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EVALUATION OF REMEDIAL ALTERNATIVES FOR SOIL PILES
NAVY FUEL FARM
AT
NAVAL AIR STATION (NAS) WILLOW GROVE
HORSHAM TOWNSHIP, PENNSYLVANIA

Contract No. N62472-92-D-1296
Contract Task Order No. 0011

Prepared for:

Department of the Navy
Northern Division
Naval Facilities Engineering Command
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24 February 1994
FINAL
EA Project No. 296.0011

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24 February 1994
FINAL
EA Project No. 296.0011

QUALITY REVIEW STATEMENT

Contract No. N62472-92-D-1296 EA Project Number: 296.0011
Contract Task Order No. 0011
Activity Naval Air Station (NAS) Willow Grove, Pennsylvania

Description of Report/Deliverable:

Evaluation of Remedial Alternatives for Soil Piles at Navy Fuel Farm

EA CTO Manager: Carl Reitenbach

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

Senior Technical Reviewer(s)

[Name] G. D. McCleary, P.E. [Date] 24 February 1994
[Title] Senior Engineer

[Name] [Date]
[Title]

CONTENTS

Page

LIST OF FIGURES

LIST OF TABLES

1. INTRODUCTION 1-1

1.1 Report Purpose and Organization 1-1
1.2 Site History 1-1
1.3 Regulatory Status 1-2

2. AVAILABLE REMEDIAL ALTERNATIVES 2-1

2.1 List of Available Remedial Alternatives 2-1
2.2 Summary of Remedial Alternatives 2-1

2.2.1 Landfarming 2-1
2.2.2 Landfilling 2-2
2.2.3 Hot Mix Asphalt Incorporation 2-4
2.2.4 Cold or Warm Mix Asphalt Incorporation 2-5
2.2.5 Soil Venting 2-6
2.2.6 Bioventing 2-8
2.2.7 Vitrification 2-9
2.2.8 Low Temperature Thermal Treatment 2-10
2.2.9 High Temperature Thermal Treatment 2-11
2.2.10 Slurry Phase Bioremediation 2-12
2.2.11 Soil Washing 2-13

2.4 Concrete Disposal Options 2-14

3. RECOMMENDATIONS FOR TREATMENT/DISPOSAL 3-1

3.1 Petroleum-Impacted Soil 3-1
3.2 Concrete 3-3

4. RECOMMENDATIONS FOR ADDITIONAL SAMPLING 4-1

4.1 Petroleum-Impacted Soil 4-1
4.2 Concrete 4-2

REFERENCES

APPENDIX A: PARTIAL ANALYTICAL RESULTS OF SOIL SAMPLES

LIST OF FIGURES

Number	Title
1-1	Site location map, NAS Willow Grove, Navy Fuel Farm.
1-2	Site map prior to 1991, NAS Willow Grove, Navy Fuel Farm, showing location of Tank Nos. 115 and 116 which were removed in 1991.
1-3	Site map 1993, NAS Willow Grove, Navy Fuel Farm, showing location of soil stockpiles.

LIST OF TABLES

Number	Title
1-1	Organic compounds in UST contaminated media and debris which are exempted from the definition of hazardous waste at sites under corrective action in accordance with the UST regulations (40 CFR 280).
1-2	Generic cleanup standards and maximum concentrations of organic compounds detected in soil samples from well installations at the Navy Fuel Farm, NAS Willow Grove.
2-1	Options for treatment/disposal of soil stockpiled at the Navy Fuel Farm, NAS Willow Grove.
3-1	Summary of soil treatment/disposal options for Level C soil.
4-1	Recommended sampling and analysis plan: Stage 1.

1. INTRODUCTION

1.1 REPORT PURPOSE AND ORGANIZATION

The purpose of this report is to evaluate alternatives for the remediation or disposal of approximately 6,500 yd^3 of soil and 250 yd^3 of concrete that was stockpiled during the removal of two 210,000-gal jet fuel storage tanks at the Navy Fuel Farm, NAS Willow Grove, Pennsylvania. This report is divided into four chapters: Introduction, Available Treatment/Disposal Options, Recommendation for Treatment/Disposal, and Recommendation for Additional Sampling.

The available analytical data are limited to four total petroleum hydrocarbons (TPH) samples collected from one portion of the soil stockpile. Additional sampling and analysis is required before a remedial alternative is selected. Some of the remedial alternatives discussed in this report may not be appropriate, based on the results of additional soil sampling and analysis. Furthermore, recommended remedial alternatives may also change, based on the additional soil analyses.

1.2 SITE HISTORY

The Navy Fuel Farm is located along the north side of Privet Road, immediately south of the Air National Guard Facility. Figure 1-1 shows the location of the Navy Fuel Farm and Figure 1-2 is a site map of the Fuel Farm prior to 1991. From 1950 to 1991, two partially buried 210,000-gal tanks (Tank Nos. 115 and 116) storing JP-4/JP-5 were located on the site. During excavation of a utility trench, free phase petroleum product was observed in the trench. As a result, the storage tanks were removed in 1991 (EA 1991). The dry well and the two underground storage tanks (USTs) shown in Figure 1-2 have also been removed. The waste oil UST was removed in 1990 (EA 1991) and the diesel fuel UST in 1991 (EA 1993). The dry well, which was used to dispose tank bottom water, was removed as part of the fuel farm renovation in 1992. New aboveground storage tanks, product distribution lines, and a truck parking area were constructed as part of the renovation. Figure 1-3 shows the current configuration of the Navy Fuel Farm.

Soil and concrete excavated during the tank removal and fuel farm construction were segregated into three stockpiles: "clean" soil (3,000 yd^3), "contaminated" soil (3,500 yd^3), and "contaminated" concrete (250 yd^3). The soil was segregated on the basis of visual inspection and field screening of the soil with an organic vapor analyzer during excavation.

The "contaminated" soil pile contains stained soil excavated from the tank pits, the "clean" soil pile contains soil from the new storage tank and truck parking areas, and the "contaminated" concrete pile is the concrete from beneath the old storage tanks. Based on monitoring well logs, the excavated soil is a mixture of silt and silty clay (EA 1989). Four soil samples were collected from the "clean" soil pile in December 1992 and analyzed for TPH diesel range organics. Results ranged from not detectable to 76 mg/kg. Partial laboratory reports are included in Appendix A. No samples from the "contaminated" soil pile or the "contaminated" concrete pile have been analyzed.

Discussions with staff from the Department of Public Works at NAS Willow Grove indicate that soil from other excavations throughout the base may have been added to these stockpiles (Edmond 1993).

1.3 REGULATORY STATUS

Petroleum-Impacted Soil

To evaluate if soil or debris is hazardous, it is tested for the four characteristics of hazardous waste: ignitability, corrosivity, reactivity, and toxicity. Petroleum-impacted soil and debris is most likely to exhibit the toxicity characteristic. The toxicity characteristic leaching procedure (TCLP) is used to evaluate toxicity. If the soil or debris exceeds the TCLP regulatory limit, it is considered a hazardous waste. However, under a temporary deferral, petroleum-contaminated soil and debris that exceed the TCLP regulatory limit for many organic chemicals (such as benzene), and are subject to a remedial action under the UST regulations (40 CFR 280), are not defined as hazardous wastes as per 40 CFR 261.4 (b)(10). EPA has proposed making the temporary deferral a permanent exemption (Fed. Regist. 12 February 1993). In addition, a proposed rule would extend this exemption to non-UST media and debris contaminated by petroleum product (Fed. Regist. 24 December 1992). Both the proposed final rule on the UST deferral and the proposed rule for non-UST media and debris had not been finalized as of 24 February 1994.

Table 1-1 lists the chemicals which are temporarily exempted from the definition of hazardous waste if the soil and debris are subject to a remedial action under the UST regulations. If the soil and debris do not exceed the TCLP regulatory limits for metals or exhibit another hazardous waste characteristic (ignitability, corrosivity, reactivity), the soil or debris would not be classified as a hazardous waste.

Non-hazardous petroleum-contaminated soil must be managed as a residual waste according to the Pennsylvania Residual Waste Management Regulations (PB 1992). In December 1993, the Pennsylvania Department of Environmental Resources (PADER) issued interim guidance on defining the cleanup standards for contaminated soil (PADER 1993). This guidance sets generic cleanup levels for soil contaminated with organic and inorganic compounds. If cleanup standards other than the generic levels are desired, site-specific standards can be determined through the risk assessment process. The generic soil cleanup standards are deemed to be acceptable under the residual waste regulations provided that remediation plans are developed and implemented in association with achieving the cleanup standards (PADER 1993).

The generic cleanup standard is the lowest of three levels: (1) the direct contact standard for noncarcinogenic chemicals, (2) the 1×10^{-6} cancer risk level for carcinogens, and (3) the ground-water protection level. For the organic compounds of concern at the Navy Fuel Farm, the cleanup standard is the ground-water protection level. When the soil has multiple organic constituents, the sum of the concentrations of the individual compounds should not exceed 500,000 μg/kg when attempting to reach levels protective of ground-water quality.

The generic cleanup standards were developed using non-equilibrium desorption of organic compounds from soil and assuming ingestion as the exposure pathway. Because of the lack of analytical data on the stockpiled soil, the generic cleanup standard was compared to analytical results of soil samples collected during well installation at the Navy Fuel Farm. Table 1-2 summarizes the maximum concentrations reported in soil samples (EA 1993; EA 1990) from well installations, as well as the generic cleanup level. It should be noted that impacted soil from the removal of the USTs was placed in the "contaminated" soil stockpile. No samples from this stockpile have been analyzed and additional sampling and analyses is necessary before any meaningful comparison of the generic cleanup standards to the analytical results can be made.

Soil which meets the generic cleanup standards may be left in place or used as backfill in onsite excavations. Furthermore, soil which has been treated to meet the cleanup standard can be used onsite as fill with PADER approval of the fill/disposal area. PADER is concerned that the fill be managed in a manner which will minimize exposure to human and environmental receptors. The guidance places no additional management constraints, such as maintaining 4 ft of uncontaminated soil between the fill and the water table, on the use of the soil as fill.

Concrete Debris

The Pennsylvania Municipal Waste Management Regulations (PB 1992), define construction/ demolition waste as municipal waste. Therefore, if the concrete is nonhazardous, it can be disposed as a municipal waste in a landfill or rubble fill.

As stated in 40 CFR 261.4(b)(10), the concrete debris is also temporarily exempted from the definition of hazardous waste if it would be classified as hazardous solely on the basis that it exceeds the TCLP regulatory limits for hazardous waste codes D018 to D043. Therefore, since the concrete is probably not a hazardous waste, the land disposal restrictions (frequently called the land ban) would not apply and the concrete could be disposed in a landfill.

TABLE 1-1 ORGANIC COMPOUNDS IN UST CONTAMINATED MEDIA AND DEBRIS WHICH ARE EXEMPTED FROM THE DEFINITION OF HAZARDOUS WASTE AT SITES UNDER CORRECTIVE ACTION IN ACCORDANCE WITH THE UST REGULATIONS (40 CFR 280)

Chemical	Hazardous Waste Code	Regulatory Level (mg/l)
Benzene	D018	0.5
Carbon Tetrachloride	D019	0.5
Chlordane	D020	0.03
Chlorobenzene	D021	100
Chloroform	D022	6.0
o-Cresol	D023	200
m-Cresol	D024	200
p-Cresol	D025	200
Cresol	D026	200
1,4-Dichlorobenzene	D027	7.5
1,2-Dichloroethane	D028	0.5
1,1-Dichlorothylene	D029	0.7
2,4-Dinitrotoluene	D030	0.13
Heptachlor	D031	0.008
Hexachlorobenzene	D032	0.13
Hexachloro-1,3-butadiene	D033	0.5
Hexachloroethane	D034	3.0
Methyl ethyl ketone	D035	200
Nitrobenzene	D036	2
Pentachlorophenol	D037	100
Pyridine	D038	5.0
Tetrachloroethylene	D039	0.7
Trichloroethylene	D040	0.5
2,4,5-Trichlorophenol	D041	400
2,4,6-Trichlorophenol	D042	2.0
Vinyl Chloride	D043	0.2

TABLE 1-2 GENERIC CLEANUP STANDARDS AND MAXIMUM CONCENTRATIONS OF ORGANIC COMPOUNDS DETECTED IN SOIL SAMPLES FROM WELL INSTALLATIONS AT THE NAVY FUEL FARM, NAS WILLOW GROVE

Compound	Maximum Soil Concentration Detected (μg/kg)	Generic Soil Cleanup Level (μg/kg)[c]
Benzene	ND[a],[b]	200
Toluene	83[a]	500
Ethylbenzene	160[a]	1,000
o-Xylene	1,500(1)[a]	700
m-Xylene	1,500(1)[a]	1,000
p-Xylene	1,500(1)[a]	1,000
Methylene chloride	2,300 (J)[a]	50
Methyl ethyl ketone (MEK) [2-butanone]	29[a]	10
Naphthalene	950 (J)[a]	2,000
TPH (GC/FID)	352,000	200,000

(J) Parameter was detected at a concentration below the quantification limit. Value reported is an estimated concentration.
(1) Value reported is for total xylenes. Generic soil cleanup level is dependent on individual xylene compounds, not on total xylene concentration.

NOTE: Analytical results are from well installation activities. No samples from the "contaminated" soil stockpile have been analyzed. Additional sampling and analyses is necessary before any meaningful comparison of analytical results to the generic cleanup standards can be made.

References

(a) EA Engineering, Science, and Technology. 1990. *Site Inspection Studies at NAS Willow Grove, Horsham Township, Pennsylvania.* Volume I. Final Report. EA. May 1990.

(b) EA Engineering, Science, and Technology. 1991. *Interim Report on Investigations at the Navy Fuel Farm, NAS Willow Grove, November 1990-July 1991.* EA. November 1991.

(c) Pennsylvania Department of Environmental Resources. 1993. *Interim Cleanup Standards for Contaminated Soils.* PADER, Bureau of Waste Management, Division of Remediation. December 1993.

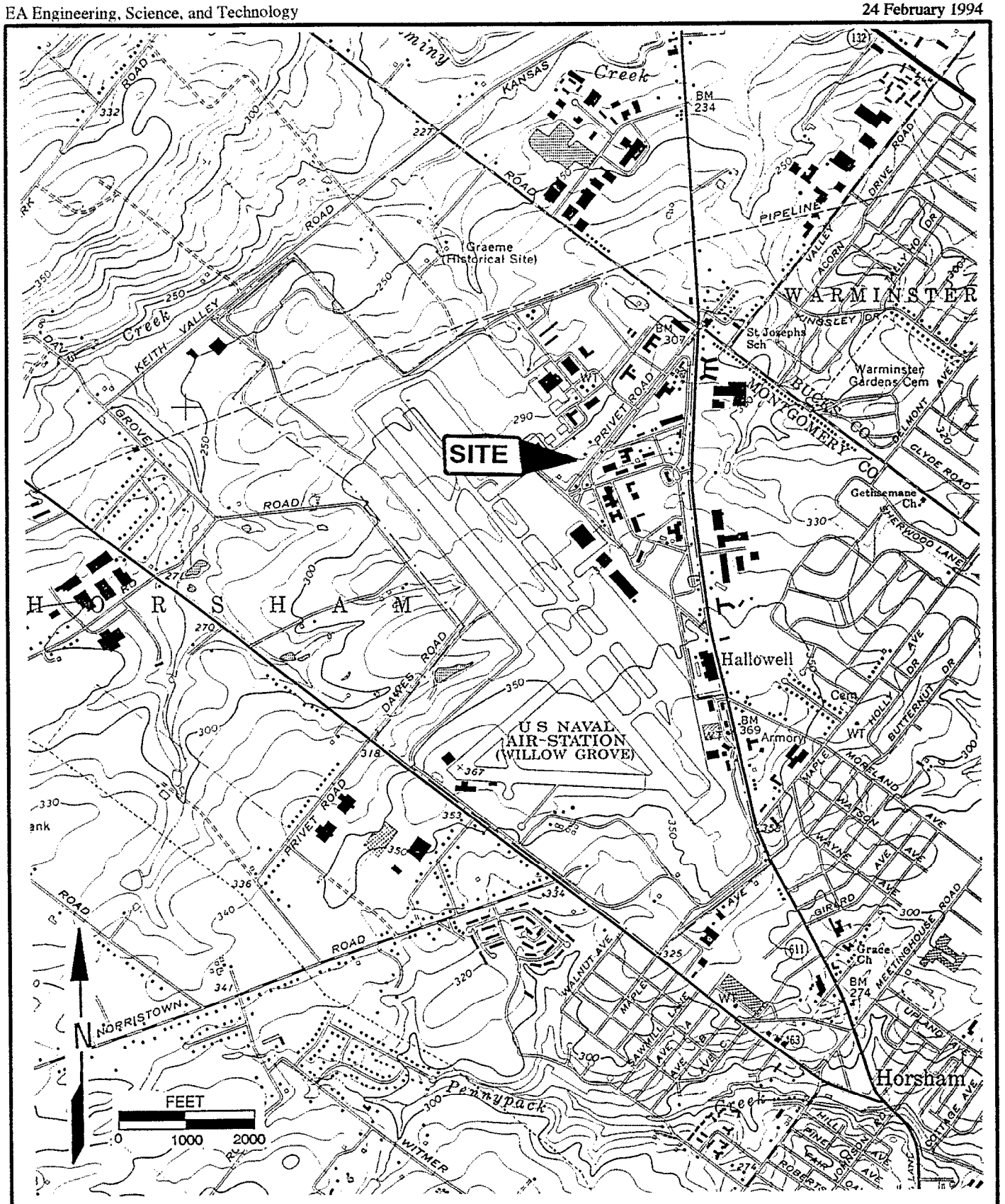

Figure 1-1. Site location map, NAS Willow Grove, Navy Fuel Farm

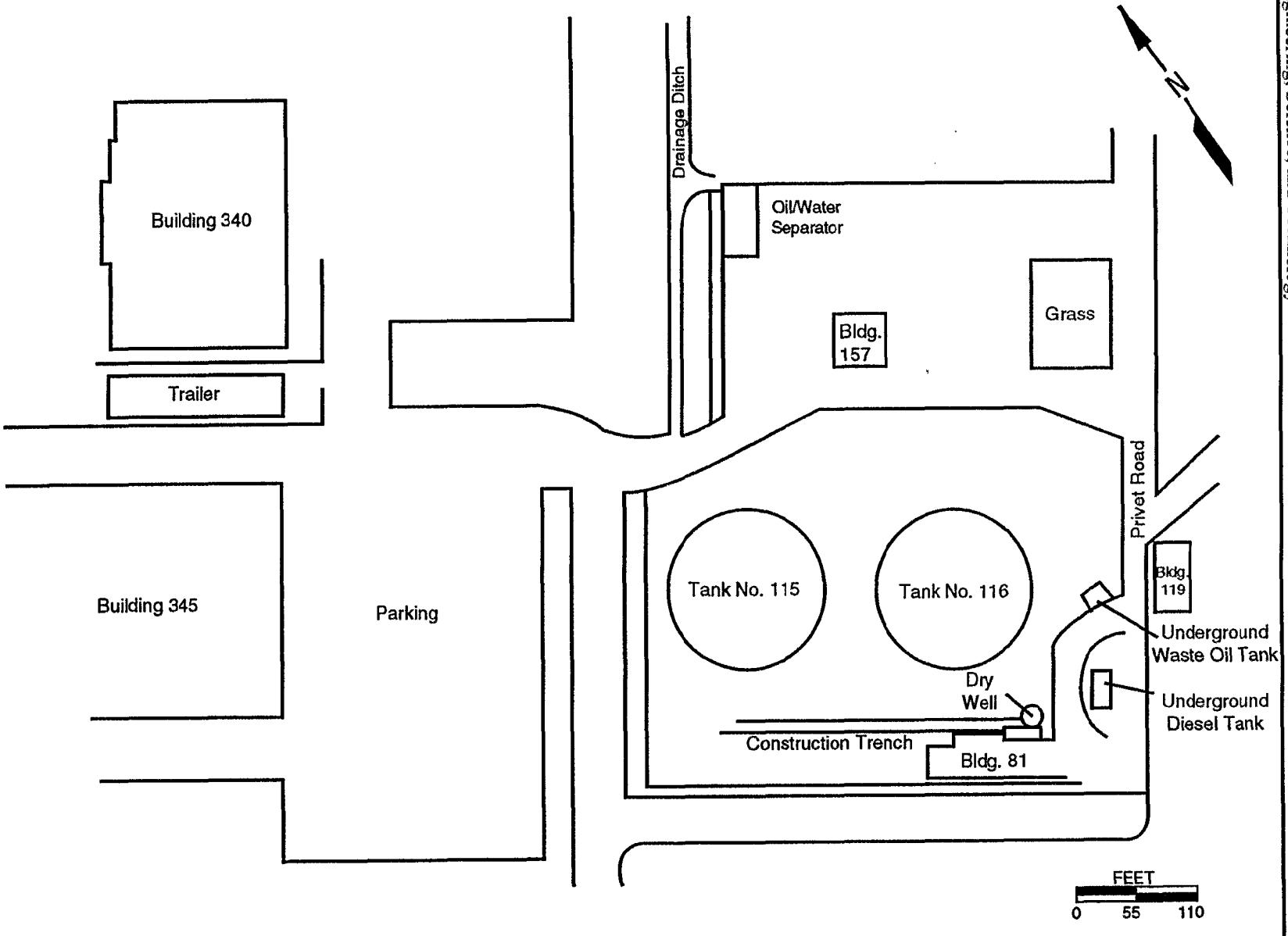

Figure 1-2. Site map prior to 1991, NAS Willow Grove, Navy Fuel Farm showing location of Tanks No. 115 and 116 which were removed in 1991.

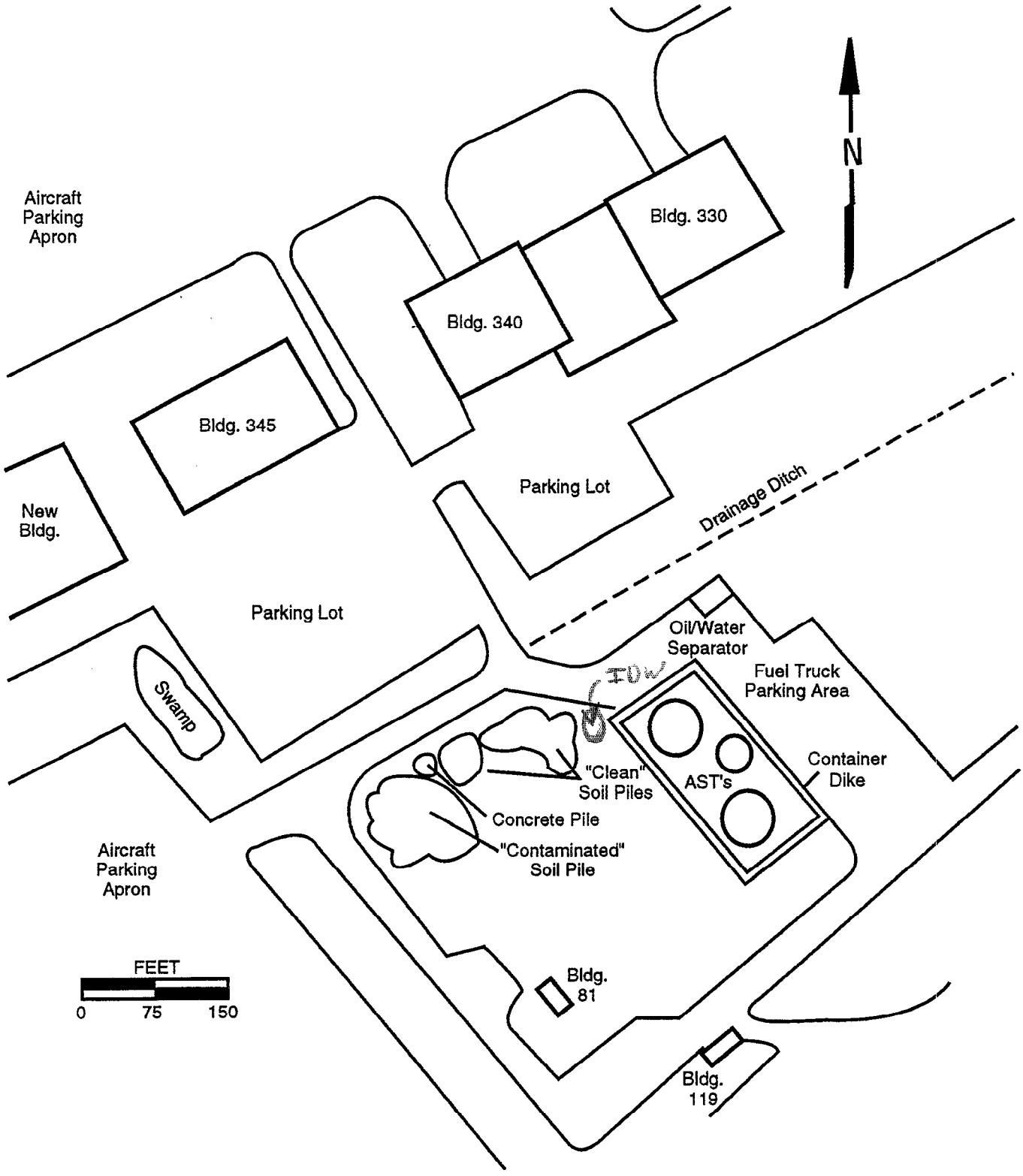

Figure 1-3. Site map - 1993 NAS Willow Grove, Navy Fuel Farm, showing location of soil stockpiles.

2. AVAILABLE REMEDIAL ALTERNATIVES

This chapter summarizes the remedial options available for non-hazardous petroleum-impacted soil and debris. Onsite and offsite treatment/disposal options are addressed. The goal is to reduce the petroleum hydrocarbon concentration of the soil to the generic cleanup level as shown in Table 1-2, or, to treat or dispose the soil and debris in a manner which is protective of human health and the environment.

2.1 LIST OF AVAILABLE REMEDIAL ALTERNATIVES

Table 2-1 is a list of available options that are technically feasible for the treatment/disposal of the soil stockpiled at the fuel farm. Onsite options include landfarming, soil venting, bioventing, slurry phase bioremediation, soil washing, asphalt incorporation, thermal treatment, and vitrification. Offsite options include landfilling, thermal treatment, and asphalt incorporation.

All of the options are technically capable of disposing or remediating the soil in a manner which is protective of ground-water quality. The advantages and disadvantages of these options, as well as the administrative (regulatory) feasibility and cost of these options are summarized in the following section.

2.2 SUMMARY OF REMEDIAL ALTERNATIVES

2.2.1 Landfarming

Process Description

Surface bioremediation of soil spread to a depth of 6 in.-1 ft is known as landfarming. This is a biological treatment utilizing natural soil microbes to degrade organic compounds. The contaminated soil is spread on the surface and regularly tilled to provide oxygen to the soil microbes. Fertilizer, lime, and water are added to provide favorable conditions for microbial growth. In Pennsylvania, off-gas emissions from onsite soil remediation systems, including landfarming, may require treatment. As a result, landfarming may need to be conducted inside a building or other enclosure, and the off-gas treated. Carbon adsorption or catalytic oxidation are the typical off-gas treatment methods.

Advantages

- Contamination is destroyed, not transferred to another media.
- Uses natural degradation processes.

Disadvantages

- Space and time constraints. Landfarming may require significant land area for application and long treatment times (6 months or more). Soil with large silt and clay fractions may require longer treatment times.
- Air emissions may require treatment.
- Heavier petroleum products may be slow to degrade.
- Labor intensive.

Costs

- Landfarming costs have been estimated at $30-$70 per ton (CPPI 1991; EPA 1992) without treatment of air emissions. Treatment of air emissions increases the cost by approximately 50 percent (Miller et al. 1990). Using this rule of thumb, costs would increase to $45-$105 per ton if a building were available for landfarming. Rental and construction of a temporary structure to house landfarming operations may cost an additional $5-$8 per square foot.

2.2.2 Landfilling

Process Description

Landfilling is the placement of petroleum-impacted soil in a secure, licensed landfill facility. The landfill is engineered to prevent release of contaminants to the environment. Liners and caps, drains, cutoff trenches, walls, or barriers are used to contain the soil. Pennsylvania, unlike some jurisdictions, does not allow petroleum-impacted soil to be used as cover material. Pennsylvania requires that a form be completed (Form FC-1; Notification of Intent

To Dispose of Soil Contaminated by Virgin Petroleum Fuel) prior to disposal at a landfill permitted to accept petroleum-impacted soil. In addition, at Pennsylvania landfills, one composite sample per 250 tons must be collected and analyzed for TPH (SW-846 Method 8015); benzene, toluene, ethylbenzene, and xylenes (BTEX) (SW-846 Method 8020); total organic halogens (TOX) (EPA Method 9020); polychlorinated biphenyls (PCB) (SW-846 Method 8080); total Resource Conservation and Recovery Act (RCRA) metals (SW-846 Method 6010); and TCLP metals (SW-846 Method 6010 with Method 1311 extraction), pesticides (SW-846 Method 8080 with Method 1311 extraction), and herbicides (SW-846 Method 8150 with Method 1311 extraction).

Advantages

- Fast—the disposal time is relatively short because soil is removed from the site.
- Quick regulatory approval—two landfills (Pottstown and G.R.O.W.S. Landfill in Morrisville) in Southeastern Pennsylvania are permitted to accept petroleum-impacted soil.

Disadvantages

- Contaminants are not treated.
- Continuing liability. Potential exists for the generator to be identified as a responsible party should the landfill require remedial action.

Cost

- Disposal at the G.R.O.W.S. Landfill in Morrisville, Pennsylvania, is estimated to cost $59 per ton. This price is based on $43 per ton for disposal, $0.25 per ton per mile for transportation, $0.40 per ton to load the soil, and the remainder for analytical testing of soil (BTEX, TPH, TOX, TCLP-metals, pH, ignitability, total RCRA metals, PCB, TCLP pesticides and herbicides) at a frequency of one test every 250 tons.

- Disposal of 3,000 yd^3 (4,500 tons) is estimated to cost $263,250 and landfilling of 6,500 yd^3 (9,750 tons) is estimated at $570,075.

2.2.3 Hot Mix Asphalt Incorporation

Process Description

Petroleum-impacted soil can be recycled in asphalt using a combination of separation, destruction, and immobilization technologies. Hot mix asphalt incorporation is the substitution of petroleum-contaminated soil for stone aggregate in hot asphalt mixes. Most of the lighter hydrocarbons are volatilized during heating of the soil to 260-425°C. Air emissions are controlled by incineration or carbon adsorption. The heavier hydrocarbons remain in the soil and are incorporated into the asphalt mix. The final asphalt mix is typically used as a subgrade material and the process can be designed to produce a material with the strength needed for the desired application. The amount of subgrade material produced per ton of soil processed depends on the amount of aggregate used in addition to the soil. A volume increase of 3-7 percent is typical. Therefore, if all 6,500 yd (9,750 tons) is treated, approximately 10,000-10,400 tons of asphalt subbase would be produced. To further evaluate the feasibility of hot mix asphalt incorporation, a soil sample (5-gal) should be submitted to the vendor for bench testing purposes. The bench test is usually conducted free of charge.

Advantages

- Short treatment/disposal time.
- Best suited to soil impacted with heavier fuels such as diesel, heating oil, and jet fuel.

Disadvantages

- Onsite asphalt incorporation may require off-gas treatment.
- Best suited for coarse-grained material; soil high in clay or silt will adversely affect asphalt quality.

- Disposal at an offsite facility could result in significant transportation costs.

Costs

- Offsite treatment by hot mix asphalt incorporation is estimated at $72-$106 per ton.

- Costs for onsite treatment depend on the soil characteristics, volume of soil to be treated, and the level of off-gas treatment necessary.

2.2.4 Cold or Warm Mix Asphalt Incorporation

Process Description

Petroleum-impacted soil can be recycled by incorporation into asphalt with minimal (warm mix) or no heating (cold mix). Both processes produce a subbase material. These methods immobilize the petroleum hydrocarbons. This differs from hot mix asphalt in that the soil is not heated (cold mix) or is heated to 140-180°F (warm mix) prior to incorporation into the subbase material. Some cold or warm mix processes require a curing period of up to 72 hours. The process can usually be modified to produce a subbase material with the strength needed for the desired application. Onsite asphalt incorporation facilities can process 800-1,000 tons per day. The volume of subbase generated depends on the amount of aggregate required in addition to the soil. Typically, volume of subbase will be 3-7 percent more than the volume of soil. If all 6,500 yd^3 (9,750 tons) is used, approximately 10,000-10,400 tons of subbase material will be generated. To further evaluate the feasibility of cold and warm mix asphalt incorporation, a soil sample (5-gal) should be submitted to the vendor for bench testing purposes. This bench test is usually conducted free of charge.

Advantages

- Short treatment/disposal time.

- Treatment of air emissions may not be required.

- Better suited to soil impacted by gasoline than hot mix asphalt incorporation.

- Onsite asphalt incorporation is feasible if volume is sufficient (10,000 tons).

Disadvantages

- Best suited for coarse-grained material; soil high in clay or silt will adversely affect the quality of the subbase material.

- Disposal at an offsite facility could result in significant transportation costs.

- Permitting could be difficult.

Costs

- Offsite treatment at Soil Safe in Baltimore, Maryland, is estimated at $45 per ton including $28 per ton for treatment, $17 ton for transportation, with the remainder for loading and analytical costs (Kennel 1993).

- Onsite treatment of 10,000 tons or more using cold mix asphalt incorporation is estimated at $28-$32 per ton (Kennel 1993).

2.2.5 Soil Venting

Process Description

Soil venting, or soil vapor extraction, is a process in which hydrocarbons are removed from the soil by volatilization through air circulation. Air circulation can be either passive or active. Passive soil venting systems use a system of perforated pipes open to the atmosphere to aerate the soil. In active systems, soil vapor is extracted from the soil by applying a vacuum to a network of pipes or wells. In both passive and active soil venting systems, as the soil vapor is removed, hydrocarbons adsorbed into the soil transfer to the vapor phase and are removed from the soil. In Pennsylvania, the extracted soil vapor must be treated to remove the volatile organic compounds (VOC) prior to emitting to the atmosphere.

Ex situ soil venting systems are typically constructed by placing the soil on an impermeable barrier such as 10-mil plastic sheeting. Wells or lateral pipes are installed to extract the soil vapor and the soil pile is covered with a layer of plastic to control runoff. Because the soil has been excavated and stockpiled and the soil beneath the stockpiles is likely to be remediated *in situ*, placement of the soil on an impermeable barrier should not be necessary. The Navy currently plans to conduct a pilot test to assess the feasibility of *in situ* soil remediation using aquifer air sparging and soil venting. Combining the remediation of the soil piles and the *in situ* soil could result in significant cost savings.

Advantages

- The soil at NAS Willow Grove is currently in piles; minimal handling of the soil would be required to implement soil venting.
- Soil impacted with jet fuel has been successfully remediated using soil venting.
- Potential cost savings associated with combining soil stockpile and *in situ* soil remediation.

Disadvantages

- Soil venting in general, and passive soil venting in particular, is not well suited to soil with low permeabilities.
- Space and time constraints. Need the area to construct the soil piles. Treatment times may be long (6 months to 2 years). Soil with large silt and clay fractions may require longer treatment times.
- Air emissions may require treatment.

Costs

- Costs for active soil venting have been estimated at $20-$63 per ton (CPPI 1991; EPA 1993), plus the cost of treating the air emissions. Air emissions treatment typically increases the cost by 50 percent (Miller et al. 1990), which would raise the cost to $40-$90 per ton. The cost of passive soil venting and *in situ* active

soil venting should be in the lower end of this range while costs for *ex situ* soil venting (passive or active) including excavation costs should be in the higher end of this cost range. Costs for passive soil venting are highly dependent on the cost of controlling air emissions and on the monitoring schedule. Annual operating costs should be significantly lower than active soil venting but the project life is typically longer in passive systems.

2.2.6 Bioventing

Process Description

Bioventing is the process of aerating soil to stimulate biological activity and promote bioremediation. This process is similar to soil venting but is different in the objective and the design and operation of the systems. The objective of soil venting is to volatilize the petroleum hydrocarbons from the soil, while the objective of bioventing is to provide sufficient oxygen to enhance the bioremediation of the soil.

Construction of the bioventing system is similar to the soil venting system except that a method of watering the soil must be provided. Soil is placed in piles with a network of pipes or wells placed throughout the soil. Air is supplied to the soil by extracting or injection. Air is then extracted from the soil pile using a vacuum pump or injected using a blower. Nutrients and water are added to the soil to provide a favorable environment for the growth of the soil microorganisms. If air is extracted, the air emissions may require treatment to control the VOC emissions. Treatment of air emissions may not be necessary if it can be demonstrated that air is injected into the soil pile results in a negligible VOC concentration in the off-gas.

Advantages

- The soil at NAS Willow Grove is currently in piles; minimal handling of the soil would be required to implement bioventing.

- Air can be injected or extracted. At locations with no nearby buildings or other potential receptors, injection of air may eliminate the need to extract air and, therefore, the need for off-gas treatment.

- Air flow and costs for air emissions treatment are also less than for soil venting.

- Bioventing may be more effective in low permeability soil than soil venting.

- Biological activity is enhanced; therefore, the treatment time is decreased.

Disadvantages

- Space and time constraints. Need the area to construct the soil piles. Treatment times may be long (3 months or more). Soils with large silt and clay fractions may require longer treatment times.

- Air emissions may require treatment.

- Heavier petroleum products may be slow to degrade.

Costs

- Costs have been estimated at $30-$125 per ton (CPPI 1991; EPA 1993) including treatment of air emissions. The costs vary with the level of off-gas treatment required. If no off-gas treatment is required, then the costs should be in the lower part of this range.

2.2.7 Vitrification

Process Description

Vitrification is the electrical heating of soil to a temperature of 1,600-2,000°C. At these temperatures, the soil becomes a molten mass and combustion of organic constituents occurs. Metals and other soil constituents are encapsulated as the soil cools and turns into an obsidian-like substance. Soil volume is reduced during vitrification. Vitrification technology is still being developed. Because the volatile compounds are emitted to the atmosphere, control of air emissions may be required in Pennsylvania.

Advantages

- Onsite treatment.
- Volume reduction. Less soil for final disposition.

Disadvantages

- Technology still developing.
- High cost.
- Air emissions treatment likely to be required.

Costs

- Treatment costs range from $200 to $600 per ton, plus mobilization of equipment (typically $100,000-$200,000) and treatability testing ($35,000-$30,000) (Hansen and Fitzpatrick 1989; EPA 1993).

2.2.8 Low Temperature Thermal Treatment

Process Description

Low temperature thermal treatment heats the soil to 150-450°C to volatilize the VOC. At this temperature, the soil is not incinerated. Low temperature thermal treatment typically uses a rotary kiln to mix, aerate, and heat the soil. The air is subsequently filtered to remove the particulates and treated with a secondary burner at 700-1,000°C to remove the VOC from the air prior to emitting it to the atmosphere. Low temperature thermal treatment is applicable to gasoline, diesel, and jet fuel. Lubricating oil is not effectively removed by low temperature thermal treatment (CPPI 1991).

The end product of this process is a soil which can be used as fill. Mobile treatment units are available which allow the treated soil to remain onsite. However, air permits for onsite treatment may be difficult to obtain.

Advantages

- Treats a wider range of petroleum hydrocarbons than soil venting.
- Mobile units are available.
- Treated soil can be used as clean fill.

Disadvantages

- Soil with a high water content or high clay content can be difficult to treat.
- Permitting of mobile units may be difficult.

Costs

- Reported treatment costs typically range from $74 to $150 per ton (CPPI 1991: EPA 1992).
- Disposal of 3,000 yd^3 (4,500 tons) of soil at Clean Earth in New Castle, Delaware, is estimated at $56 per ton, including $44 per ton for treatment, $10 per ton for transportation, and the remainder for loading and analytical testing of soil.
- Mobile units for treatment onsite typically cost $60-$80 (Dohn 1993; Meekins 1993).

2.2.9 High Temperature Thermal Treatment

Process Description

High temperature thermal treatment heats the soil to 815-1,200°C. At these temperatures, the organic constituents in the soil are completely combusted. Rotary kilns, infrared incinerators, and circulating bed combustors are used. To ensure combustion of organic constituent, a secondary burner is used to heat the air to approximately 1,500°C prior to

emitting it to the atmosphere. This process produces an ash which requires landfilling. All types of petroleum contamination, including gasoline, diesel, jet fuels, and lubricating oils, have been successfully treated by high temperature thermal treatment.

Advantages

- Complete destruction of petroleum hydrocarbons.
- Applicable to a wide range of contaminants and soil types.
- Mobile units are available for onsite treatment.

Disadvantages

- Residual ash needs to be landfilled.
- Thoughts of having an incinerator in their back yard would not sit well with community.

Costs

- Costs have been estimated at $100-$400 per ton, depending on type of incinerator, soil characteristics, and volume of soil (CPPI 1991).

2.2.10 Slurry Phase Bioremediation

Process Description

This process mixes soil, water, air, and nutrients in a reactor to enhance the growth of soil micro-organisms to biodegrade the petroleum hydrocarbons. The reactors can be batch fed, sequencing batch fed, or continuously fed into a mixing vessel. This can be conducted onsite. Once treatment is complete, the slurry must be dewatered before the dewatered soil can be used as clean fill.

Treatment time is a function of the type of petroleum and soil type. Residence time in bioreactors ranges from several days to 2-3 weeks (CPPI 1991).

Advantages

- Complete degradation of petroleum hydrocarbons.
- Reactor environment can be easily controlled, which results in faster treatment than other bioremediation techniques.
- Onsite treatment.
- Treated soil can be used as clean fill.

Disadvantages

- Soil with a high water content or high clay contents can be difficult to treat.
- A significant amount of water requiring treatment is generated. Costs associated with treatment of water discharge may be significant.

Costs

- Reported treatment costs range from $47 to $250 per ton (CPPI 1991; EPA 1993).

2.2.11 Soil Washing

Process Description

Soil washing is a water-based process for mechanically scrubbing soil to remove the contaminants. Soil washing can include one or both of two types of processes: (1) dissolving contaminants in a solvent or (2) concentrating contaminants into a smaller volume of soil through particle size separation. Because organic constituents tend to adsorb to clay and silt, particle-size separation is used to reduce the volume of soil requiring washing with a solvent.

Advantages

- Applicable to a wide range of contaminants.
- Onsite treatment.
- Treated soil can be used as clean fill.

Disadvantages

- Not cost-effective for soil with a high silt or clay content (greater than 20 percent).
- Significant amounts of water requiring treatment are generated.

Costs

- Reported treatment costs range from $50 to $300 per ton, plus treatment of wastewater (CPPI 1991; EPA 1987; EPA 1993).

2.4 CONCRETE DISPOSAL OPTIONS

Non-hazardous concrete is not subject to the Land Ban restrictions of 40 CFR 268. Therefore, the concrete can be disposed in a landfill. Disposal at a landfill is estimated at $45-$55 per ton, plus transportation costs.

TABLE 2-1 OPTIONS FOR TREATMENT/DISPOSAL OF SOIL STOCKPILED AT THE NAVY FUEL FARM, NAS WILLOW GROVE

ONSITE	OFFSITE
Landfarming	Landfilling
Bioventing	Low Temperature Thermal Treatment
Slurry Phase Bioremediation	High Temperature Thermal Treatment
Soil Venting	Asphalt Incorporation (Hot Mix)
Soil Washing	Asphalt Incorporation (Cold or Warm Mix)
Asphalt Incorporation (Hot Mix)	
Asphalt Incorporation (Cold or Warm Mix)	
Low Temperature Thermal Treatment	
High Temperature Thermal Treatment	
Vitrification	

3. RECOMMENDATIONS FOR TREATMENT/DISPOSAL

3.1 PETROLEUM-IMPACTED SOIL

The disposal/treatment options for soil stockpiled at the Navy Fuel Farm at NAS Willow Grove are briefly summarized in Table 3-1. Selection of an option is dependent on the results of additional sampling and analyses of the stockpiles as described in Chapter 4, Recommendations for Additional Sampling.

Under the proper conditions, all of the options should be able to remediate or treat/dispose the soil to levels protective of ground water. Therefore, cost, the Navy's preference, and community and regulatory acceptance become the deciding factors in selecting a treatment/ disposal option. Once an option has been selected, regulatory and community approval could be obtained through the Technical Review Committee.

Offsite Options

The cost for offsite options (landfilling, low or high temperature thermal treatment, hot mix or cold/warm mix asphalt incorporation) shown in Table 3-1 were obtained from vendors in the mid-Atlantic region. Costs ranged from $45 per ton for cold mix asphalt incorporation to $59 per ton for landfilling. Landfilling is not recommended because of the potential liability as a responsible party in a possible future cleanup of the landfill. Cold or warm mix asphalt incorporation ($56/ton) is cheaper and more common than hot mix ($72-$106/ton). The cost for low temperature thermal treatment is estimated at $56 per ton which is significantly less per ton than for high temperature thermal treatment. Assuming that approximately 3,000 yd^3 (4,500 tons) of soil will require treatment/disposal, offsite cold/warm mix asphalt incorporation or low temperature thermal treatment is cost-competitive. Onsite low temperature thermal treatment or asphalt incorporation becomes cost-competitive at a volume of approximately 10,000 tons. Both thermal treatment and asphalt incorporation treat the petroleum hydrocarbons in the soil and the potential for continuing liability is low. If liability issues are a concern, soil thermally treated offsite could be returned to NAS Willow Grove for use as fill at an additional charge of approximately $5 per ton.

Onsite Options

PADER and EPA encourage onsite treatment and disposal of petroleum-impacted soil. The larger the volume of soil to be treated, the more cost-effective onsite options become. The costs for onsite treatment are dependent on the level of contamination and the level of treatment for process wastes such as off-gas treatment. In addition, thermal treatment, soil venting, and bioventing require conducting a treatability test and pilot testing prior to design and implementation of a full scale system. The feasibility of asphalt incorporation can be determined through a bench test. A 5-gal soil sample can usually be sent to asphalt incorporation vendors for bench testing free of charge.

Off-gas treatment is more expensive in hot mix asphalt treatment than cold/warm mix and in high temperature thermal treatment than in low temperature thermal treatment. As a result, onsite cold or warm mix asphalt incorporation is more common than onsite hot mix and onsite low temperature thermal treatment is more common than onsite high temperature thermal treatment. Onsite cold or warm mix asphalt incorporation and low temperature thermal treatment become cost-effective when approximately 10,000 tons or more of soil are treated. The cost of onsite cold or warm mix asphalt incorporation is estimated at $28-$32/ton and the cost of onsite low temperature thermal treatment at $60-$80/ton.

Landfarming may be required to be conducted inside a building to allow for tilling or discing of the soil and off-gas treatment. The logistics and design of such a landfarming operation may make this option undesirable. However, if an existing building is available, landfarming could be a viable option. Mobile slurry phase bioremediation and soil washing units are available from numerous vendors (EPA 1993). However, the costs for treatability testing and treatment of the wastewater have the potential to make this option significantly more expensive than soil venting or bioventing. Vitrification is not cost-competitive and is not recommended.

Reported costs for bioventing ($30-$125) and soil venting ($40-$90) are approximately the same. The wide range of costs reflects the costs associated with off-gas treatment, and in the case of bioventing, pilot testing. The rate of air emissions are lower in bioventing than soil venting; therefore, air treatment costs should be lower. It should be noted that the air sparging pilot system being installed at the Fuel Farm as part of a separate project will also require treatment of air emissions. The air sparging pilot system has not been designed as of the date of this report; however, on completion of a vent/biovent test on the soil piles and the design of the pilot air sparging system, the potential for combining the pilot system with a

remedial system for the soil piles should be evaluated. Significant savings could be realized by using a single air emissions treatment system for the soil pile remediation and the air sparging system.

Recommendation

Assuming that approximately 4,500 tons of soil (from a total of 9,750 tons) will require treatment/disposal, offsite options, such as cold or warm mix asphalt incorporation, are price-competitive with onsite options such as soil venting or bioventing. As the volume of soil to be treated increases, onsite options become more cost-effective. Both soil venting and bioventing have the potential to be significantly more or less expensive than cold or warm mix asphalt incorporation, depending on the potential cost savings resulting from combining soil pile remediation with other remedial actions at the site. In the absence of these potential savings, offsite cold or warm mix asphalt incorporation would be the recommended disposal/treatment method for the soil piles. However, when considered together with additional onsite soil to be remediated, onsite treatment is likely to be more cost-effective.

3.2 CONCRETE

If the concrete is determined to be nonhazardous, the recommended disposal option is landfilling.

TABLE 3-1 SUMMARY OF SOIL TREATMENT/DISPOSAL OPTIONS

Option	Onsite or Offsite	Cost Per Ton	Advantages	Disadvantages
Landfarming	Onsite	$45-$105	Complete degradation of petroleum hydrocarbons.	May have to be done inside to allow for treatment of air emissions.
Hot Mix Asphalt Incorporation	Offsite	$72-$106	Short treatment/disposal time. Well suited to jet fuel.	Transportation costs could be significant.
	Onsite	Dependent on level of air emissions treatment required.	Well suited to jet fuel. Asphalt subgrade material used onsite.	Air emissions require treatment.
Cold or Warm Mix Asphalt Incorporation	Offsite	$45	Short treatment/disposal time. Cold mix may not require treatment of air emissions.	Warm mix may require treatment of air emissions.
	Onsite	$28-$32	Short treatment/disposal time. Cold mix may not require treatment of air emissions. Asphalt subgrade material used onsite.	Need sufficient quantity (10,000 tons). Warm mix may require treatment of air emissions. May require a curing period.
Low Temperature Thermal Treatment	Offsite	$56	Short treatment/disposal time.	Soil with high water content may be difficult to treat.
	Onsite	$60-$80	Short treatment/disposal time. Treated soil can be used onsite as fill.	Must have sufficient volume (10,000 tons). Permitting may be difficult. Soil with high water content may be difficult to treat.
High Temperature Thermal Treatment	Offsite	$100-$400	Applicable to a wide range of soil types.	Produces an ash which requires landfilling.
	Onsite	Dependent on level of air emissions treatment required.	Applicable to a wide range of soil types.	Produces an ash which requires landfilling.
Bioventing	Onsite	$30-$125	Minimal handling of soil; air emission treatment less costly than in soil venting.	Off-gas treatment may be required.
Slurry Phase Bioremediation	Onsite	$47-$250	Bioremediation variables easily controlled (oxygen, pH, temperature).	Produces water which needs to be treated.
Soil Venting	Onsite	$40-$90	Minimal handling of soil.	Soil with high clay and silt may be difficult to treat.
Soil Washing	Onsite	$50-$300	Applicable to wide range of contaminants.	Not applicable to soil with more than 20% clay or silt.
Landfilling	Offsite	$59/ton	Fast disposal and quick regulatory approval.	Contaminants are not treated; continued liability.
Vitrification	Onsite	$200-$600	Complete degradation of petroleum hydrocarbons.	Technology still developing; high cost.

4. RECOMMENDATIONS FOR ADDITIONAL SAMPLING

Inadequate analytical data exist to properly characterize the stockpiles so further sampling and analyses are necessary. This chapter summarizes a plan for additional sampling and analyses of the soil and concrete stockpiles. Table 4-1 summarizes the recommended sampling plan.

4.1 PETROLEUM-IMPACTED SOIL

The soil is currently segregated into "clean" (3,000 yd^3) and "contaminated" (3,500 yd^3) stockpiles. Sampling of both soil piles should be conducted in a two-stage process. The goal of the first stage is to further characterize the soil according to PADER guidance on cleanup standards for contaminated soil (PADER 1993). This will be accomplished by collecting composite soil samples for TPH and discrete soil samples for BTEX, acetone, methyl ethyl ketone (MEK), and methylene chloride. BTEX and TPH are indicators of petroleum contamination. Acetone, MEK, and methylene chloride have been reported in samples analyzed during well installations (see Table 1-2). These compounds are common laboratory contaminants, however, the previous studies did not report these compounds in the laboratory method blanks. As a result it is recommended that field blanks be analyzed in addition to trip blanks and laboratory method blanks.

The soil piles should be divided into grids of approximately 250 yd^3 and four to five hand auger borings should be made in each grid to collect composite soil samples for TPH analysis. One TPH analysis per grid will be conducted. While conducting the soil borings, the soil type (sand, silt, clay, loam, gravel) should be recorded with visual and olfactory evidence of petroleum impacts noted. Soil boring locations will be recorded on a sketch of the soil stockpiles. Soil from each boring should be screened for volatile organic compounds with an appropriate field instrument (flame ionization detector or photo-ionization detector). The soil from each grid with the highest volatile organic measurement should be sampled and analyzed for BTEX, MEK, acetone, and methylene chloride. Twenty-six TPH and twenty-six BTEX/MEK/acetone/methylene chloride samples will be analyzed. Recommended analytical methods are EPA Methods 5030/8020 for BTEX/MEK/acetone/methylene chloride and modified EPA Method 8015 for TPH as JP-4. This TPH method can be substituted (with PADER approval) for the PADER-specified TPH method developed by the American Petroleum Institute (API) (PADER 1993). The API method is based on the EPA Method SW-846, which includes Method 8015. Therefore, using Method 8015 should be readily approved by PADER.

Upon receipt of the analytical results, the amount of soil exceeding the generic cleanup standard may be estimated. If the soil meets the cleanup standards, further sampling and analysis may not be necessary, and the soil may be used as fill onsite, with PADER approval of the fill site. Depending on the analytical results and the proposed disposition of the soil, PADER may require additional soil analysis.

Additional sampling of soil which exceeds the generic cleanup standards is the second stage of the sampling plan. The method of treatment/disposal would determine the number of samples collected and the analyses conducted. For example, offsite disposal at an asphalt incorporation facility may require only a few samples be analyzed for TPH, BTEX, total organic halogens (TOX), ignitability, pH, PCB, TCLP-metals, and TCLP-pesticides/ herbicides. If onsite treatment by soil venting or bioventing is the selected soil treatment method, additional analyses may not be required to characterize the soil, but analyses and field tests (such as vent tests) may be necessary to design a treatment system. Recommendations for stage two of the sampling plan would best be assessed after receipt of the stage one analytical results.

If asphalt incorporation is the selected method of treatment, vendors will require a soil sample and probably a site visit to assess the suitability of the soil for their particular process. Typically, vendors need a 5-gal bucket of soil to conduct bench scale testing. Site visits are usually conducted by vendors free of charge as part of the bidding/cost estimating process.

4.2 CONCRETE

Landfilling is the recommended disposal option for the concrete. As a result, the purpose of sampling and analyses of the concrete is to classify the concrete as hazardous or nonhazardous. This will be accomplished by collecting a representative sample and analyzing for TCLP metals (Method 6010).

TABLE 4-1 RECOMMENDED SAMPLING AND ANALYSIS PLAN: STAGE 1

Media	Parameter	Method	Number of Samples
Soil Piles	TPH	EPA modified 8015 as JP-4	26
	BTEX/MEK/Acetone Methylene Chloride	EPA Method 8020	26
Concrete	TCLP-Metals	EPA Method 6010	1

Note: Additional Stage 2 samples may be required depending on results of these samples.

REFERENCES

Canadian Petroleum Products Institute. 1991. *Manual of Petroleum Contaminated Soil Treatment Technologies*. CPPI Report No. 91-9. CPPI. November.

Dohn, G. 1993. TPS Technologies. Personal communication. 20 October.

EA Engineering, Science, and Technology. 1989. *Environmental Test Boring Investigation at the Navy Fuel Farm, NAS Willow Grove*. Draft Report. June.

EA Engineering, Science, and Technology. 1990. *Site Inspection Studies at NAS Willow Grove, Horsham Township, Pennsylvania*. Volume I. Final Report. EA. May 1990.

EA Engineering, Science, and Technology. 1991. *Interim Report on Investigations at the Navy Fuel Farm, NAS Willow Grove, November 1990-July 1991*. EA. November 1991.

EA Engineering, Science, and Technology. 1993. *Draft Report of Interim Site Investigations, Navy Fuel Farm, Willow Grove NAS*. July.

Edmond, J. 1993. NAS Willow Grove, Dept. of Public Works. Personal communication. 15 October.

Federal Register. 24 December 1992. pp. 61542-61556.

Federal Register. 12 February 1993. pp. 8504-8512.

Hansen, J., and V. Fitzpatrick. 1989. *In-Situ Vitrification: Heat and Immobilization are Combined for Soil Remediation*.

Kennel, W. 1993. Soil Safe. Personal communication. 13 October.

Meekins, K. 1993. Clean Earth. Personal communication. 18 October.

Miller, R.N., R.E. Hinchee, C.M. Vogel, R.R. Dupont, and D.C. Downey. 1990. A field scale investigation of enhanced petroleum hydrocarbon biodegradation in the vadose zone at Tyndall AFB, Florida. NWWA/API Proceedings of Petroleum Hydrocarbons and Organic Chemicals in Ground Water: Prevention, Detection, and Restoration. 31 October-2 November. Houston, Texas.

PB 1992. *Pennsylvania Bulletin, Vol 22, No. 7, July 4, 1992*. Part II Environmental Quality Board, Residual Waste Management

Pennsylvania Department of Environmental Resources. 1993. *Interim Cleanup Standards for Contaminated Soils*. PADER. December.

U.S. Environmental Protection Agency. 1987. *Underground Storage Tank Corrective Action Technologies: Office of Solid Waste and Emergency Response*. Report No. EPA/625/6-87-015. U.S. EPA, Washington, D.C. January.

U.S. Environmental Protection Agency. 1992. *Technologies and Options for UST Corrective Actions: Overview of Current Practice*. Report No. EPA/542/R-92/010. U.S. EPA, Office of Solid Waste and Emergency Response, Washington, D.C. August.

U.S. Environmental Protection Agency. 1993. VISITT: Vendor Information System for Innovative Treatment Technologies. Version 2.0. April.

APPENDIX A

PARTIAL ANALYTICAL RESULTS OF SOIL SAMPLES

Page # 1
Sample # 43315-4

ATTN: Off.in Chg./Jack Fox
Naval Air Station
Public Works Dept., Bldg.78
NAVFAC Contracts
Willow Grove PA 190905010

December 16, 1992

LAB ANALYSIS REPORT

Job Name	: Naval Air Station	Customer PO#	: N62472-93M-6447
Job Number	: N1714-OIC-MC	Date Sampled	: 12/07/92 11:05 AM
Location	: Sample 4	Date Received	: 12/08/92
Sample State	: Soil Grab	Date Completed	: 12/11/92
Inspector	: JF	Discard Date	: 12/26/92

TEST/PARAMETER	RESULT	UNITS	DETECTION LIMIT	METHOD
GAS CHROMATOGRAPH ANALYSES				
TPH - Diesel Range Organics	10	mg/kg	4.4	

Respectfully Submitted,
WRIGHT LAB SERVICES

Ian Milnes
Laboratory Manager

Page # 1
Sample # 43315-3

ATTN: Off.in Chg./Jack Fox
Naval Air Station
Public Works Dept., Bldg.78
NAVFAC Contracts
Willow Grove PA 190905010

December 16, 1992

LAB ANALYSIS REPORT

Job Name	: Naval Air Station	Customer PO#	: N62472-93M-6447
Job Number	: N1714-OIC-MC	Date Sampled	: 12/07/92 10:55 AM
Location	: Sample 3	Date Received	: 12/08/92
Sample State	: Soil Grab	Date Completed	: 12/11/92
Collector	: JF	Discard Date	: 12/26/92

TEST/PARAMETER	RESULT	UNITS	DETECTION LIMIT	METHOD
GAS CHROMATOGRAPH ANALYSES				
TPH - Diesel Range Organics	54	mg/kg	4.4	

Respectfully Submitted,
WRIGHT LAB SERVICES

Ian Milnes
Laboratory Manager

Page # 1
Sample # 43315-2

TN: Off.in Chg./Jack Fox
val Air Station
Public Works Dept., Bldg.78
FAC Contracts
low Grove PA 190905010

December 16, 1992

LAB ANALYSIS REPORT

Name	: Naval Air Station	Customer PO#	: N62472-93M-6447
Number	: N1714-OIC-MC	Date Sampled	: 12/07/92 11:40 AM
ation	: Sample 2	Date Received	: 12/08/92
ple State	: Soil Grab	Date Completed	: 12/11/92
tor	: JF	Discard Date	: 12/26/92

TEST/PARAMETER	RESULT	UNITS	DETECTION LIMIT	METHOD
CHROMATOGRAPH ANALYSES				
TPH - Diesel Range Organics	N.D.	mg/kg	4.4	

N.D. - Not Detected

Respectfully Submitted,
WRIGHT LAB SERVICES

Ian Milnes
Laboratory Manager