**UNITED STATES ENVIRONMENTAL PROTECTION AGENCY**
Region III
841 Chestnut Building
Philadelphia, Pennsylvania 19107

**REPLY TO ATTENTION OF:**

**General Federal Facilities Section (3HW72)**

**FEDERAL EXPRESS**
**TELEFACSIMILE**

January 6, 1994

Department of the Navy
Northern Division
Naval Facilities Engineering Command
10 Industrial Highway
Mail Stop #82
Lester, PA 19113-2090

Attn: James L. Colter (Code 1821/JLC)
Remedial Project Manager

Re: Free-Product Recovery and Aquifer Air Sparging
Navy Fuel Farm, Naval Air Station Willow Grove
Horsham Township, PA

Dear Mr. Colter:

As you requested, the U.S. Environmental Protection Agency ("EPA" or "Agency") has reviewed the final *Work Plan for Pilot-Scale Testing of Free-Product Recovery and Aquifer Air Sparging*, dated November 1993 and prepared by EA Engineering, Science, and Technology, Inc. ("EA") on behalf of the Northern Division, Naval Facilities Engineering Command ("NORTHDIV"). EPA received this document on November 26, 1993.

Specific comments, which have been generated by members of EPA's Superfund Technical Assistance Response Team ("START"), are enclosed for your information (*Attachment One*). The EPA/START technical evaluation focused primarily on the following aspects of this work plan:

1. Implementability and effectiveness of aquifer air sparging in reducing the toxicity, mobility and volume of observed contamination, given the information presented in background documents.

2. Appropriateness of proposed pre-testing sampling and analysis, treatability testing, and data analysis/reporting.

3. Recommendations for addressing any observed deficiencies in the scope of work, intended use of data and/or reporting requirements.

4. Recommendations for considering additional technologies to replace and/or supplement aquifer air sparging.

Generally speaking, the work plan is high-quality, technically sound document. However, given the site-specific characteristics (i.e., relatively low aquifer hydraulic conductivity), EPA believes that the Navy Fuel Farm may only be marginally amenable to a soil vapor extraction/air aquifer sparging ("SVE/AAS") system. Although EPA has discussed technologies that could be used to enhance in situ hydraulic conductivity and maximize the implementability and effectiveness of SVE/AAS, the Agency feels as though the scope of the proposed pilot study is considerably more extensive than necessary.

Therefore, EPA strongly suggests conducting the SVE/AAS pilot study in a "phased" approach, whereby air permeability testing is **initially** performed and data is collected/analyzed. NORTHDIV should proceed with the actual pilot study only **after** thoroughly evaluating data obtained during the initial phase. In this manner, it would be possible to conduct the entire pilot study in a cost-effective manner, while still acquiring data of sufficient quantity and quality.

After you have had an adequate opportunity to review comments in Attachment One, I would be happy to arrange a meeting among project managers and technical specialists from NORTHDIV, EA and EPA/START. The Agency looks forward to working with NORTHDIV to ensure that SVE/AAS achieves its intended objectives.

In the meantime, if you have any questions or wish to further discuss these comments, please do not hesitate to contact m at (215) 597-3161.

Sincerely,

Drew Lausch
Remedial Project Manager

Attachment

cc w/enclosure:

Ben Mykijewycz (EPA)
Mary Stinson (EPA/START)
Joan Colson (EPA/RREL)
Bob France (PADER)
LCDR Eric Milner (NAS)
Hal Dusen (ARF)

# WORK PLAN REVIEW - FREE PRODUCT RECOVERY AND AQUIFER AIR SPARGING AT THE WILLOW GROVE NAVAL AIR STATION, PA

## 1.0 INTRODUCTION AND SUMMARY

### 1.1 Site Background

This report reviews the "Work Plan for Pilot-Scale Testing of Free-Product Recovery and Aquifer Air Sparging at the Navy Fuel Farm Facility Naval Air Station, Willow Grove, Pennsylvania," prepared by EA Engineering, Science and Technology. The site is a Naval Fuel Farm facility and is contaminated with HP-5 jet aviation fuel from a spill occurring in 1986, when Tank 115, one of two 210,000 gallon storage tanks, was overfilled and fuel was released from a vent pipe onto the ground. Free product has been observed in a utility trench on the western boundary of the site. In March 1989, JP-5 was detected emanating from the ground west of Tank 115. The JP-5 was washed into a ditch adjacent to the tank by heavy rains. Both 210,000 gallon fuel storage tanks were emptied and removed when evidence of leakage was found. An additional 500 gallon underground waste oil tank and an underground diesel storage tank were removed. Inspection showed holes in the waste oil tank up to 1-in. in diameter.

The soil cover at the site ranges in depth from 6 feet to 21 feet. The shallow stratigraphy is comprised of silty clay and clayey silt with varying amounts of sand and gravel. These types of soil exhibit reduced permeability leading to slow infiltration rates. The average depth of groundwater at the site ranges from 7 feet to 32 feet with seasonal variations of several feet. The average hydraulic conductivity of the unconfined aquifer in the underlying bedrock is $4.05 \times 10^{-5}$ cm/sec.

### 1.2 Work Plan

The major finding of this review concerns the organization and scope of the proposed Soil Vapor Extraction/Aquifer Air Sparging pilot-scale testing program. The Work Plan states that "the vadose soil permeability (air) has not been determined during prior investigations". It is necessary to determine the air permeability at the site before the extraction well trenches and AAS sparging wells can be specified. Therefore, the SVE/AAS Pilot Study would be better if it were organized in two phases, namely:

- Phase I - Air Permeability Testing
- Phase II - Pilot Study Testing

The scope of the SVE/AAS pilot study should be reduced, since the hydraulic conductivity of 4.05 x $10^{-5}$ cm/sec makes application of the technology marginal. It is felt that the projected total of 24 AAS wells at intervals up to 40 ft are too many for this study. The 14 SVE trenches ranging in length from 15 to 40 ft are also too many for this project.

The Work Plan, while well written, is incomplete. The section of the Work Plan dealing with Free Product Recovery is more complete than the Aquifer Air Sparging section. The Work Plan should follow the EPA guidance documents on conducting treatability studies and is lacking the following:

- Free Product Recovery Section
  - Quality Assurance Project Plan (QAPjP)
  - Budget section
- Aquifer Air Sparging Section
  - Equipment and Materials Section
  - Sampling and Analysis Plan and QAPjP
  - Residuals Management Section
  - Budget Section

Techniques to increase site permeabilities, such as pneumatic fracturing and hydraulic fracturing, should be considered the pilot testing of SVE/AAS show unacceptable vapor recovery rates.

## 2.0 ANALYSIS OF TECHNICAL ISSUES AND TEST DESIGN

### 2.1 Assessment of Technology Applicability

#### 2.1.1 **Free Product Recovery**

Site remediation time can be reduced significantly by the application of free-product recovery techniques. Two techniques are being employed for this pilot test, namely automated product skimming for wells NFFW-6 and NFFW-19, and vacuum enhanced pumping in well NFFW-2R.

Product skimming or pumping free product from wells without pumping groundwater is an effective techniques for static layers of free product that remain in the vicinity of the spill. Vacuum enhanced pumping should enhance the oil pressure gradient to the well and thus increase the oil recovery rate. Both techniques are employed in areas of low hydraulic conductivity. Vacuum enhanced pumping is considerably more expensive than product skimming and the pilot testing of both techniques should determine which is more feasible.

2.1.2 **SVE/AAS Pilot System**

The applicability of SVE/AAS to this site is marginal, given the nature of the stratigraphy and the aquifer hydraulic conductivity of $4.05 \times 10^{-5}$ cm/sec. Therefore, it is necessary to structure the pilot testing at the site in phases, so that data collected from the first phase of the testing may be used in the specification of the next phase. Phase I of the pilot testing should involve only that equipment and well installations necessary to determine the air permeability and radius of influence. If the air permeability is determined to be greater than $10^{-10}$ $cm^2$, then the next phase of testing may be designed using the data obtained in Phase I. In any case, the pilot testing at this site should not be as extensive as that specified in the Work Plan. The Work Plan specifies 24 AAS wells and 14 SVE trenches, which is far too great a scope for a marginal site such as this. The number of SVE trenches and AAS wells should be specified in such a way as to constitute a unit cell so that the degree of vadose zone remediation may be more readily evaluated.

2.2 Site Sample Requirements

2.2.1 **Free Product Recovery**

The amount and frequency of sampling and monitoring are deemed adequate for the duration of the 39-week pilot test.

2.2.2 **SVE/AAS**

There is no sampling and analytical plan for this section of the Work Plan and one must be included to define S&A methodologies and protocols. Included in the S&A plan should be a Quality Assurance Project Plan (QAPjP). The section dealing with Data Interpretation is adequate and well written.

2.3 Minor Specific Comments

Page 5-14, Section 5.3.1.1 Vadose Zone Remediation - In the formula,

$ER = Q * C * MW * 1.58 \times 10^{-7} * 24$

the units of Q should read standard cubic feet per minute rather than cubic feet per minute.

Page 5-22, Section 5.3.34 Short Circuiting - The sentence "The need for passive or active air injection wells must be considered to promote vertical air flow in the event a high degree of short circuiting is indicated" is in error. The words "promote vertical air flow" should be changed to "modify air flow patterns".

## 3.0 ADDITIONAL TECHNOLOGY RECOMMENDATIONS

Should the pilot testing of the SVE/AAS technology show unacceptable vapor recovery rates because of low permeabilities in the vadose zone and the underlying saturated soils and weathered/ fractured bedrock, pneumatic fracturing, or hydraulic fracturing techniques should be considered to increase these permeabilities. Both pneumatic fracturing extraction (PFE) and hydraulic fracturing technology (HFT) have been successfully demonstrated in EPA's SITE program.

PFE is a process which removes VOCs from tight geologic matrices. It overcomes low permeability problems by injecting a controlled burst of compressed air into an isolated interval of a borehole. This creates a fracture network in the soil or sedimentary rock up to 35 feet from the injection point, thereby increasing permeability and exposing more of the contaminants to subsurface air flow. The SITE program demonstration applied PFE successfully to TCE contamination in the vadose zone. Research at the Hazardous Substance Management Research Center of the New Jersey Institute of Technology has developed evidence that fracturing can be carried out in a saturated zone without dewatering. Subsequent VOC removal by a combination of stripping and vapor extraction is enhanced. Free product recovery may be enhanced by this technique as demonstrated at Tinker AFB, Oklahoma City, OK, where pre-fracture data showed 0.2 gallons pe day of free #2 fuel oil recovered from a recovery well, the well recovered 22 gallons per day of free product for over two months.

Fractures produced by the PFE technique may close over time and refracturing done when this occurs. Fracturing is not an expensive process and this technique has been demonstrated to be cost effective.

Hydraulic fracturing technology (HFT) creates fractures in low permeability clays by pumping a gel containing coarse sand into the zone to be fractured. Sand is deposited in the fractures and enhances the permeability of the contaminated soil. The SITE program applied this technology to an SVE site and a bioremediation site. Conclusions from the SVE site were:

Fractured wells yielded vapor flow rates 15 to 30 times greater than unfractured wells.

Contaminant yields from the fractured well zones were 7 to 14 times greater than from comparable zones in the unfractured wells.

- The vapor flow rate from fractured wells was adversely affected by precipitation.

Conclusions from the bioremediation site were:

- Moisture content increased in the vicinity of the fractured well, especially in the fractured zones.
- The flow of water was about 25 to 40 times greater in the fractured well than in the unfractured well.
- Petroleum hydrocarbon removal was higher in the fractured well than in the unfractured well.

Pneumatic fracturing and hydraulic fracturing should both enhance SVE/AAS, free product recovery, and in situ bioremediation technologies. Should these techniques fail, there should be a closer look at on site technologies on excavated soil. These could be: land treatment (biological), soil washing, and thermal desorption. However, every effort should be taken to explore the full potential of in situ technologies.

**REFERENCES**

1. USEPA. Guide for Conducting Treatability Studies Under CERCLA. Soil Vapor Extraction. EPA/540/2-91/019A. September 1991.
2. USEPA. A Technology Assessment of Soil Vapor Extraction and Air Sparging. EPA/600/R-92/173. September 1992.
3. USEPA. Soil Vapor Extraction Technology Reference Handbook. EPA/540/2-91/003. February 1991.
4. USEPA. Free Product Recovery and Residual Hydrocarbon Removal - UST Corrective Action Workshop - Unpublished Draft Document.
5. USEPA. Accutech Pneumatic Fracturing and Hot Gas Injection, Phase I, Applications Analysis Report. EPA/540/AR-93/509. July 1993.
6. USEPA. Hydraulic Fracturing Technology, Applications Analysis and Technology Evaluation Report. EPA/540/R-93/505. September 1993.