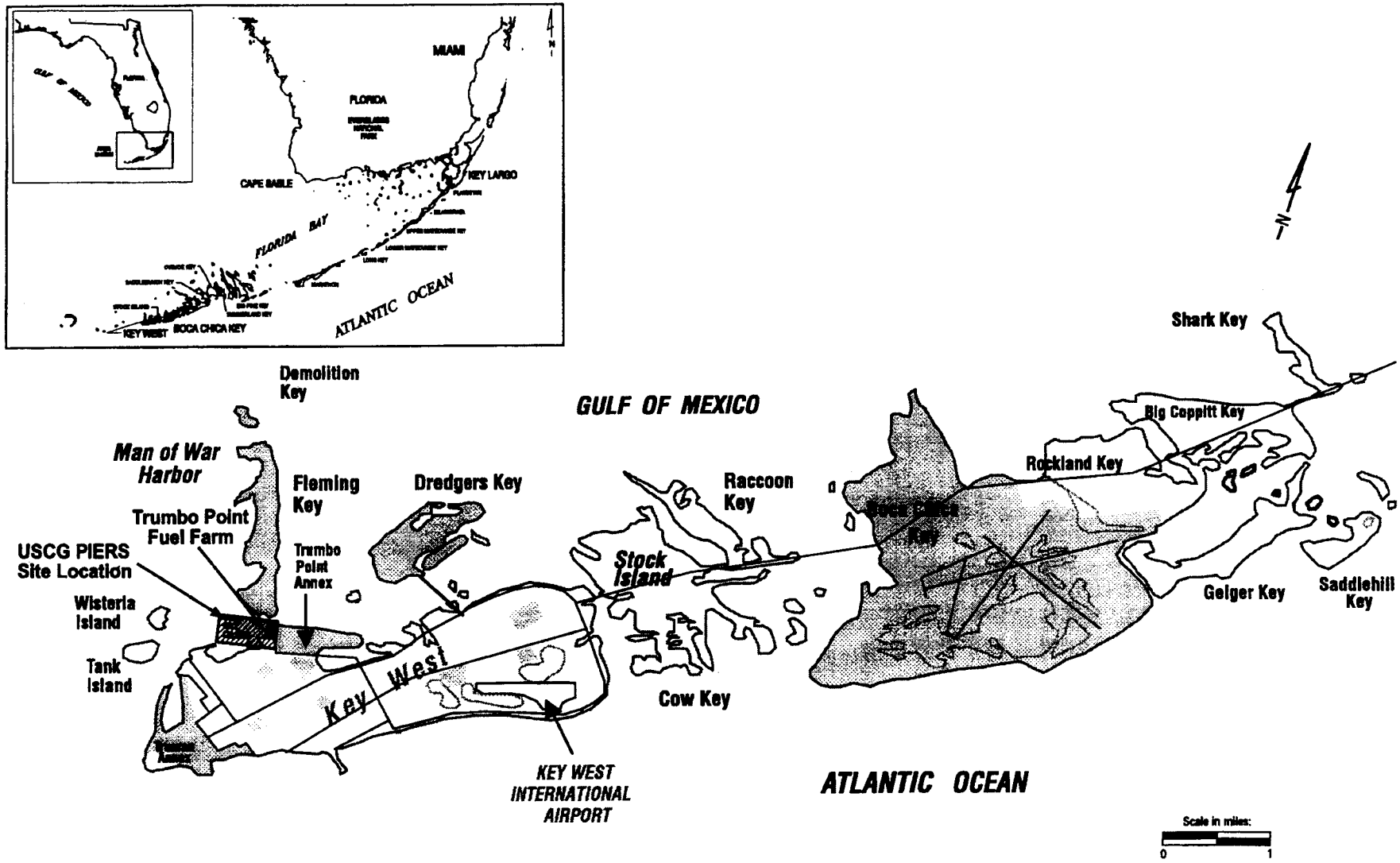

Figure 2-1
Site Location Map
Building 103 Truman Annex
NAS Key West
Key West, Florida

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Three abandoned underground pipelines are located under the USCG facility access road south of the tennis court. One pipeline was used to transport DFM and a second transported Bunker C oil. The third pipeline is described as a 4-inch sump. The pipelines continue west along the access road, then turn north near Building 103 toward the slip north of Pier D-2. Additional fuel pipelines were abandoned when fuel storage tanks south and west of the bermed area were removed.

An oily wastewater pipeline and a pump station are located on Pier D-1. The oily wastewater pipeline continues from the pump station to an oil-water separator located northwest of Building B-48 (see Figure 2-2). The pump station and oil-water separator are no longer in use. An oily wastewater pipeline and pump station located on the north side of Pier D-3 have never been used.

In addition to the various fuel pipelines, active and inactive, a large number of active buried utilities (electric, communications, water, and sewer), and abandoned utilities are present on the site (see Figure 2-3).

2.2 SITE HISTORY AND CURRENT SITE ACTIVITIES AND CONDITIONS. NAS Key West was first commissioned in 1917 and located on land leased from the Florida East Coast Railroad Company at Trumbo Point. Trumbo Point Annex was constructed in 1918 using dredged materials for use as a seaplane training and blimp facility. At the end of World War I, what is presently NAS Key West was decommissioned. With the outbreak of World War II, NAS Key West was recommissioned and expanded. Beginning in 1942, fuel has been brought into Trumbo Point by tanker and stored at the tank farm. Trumbo Point has been used for storage and distribution of fuels to both the Truman Annex and Boca Chica field. Fuels formerly stored at the fuel farm include Number 6 fuel oil, Bunker C oil, diesel fuel, JP-4, and JP-5. From 1973 to the late 1970s, one tank, D-21, was used for the storage of hazardous wastes that may have included waste oils, hydraulic fluids, solvents, pesticides, and polychlorinated biphenyls.

Until 1984, the TPFF consisted of 28 active fuel storage tanks. The removal of fuel storage tanks began after 1984. By 1988, only 15 tanks remained at the TPFF with 11 that were actively used. Presently within the TPFF, only three ASTs operated by the Key West Pipeline Company are being actively used. All cut and cover tanks have been removed.

Assessment activities for the site have included work by Geraghty & Miller in 1985 and by HLA in 1993, 1996, 1998, and 1999. Remedial activities at the site have included a pilot study by IT Corporation for the collection of free-phase product adjacent to former fuel Tank D-4 in 1990. The action by IT Corporation included the installation of a trench in the area of D-4 to recover free product and excavate excessively contaminated soil. Some of the observations from this activity indicated the following with regard to remediation at the site:

- A groundwater/product recovery system is not a feasible remediation alternative. Low hydraulic conductivity limits the formation of a capture zone, groundwater recovery, and transport of free product.

- The presence of free product indicated by measurements in monitoring wells near Tank D-4 does not correspond with observed accumulations of fuel in excavations or below surface structures in the same area.

Other remedial efforts performed by Bechtel in 1996 included the installation of another trench and recovery sump in the area of former storage Tanks D-2 and D-4. This effort did not result in significant product recovery either.

2.3 CAR SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS.

2.3.1 CAR Summary Based on the findings of the CA and subsequent field investigations and laboratory analytical results, the following is a summary of existing conditions at the site.

Aquifer Characteristics and Hydrogeologic Parameters Summary.

- The sediments encountered during drilling operations are generally composed of silty clay, oolitic lime mud, and oolitic limestone.
- Groundwater beneath the site was encountered at depths of approximately 4 to 6 feet bls and is classified as G-III.
- The direction of groundwater flow in the surficial zone has consistently been radially away from the TPFF and toward the northwest on the piers.
- The average hydraulic gradient in the shallow zone at the site ranges from 8×10^{-4} to 1×10^{-2} feet per foot (ft/ft).
- The average hydraulic gradient in the deep zone at the site ranges from 2.5×10^{-4} to 1×10^{-3} ft/ft.
- The hydraulic conductivity in the shallow zone at the site is 2.88×10^{-2} feet per day (ft/d).
- The hydraulic conductivity in the deep zone at the site is 1.63 ft/d.
- The shallow zone pore water velocity ranges from 5.12×10^{-5} to 6.4×10^{-4} feet per day (ft/day).
- The deep zone pore water velocity ranges from 2.04×10^{-3} to 8.15×10^{-3} ft/day.

Subsurface Soil CA Summary.

- Five areas of excessively contaminated soil, as defined by non-risk based cleanup standards, were identified by OVA headspace analyses. The largest areal extent of soil contamination is located immediately north of the JP-5 tanks. Other areas of excessively contaminated soil included Pier D-2 in the vicinity of Building 105, the area around the basketball court and softball field, the west end of Pier D-1, and the east end of Pier D-1 (see Figure 2-4). Excessively contaminated soil was detected mostly between the 4 and 6 feet bls interval.
- Four areas of excessively contaminated soil, as defined by non-risk based cleanup standards were identified by laboratory analysis: the former Tank D-5 area, the area around tank D-21, the area of the oil

water separator, and the area of the oily wastewater pump station on Pier D-1.

Additional Surface Soil Investigation Summary.

- Fourteen locations out of 36 non-background locations sampled had concentrations of one or more analytes above industrial soil cleanup target levels as defined in Chapter 62-730, FAC. This excessive contamination was due to high arsenic and PAH concentrations. The contamination is found scattered across former AST areas, although one very high (440 mg/kg) arsenic sample is associated with a pesticide-mixing building.

- When compared against a site-specific background screening level of 6.9 mg/kg, 13 locations out of 36 non-background locations sampled had concentrations of arsenic in surface soil above background. Figure 2-5 shows arsenic in surface soil above background.

Groundwater CA Summary.

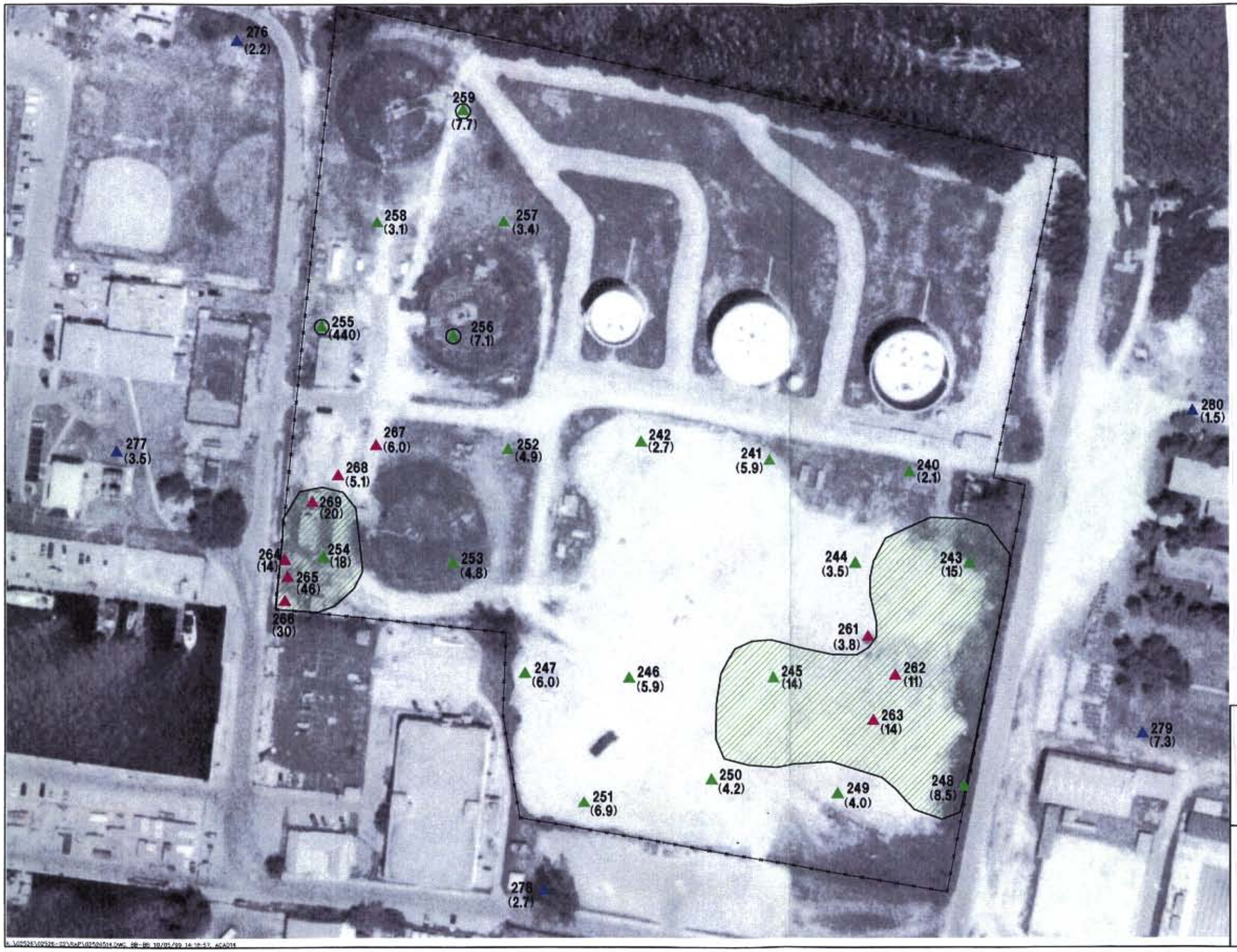
- Two areas of total volatile organic aromatics (VOA) contamination in groundwater were identified during the CA. One large area is in the northeast part of the fuel farm in the vicinity of the JP-5 tanks. The highest total VOA concentrations in this area were observed in MW-4 (1,193 micrograms per liter [$\mu g/\ell$]) and MW-60 (670 $\mu g/\ell$). The second smaller area is on the north side of Pier D-1 in the vicinity of the oily wastewater lines. Total VOA concentrations observed in MW-15 were 87.2 $\mu g/\ell$ (see Figure 2-6).

- The benzene contamination plume overlaps the area of total VOA contamination and is generally in the same location. The area of benzene contamination includes the former AVGAS AST area occupied by tanks D-15 through D-18 and the associated pipelines (see Figure 2-6). The highest benzene concentrations were in the groundwater samples collected from MW-4 (990 $\mu g/\ell$) and MW-60 (620 $\mu g/\ell$). This area of benzene contamination exceed the risk-based corrective action (RBCA) standard of 70 $\mu g/\ell$.

- Total naphthalenes concentrations in the samples collected from monitoring wells MW-15, MW-50, and MW-55 were 174 $\mu g/\ell$, 196 $\mu g/\ell$, and 1,750 $\mu g/\ell$, respectively. MW-15 is located on the north side of Pier D-1, MW-50 is located north of Building D-19, and MW-55 is located north of the Key West Pipeline Company JP-5 Tank No. 1 (see Figure 2-6).

- Two small areas of total recoverable petroleum hydrocarbons (TRPH) contamination in groundwater were identified. These areas are associated with samples collected from monitoring wells KWM-01 (15.7 milligrams per liter [mg/ℓ]) and MW-86 (5.1 mg/ℓ).

- Lead concentrations in all monitoring well samples did not exceed 50 $\mu g/\ell$.



N

LEGEND

- Arsenic above background
- 276 ▲ Background surface soil sample location and designation
- 242 ▲ Grid surface soil sample location and designation
- 267 ▲ Used oil surface soil sample location and designation
- (3.4) Arsenic concentration (in milligrams per kilogram)
- Fence

Notes:

1. Background concentration is 6.9 milligrams per kilogram.
2. Samples collected in April, 1999.

0 60 120
SCALE: 1 INCH = 120 FEET

FIGURE 2-5
ARSENIC IN SURFACE SOIL ABOVE BACKGROUND

REMEDIAL ACTION PLAN

TRUMBO POINT FUEL FARM
NAVAL AIR STATION KEY WEST
KEY WEST, FLORIDA

- Free-floating petroleum product was observed in 18 site monitoring wells during the CA.

- No potable water sources were identified within a 0.25-mile radius of the site. Water is supplied via aqueduct from the mainland.

2.3.2 CAR Conclusions Based on the findings of the CA and site conditions, the following can be concluded.

- Excessive subsurface soil contamination in the area of the former AVGAS ASTs and associated piping is apparently related to leaks or releases from the ASTs and the fuel lines in the northern area of the TPFF. Overall, soil contamination is limited to a 1- to 2-foot interval immediately above the water table.

- Excessive arsenic in surface soil contamination is limited to three small regions now former tanks D-1, D-2, and D-3; and one large region (>1 acre) now former tank D-5. Arsenic in surface soil may be associated with former pesticide use.

- The areal extent of groundwater contamination is associated with the areas of excessively contaminated soil.

- The vertical extent of groundwater petroleum contamination appears to extend to greater than 30 feet of the surficial aquifer. Laboratory results reported that contaminant concentrations in the groundwater sample collected from vertical extent well MW-74D (30 feet bls) are 38 $\mu g/\ell$ of benzene, 53.7 $\mu g/\ell$ of total VOA, and 19.2 $\mu g/\ell$ of total naphthalenes. MW-74D was resampled in July 1996 and analyzed for U.S. Environmental Protection Agency (USEPA) Method 602 only. Reported concentrations are 57 $\mu g/\ell$ of benzene and 66.6 $\mu g/\ell$ of total VOA.

- The source of groundwater contamination is apparently due to previous releases from the associated AVGAS fuel pipelines in the vicinity of the ASTs, releases from pipeline junctions, a release from the oily wastewater line, and a release from the oily wastewater pump station.

- There are no potable water wells within a 0.25-mile radius of the site and drinking water is obtained via aqueduct from the mainland. The risk to human health caused by groundwater contamination is extremely low.

- There is no evidence to indicate that groundwater contaminants are migrating off the facility. Contamination is moving toward Fleming Key Cut, but does not appear to be a threat to surface water. For this reason, groundwater contamination at the site appears to be a low risk to area fish and wildlife.

2.3.3 CAR Recommendations Based on the findings, conclusions, and interpretations of the CA, HLA recommends the development of a RAP. The primary contamination includes excessively contaminated soil, and benzene, total VOAs, naphthalenes, and TRPH in groundwater. Free-product recovery efforts initiated at the site should be continued. An RAP will be developed to address the requirements of Chapter 62-770, FAC.

3.0 REMEDIAL ALTERNATIVE SELECTION

The site possesses diverse characteristics that significantly affect potential exposure scenarios and the feasibility of potential remedial actions. Land use at the site ranges from park and recreation areas to port facilities for off-loading oil tankers. Groundwater flow conditions range from grass-covered aquifer zones with no subsurface obstructions to paved areas contained on three sides by steel sheetpile bulkheads. Furthermore, the site includes 21 distinct contaminant plumes that are separated not only by physical location, but also by contaminant characteristics. The conditions at this site are not those found at most petroleum-contaminated sites. Site activities, site ownership, ecological setting, and groundwater conditions are such that risk-based alternative cleanup target levels should be considered. For these reasons, and to simplify the evaluation of remedial alternatives, the site has been subdivided into land-use areas.

3.1 SITE PARTITIONING During the initial remedial evaluation of the TPFF area and each of the three piers adjacent to the fuel farm, it was identified that the site-specific characteristics, types of materials identified for remedial efforts, and the nature and varied activities of the site warranted a further breakdown of the site into action areas to address the site-specific remedial action needs. The separation of the site into five land-use areas is an attempt to focus the remedial efforts on the specific needs of each area. Due to the size of the facility at Trumbo Point, widely varying conditions exist across the site. The two primary variables on the site include the activities taking place at different parts of the site and the natural and/or man-made physical conditions of the site. Figure 3-1 shows the five land-use areas

3.1.1 Site Activities The 46-acre facility contains various activities performed by three separate groups. Operations on the facility include a commercial fuel supply contractor Key West Pipeline Company, the Navy Acoustics Warfare Center (NAWC) on Pier D1, and the USCG Station and USCG operations on Piers D2 and D3.

Piers D1 and D3 are presently separated for use by both the USCG and the Navy. The southern half of Pier D1 is enclosed and operated by the NAWC. The northern half of Pier D1 is leased to the USCG. The southern half of the pier D3 is enclosed and operated by the USCG. The northern half of Pier D3 along the Fleming Key Cut belongs to the Navy and does not have any specific use at this time. Both Pier D1 and the northern half of Pier D3 are scheduled to be transferred to the USCG within the next two years. A central area adjacent to Piers D2 and D3 is designated for the housing of USCG personnel and operation of the pier facility.

The fuel farm also has a split use. The bermed AST area is presently operated by the Key West Pipeline Company. The southern area of the fuel farm, formerly operated by Avantra, contained five cut-and-cover tanks during the CA, all of which have since been removed.

3.1.2 Physical Site Characteristics Groundwater beneath the site was encountered at depths of approximately 4 to 6 feet bls and is classified as G-III, non-potable water use. While the site has relatively homogenous geological

conditions, the man-made features on the site distinctly divide the site. All three piers are paved with asphalt or concrete with the exception of a small grassy area along the parking lot on Pier D2 and an oval shaped grassy area at the end of Pier D2. The USCG housing area adjacent to Piers D2 and D3 consist of a grassy area with several buildings, a basketball court, a baseball field, and a tennis court. One two-lane driveway extends north and south through the center of the housing area and then along the north and west of the housing area. The fuel farm consists of a large grassy area in the southern portion of the fuel farm and several bermed areas around the Key West Pipeline ASTs in the northern portion of the fuel farm.

Piers D2 and D3 are of similar construction, and have been extended twice in the past by placing a new perimeter of interlocking steel sheet piling outside the existing bulkheads and placing backfill in the interim space. Both piers have concrete bulkhead covers that extend to a depth of 3 feet below mean low water. Pier D1 has not been extended and has the original 1912 structure of wooden piles with a concrete cover to a depth of approximately 3 feet below mean low water. The expanses between the Pier D1 and D2 and between D2 and D3 are supported through interlocking steel sheet piling; however, the expanse of sheetpile between D2 and D3 does not have a concrete bulkhead. The areas north of the USCG housing area and the fuel farm are contained with an interlocking steel sheetpile wall with a concrete cover to a depth of 3 feet below mean low water that has been extended over the existing wooden pile structure. The areas to the east and south of the fuel farm area do not have any man-made subsurface walls.

<u>3.1.3 Site Land-use Areas</u> Given the site activities and site characteristics, the site can be broken down into the following five areas.

3.1.3.1 **Pier D1** This land-use area is similar to Piers D2 and D3 in that the surface is paved and activities are of a light industrial nature. However, at Pier D1 the waterfront has the original 1912 structure of wooden piles faced with concrete to 3 feet below mean low water. Three product contaminated regions are found in this area. One of these has no monitoring well; the easternmost of these is the only region that has evidence of mobile product.

3.1.3.2 **Piers D2 and D3** Piers D2 and D3 have unique features that allow them to be treated as a combined land-use area. A majority of the activities on these piers are activities related to the USCG. The structure of these piers is similar in design and condition. Activities on Piers D2 and D3 are of a light industrial nature.

3.1.3.3 **USCG Station** The USCG Station has unique features that allow it to be treated as a separate land-use area. The functions carried out in the station area are housing USCG personnel and administrative functions. The conditions at the USCG Station differ from the adjacent pier areas because the station does not face the water, includes large unpaved areas, and has few subsurface utilities and structures.

3.1.3.4 **Key West Pipeline Company Tank Area (ASTs)** The Key West Pipeline Company tank area is separated from the remainder of the fuel farm by earthen containment berms. This area is presently being operated by a commercial contractor and will continue to be operated under this contractor for the foreseeable future. The north boundary of the site is contained along the

Fleming Key Cut by an interlocking steel sheetpile bulkhead with a concrete cap to approximately 3 feet below mean low water.

3.1.3.5 **Navy Tank Area** The Navy tank area differs from the Key West Pipeline Company area in that no ASTs remain in the Navy tank area, and the Navy tank area does not face the waterfront. The expected future use for this area following the tank removal is expected to include varied industrial activities.

3.1.4 **Basis for Alternative Cleanup Target Levels** Contaminant concentrations corresponding to certain hazard indices or cancer risks (combined into one representative concentration) will be calculated for each of the five land-use areas. These will be compared to contaminant concentration data to identify low-risk subareas, which do not require remedial action. Concentrations will also be calculated that correspond to an upper limit of risk beyond which action will be required. Areas corresponding to these concentrations will be identified. Any remaining areas will be dealt with on a case-by-case basis. Various remedial alternatives will then be considered for each area or subarea.

3.2 **CHEMICALS OF CONCERN**. Petroleum contamination at the site appears to be the result of leaks and spills from the former ASTs, USTs, and associated piping. Arsenic contamination at the site appears to be the result of former application practices. Based on the available data, the Chapter 62-770, FAC, Gasoline and Kerosene Analytical Groups of contaminants, and arsenic, are potential chemicals of concern for soil and groundwater remedial efforts. These include the following:

- benzene, ethylbenzene, toluene, total xylenes, and methyl tert-butyl ether (MTBE);
- naphthalene and the 15 method-listed polynuclear aromatic hydrocarbons (PAHs);
- TRPH;
- 1,2-dichloroethane and other priority pollutant volatile organic halocarbons (for groundwater and surface water only);
- 1,2-dibromoethane (for groundwater and surface water only);
- total lead (for groundwater and surface water only), and
- arsenic (for surface soil only)

MTBE and TRPH were detected at concentrations below action levels as prescribed by Chapter 62-770, FAC; therefore, MTBE and TRPH are not considered to be site chemicals of concern.

3.3 **SUMMARY OF HUMAN HEALTH AND ECOLOGICAL RISK EVALUATION**. A risk evaluation was completed to characterize the human health and ecological risks associated with potential exposures to site-related contaminants in environmental media at the site. A summary is presented here. The complete risk evaluation is presented in Appendix A.

3.3.1 **Summary of Human Health Risk Evaluation** The purpose of the human health risk evaluation is to determine if contamination at the NAS Key West TPFF sites could pose a potential health risk to individuals under current and/or foreseeable future site conditions in the absence of remediation. The risk evaluation was conducted in accordance with FDEP Petroleum Contamination Site Cleanup Criteria (Chapter 62-770, FAC). Other risk guidance from appropriate USEPA sources included: Risk *Assessment Guidance for Superfund, Volume 1, Human Health Evaluation Manual (Part A)* (USEPA, 1989a), *Guidance for Data Usability in Risk Assessment (Part A), Final* (USEPA, 1992a), Region IV Risk Assessment Guidance (USEPA, 1995a).

Based on geography and land use, the site has been divided into five areas. These areas are Pier D-1, Piers D-2 and D-3, the USCG Station, the Navy Fuel Tanks, and the Key West Pipeline Tanks area. The five areas were evaluated separately in this analysis.

Pier D-1 Risk Summary. The entire site is covered with concrete and no surface soil is present. For current and future land use, excavation worker exposures to subsurface soil and a worker washing his hands with groundwater were evaluated. For all exposure scenarios, both cancer and noncancer risk estimates are below USEPA levels of concern

Piers D-2 and D-3 Risk Summary. The entire site is covered with concrete except for a small area at the end of Pier D-2 and no natural surface soil is present. For current and future land use a worker washing his hands with groundwater was evaluated. For this exposure scenario, both cancer and noncancer risk estimates are below USEPA levels of concern.

The USCG Station Risk Summary. The site is partially covered with concrete with open areas consisting of athletic fields and landscaped areas. The material used to develop these areas was brought in for that purpose. For current and future land use a worker washing his hands with groundwater was evaluated. For this exposure scenario, both cancer and noncancer risk estimates are below USEPA levels of concern.

Navy Tank Farm Risk Summary. The Navy Tank Farm site is an area of bare ground and debris located between the USCG Station and the Key West Pipeline Fuel Tanks. In the past, above ground fuel tanks were located on this site. The tanks have been removed, but some minor rubble and debris currently remains. The surface of the area can best be described as crushed marl rock with an average particle diameter of 3 mm. Some paved and unpaved roads are also present at the site. For current and future land use, excavation worker exposures to subsurface soil and a worker washing his hands with groundwater were evaluated. For all exposure scenarios, both cancer and noncancer risk estimates are below USEPA levels of concern.

The cancer risk for the part-time "snow-bird" resident and occupational worker surface soil exposure were identical. The 1x10-6 RGO for arsenic in surface soil is 3.3 mg/kg. This RGO level is much less than the site-specific background. Therefore the recommended RGO for arsenic in surface soil is the background value of 6.9 mg/kg.

Key West Pipeline Tanks Area Risk Summary. The Key West Pipeline Tanks area is the site of above ground fuel tanks, located north of the Navy Tank Farm. The

tanks are surrounded with crushed marl berms. The surface of the area can best be described as crushed marl rock with an average particle diameter of 3 mm. Some unpaved roads are also present at the site. For current and future land use, excavation worker exposures to subsurface soil and a worker washing his hands with groundwater were evaluated. For all exposure scenarios, both cancer and noncancer risk estimates are below USEPA levels of concern.

An RGO for benzene was calculated for groundwater at the Key West Pipeline Tanks area. The 1x10-6 RGO value for benzene is 70.75 $\mu g/\ell$.

3.3.2 Summary of Ecological Risk Evaluation The ecological risk evaluation evaluates potential adverse effects to ecological receptors associated with exposure to petroleum products from TPFF, NAS Key West. The ecological evaluation follows current guidance materials including the following:

- *Risk Assessment Guidance for Superfund Environmental Evaluation Manual* (USEPA, 1989)
- *Ecological Assessment of Hazardous Waste Sites: A Field and Laboratory Reference* (USEPA, 1989)
- *Framework for Ecological Risk Assessment* (USEPA, 1992)
- *Supplemental Guidance to RAGS: Region 4 Bulletins on Ecological Risk Assessment* (USEPA, 1995)
- *Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments* (USEPA, 1997)
- *Guidelines for Ecological Risk Assessment* (USEPA, 1998)
- Standard Guidelines for Risk-Based Corrective Action Applied at Petroleum Release Sites, American Society for Testing and Materials (ASTM, 1997)

All potential routes of exposure are considered in the ecological risk evaluation. The evaluation identified those chemical pathways representing the greatest potential risks to native receptors likely to be present at the site. Migration of contaminants from the site into surface water or sediment adjacent to TPFF represented the pathway with the highest probability to adversely affect receptors. Surface water, sediment, and fish tissue samples were collected for the ecological risk evaluation.

Analytes detected in the surface water were below the state and federal regulatory levels and should not present a risk to marine receptors. Sediment samples contained twelve PAHs, lead, and TRPH. While most of the PAHs exceeded Florida sediment TEL values, only four exceeded the USEPA sediment screening criteria and no PAHs exceeded the PEL.

Lead was detected in all sediment samples at concentrations greater than the state and federal sediment screening criteria. Lead concentrations ranged from 30.4 to 732 mg/kg with a mean of 159. Excluding the highest concentration of 732 mg/kg, the average concentration for the remaining samples is 44 mg/kg, which is

less than the PEL concentration for lead of 112 mg/kg. This suggests a lead hot spot.

Twenty-three fish were collected and analyzed for petroleum related chemicals. No contaminants were detected in fish tissues; therefore, it is assumed that contaminants in surface water and sediment are not present at concentrations that will present a significant risk to top predators.

In summary, because the land use is industrial and the petroleum releases were mostly underground, it is unlikely that terrestrial wildlife will be adversely effected. There is a slight increase in the potential risks to ecological receptors as a result of exposure to PAHs in sediments. However, the PAHs are characteristic of urban areas. Based on the lead concentrations found in sediment samples at TPFF, adverse ecological effects could occur. Additional sampling for lead around sediment location 01D00801 may be warranted.

3.3.3 Total Risk Analysis The risk evaluation at NAS Key West TPFF demonstrates that, under reasonable exposure assumptions, no unacceptable human health or ecological risks are present at the site. Additional investigation of lead-contaminated sediments at sample location 01D00801 is recommended, but should be performed independent of this RAP. The groundwater at the Key West Pipeline area may need some engineering or land use controls due to benzene in the groundwater. However, there are no complete exposure pathways for either humans or ecological receptors. The area is covered with crushed marl and is unsuitable for residential development in its existing condition. Sheet piles at the piers contain the groundwater and there is no complete pathway for groundwater contamination to impact either the surface water or the sediment. The site poses no unacceptable health risks to either human or ecological receptors.

3.4 CLEANUP TARGET LEVELS. Based on the site specific risk evaluation and current and future land use, cleanup target levels have been developed for the Navy Tank Farm area and the Key West Pipeline area.

For the Navy Tank Farm area the cleanup target level for arsenic in surface soil in is 6.9 mg/kg. This is equivalent to the site-specific arsenic background concentration.

For the excavation and treatment of free product contaminated soil in the Navy Tank Farm area (free product areas FP-16 and FP-17) the cleanup target levels for treated soil will be the industrial values established in Table IV, Chapter 62-770, FAC.

For benzene in groundwater in the Key West Pipeline area the cleanup target level is 70 $\mu g/\ell$. The 1x10-6 RGO for benzene of 70.75 $\mu g/\ell$ and the Florida Surface Water Quality Standard for Class III surface water of 71.28 $\mu g/\ell$ were considered in establishing the cleanup target level for benzene in groundwater.

3.5 EXTENT OF CONTAMINATION. Section 2.3.1 summarized the data and conclusions from the CAR on the extent of contamination. As was noted in that section, sample concentrations were classified as "excessively contaminated" or "contaminated" on the basis of the default Section 62-770, FAC, soil cleanup target levels. With the benefit of the RBCA Standards the contaminated areas can

be reclassified on the same basis as what will be used for determining the remedial action(s).

3.5.1 Groundwater Contamination The application of RBCA Standards reveals that only one area has excessively contaminated groundwater. The region on the east side of the Key West Pipeline Company has benzene levels above the site-specific RBCA standard of 70 $\mu g/\ell$. This groundwater plume is associated with a free-product plume found under the Key West Pipeline Company JP-5 Tank 1 and 2, and is assumed to extend beneath that product plume. Other areas of excessively contaminated groundwater are assumed to exist below the free-product plumes discussed below.

3.5.2 Soil Contamination Soil contamination was delineated by OVA headspace readings taken both on the surface and in the soil subsurface.

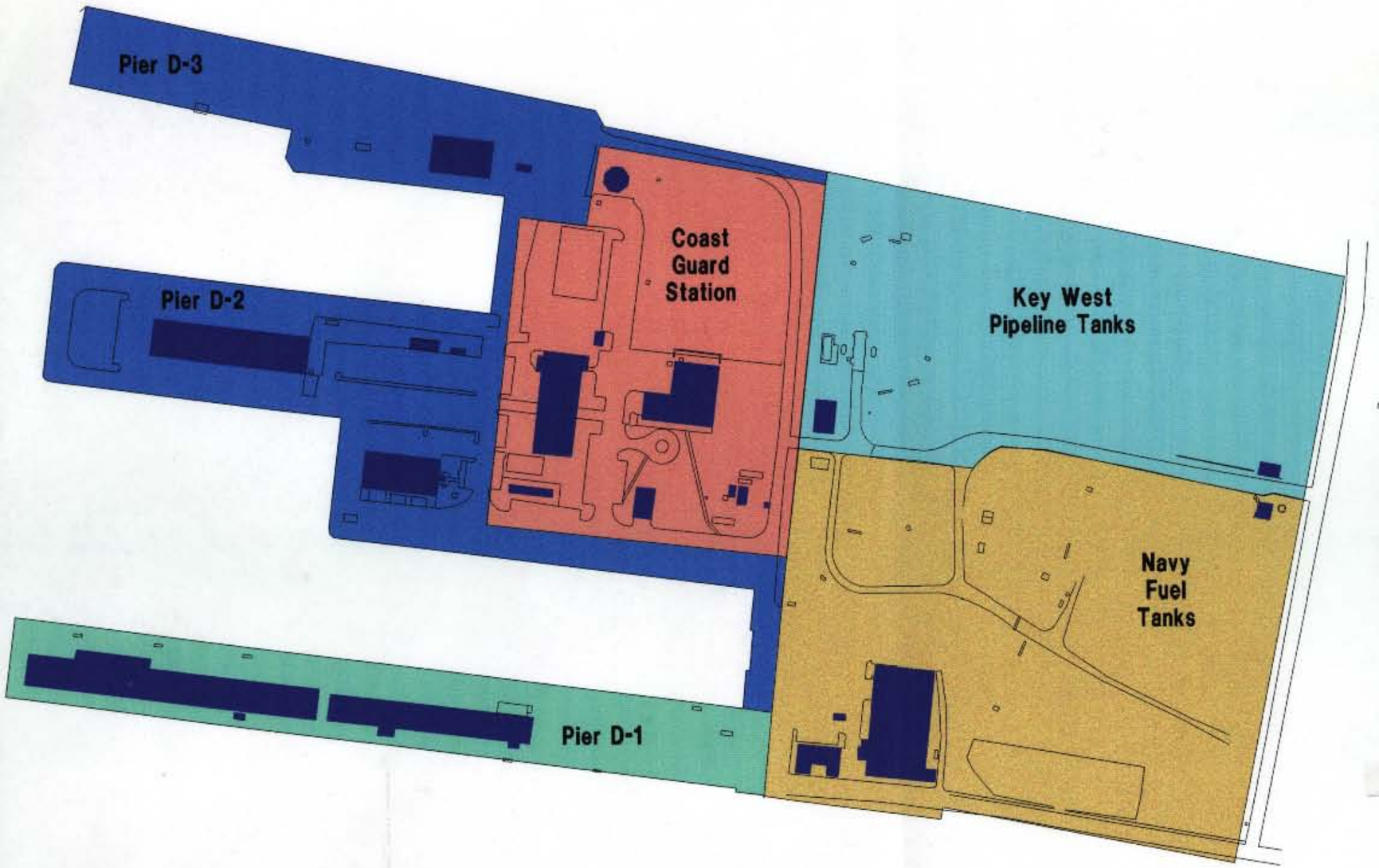
3.5.2.1 **Subsurface Soil** Subsurface soil samples were taken for laboratory analysis in the former Tank D-5 area, the Tank D-21 area, the oil-water separator area, and the area of the oil-water pump station on Pier D-1. The site-specific risk assessment determined that contaminants in the subsurface soil do not pose any unacceptable risk.

3.5.2.2 **Surface Soil** Surface soil sampling was completed in April of 1999. Analytical results show arsenic concentrations above the site background screening concentration of 6.9 mg/kg.

3.5.3 Free Product Areas of product contamination were delineated during the 1993 PCA and the 1996 CA by

- OVA readings during advancement of soil borings and installation of monitoring wells;
- direct observation of soil samples taken during advancement of soil borings and installation of monitoring wells; or
- product measurements by bailer or product-water interface probe in completed monitoring wells.

Figure 3-2 shows areas of product-contaminated soil overlain on the five land-use areas defined in Section 3.1. For the purposes of this RAP, product areas FP-3, FP-4, and FP-8 are considered part of the USCG Station land-use area, whereas area FP-18 is considered part of the Piers D2 and D3 land-use area. This was done so that the product areas in question would be grouped in the more stringently examined land-use area of the two land-use areas the product areas overlap. Not all areas of product contamination show evidence of mobile product. The product-contaminated areas are labeled FP-1 through FP-21. The product-contaminated areas are grouped by land-use area in Table 3-1 and in the discussion that follows. In Table 3-1 the volume of contaminated soil was determined by multiplying the area of each product-contaminated region by the product-layer thickness. The product-layer thickness was itself determined as the difference between the depth to topmost contamination and the depth of lowest groundwater noted in the product-contaminated region, with 1 foot added to the



N

LEGEND

Buildings

LANDUSE AREAS

Coast Guard Station

Key West Pipeline Tanks

Navy Fuel Tanks

Pier D-1

Piers D-2 and D-3

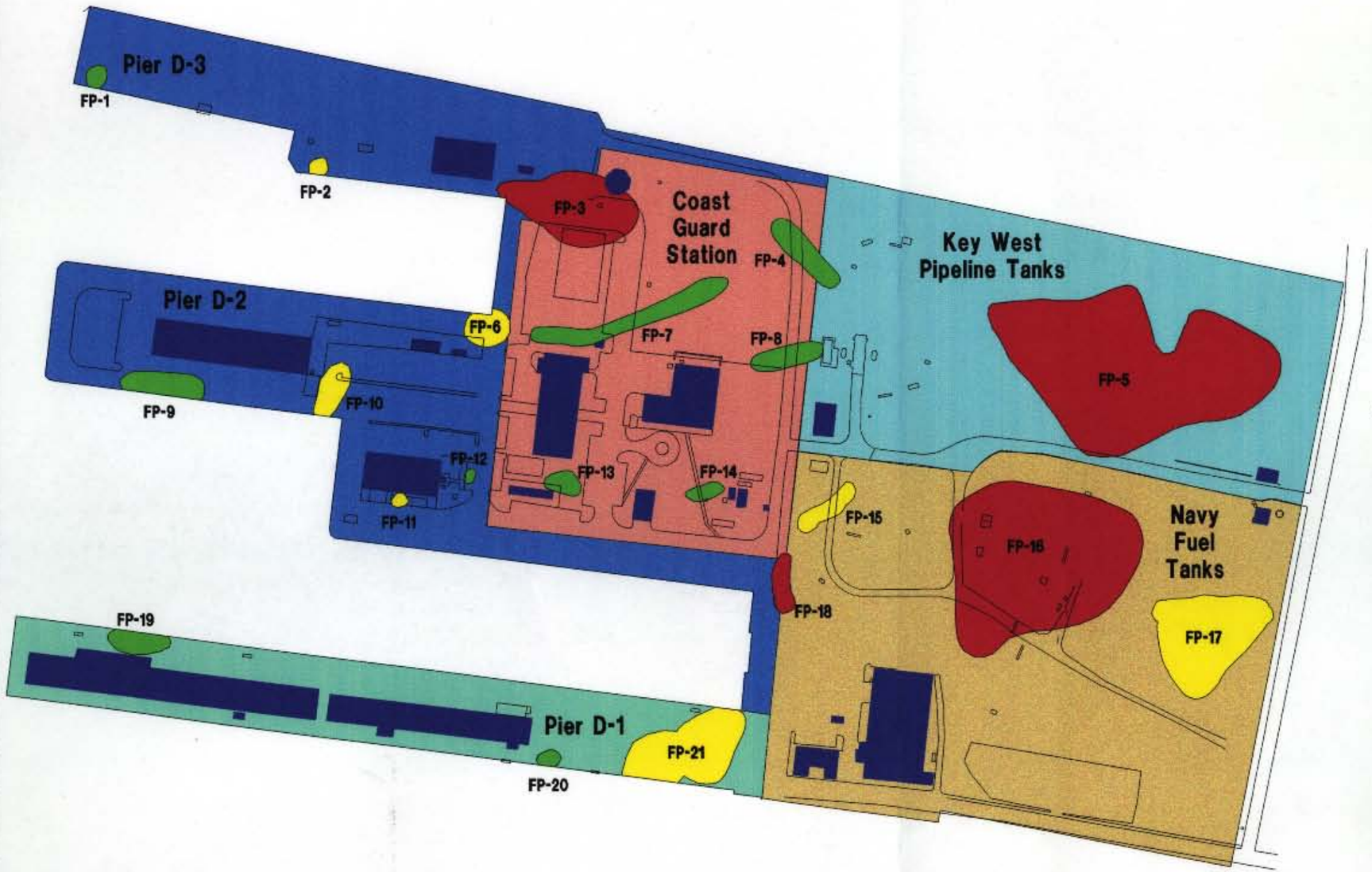
0 100 200

SCALE: 1 INCH = 200 FEET

FIGURE 3-1
LAND USE AREAS

REMEDIAL ACTION PLAN

TRUMBO POINT FUEL FARM
NAVAL AIR STATION KEY WEST
KEY WEST, FLORIDA



N

LEGEND

Buildings

PRODUCT CONTAMINATED SOIL AREAS

No mobile product

Less than 0.1 foot mobile product

Greater than 0.1 foot mobile product

LANDUSE AREAS

Coast Guard Station

Key West Pipeline Tanks

Navy Fuel Tanks

Pier D-1

Piers D-2 and D-3

0 100 200

SCALE: 1 INCH = 200 FEET

FIGURE 3-2
PRODUCT CONTAMINATED SOIL AREAS

REMEDIAL ACTION PLAN

TRUMBO POINT FUEL FARM
NAVAL AIR STATION KEY WEST
KEY WEST, FLORIDA

Table 3-1
Characteristics of Product - Contaminated Areas

Remedial Action Plan
Trumbo Point Fuel Farm
Naval Air Station Key West
Trumbo Point Annex, Key West, Florida

Product Area ID	Area (ft^2)	Volume Contaminant Soil (yd^3)	Estimate Mobile Product Volume (gallon)	Maximum Contaminant Layer Thickness (ft)	Product Description	Surface Condition	Monitoring Well in Product Area?
Piers D2 and D3							
FP-1	1,080	40	0	1	Red-brown medium-high viscosity	Paved	No
FP-2	758	84	6	3	Dark red-brown, medium-high viscosity	Paved	No
FP-6	3,662	678	41	5	Black, high viscosity	Paved	Yes
FP-9	4,913	182	2	1	Dark red, high viscosity	Paved	Yes
FP-10	3,821	283	561	2	Black red-brown, degraded	Paved	Yes
FP-11	503	19	4	1	Brown-black, medium-high viscosity	Paved	No
FP-12	370	41	0	3	Red-brown, medium viscosity	Paved	No
FP-18	3,837	400	5,747		Yellowish-gray, degraded	Partially Paved	No
Coast Guard Station							
FP-3	22,333	2,948	15,095	4	Black, dark red-brown, high viscosity	Partially Paved	Yes
FP-4	5,225	774	2	2	No data	Partially Paved	Yes
FP-7	9,502	1,408	3	4	Dark red-brown to black, medium viscosity, degraded	Partially Paved	Yes
FP-8	3,867	430	1	3	Red-brown, medium to high viscosity	Partially Paved	No
FP-13	1,877	209	1	3	Dark brown to black, high viscosity, degraded	Part under Flammable Storage	Yes
FP-14	1,352	250	0	5	Dark red-brown to black, high viscosity, degraded	Unpaved	No

See notes at end of table.

Table 3-1 (Continued)
Characteristics of Product - Contaminated Areas

Remedial Action Plan
Trumbo Point Fuel Farm
Naval Air Station Key West
Trumbo Point Annex, Key West, Florida

Product Area ID	Area (ft^2)	Volume Contaminant Soil (yd^3)	Estimate Mobile Product Volume (gallon)	Maximum Contaminant Layer Thickness (ft)	Product Description	Surface Condition	Monitoring Well in Product Area?
Pier D1							
FP-19	3,218	358	1	3	Brown, degraded	Paved	Yes
FP-20	848	157	0	5	Grayish brown, opaque, very degraded	Paved	No
FP-21	20,309	3,196	212	5	Dark red to dark gray, low to medium viscosity, degraded	Paved	Yes
Key West Pipeline Tanks							
FP-5	205,963	8,320	28,499	6	Pale yellow to golden, low viscosity	Unpaved	Yes
Navy Tank Area							
FP-15	4,116	357	31	3	Brown to grayish brown, opaque, degraded	Unpaved	Yes
FP-16	67,873	5,086	79,496	2	Varied	Unpaved	Yes
FP-17	22,701	3,365	931	4	Brown to blue-black opaque, medium to high viscosity	Unpaved	Yes

Notes: ID = identification.
ft^2 = square feet.
yd^3 = cubic yard.

product thickness as a factor of safety. The mobile product volume was estimated by:

- averaging over time product-thickness levels noted in individual soil borings and monitoring wells (with the monitoring well data corrected to give an in-soil value),

- determining product-thickness areas within the product-contaminated regions corresponding to each monitoring well or soil boring (occasionally grouping together soil borings and/or monitoring wells that have similar time-averaged thickness values), and

- multiplying each product-thickness by each product-thickness area, summing the results, and multiplying that sum by the porosity value given in the CAR (0.45) (ABB-ES, 1996).

Piers D2 and D3. This land-use area is characterized by paved surfaces, a waterfront bulkhead consisting of interlocking sheet piling covered by concrete to 3 feet below mean low water, and activities of a light industrial nature. Product-contaminated regions in this land-use area include FP-1, FP-2, FP-6, FP-9, FP-10, FP-11, FP-12, and FP-18. Regions FP-1 and FP-12 show no evidence of mobile product; however, no monitoring wells have been installed in these regions. Region FP-18 also has no monitoring wells, but evidence of product was found in soil borings in the region. Region FP-9, which encompasses two monitoring wells, has never shown product in the monitoring wells. Evidence of petroleum contamination was found during the advancement of soil borings, but the mobility of this product has never been demonstrated. The remaining regions, FP-2, FP-6, FP-10, and FP-11, all present indications of mobile product, from product accumulation in either monitoring wells or in groundwater samples taken from boreholes. Regions FP-2 and FP-11 do not have monitoring wells.

USCG Station. This land-use area is characterized by grassy surface cover interspersed with partially paved areas and with buildings, without waterfront areas. The land-use area is occupied by USCG administrative offices and personnel quarters. It includes product-contaminated regions FP-3, FP-4, FP-7, FP-8, FP-13, and FP-14. Regions FP-4, FP-7, and FP-13 had product visible during soil boring advancement, but no mobile product evident in subsequently installed monitoring wells. Regions FP-8 and FP-14 only showed evidence of residual product during soil boring advancement, but lack monitoring wells. FP-3 showed evidence of mobile product in both soil borings and monitoring wells.

Pier D1. This land-use area is similar to Piers D2 and D3 in that the surface is paved and activities are of a light industrial nature. However, at Pier D1, the waterfront has the original 1912 structure of wooden piles covered with concrete to 3 feet below mean low water. Product contaminated regions in this land-use area include FP-19, FP-20, and FP-21. Region FP-20 includes no monitoring wells; Region FP-21 is the only region that has evidence of mobile product.

Key West Pipeline Company Tanks. This land-use area is separated by a berm from the rest of the site, and has little paved surface area. Activities in this area include operation of three large ASTs by the Key West Pipeline Company. The north side of the area faces Fleming Key Cut, and is faced by a bulkhead similar in construction to the waterfront bulkhead on Piers D2 and D3. The only product-

contaminated region in the land-use area is FP-5. FP-5 covers a large area, includes several monitoring wells, and shows evidence of mobile product.

Navy Tank Area. This land-use area includes few paved surface areas, but several buildings. Future uses are expected to be of a varied industrial nature. The land-use area does not face any waterfront. Product-contaminated regions in this area are FP-15, FP-16, and FP-17. FP-15, FP-16, and FP-17 all have mobile product and monitoring wells. Because FP-16 and FP-17 are accessible, the Navy has agreed to use excavation to remove free product in these areas.

3.5.4 Sediment Sediment sample D008 shows contamination levels for lead and PAHs elevated far above risk-based standards. Although the contamination could be associated with product contamination on Pier D2, it is also quite possible that the contamination resulted from fueling activities in the dock areas, from the lead-based paint used on ships in the dock areas, or that the contamination is associated with sediment transported from another location by an undersea current. In any case, further investigation or action regarding this sample is beyond the scope of this document. It is recommended that the matter be pursued further as a separate action.

3.6 SITE-SPECIFIC LIMITATIONS TO ALTERNATIVES. Site-specific limitations often exist that can affect remedial alternative selection. At the TPFF site, several factors that should be considered in the design process are the low permeability of the soil at and below the water table, the shallow water table, the surface cover composed of hard, sandy limestone fill on the site, and the groundwater containment already afforded by the pier seawalls. Furthermore, access to the site is limited. Subsurface features such as storm water sewers, electric lines, telephone lines, and service lines are found at the site. These subsurface features should be located through the Base Public Works Department prior to any excavation, drilling, or trenching activities at the site.

3.7 REMEDIAL STRATEGY. The remedial option or options chosen for NAS Key West TPFF should, as much as is possible:

- eliminate the potential for exposure to groundwater contaminated above human-health and ecological risk-based alternative groundwater cleanup standards;
- prevent any contamination of surface water to a level above human-health and ecological risk-based alternative cleanup standards for surface water;
- eliminate the potential for future exposure to groundwater or surface-water contamination posed by the product-contaminated areas; and
- eliminate the potential for exposure to contaminated surface soil.

There are 21 product-contaminated regions, which are found in a wide variety of settings. Therefore, more than one remedial option may be implemented for the product-contaminated regions. To simplify matters, the product-contaminated regions will be grouped by land-use area as discussed above or otherwise grouped where appropriate.

3.8 ALTERNATIVES CONSIDERED. Because cleanup technologies applicable to sites contaminated with petroleum substances are continually being improved and developed, it is important to develop remedial action alternatives using the most effective technologies available.

Appendix B provides a detailed discussion of the alternatives that were evaluated for this RAP.

3.9 ALTERNATIVE SELECTED. The following are brief explanations of the selected remedies:

1. **Soil Washing**. In areas that are accessible, free product and contaminated subsurface soil will be excavated and treated onsite using soil washing.

2. **Excavation**. To prevent exposure to arsenic in surface soil, areas that exceed the background value for arsenic will be excavated. Excavated material will be disposed of offsite in a permitted facility.

3. **Free-Product Recovery**. In areas that are not accessible to excavation, free product will be recovered actively using multiphase extraction vacuum trucks and passively using in-well passive product skimmers.

4. **Natural Attenuation with Contingency**. Groundwater will be monitored for natural attenuation. If dissolved phase contaminants reach point of compliance wells located in the easternmost portion of the site, the existing seawall will be extended.

5. **Land Use Controls**. Land-use controls will be established to manage exposure through institutional controls.

4.0 RECOMMENDED REMEDIAL ACTION

The recommended remedial action for the TPFF site at NAS Key West consists of soil excavation and treatment, product recovery using multiphase extraction and passive in-well skimmers, monitored natural attenuation, and land-use controls. These actions will cost effectively minimize environmental risks while maintaining and enhancing favorable site conditions.

4.1 *EX SITU* SOIL WASHING. One part of the recommended remedial action for the TPFF site consists of source abatement through excavation of product-saturated soils in two accessible areas of known free-product contamination, FP-16 and FP-17. The areas of excavation are shown on Figure 4-1. The excavation areas represent areas where the most contaminant mass can be removed economically. The methodology used to determine the excavation areas is presented in Appendix C.

Excavation and on-site treatment through the use of soil washing is recommended. Excavation shall be to a depth of 7 feet bls. The soil from 0 to 4 feet bls is considered clean and does not require treatment. The total volume of soil to be excavated is 9,300 cubic yards (approximately 14,000 tons) with approximately 4,000 cubic yards (6,000 tons) of soil requiring treatment. Soil volume calculations are presented in Appendix C, Engineering Calculations. The excavation will include the evacuation and capping or removal of any abandoned fuel distribution lines encountered. Existing buried electrical lines and aboveground transformers must be relocated before excavation begins.

4.1.1 Pretreatment Sampling Based on the volume of contaminated soil expected, 11 composite pretreatment samples must be analyzed for VOAs, TRPHs, and naphthalenes in accordance with Chapter 62-775.410, FAC. Each composite soil sample must be collected from at least four locations in the contaminated area and may be taken while performing the excavation.

4.1.2 Excavation Excavation shall be conducted using standard earth-moving equipment. All operators will be certified by the Occupational Safety and Health Administration. OVA headspace analyses will be performed at set intervals during the excavation to monitor soil contaminant levels; however, visual inspection and knowledge of the apparent extent of free-product will be used to delineate the area to be removed and treated. Excavation to a depth approximately 1 foot below the mean low groundwater table is necessary to implement free-product removal. Excavated soil should be loaded directly into trucks to facilitate immediate site removal and delivery to the treatment area and to prevent spreading of the contaminated soil at the site. If free product is encountered in ponded water within the excavation, it shall be removed with absorbent pads.

4.1.3 Soil Washing Excavated soil will be treated using the Ion Collider Process (ICP). The ICP is an innovative technology used to treat petroleum contaminated soil. A detailed description of this technology is provided in Appendix D. This technology was successfully pilot tested at the Flying Club Site on Boca Chica in 1998. Figure 4-2 shows the process flow diagram for this technology. Excavated soils are run through a series of conveyors and sprayed with a mixture of ionized water and potassium permanganate ($KMNO_4$). Treated soil is stockpiled and tested after a 48-hour waiting period. Treated soil is then

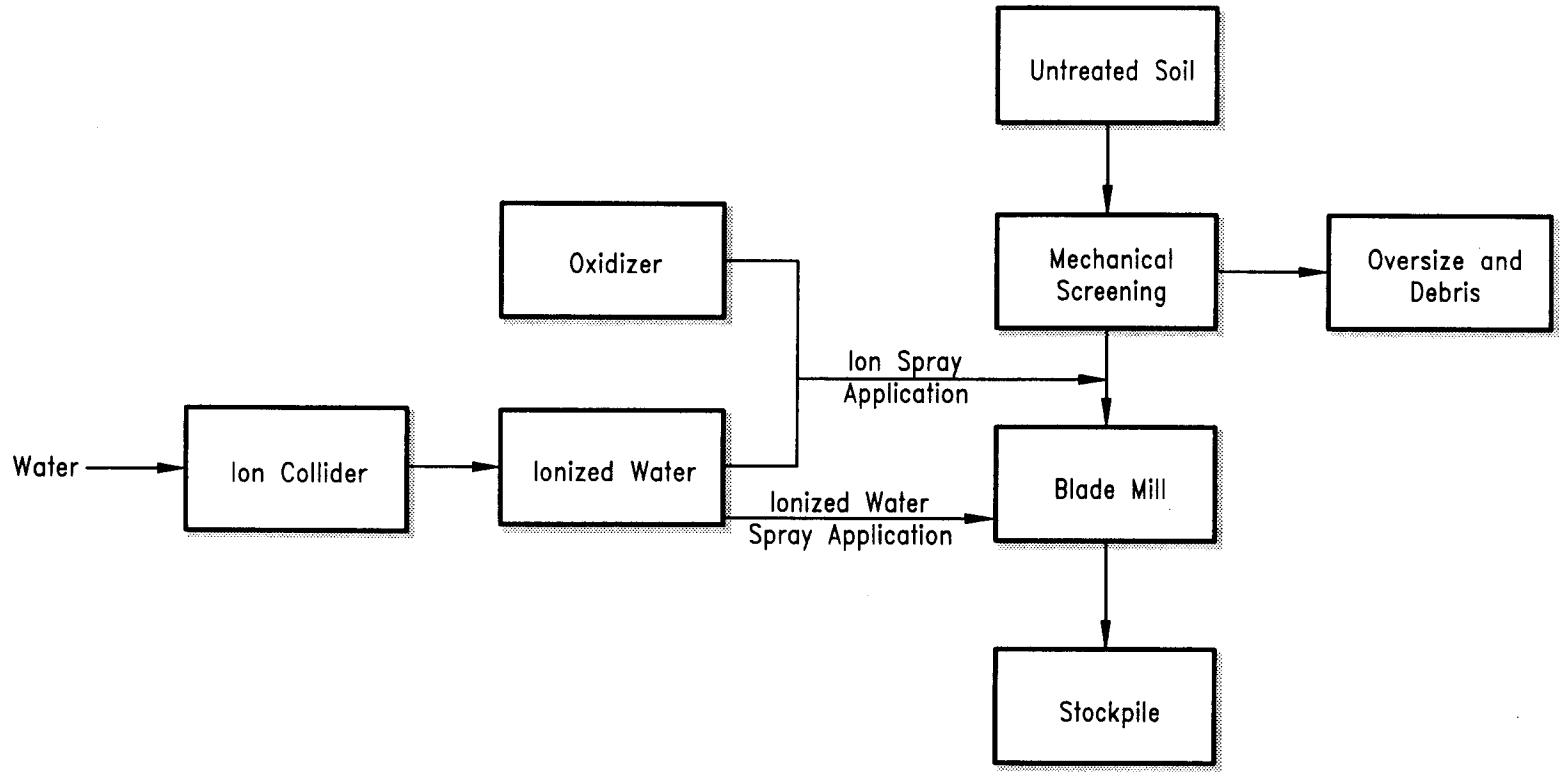


FIGURE 4-2
SOIL TREATMENT PROCESS FLOW DIAGRAM

REMEDIAL ACTION PLAN

TRUMBO POINT FUEL FARM
NAVAL AIR STATION KEY WEST
KEY WEST, FLORIDA

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returned to the excavation, compacted to 85 percent Modified Proctor, and the site reseeded. Signed and sealed as-built drawings shall be provided upon project completion.

4.1.4 Confirmatory Sampling Following treatment composite soil samples shall be collected from each stockpile at the rate of one sample per 400 tons. Confirmatory samples shall be analyzed for total VOAs (USEPA Method 8020), TRPH (FL-PRO), and PAHs (USEPA Method 8270). Soil that meets the direct exposure industrial values listed in Chapter 62-770, FAC, shall be considered clean and suitable for backfill.

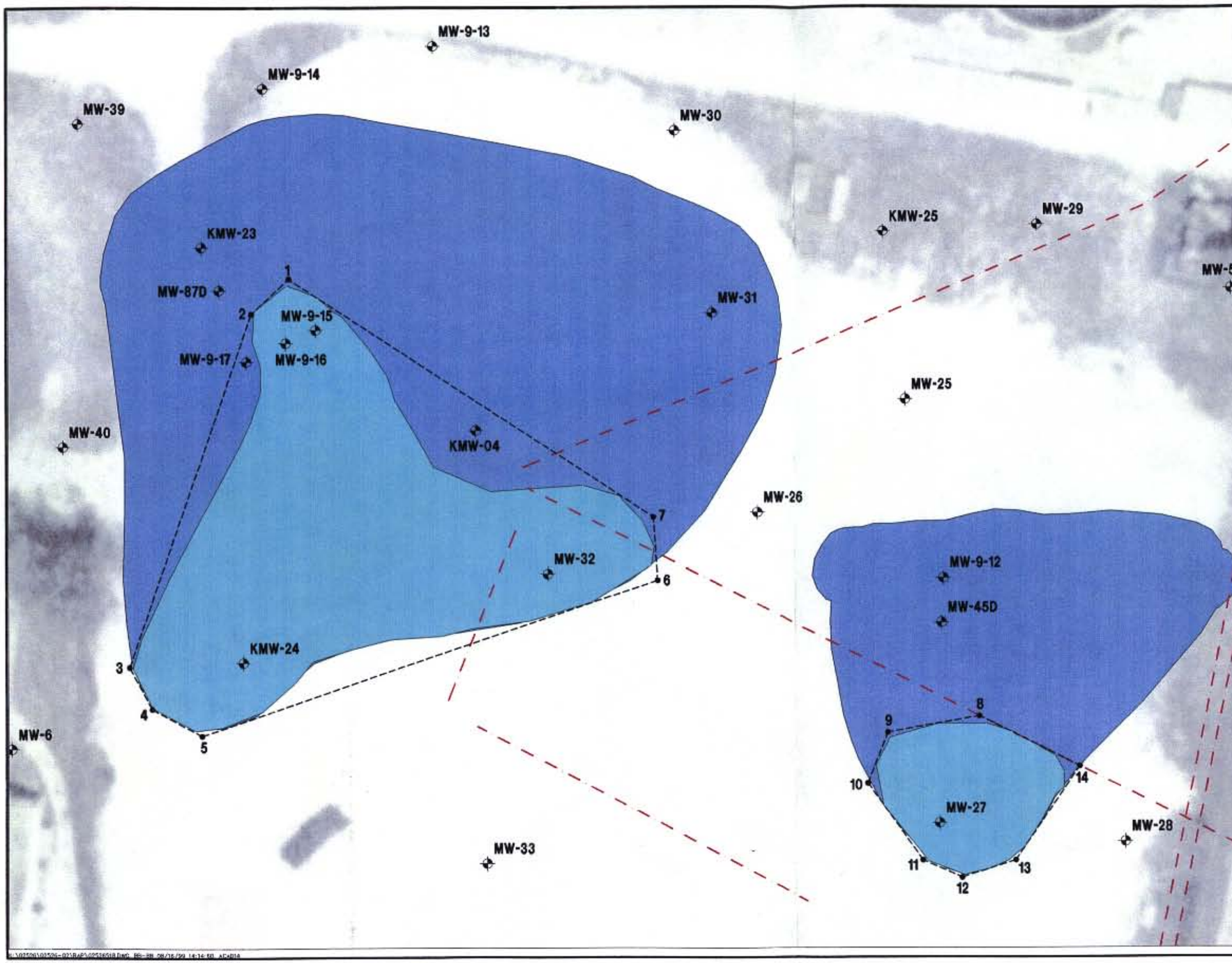
4.2 EXCAVATION. Arsenic in surface soil was found above the site-specific background concentration of 6.9 mg/kg at five areas within TPFF (Figure 4-3). Three of the areas are within the Key West Pipeline land use area and two of the areas are within the Navy Fuel Tanks land use area. Sample number 255 had the highest concentration, 440 mg/kg. The two other areas located in the Key West Pipeline land use area, samples 256 and 259, had concentrations above background of 7.1 and 7.7 mg/kg respectively.

In the Navy Fuel Tanks land use area there are two areas with arsenic above background. All five areas shall be excavated to a depth of 2 feet in order to remove arsenic contaminated surface soil. The estimated amount of soil to be excavated is 6,800 cy or 8,500 tons. Volume calculations are included in Appendix C. For each of the three areas in the Key West Pipeline land use area a 10 feet by 10 feet excavation area was assumed. Excavated areas shall be backfilled with clean fill and compacted to 85 percent standard proctor as determined by, ASTM D-698 latest revision.

4.2.1 Confirmatory Sampling The existing excavation limits are based on a limited number of surface soil samples. It is recommended that additional surface soil samples be collected and analyzed for arsenic prior to excavation activities. The purpose of additional sampling will be further define the areas above background. It is anticipated that additional sampling will decrease the area requiring excavation. Since the purpose of excavation is to prevent exposure to arsenic in surface soil post excavation sampling is not required.

4.2.2 Disposal Excavated soil shall be manifested, transported, and disposed in a permitted disposal facility. Contaminated soil shall be handled in accordance with Federal, State, and local regulations. Detailed delivery tickets prepared, signed, and dated by an agent of the disposal facility, certifying the type and amount of materials delivered to the facility, shall be provided to the Navy by the construction contractor.

4.3 MULTIPHASE EXTRACTION. Multiphase extraction is proposed as a source abatement technology for product-contaminated areas FP-3, FP-5, FP-16, and FP-18. Assuming each well used for multiphase extraction has a radius of influence of 50 feet, 2, 6, 2, and 1 additional wells would have to be added in product-contaminated areas FP-3, FP-5, FP-16, and FP-18, respectively. Table 4-1 lists



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Point ID	Northing (Y)	Easting (X)
MW-39	5381	5298
MW-6	5085	5266
MW-28	5041	5796
MW-5	5303	5846
1	5308	5398
2	5291	5380
3	5124	5322
4	5104	5333
5	5092	5356
6	5165	5573
7	5204	5572
8	5100	5726
9	5093	5683
10	5069	5673
11	5032	5700
12	5024	5718
13	5032	5744
14	5077	5774

LEGEND

- Product contaminated areas
- Excavation areas
- MW-5 Monitoring well location and designation
- Buried electrical lines
- Edge of excavation

Note:

1. Relocate buried electrical lines and above ground transformers as necessary to access excavation areas.

0 25 50

SCALE: 1 INCH = 50 FEET

FIGURE 4-1
SUBSURFACE SOIL EXCAVATION AREAS

REMEDIAL ACTION PLAN

TRUMBO POINT FUEL FARM
NAVAL AIR STATION KEY WEST
KEY WEST, FLORIDA

N

LEGEND

- Arsenic above background
- Excavation limits
- Fence
- (150,595) Sample location

NOTE:
The Y axis runs along the fence in a northerly direction with the X axis being perpendicular.

0 50 100
SCALE: 1 INCH = 100 FEET

FIGURE 4-3
ARSENIC IN SURFACE SOIL AREAS OF EXCAVATION

REMEDIAL ACTION PLAN

TRUMBO POINT FUEL FARM
NAVAL AIR STATION KEY WEST
KEY WEST, FLORIDA

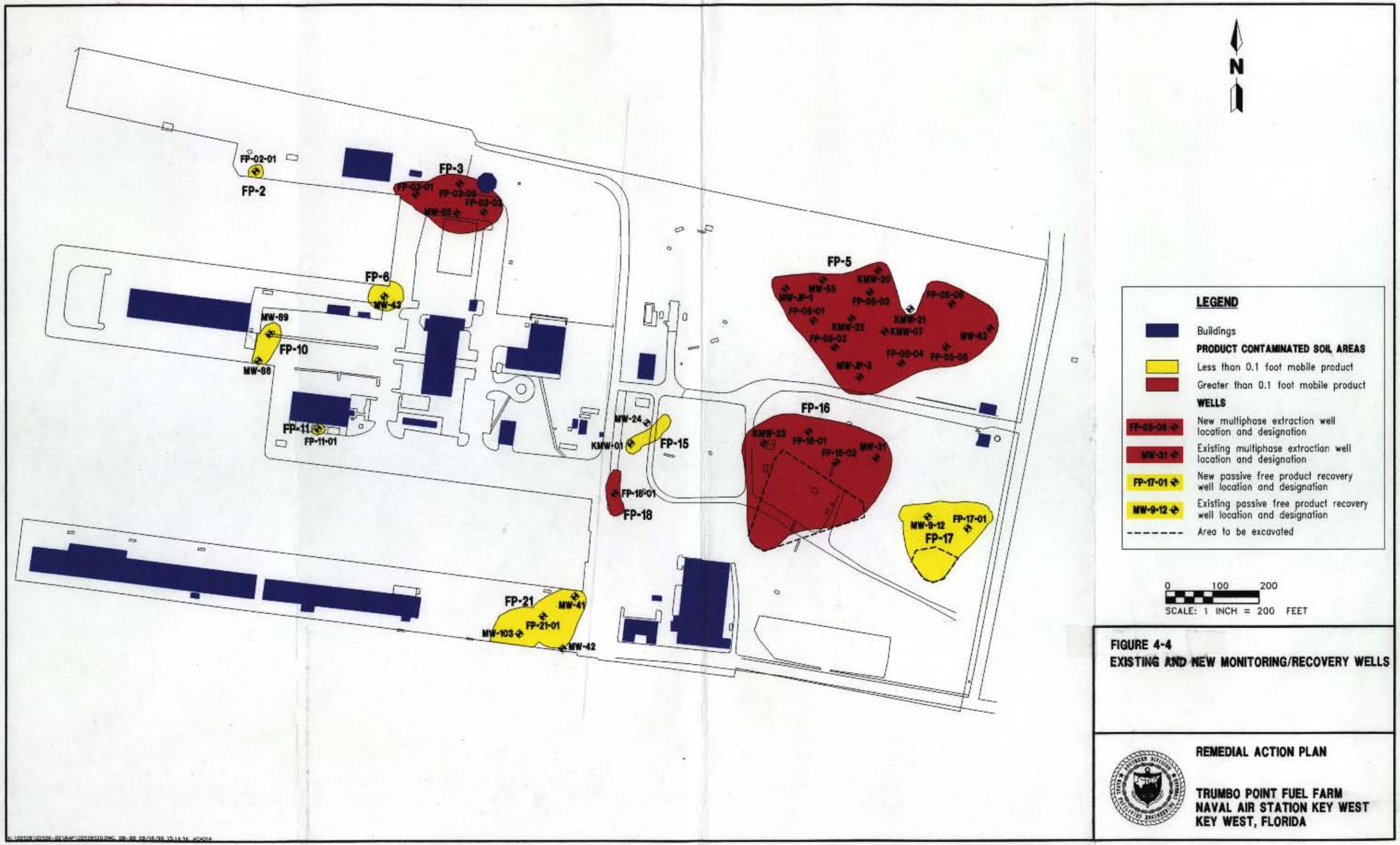


FIGURE 4-4
EXISTING AND NEW MONITORING/RECOVERY WELLS

REMEDIAL ACTION PLAN

TRUMBO POINT FUEL FARM
NAVAL AIR STATION KEY WEST
KEY WEST, FLORIDA

Table 4-1
Multiphase Free Product Recovery

Remedial Action Plan
Trumbo Point Fuel Farm
Naval Air Station Key West
Trumbo Point Annex, Key West, Florida

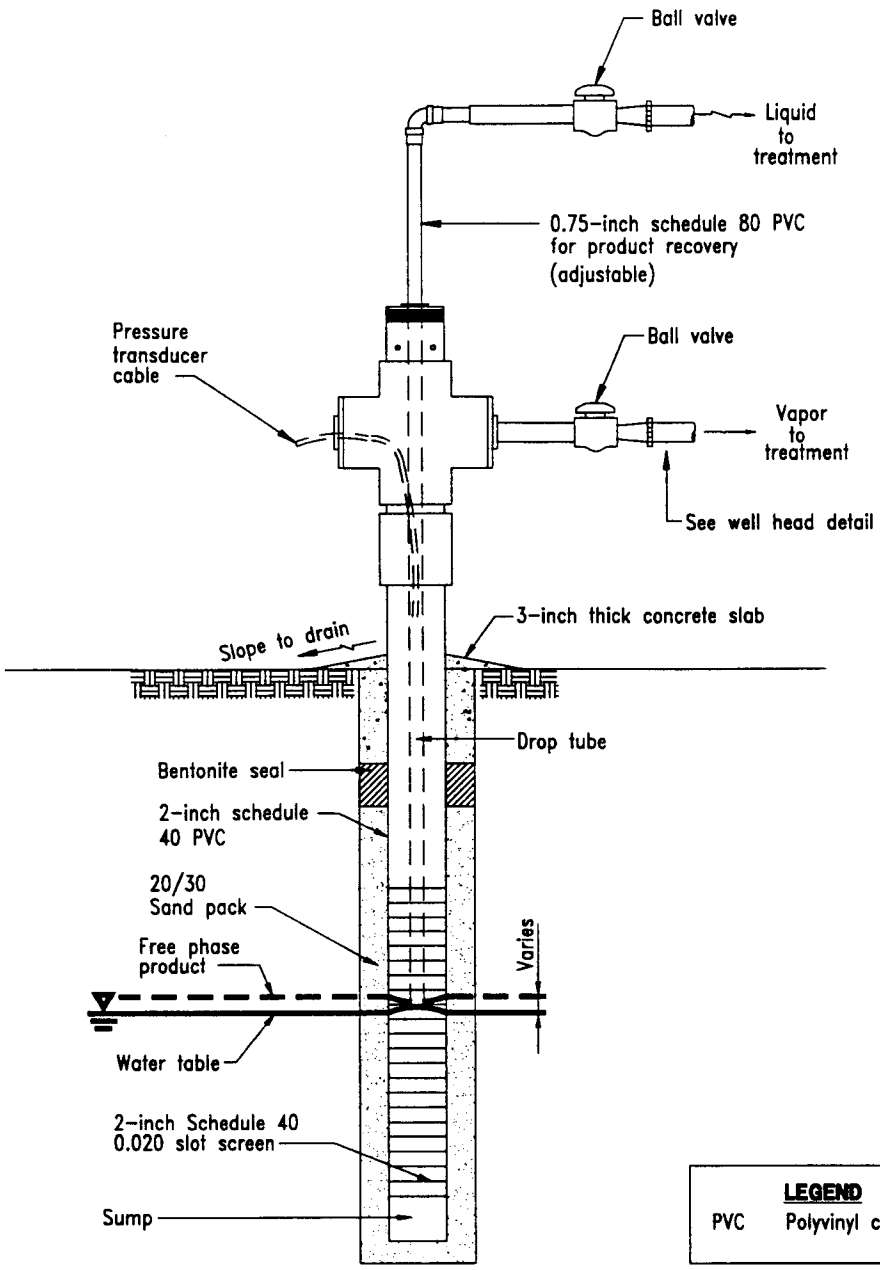
Product Contaminated Area	Estimated Mobile Product Volume (gallons)	Number of Monitoring/-Recovery Wells	Monitoring/Recovery Well Identification	Estimated Time to Cleanup (years)
FP-3	15,095	4	MW-65 FP-3-01 FP-3-02 FP-3-03	1.4
FP-5	28,499	14	MW-62 KMW-21 MMW-20 MW-55 KMW-22 MW-JP-1 MW-JP-3 KMW-07 FP-5-01 FP-5-02 FP-5-03 FP-5-04 FP-5-05 FP-5-06	2.6
FP-16	33,129	4	KMW-23 MW-31 FP-16-01, FP-16-02	3.0
FP-18	5,747	1	FP-18-01	0.5

Note: Wells with free product (FP) label are new. All others are existing.

the wells to be used and shows the estimated time cleanup. Figure 4-4 shows the locations of the proposed additional wells. These wells would also function to confirm the condition of the product-contaminated areas before remediation began, and allow monitoring of the remediation process.

Figure 4-5 shows a schematic of the multiphase extraction system. Mobile product and groundwater are extracted, using a drop tube with its tip located near or at the product-groundwater interface. The top of the well casing is sealed, so that a strong vacuum develops in the well. Mobile petroleum product is drawn to the extraction point primarily by the airflow in the vadose zone, and by the gradient in the product itself. Product and/or groundwater is drawn upward into the drop tube, depressing the product layer and causing product flow towards the well. Simultaneously, the vadose zone is remediated through the airflow induced therein.

The vacuum truck consists of a vacuum pump, total fluids collection tank, and a vapor containment and treatment unit. Generally vacuum trucks are equipped with a vacuum pump that is capable of producing a range of air flow rates (1,000 to 3,000 cubic feet per minute) and vacuum (up to 27 inches of mercury) to facilitate the selective extraction of free-phase petroleum products and groundwater from the extraction well. Vacuum levels are determined in the field during the initial events of multiphase extraction. The maximum allowable vacuum



LEGEND

PVC Polyvinyl chloride

VACUUM ENHANCED EXTRACTION WELL DETAIL

NOT TO SCALE

FIGURE 4-5
VACUUM ENHANCED EXTRACTION WELL DETAIL

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REMEDIAL ACTION PLAN

TRUMBO POINT FUEL FARM
NAVAL AIR STATION
KEY WEST, FLORIDA

at the extraction well is limited by the structural stability of the extraction well construction materials. For a typical extraction well made of schedule 40, 2-inch diameter polyvinyl chloride (PVC), with a 0.1-inch slotted screen, the maximum allowable vacuum is 24 inches of mercury. Vacuum trucks may be equipped with vapor containment and treatment equipment. Both activated carbon and thermal oxidizer treatment units are available. The vacuum pump itself is usually a liquid ring pump. The liquid ring pump, which is also known as a true vacuum pump, consists of the aluminum impeller that spins at a very low speed (700 revolutions per minute) inside an aluminum housing. The liquid ring is developed inside the pump housing and becomes the housing wall. The liquid used inside the pump is generally water. As the product vapor enters the liquid ring pump, it is compressed on the water layer over the housing wall. The discharge air and vapor, including a portion of the pump's liquid supply, are then released for further processing. These principle design characteristics of liquid ring pumps minimize the risk of a spark occurring in the pump.

The liquid collected during multiphase extraction is a mixture of product and groundwater. The proper handling and disposal of this liquid is the responsibility of the vacuum truck subcontractor. During the initial stage of multiphase extraction remediation activities, it is anticipated that vacuum truck event frequency would be great enough to warrant on-site storage of collected liquids in a tanker semitrailer.

The overall performance of multiphase extraction will be evaluated based on the data obtained for the parameters listed below.

- Initial and final thicknesses of free product in source area and perimeter area monitoring wells;
- Composition of fluids collected at the end of the extraction event.

Additional data will be gathered during each multiphase extraction event, including

- vapor flow rates from the extraction wells,
- vapor concentrations during application of multiphase extraction, and
- vacuum readings at the well heads from the source area and perimeter area wells.

Figure 4-6 shows the decision-making process to be followed in applying multiphase extraction to product-contaminated areas FP-3, FP-5, FP-16, and FP-18. The rules in the figure are summarized below.

- Initially, multiphase extraction will be applied weekly.
- Data parameters will be gathered at each multiphase extraction event.
- If product thickness in an extraction well drops to below 0.1 foot one week after an event (immediately before the following multiphase extraction event), the extraction well will be switched to a monthly event schedule.

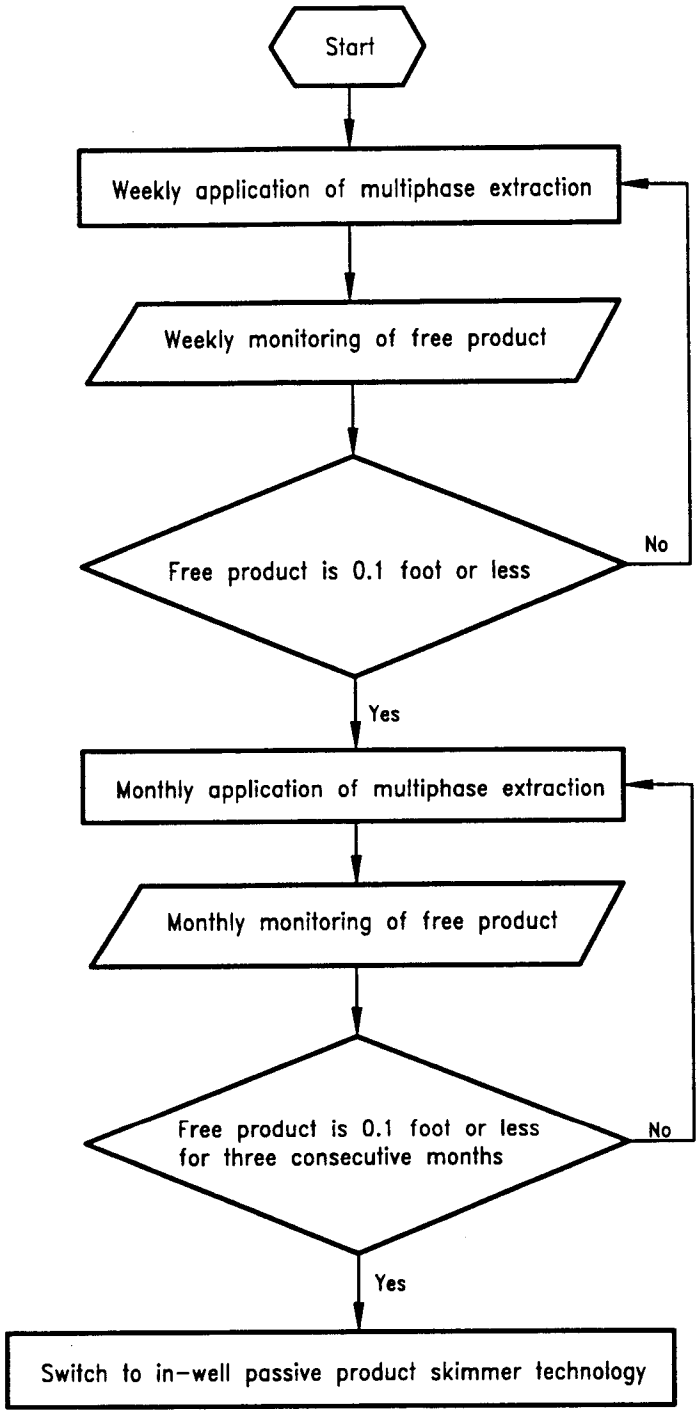

FIGURE 4-6
MULTIPHASE EXTRACTION DECISION TREE

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REMEDIAL ACTION PLAN

TRUMBO POINT FUEL FARM
NAVAL AIR STATION
KEY WEST, FLORIDA

- If product thickness is less than 0.1 foot in an extraction well for three consecutive months of monitoring, the well (and by implication the surrounding product-contaminated area) will be removed from the multiphase extraction schedule and subjected to remediation with the in-well passive product skimmer technology, as detailed in Section 4.4.

It is anticipated that the mobile product recovery program using multiphase extraction will last up to approximately 0.5 years for product-contaminated area FP-18, and up to approximately 1.4 years for product-contaminated areas FP-3, approximately 2.6 years for FP-5, and 3.0 years for FP-16.

4.4 IN-WELL PASSIVE FREE PRODUCT REMOVAL. Product-contaminated areas FP-2, FP-6, FP-10, FP-11, FP-15, FP-17, and FP-21 will be remediated through passive in-well product skimmers, in combination with the containment presently afforded by the relatively impermeable soil and the pier and seawall bulkheads. Product areas FP-3, FP-5, FP-16, and FP-18 will also be subject to this remediation alternative, upon completion of the multiphase extraction remediation alternative (see Section 4.3). This section will focus on the in-well passive selective product skimmers, as the above-mentioned containment is in place and completely passive.

Passive selective product skimmers are available for 2-inch and 4-inch wells, and are designed to remove product down to an in-well thickness of less than 0.01 inches. Detailed information on passive skimmers is presented in Appendix D. Models for areas where groundwater elevations fluctuate with the tides are available. The skimmer typically uses a floating intake with an outer debris screen surrounding an oileophilic/hydrophobic inner screen. Product enters the intake and moves freely through the oileophilic/hydrophobic inner screen to a collection container, while groundwater trying to enter the unit is repelled. The units will be retrieved from the recovery well on a regular basis, the collected product measured, and the collection container emptied into a drum for disposal.

Figure 4-7 shows the decision-making process proposed for the remediation of the product-contaminated areas using passive product skimmers in schematic form. The rules are summarized below.

- A product-contaminated area is a candidate for passive skimmer product recovery if it has recovery wells showing product thicknesses between 0 and 0.1 feet.

- Passive selective product skimmers like those described above will be installed in recovery wells meeting the above criterion. The product skimmers will be checked, volume of product captured recorded, and collected product emptied from the skimmer on a daily basis.

- If the product skimmer collection container is less than 25 percent full when checked for three consecutive days, the recovery well will be demoted to a weekly visit schedule.

- If the product skimmer collection container is less than 25 percent full when checked for three consecutive weeks, the recovery well will be demoted to a monthly visit schedule.

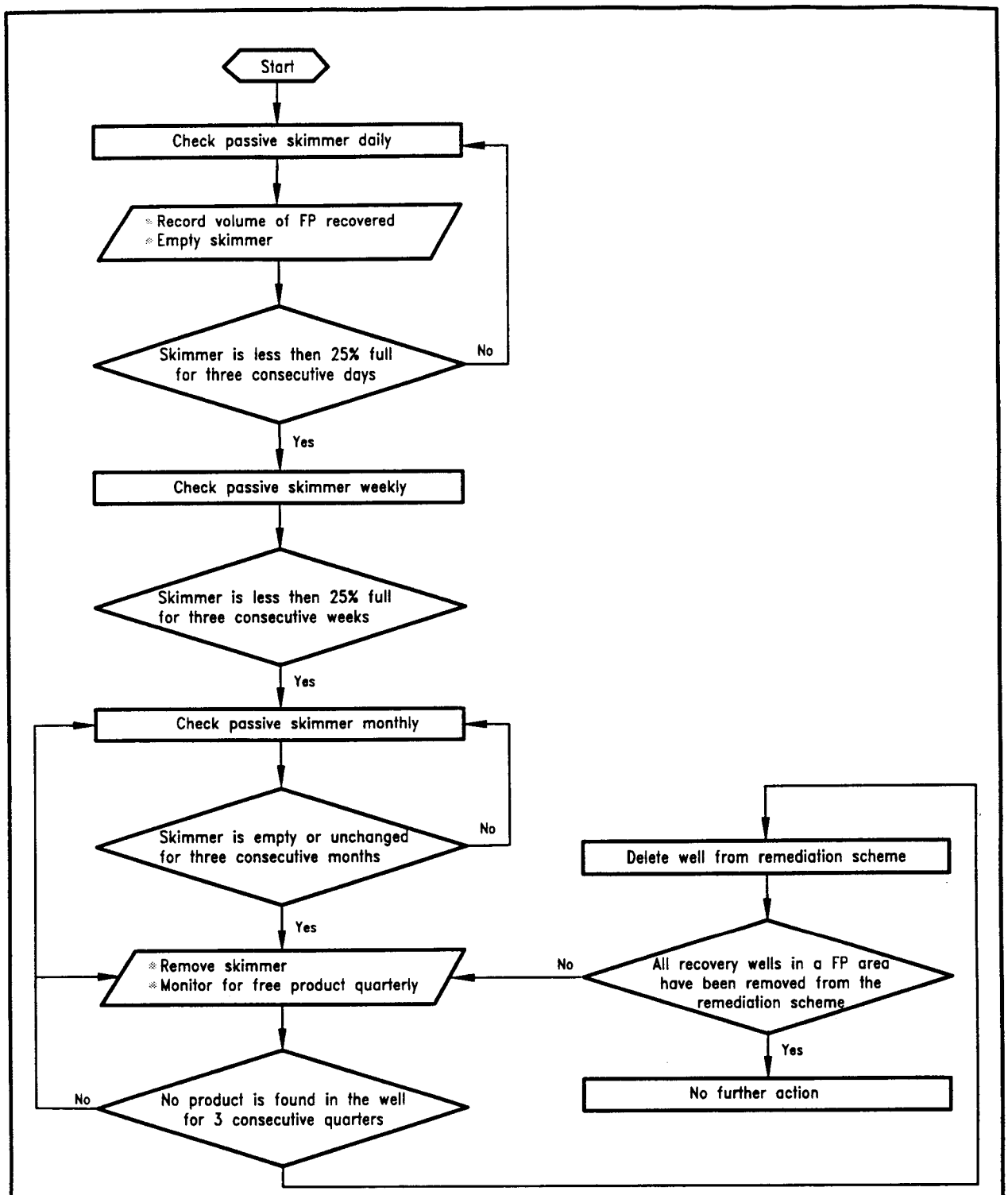

FIGURE 4-7
PASSIVE FREE PRODUCT RECOVERY DECISION TREE

REMEDIAL ACTION PLAN

TRUMBO POINT FUEL FARM
NAVAL AIR STATION
KEY WEST, FLORIDA

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- If the product skimmer collection container is empty or unchanged for three consecutive months, the product skimmer will be removed and the well subjected to quarterly monitoring of product levels.

- If no product is found in the well for the three quarters following the removal of the product skimmer, the recovery well will be removed from the remediation scheme.

- If all the recovery wells in a (formerly) product-contaminated area have been removed from the remediation scheme, a no further action designation will be requested for the (formerly) product-contaminated area.

Product skimmers will be lowered to a depth allowing immediate product recovery at current groundwater elevations, but adjusted so that the movement range of the product intake corresponds as closely as possible to historic groundwater elevation range. Collected product will be drummed and disposed of in the NAS Key West Trumbo Point oil-water separators, under supervision of appropriate base personnel, and following all applicable Federal and State statutes and regulations.

Table 4-2 shows the estimated time to cleanup for product-contaminated areas FP-2, FP-6, FP-10, FP-11, FP-15, FP-17, and FP-21, based on estimated mobile product volumes, a 25.5-ounce product collection container in each product skimmer, and assuming a weekly skimmer maintenance schedule and all recovery wells in each area undergo recovery operations for the same time period. It is to be stressed that this table shows a conservative time-to-cleanup scenario. Six new product recovery wells are necessary for delineation. A maximum 100-foot spacing between wells in product-contaminated areas is recommended. Recovery rates should be monitored and more recovery wells installed in product areas if necessary to reduce time-to-cleanup. Table 4-2 lists the new and existing recovery wells to be used for passive free product recovery. Figure 4-4 shows the location of the wells.

Table 4-2
Passive Free Product Recovery

Remedial Action Plan
Trumbo Point Fuel Farm
Naval Air Station Key West
Trumbo Point Annex, Key

Product Contaminated Area Identification	Estimated Mobile Product Volume (gallons)	Number of Monitoring/ Recovery Wells	Time to Cleanup (years)	Monitoring Well Identification
FP-2	6	1	0.32	FP-02-01
FP-6	41	1	2.0	MW-43
FP-10	561	2	13	MW-88, MW-89
FP-11	4	1	0.20	FP-11-01
FP-15	31	2	0.72	MW-24, KMW-01
FP-17	6	2	0.15	FP-17-01, MW-9-12
FP-21	212	4	2.6	FP-21-01, MW-103, MW-41, MW-42

Note: Wells with FP label are new, all others are existing.

4.5 MONITORED NATURAL ATTENUATION. To monitor decreases in dissolved phase contaminant concentrations and to verify that the plume is shrinking and not expanding a groundwater monitoring program for natural attenuation shall be initiated, in accordance with Chapter 62-770.690, FAC. The monitoring program will focus on the dissolved plume associated with FP-5 on the east end of the site. The monitoring program is designed to evaluate the progress and effectiveness of natural attenuation to reduce contaminants and retard their migration. In the event that data collected under this long-term monitoring plan indicate that intrinsic remediation is not occurring or is insufficient to protect human health and the environment or that contaminant reduction rates indicate more costly monitoring than anticipated, a contingency plan has been developed to augment or replace the intrinsic remediation alternative.

This remedy will have the following contingency. If the monitoring program indicates that the plume is migrating offsite and into Fleming Key Cut surface water then a barrier will be constructed. The barrier will be an extension of the existing sea wall along Fleming Key Cut. The barrier will increase the travel time necessary for the plume to migrate thereby allowing sufficient time for plume degradation by natural attenuation prior to any possible discharge to surface water.

Natural attenuation data was collected in April 1999 from the FP-5 plume. Groundwater from five monitoring wells was sampled and analyzed for natural attenuation parameters. Figure 4-8 shows the results of these analyses. The data indicate that anaerobic conditions exist, redox conditions are optimum for natural attenuation (-200 to -350 mv), and the primary microbial process is sulfate reduction. The elevated concentrations of methane suggest that anaerobic biodegradation is occurring through methanogenesis. The primary microbial process may be transitioning from sulfate reduction to methanogenesis.

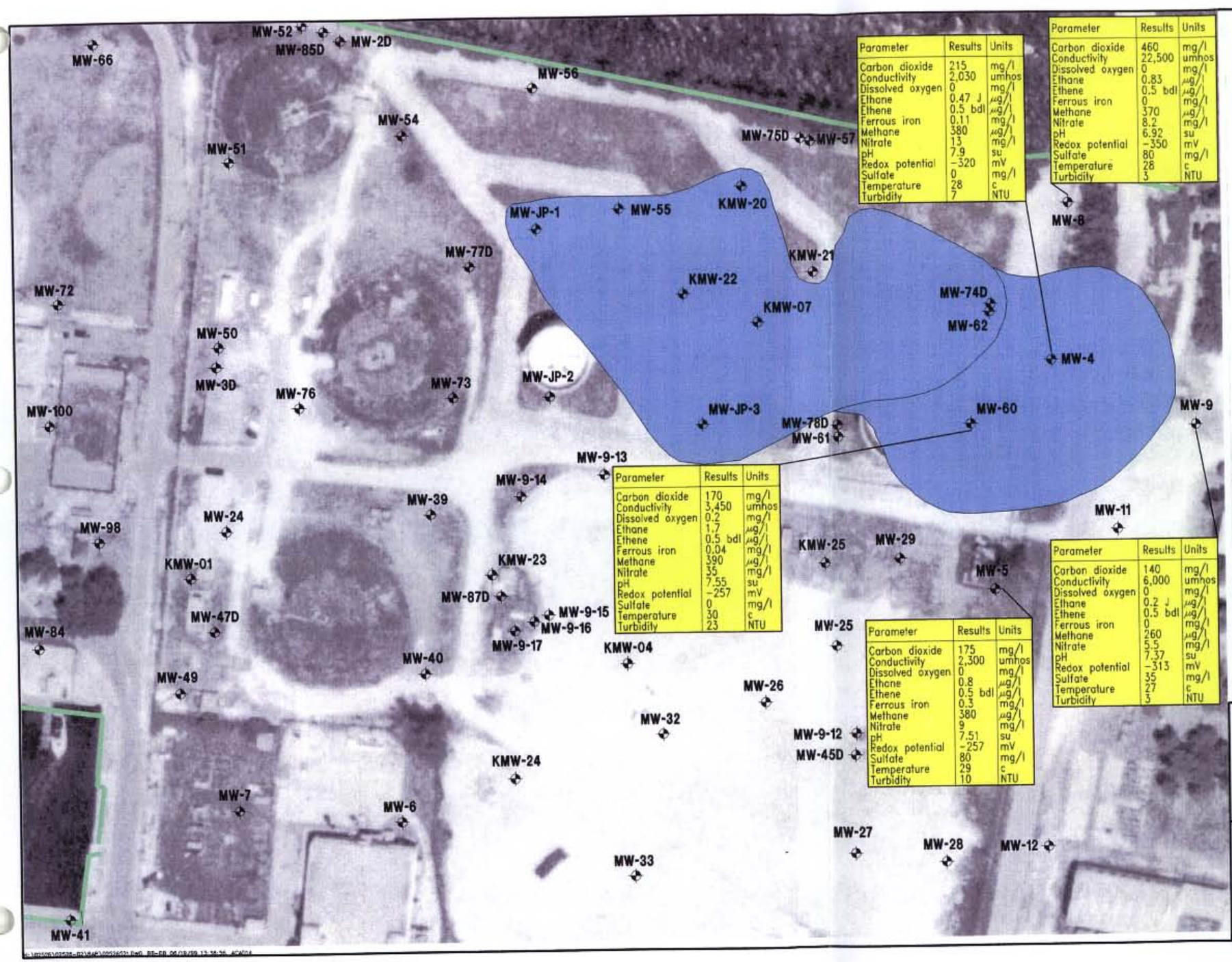
4.5.1 Monitoring Well Locations Monitoring wells to be used for groundwater monitoring are already in place within, and downgradient of, the groundwater plume. Groundwater flow direction at the site was interpreted on July 30, 1996, and in general, is radially outward from the center of the site (see CAR Figure 5-8). Table 4-3 lists the monitoring wells to be used for natural attenuation sampling. Monitoring wells are shown on Figure 4-8.

Table 4-3
Natural Attenuation Monitoring Wells

Remedial Action Plan
Trumbo Point Fuel Farm
Naval Air Station Key West
Trumbo Point Annex, Key West, Florida

Area	Monitoring Well Identification	Location	Purpose
FP-5	MW-4	Plume Interior	COC analyses
	MW-60	Plume Interior	COC analyses
	MW-8	Cross Gradient	Background
	MW-5	Cross Gradient	Background
	MW-9	Down Gradient	Point of compliance
	MW-11	Down Gradient	Point of compliance

Notes: COC = chemicals of concern.



Parameter	Results	Units
Carbon dioxide	215	mg/l
Conductivity	2,030	umhos
Dissolved oxygen	0	mg/l
Ethane	0.47 J	µg/l
Ethene	0.5 bdl	µg/l
Ferrous iron	0.11	mg/l
Methane	380	µg/l
Nitrate	13	mg/l
pH	7.9	su
Redox potential	−320	mV
Sulfate	0	mg/l
Temperature	28	c
Turbidity	7	NTU

Parameter	Results	Units
Carbon dioxide	460	mg/l
Conductivity	22,500	umhos
Dissolved oxygen	0	mg/l
Ethane	0.83	µg/l
Ethene	0.5 bdl	µg/l
Ferrous iron	0	mg/l
Methane	370	µg/l
Nitrate	8.2	mg/l
pH	6.92	su
Redox potential	−350	mV
Sulfate	80	mg/l
Temperature	28	c
Turbidity	3	NTU

Parameter	Results	Units
Carbon dioxide	170	mg/l
Conductivity	3,450	umhos
Dissolved oxygen	0.2	mg/l
Ethane	1.7	µg/l
Ethene	0.5 bdl	µg/l
Ferrous iron	0.04	mg/l
Methane	390	µg/l
Nitrate	35	mg/l
pH	7.55	su
Redox potential	−257	mV
Sulfate	0	mg/l
Temperature	30	c
Turbidity	23	NTU

Parameter	Results	Units
Carbon dioxide	140	mg/l
Conductivity	6,000	umhos
Dissolved oxygen	0	mg/l
Ethane	0.2 J	µg/l
Ethene	0.5 bdl	µg/l
Ferrous iron	0	mg/l
Methane	260	µg/l
Nitrate	5.5	mg/l
pH	7.37	su
Redox potential	−313	mV
Sulfate	35	mg/l
Temperature	27	c
Turbidity	3	NTU

Parameter	Results	Units
Carbon dioxide	175	mg/l
Conductivity	2,300	umhos
Dissolved oxygen	0	mg/l
Ethane	0.8	µg/l
Ethene	0.5 bdl	µg/l
Ferrous iron	0.3	mg/l
Methane	380	µg/l
Nitrate	9	mg/l
pH	7.51	su
Redox potential	−257	mV
Sulfate	80	mg/l
Temperature	29	c
Turbidity	10	NTU

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LEGEND

	Benzene plume
MW-5	Monitoring well location and designation
	Seawall
mg/l	Milligrams per liter
µg/l	Micrograms per liter
umhos	Micromhos per centimeter
mV	Millivolt
c	Centigrade
su	Standard units
NTU	Nephelometric turbidity unit
bdl	Below detection level
J	Estimated

0 50 100
SCALE: 1 INCH = 100 FEET

FIGURE 4-8
NATURAL ATTENUATION DATA
APRIL 1999

REMEDIAL ACTION PLAN

TRUMBO POINT FUEL FARM
NAVAL AIR STATION KEY WEST
KEY WEST, FLORIDA

4.5.2 **Groundwater Sampling** Groundwater sampling will be conducted quarterly for the first year and annually for four additional years, if necessary, to verify that the contaminant mass and mobility are being effectively reduced by natural attenuation. Water-level measurements will be collected during each sampling event. Groundwater samples will be collected during each sampling event from the designated source area and downgradient well and analyzed for the COCs in groundwater using the test methods shown in Table 4-4. Natural attenuation parameters listed in Table 4-4 will be collected from the source wells and hydraulically downgradient monitoring wells and background monitoring wells and analyzed during each sampling event to establish trends and supporting evidence that natural attenuation is occurring.

If two consecutive sampling events show that the concentration of benzene is below the site-specific risk-based cleanup goal of 70 $\mu g/\ell$, natural attenuation monitoring may be considered complete. A Site Rehabilitation Completion Report shall be completed and submitted to the FDEP for review (Chapter 62-770.690 (8), FAC). On the other hand, if the data collected at any time during the monitoring period indicate plume migration or a risk to human health, the sampling frequency will be adjusted accordingly and/or the contingency plan will be further developed, approved by FDEP, and implemented.

4.5.3 **Reporting** Within 60 days of each groundwater sampling event, a report will be prepared and submitted to SOUTHNAVFACENGCOM and FDEP, in accordance with Chapter 62-770.690 (7)(e), FAC. The report will include the laboratory report of sample analytical results, the chain of custody, a summary table and site map of the analytical results, water table elevation information (including a summary table and flow map), and recommendations for future actions.

4.6 **LAND-USE CONTROLS**. The MOA between the USEPA, the FDEP and the U.S. Department of the Navy, NAS, Key West, Florida, dated August 31, 1998, will be the basis for implementing all necessary LUCs. Because this plan incorporates the use of risk-based cleanup criteria as a basis for remedial action, future LUCs are necessary to ensure the reliability of land-use assumptions. The MOA ensures that such controls will be maintained for as long as necessary to keep the chosen remedy fully protective of human health and the environment.

An individual LUC Implementation Plan (LUCIP) for this site will be added to Appendix C of the MOA. The LUCIP will identify both the LUC objective as well as the particular LUCs that will be used to achieve that objective. It will also specify the actions necessary to implement and maintain the specific LUCs required for the site.

Information necessary for preparation of the LUCIP is as follows:

Objective. The objective of the LUCs at the TPFF site is to manage exposure through institutional controls.

Land-Use Controls. The withdrawal and/or use of groundwater from the shallow aquifer beneath the site will not be allowed. This will eliminate potential human health and ecological risks associated with exposures to contaminated groundwater by eliminating the only viable exposure pathway.

Table 4-4
Groundwater Monitoring Parameters

Remedial Action Plan
Trumbo Point Fuel Farm
Naval Air Station Key West
Trumbo Point Annex, Key West, Florida

Analysis	Method/ Reference[2]	Data Use	Sample Volume, Sample Container, Sample Preservation	Field or Fixed-Base Laboratory
Chemical(s) of Concern				
Volatile Organic Compounds (VOCs)	602	Method of analysis that includes benzene (COC for groundwater)	Collect water samples in a 40 mℓ VOC vial; cool to 4°C; add hydrochloric acid to pH 2.	Fixed
Natural Attenuation Parameters[1]				
Temperature	170.1, Direct reading thermometer	Well development; biological processes are temperature dependent	Conduct *in situ*	Field
Oxygen	Dissolved oxygen meter or HACH kit	The oxygen concentration is a data input to most biological models; concentrations less than 1 mg/ℓ generally indicate an anaerobic pathway	Collect 300 ml of water in biochemical demand bottles; analyze immediately; alternately measure dissolved oxygen *in situ*	Field
pH	150.1, Direct reading meter	Biological processes are pH sensitive	Collect 100 to 250 mℓ of water in a glass or plastic container; analyze immediately	Field
Conductivity	120.1, Direct reading meter	General water quality parameter used to verify that site samples are obtained from the same groundwater system	Collect 100 to 250 mℓ of water in a glass or plastic container; analyze immediately	Field
Alkalinity	310.1, Manual titrimetric	General water quality parameter used to verify that site samples are obtained from the same groundwater system and to measure the buffering capacity of groundwater	Collect 250 mℓ of water in a glass or plastic container; analyze within 6 hours	Field
Ferrous (Fe^{+2})	HACH DR 850	May indicate an anaerobic degradation process due to depletion of oxygen, nitrate, and manganese	Collect 100 mℓ of water in a glass container and follow kit instructions	Field

See notes at end of table

Table 4-4 (Continued)
Groundwater Monitoring Parameters

Remedial Action Plan
Trumbo Point Fuel Farm
Naval Air Station Key West
Trumbo Point Annex, Key West, Florida

Analysis	Method/ Reference[2]	Data Use	Sample Volume, Sample Container, Sample Preservation	Field or Fixed-Base Laboratory
Nitrate (NO_3^{-1})	HACH DR 850	Substrate for microbial respiration if oxygen is depleted	Collect up to 40 mℓ of water in a glass or plastic container and follow kit instructions	Field
Sulfate (SO_4^{-2})	HACH DR 850	Substrate for anaerobic microbial respiration	Collect up to 40 mℓ of water in a glass container and follow kit instructions	Field
Redox potential	Standard Methods A2580 B	The redox potential of groundwater provides information on environmental conditions and is used to interpret the nature and state of chemical compounds and biological conditions; the redox potential may range from 200 mV to less than -400 mV	Collect 100 to 250 mℓ of water in a glass container, filling container from bottom; analyze immediately	Field
Carbon dioxide	HACH[3] CO_2 titrimetric kit	Elevated levels of free carbon dioxide dissolved in groundwater above background concentrations could indicate an aerobic mechanism for bacterial degradation	Collect 100 mℓ of water in a glass container; analyze immediately	Field
Methane, ethane, ethene	RSK 175	The presence of methane indicates biological degradation via an anaerobic pathway utilizing CO_2 as the electron acceptor	Collect water samples in 40 mℓ VOC vials with butyl gray/Teflon®-lined caps; cool to 4°C	Fixed

[1] Groundwater analytical protocol adapted from Table 2.1 in the *Technical Protocol for Implementing the Intrinsic Remediation with Long-Term Monitoring Option for Natural Attenuation of Dissolved-Phase Fuel Contamination in Ground Water* (Wiedemeier, Todd H., 1995).
[2] Method refers to U.S. Environmental Protection Agency test methods.
[3] HACH refers to the HACH Company catalog.

Notes: COC = chemicals of concern.
mℓ = milliliter.
°C = degrees Celsius.
mg/ℓ = milligrams per liter.
mV = millivolts.
GC/FID = gas chromatograph per flame ionization detector.
TCD = thermal conductivity defecter.

Land use at the site will be nonresidential; however, use of the Navy Tanks Areas for temporary RV camping is acceptable.

The potential to encounter contaminated soil or groundwater during any invasive construction activity must be recorded and adequately communicated to anyone initiating any such activities so that appropriate health and safety precautions can be implemented. Any contaminated soil excavated as part of the construction should be disposed of as petroleum-contaminated soil and not returned to the excavation unless properly treated.

Implementation. The required LUCs will be incorporated into the Base Master Plan.

4.7 RECOVERY WELL INSTALLATION. A total of 15 new recovery wells are required (11 for multiphase extraction and 4 for passive free product recovery). All wells will be screened in the shallow aquifer approximately 5 to 15 feet bls. Monitoring well installation and well development will comply with Southern Division, Naval Facilities Engineering Command *Guidelines for Groundwater Monitoring Well Installation* and with USEPA's *Handbook of Suggested Practices for the Design and Installation of Groundwater Monitoring Wells*, EPA/600/4-89/034, April 1989. In addition, recovery well installation will comply with the Chapter 62-532, FAC. Figure 4-9 shows a typical shallow monitoring well construction detail.

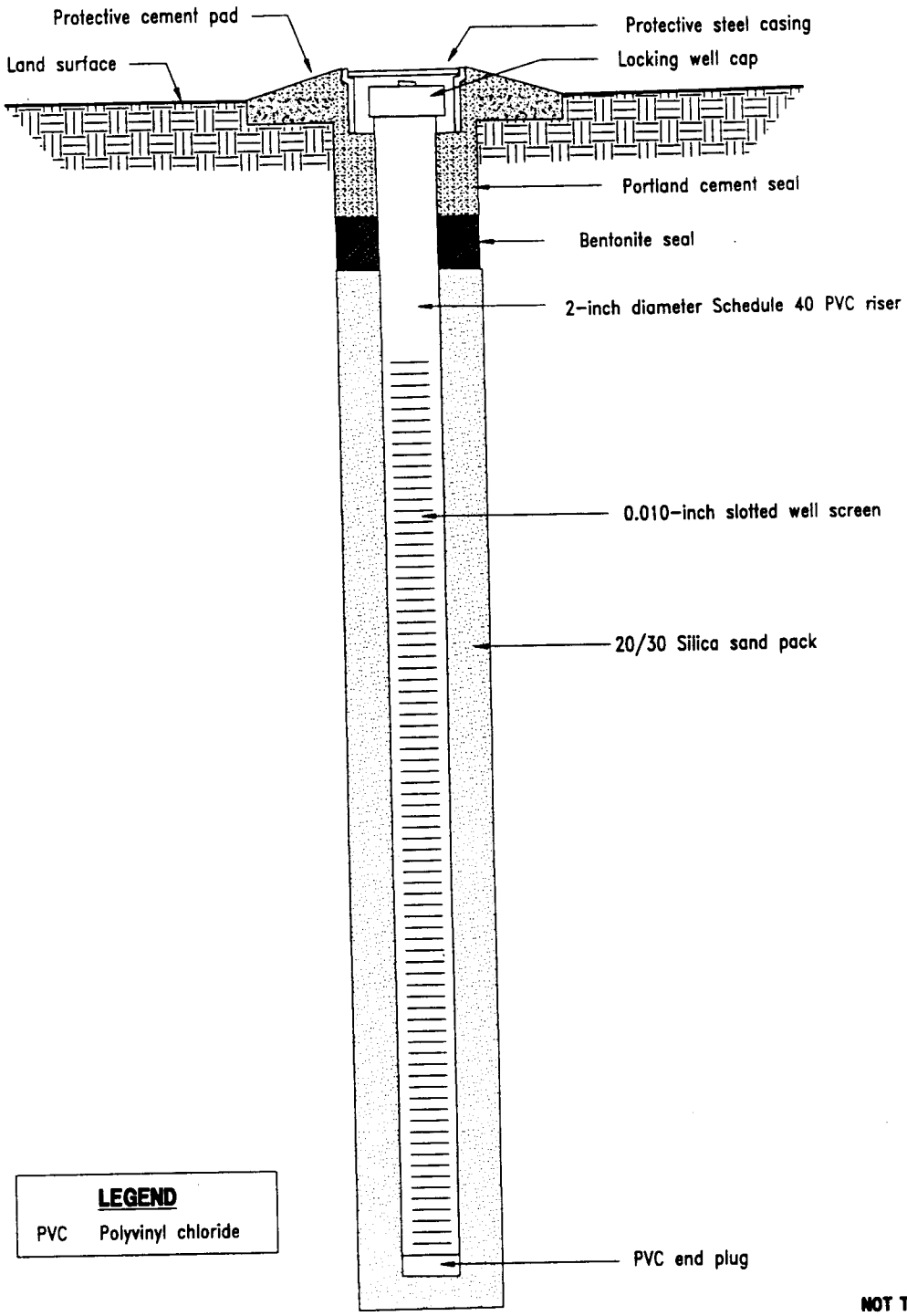

FIGURE 4-9
TYPICAL SHALLOW MONITORING WELL CONSTRUCTION DETAIL

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REMEDIAL ACTION PLAN

TRUMBO ACTION PLAN
NAVAL AIR STATION
KEY WEST, FLORIDA

5.0 COST ESTIMATE

The engineering cost estimate for implementing this RAP is contained in Appendix H only in those report copies that require it. This was done to facilitate Navy procurement requirements. The cost estimate was generated using Remedial Action Cost Engineering and Requirements System (RACER) 99.

6.0 SCHEDULE

Source removal and free-product recovery actions described in this RAP can begin following FDEP RAP approval. It is estimated that approximately 2 weeks would be necessary for site mobilization and site staging for free-product recovery and monitoring well installations. Preparation of any permit applications should begin immediately upon notice to proceed from the Navy. The location of all underground utilities should also be determined and marked during this time period.

Well permits from the South Florida Water Management District for the abandonment and installation of shallow monitoring wells will be required. This permitting process is expected to take approximately 1 week.

Mobilization and well installation for 15 shallow monitoring wells is expected to be completed within 1 week following mobilization.

Following notice to proceed, including 1 month of procurement, approximately 4 months should be budgeted for implementation of remedial activities at the TPFF site. Active removal of free product will be ongoing until recovery rates indicate it is no longer economically feasible.

Completion of Site Rehabilitation. Upon completion of remedial actions described in this plan at this site, or subsites based on contaminant plumes, land use, or other logical groupings, a Site Rehabilitation Completion Report will be submitted to FDEP for approval in accordance with Chapter 62-770.750 paragraphs (7) through (9), FAC. Upon issuance of a Site Rehabilitation Completion Order for subsites, remedial actions for those subsites will be considered complete.

7.0 DOCUMENTATION

A site closure report will be provided following the completion of remedial actions at each plume area. The report should provide at a minimum the following:

- description of actions completed;
- log of field and analytical sampling locations and laboratory analytical results;
- a map of the remediated area, including locations of utilities and obstructions or other features relevant to remedial activities;
- manifests and documentation of treatment and disposal;
- posttreatment analytical results for any soil which required treatment;
- soil compaction confirmation; and
- volume and disposition of water removed during remedial actions.

8.0 PROFESSIONAL REVIEW CERTIFICATION

This RAP was prepared using standard engineering practices and designs. The plan for remediating this site is based on information presented in the October 1996 Contamination Assessment Report, the most recent surface soil and groundwater data collected in April 1999, and engineering detailed in the text and appended to this report. If conditions are determined to be different than those described, the undersigned professional engineer should be notified to evaluate the effects of any additional information on the design described in this report.

This RAP was developed for the TPFF site, NAS Key West, Key West, Florida, and should not be construed to apply to any other site.

This certification does not include the risk evaluation presented in Appendix A.

Robert C. Lunardini, Jr.
Florida P.E. No.: 46657
Expires February 28, 2001

Robert C Lunardini Jr

12/16/99

USEPA. 1992d, "Supplemental Guidance to RAGS: Calculating the Concentration Term," PB92-963373, Office of Solid Waste and Emergency Response, Washington, D.C, (May).

USEPA. 1992b. "Dermal Exposure Assessment: Principals and Applications Interim Report." EPA/600/8-91/011B (January). Office of Research and Development. Washington, D.C.

USEPA. 1995. Supplemental Guidance to RAGS: Region IV Bulletins on Ecological Risk Assessment. USEPA Region IV Waste Management Division. Atlanta, Georgia.

USEPA. 1997a. Region III Risk Based Concentration (RBC) Table for Industrial Exposure.

USEPA. 1997b. Integrated Risk Information System (IRIS). http://www.epa.gov/-ngispgm3/iris/.

USEPA. 1997c. "Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments, Interim Final Draft." Environmental Response Team, Edison, New Jersey.

USEPA. 1998. "Guidelines for Ecological Risk Assessment." USEPA, 1998.

USEPA, Florida Department of Environmental Protection, and U.S. Department of the Navy. 1998. Memorandum of Agreement Between U.S. Environmental Protection Agency, Florida Department of Environmental Protection, and Department of the Navy, Naval Air Station, Jacksonville, Florida.