DRAFT PILOT STUDY WORK PLAN FOR REMEDIATING SUBSURFACE LIQUID-PHASE HYDROCARBONS SURROUNDING THE TANK D-4 AT THE TRUMBO POINT FUEL FARM
NAS KEY WEST FL
10/1/1988
GERAGHTY AND MILLER INC

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PILOT STUDY
WORK PLAN FOR REMEDIATING
SUBSURFACE LIQUID-PHASE HYDROCARBONS
SURROUNDING TANK D-4 AT THE
TRUMBO POINT FUEL FARM,
NAVAL AIR STATION,
KEY WEST, FLORIDA

DRAFT

Prepared for

DEPARTMENT OF THE NAVY
SOUTHERN DIVISION
NAVAL FACILITIES ENGINEERING COMMAND
CHARLESTON, SOUTH CAROLINA

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INTRODUCTION

Since October 1985, Geraghty & Miller, Inc., (G&M) has provided architect/engineering services which includes hydrogeologic consulting investigations for the Naval Facilities Engineering Command, Southern Division, (Navy) at the Naval Air Station (NAS) in Key West, Florida (Figure 1). This work has been conducted in connection with the Naval Installation Restoration Program (NIRP) which is designed to identify, investigate, and remediate sites where past use or disposal of hazardous-substances occurred on Naval and related facilities.

In April 1988, the Navy contracted G&M to prepare the following Pilot Study work plan. The goal of the work plan is to test and evaluate a method for remediating subsurface liquid-phase and dissolved hydrocarbon contamination at the Trumbo Point Annex Fuel Farm at the NAS in the vicinity of tank D-4 (Figure 2). Prior to preparing the work plan, several remedial alternatives were screened resulting in the selection of one alternative for evaluation during a pilot study. This information was then used to prepare the work plan which describes the selected remedial alternative and outlines how the pilot study will be performed. The preparation of the work plan is the first of four phases of work to be performed, ultimately leading to remediation of hydrocarbon contamination in this area. The subsequent three phases include a Phase II-Pilot Study, Phase III-Feasibility Study, and Phase IV-Remedial Action. The information gained during Phase II will be used to perform Phases III and IV.

The following document discusses the background conditions at the site, the screening and preliminary selection of a remedial alternative, and presents a work plan for performing a pilot study.

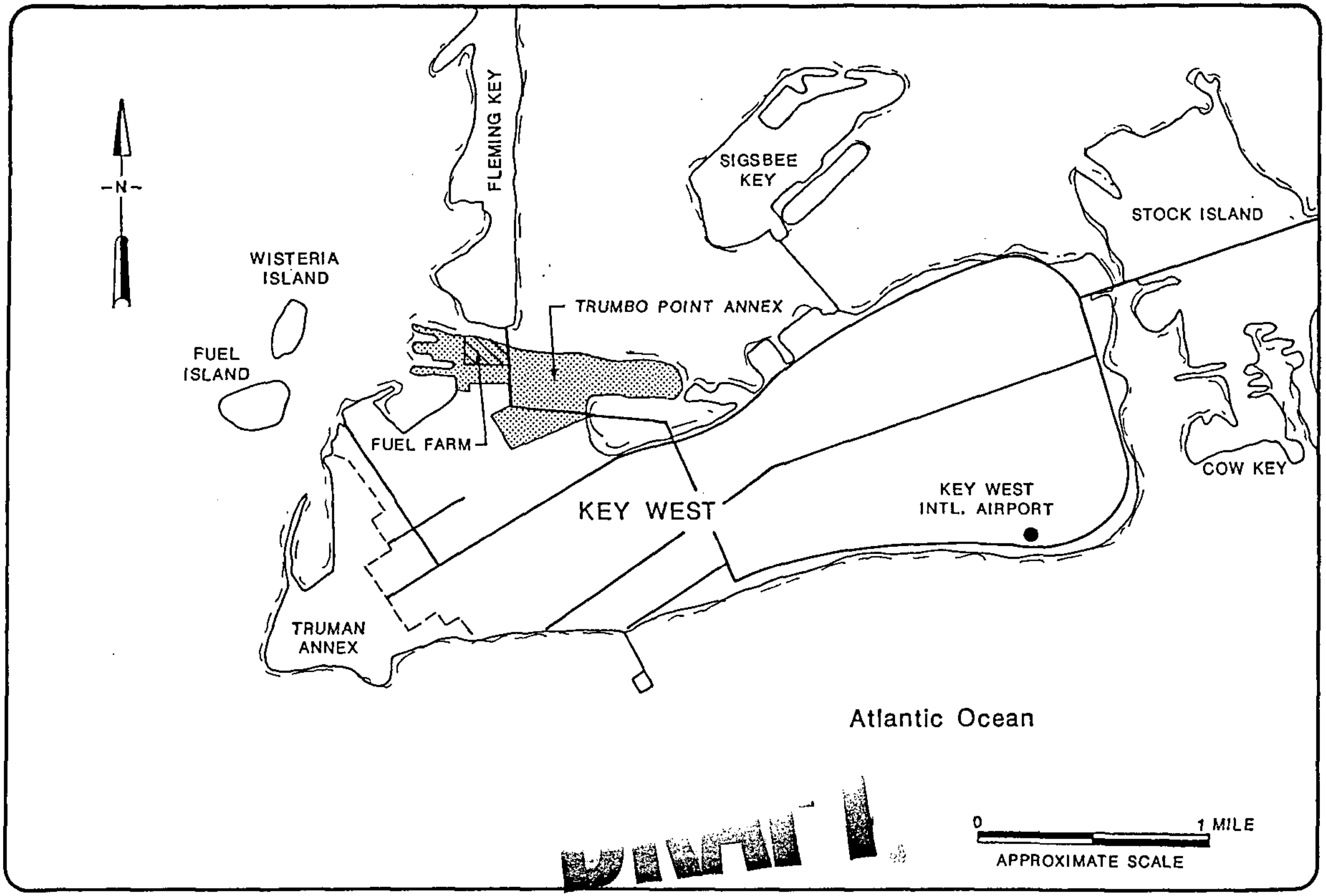

Figure 1.

Location of Trumbo Point Fuel Farm, Naval Air Station, Key West, Florida.

CLIENT NAME:

Department of the Navy
Naval Air Station
Key West, Florida

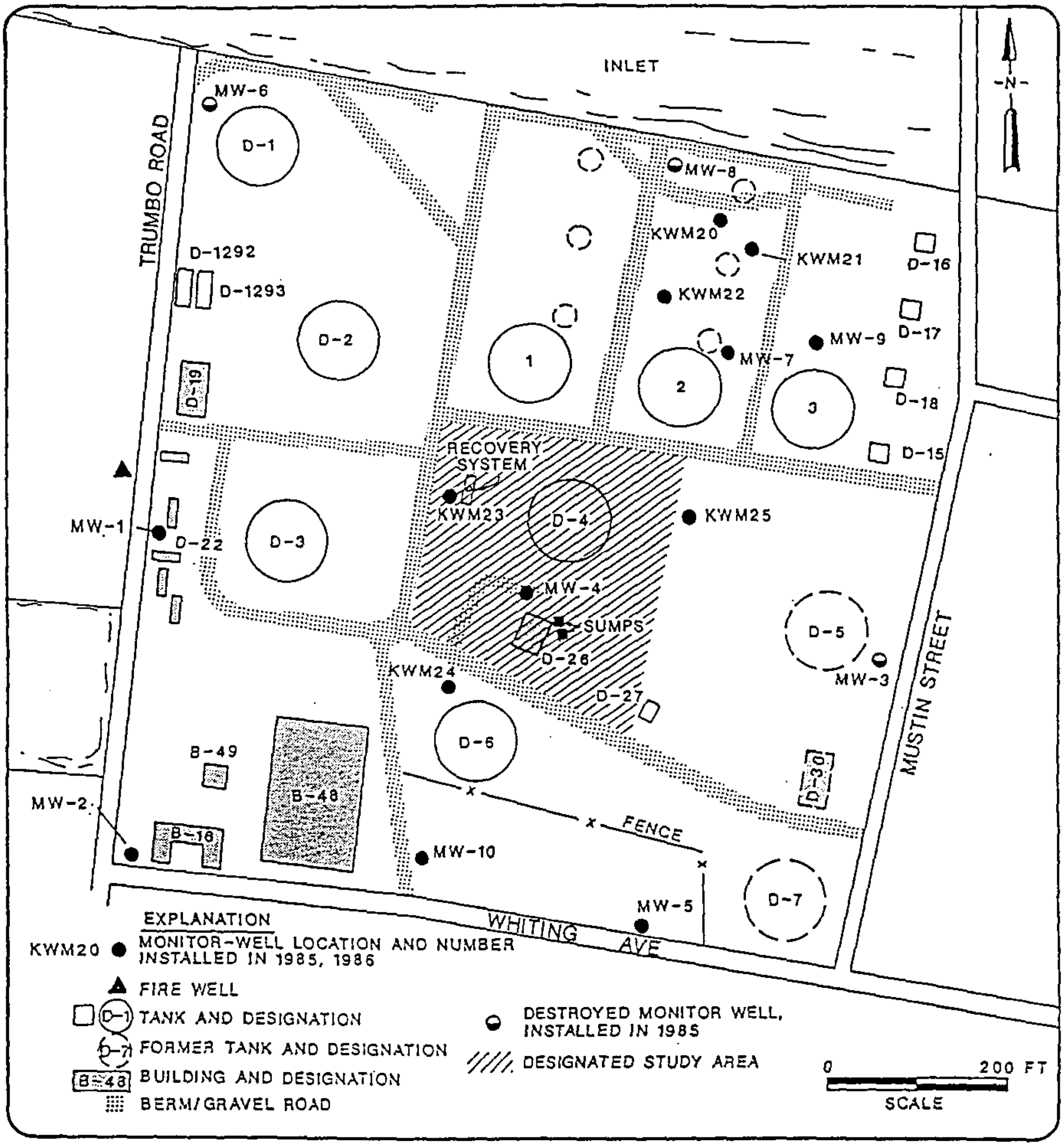

Figure 2.

Location of Tank D-4 and Recovery System at Trumbo Point Fuel Farm.

CLIENT NAME:

Department of the Navy
Naval Air Station
Key West, Florida

BACKGROUND

The Trumbo Point Annex is located on the north side of Key West. According to Navy personnel, in 1918 the Annex was originally constructed of dredged materials for use as a seaplane base. The fuel farm, located on the north side of the Annex (Figure 1), has been used as a distribution and storage facility for various types of fuels since 1942. Until about 1985, the fuel farm consisted of 28 tanks; however, at present, 15 tanks are still intact. Four of the tanks, including tank D-4 are not presently in use (Figure 2).

G&M has previously performed three hydrogeologic investigations at the fuel farm. The results of the first investigation were presented in a report entitled "Subsurface Hydrocarbon Investigation at Trumbo Point Annex, NAS-Key West, Florida, June 1985." This report indicated that in 1981 a loss of diesel fuel occurred from a corroded pipe between tank D-4 and the D-26 pumphouse (Figure 2). As part of the overall investigation of this area, a monitor well (MW-4) was installed between these two structures. Daily water-level measurements collected in this well between April 23 and 26, 1985 (see Table 1), showed that liquid-phase hydrocarbon thicknesses ranged from 0.03 to 1.39 feet (ft).

The second investigation conducted at the NAS that included this area was the "Verification Study, Assessment of Potential Ground-Water Pollution at the Naval Air Station, Key West, Florida, March 1987." As part of this investigation, additional wells, KWM23 and KWM25, were installed at the locations shown in Figure 2. The results of data collected during this study indicated that no liquid-phase hydrocarbons were present in well KWM25. On July 9, July 10, and August 4, 1986, thicknesses of liquid-phase hydrocarbon in KWM23 were 2.66, 2.96, and 5.80 ft, respectively. In well

Table 1. Thickness of Liquid-Phase Hydrocarbon in Monitor Wells MW-4, KWM23, and KWM25

	Liquid-Phase Hydrocarbon Thickness (ft)[1/]		
Date	MW-4	KWM23	KWM25
4-23-85	0.03		
4-24-85	0.75		
4-25-85	1.39		
4-26-85	0.66		
7-9-86	--[2/]	2.66	0[3/]
7-10-86	0.16	2.96	0
8-4-86	0.48	5.80	0
4-15-88	0	7.71	0

1/ ft = feet

2/ -- = no measurement taken

3/ no liquid-phase hydrocarbon present

Note: KWM23 and KWM25 were installed in 1986.

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MW-4, 0.16 and 0.48 ft of liquid-phase hydrocarbon was measured on July 10, and August 4, 1986, respectively. No measurements were made in well MW-4 on July 9, 1986 (Table 1).

In March 1988, the Navy contracted G&M to perform an investigation entitled "Draft Preliminary Site Investigation Report and Expanded Site Investigation/Remedial Field Investigation Work Plan, Trumbo Point Fuel Farm and Piers D-1 and D-3, Naval Air Station, Key West, Florida." As requested by the Navy, this study did not include the area around tank D-4. However, when the field portion of this study was performed on April 13, 1988, water-level and liquid-phase hydrocarbon measurements were collected from well MW-4, KWM23, and KWM25 so that a complete data base could be obtained. These data (Table 1) indicated that liquid-phase hydrocarbon was not present in wells MW-4 and KWM25. However, 7.71 ft of liquid-phase hydrocarbon was detected in well KWM23 and between 0.01 and 0.25 ft of liquid-phase hydrocarbon was found in two sumps adjacent to building D-26 (see Figure 2). Additionally, a strong fuel odor was noted when the inside of this building (D-26) was inspected, and the floor had been stained by what appeared to be fuel.

The information acquired during these previous investigations indicates that liquid-phase hydrocarbon has been detected in monitor wells in the vicinity of tank D-4 since April of 1985. This information also suggests that the hydrocarbon plume has changed in either location, extent or thickness, and presently the areal extent of the plume is not certain. However, in April 1988, to begin remediation of this plume, the Navy requested G&M to prepare the following work plan that describes a pilot study to evaluate recovery of dissolved and liquid-phase hydrocarbon contamination. The work plan also includes a discussion of the preliminary selection of the remedial technology to be evaluated during the pilot study.

PRELIMINARY EVALUATION OF REMEDIAL ALTERNATIVES

Prior to preparing the Pilot Study work plan, G&M screened several remedial alternatives for ground water and liquid-phase hydrocarbon recovery for site-specific conditions in order to select the preferred method to be evaluated during the pilot study. Given the site-specific information available, it was necessary to make assumptions about the local hydrogeology based on information acquired during the previously discussed investigations. These assumptions, which were considered during the preliminary evaluation of a remedial alternative, are listed below.

- Lithologic data collected during installation of wells MW-4 (G&M, 1985), KWM23, and KWM25 (G&M, 1987) were compared to published literature (Davis and DeWeist, 1966) to acquire an estimate of the hydraulic conductivity of soils in the study area. This comparison indicates that these soils probably have a relatively low hydraulic conductivity (10^{-6} to 10^{-3} cm/sec). No in-situ aquifer testing to determine actual hydraulic conductivity values of the soils at the site has been performed.

- Water-table elevations are affected by tidal fluctuations in the surrounding marine surface-water bodies (G&M, 1987). As a result, the predominant direction of ground-water flow has not been ascertained because continuous water-level monitoring has not yet been performed to evaluate the effects of tides on the water table.

Considering these assumptions, an appropriate remedial alternative was selected for evaluation during the Pilot Study. The first step in selection was to compile a list of collection systems that would be appropriate to the known hydrogeologic conditions at the site, and then to choose a complementary fluid-handling system. After the remedial alternative was selected, a pilot study work plan was developed for the preferred alternative.

Collection Systems

The use of recovery wells, infiltration galleries, or a combination of both was considered for collection of liquid-phase hydrocarbon and ground water (see Table 2). Because of the low hydraulic conductivity of the soils comprising the shallow aquifer, the anticipated yields from these types of collection systems will be relatively low. However, if properly located, these collection systems should be able to recover ground water and liquid-phase hydrocarbon.

Recovery wells could be utilized to capture ground water and/or liquid-phase hydrocarbon and are generally easily installed at a relatively low cost. However, the areal influence of one recovery well would be limited due to the low transmissivity of the aquifer at the site, thereby requiring a multiple well system.

An infiltration gallery would consist of a trench backfilled with pea gravel. The gallery would convey ground water and/or liquid-phase hydrocarbon to a common collection point (sump) creating a continuous hydraulic zone of influence, similar to a line of closely spaced recovery wells. Although infiltration galleries are generally more expensive to install, experience has shown that periodic redevelopment of recovery wells is usually required to maintain efficient yields, thereby resulting in higher long-term O&M costs. Therefore, because of the shallow depth of and tidal influence on the water-table surface, and low hydraulic conductivity of the aquifer, infiltration galleries would be generally more cost effective to operate and

Table 2. Comparison of Collection Systems

Collection System	Effectiveness	Implementability	Cost
Recovery Wells	o Due to low permeability of soils, zone of influence of each well might be small. o Large number of wells would be required to effectively capture floating layer.	o Easily Installed.	o Low Capital o Moderate O&M
Infiltration Gallery	o Creates a continuous zone of influence. o Requires minimal maintenance.	o Underground piping may pose location and/or construction difficulties.	o Moderate to High Capital o Low O&M
Infiltration Gallery/ Recovery Wells	o Would utilize infiltration gallery in large areas requiring remediation.	o Site characteristics will dictate which system gets implemented in various areas.	o Moderate to High Capital o Low O&M

maintain than recovery wells. As in the case with any infiltration gallery, a collection sump is needed to pump the liquid-phase hydrocarbon and/or dissolved hydrocarbon from the subsurface. For the above-stated reasons, the use of an infiltration gallery to intercept and collect ground water and/or liquid-phase hydrocarbon appears to be the most favorable alternative.

Fluid Handling Systems

Four fluid handling systems for hydrocarbon recovery were evaluated (see Table 3) including: (1) Auto Skimmer(s)™ for removing liquid-phase hydrocarbon, (2) Scavenger® pump for removing liquid-phase hydrocarbon, (3) a two-pump system consisting of a liquid-phase hydrocarbon recovery pump (Probe-Scavenger®) and a water-table depression pump, and (4) a total-fluid system which collects both liquid-phase hydrocarbon and ground water.

The Auto Skimmer™ is capable of recovering liquid-phase hydrocarbon from wells as small as two inches in diameter using a bailer-type mechanism and can work without, or in conjunction with, a water-table depression pump. The skimmer can be set to recover small liquid-phase hydrocarbon thicknesses from the top of the water table and can be installed below grade, if desired. A fluid handling system utilizing the Auto Skimmer™ without the use of a water table depression pump would require a large number of recovery wells to be effective. Auto Skimmers™ can be difficult to install, generally need frequent maintenance to be effective, and G&M's previous on-site applications with similar devices have not been always successful. For these reasons, the Auto Skimmer™ is not considered appropriate for conditions at the site.

Table 3. Fluid Handling Systems

Fluid Handling System	Effectiveness	Implementability
Auto Skimmer(s)™	o Can skim small product thicknesses. o Generally requires frequent operator attention.	o Easily implemented in wells as small as 2 inches.
Scavenger®	o Generaly requires minimal operator attention. o Can skim small product thicknesses. o Effectively recovers up to 5 gallons per minute.	o Requires large-diameter (24 inches) recovery well.
Probe-Scavenger®	o Generally requires frequent attention. o Requires approximately 1 inch of product before it initiates recovery. o Effectively recovers up to 35 gallons per minute.	o Requires 8 to 12-inch-diameter recovery wells.
Pneumatic	o Generally requires frequent operator attention. o Effectively recovers ground water and/or product from low yielding wells.	o Requires an oil-water separator. o Requires an air compressor.

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The Scavenger[R] pump is used for recovering liquid-phase hydrocarbon and operates by floating on top of the liquid-phase hydrocarbon layer. It is essentially an in-situ oil/water separator which collects liquid-phase hydrocarbon by utilizing a membrane which repels water while allowing liquid-phase hydrocarbon to pass through for discharge to an above-ground storage tank. Unlike other pumps, the Scavenger[R] floats on the liquid-phase hydrocarbon layer so that no adjustments in pump level would be necessary as the water table fluctuates in response to tidal action or rainfall events. The Scavenger[R] system requires a large-diameter recovery well (at least 24 inches in diameter) to act as a collection sump and is capable of removing liquid-phase hydrocarbon thicknesses as small as 0.01 feet (ft) from the water table. It is designed to recover liquid-phase hydrocarbon at a rate of up to 5 gallons per minute (gpm). Since this type of pump eliminates the need for an above-ground oil/water separator and can be used only to recover liquid-phase hydrocarbon or in conjunction with a water-table depression pump to recover ground water, it will be considered for use at the site.

The Probe-Scavenger[R] system also utilizes a membrane to separate liquid-phase hydrocarbon and water. However, the unit utilizes a submersible rather than floating pump to recover the liquid-phase hydrocarbon for discharge to an above-ground storage tank. This system is capable of recovering liquid-phase hydrocarbon at up to 35 gallons per minute (gpm) and can be installed in wells as small as 8 inches in diameter although, generally 12-inch-diameter wells are utilized. This system is less sensitive to liquid-phase hydrocarbon thicknesses than the Scavenger[R] pump, and it requires about 0.08 ft (one inch) of liquid-phase hydrocarbon thickness before it initiates recovery. If it is assumed that the soils at the site have a low hydraulic conductivity, then it would seem unlikely that liquid-phase hydrocarbon could be recovered from the soils at yields high enough to operate a Probe-Scavenger[R] system. Therefore, a Probe-Scavenger[R] system is not considered appropriate for conditions at the site.

Total fluid handling systems are pneumatic systems designed to collect both liquid-phase hydrocarbon and ground water from a recovery well for discharge to an oil/water separator. This system utilizes compressed air to convey the fluids and can be installed in a recovery well as small as two inches in diameter (four-inch-diameter wells are recommended). Remote control panels, up to 200 feet away from the well, can be used to operate a multiple well system, if required. The system can be modified to use a ballasted float to pump only liquid-phase hydrocarbon from the well. Total fluid handling systems may be desirable if the yields from a well are small; however, they generally require more operator attention than the other pump systems.

Each of the four liquid-phase hydrocarbon recovery systems discussed above are capable of operating in conjunction with a water-table depression pump. This pump withdraws ground water from beneath the liquid-phase hydrocarbon/ground-water interface so that a cone of depression is formed in the water table causing floating liquid-phase hydrocarbon to move towards the recovery well and/or infiltration gallery. Generally, the water-table depression pump is designed to maintain a predetermined drawdown in the recovery well and probes are commercially available which will automatically shut the pump off if liquid-phase hydrocarbon approach the pump intake.

SELECTION OF REMEDIAL ALTERNATIVES

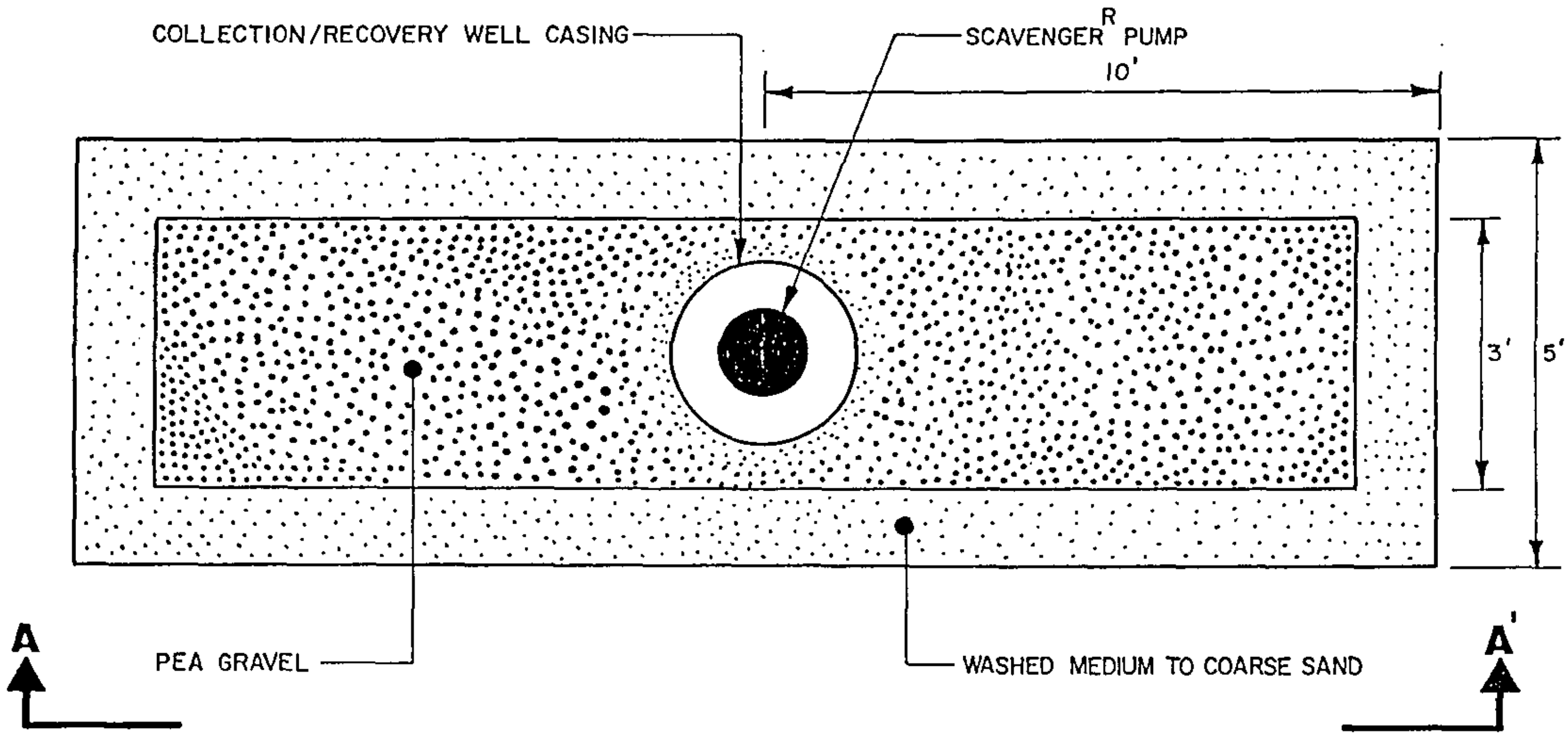
Due to the assumed hydraulic conductivity of the soils and tidal influence on the water table at the site, an infiltration gallery with a Scavenger® pump and water-table depression pump installed at the collection point (recovery well) is recommended for evaluation during the pilot study. Because of the unknown stability of the soils, it is recommended that an inert material be placed in the trench to serve as a filter and stabilizer material.

Upon conducting a pilot test using this system, the findings will be used to design a full-scale liquid-phase and dissolved hydrocarbon collection system. The engineering plans and construction specifications will be prepared during Phase III and implemented during Phase IV.

PILOT SCALE STUDY

To assist in the design of a full-scale system, a pilot study is needed to provide design parameters including the zone of influence of an infiltration gallery and its anticipated liquid-phase hydrocarbon recovery rate. This information is critical to evaluate a liquid-phase hydrocarbon and/or ground-water recovery system. Also, because tidal influences might cause the thickness and elevation of the liquid-phase hydrocarbon layer and the direction of ground-water flow to fluctuate, the effect on the depth and location of the liquid-phase hydrocarbon layer should be better defined.

It is proposed that an infiltration gallery connected to a collection/recovery well will be installed for recovery of liquid-phase hydrocarbon and/or ground water at the site. A trench will be excavated laterally from the collection/recovery well to form the infiltration gallery. The trench will be excavated to a depth of approximately eight to ten feet, a width of about five feet and extend ten feet on either side from the collection/recovery well. The infiltration gallery will be constructed similar to that shown in Figures 3 and 4 and at the location proposed in Figure 2. The length has been selected so that the hydraulic zone of influence of the gallery can be evaluated separately from the zone of influence of the collection/recovery well. The width and depth of the infiltration gallery has been selected as the minimum that will effectively recover liquid-phase hydrocarbon and ground water using G&M's previous experience with these systems. The exact dimensions of the trench will be dictated by field conditions during construction. The angle of repose (the maximum slope or angle at which a soil remains stable) may require that a trench box or sheet pile is required to construct the gallery. The inner core (three feet) of the infiltration gallery will be constructed of pea



PLAN VIEW
NOT TO SCALE

DRAWING NO: TE0004-KW1-A02	
DRAWN BY: Ken Carroll	DATE: 8-8-88
CHECKED: GJR	DATE: 8/8/88
APPROVED: GJF	DATE: 8/29/88

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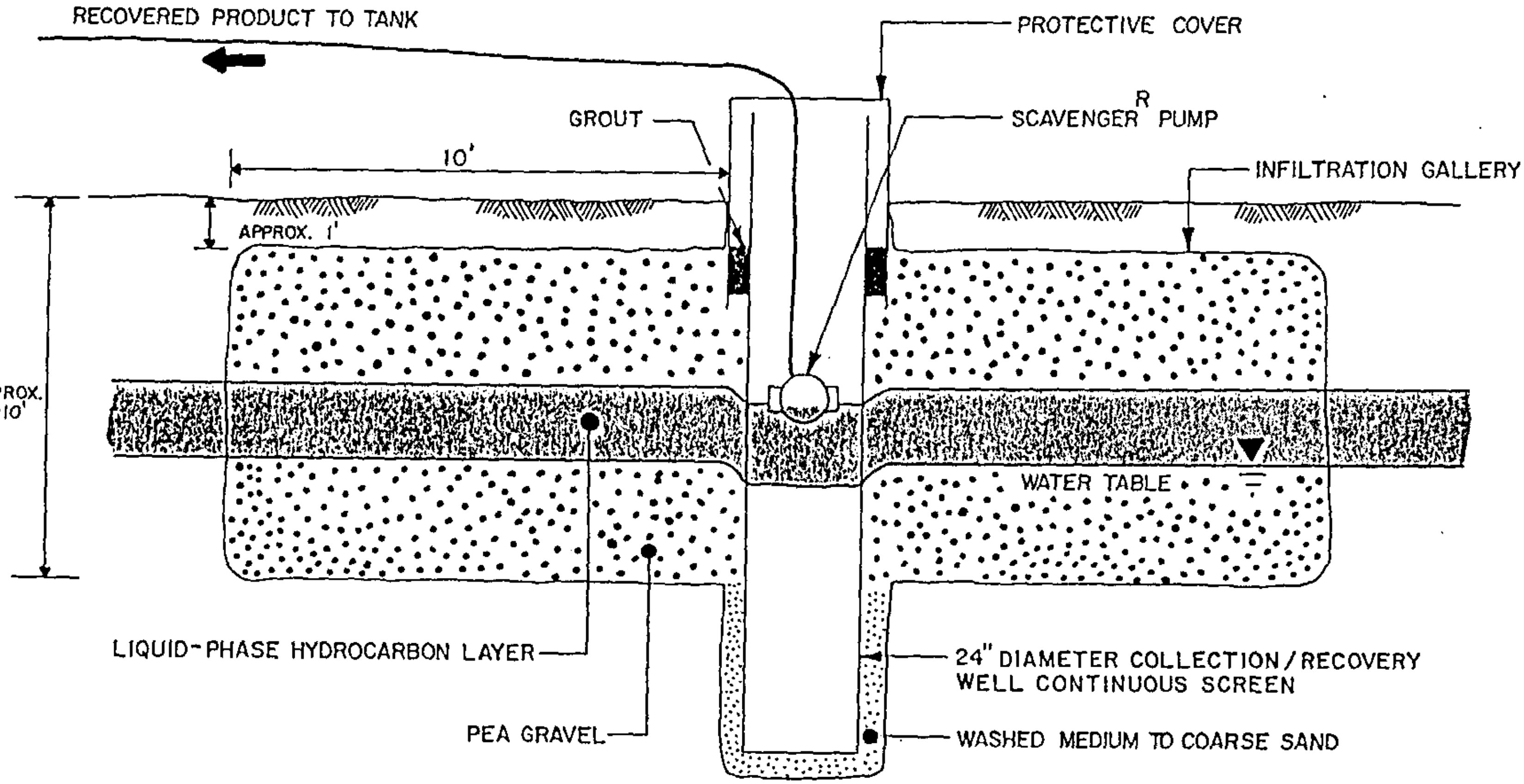
FIGURE 3

PLAN VIEW OF CONCEPTUAL INFILTRATION GALLERY
DEPARTMENT OF THE NAVY
NAVAL AIR STATION
KEY WEST, FLORIDA



SECTION A-A'

ELEVATION VIEW
NOT TO SCALE

DRAWING NO: TE0004-KW1-A01

DRAWN BY: KenCarey	DATE: 8-8-88
CHECKED: GJR	DATE: 8/8/88
APPROVED: SYLP	DATE: 8/29/88

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FIGURE 4

ELEVATION VIEW OF CONCEPTUAL INFILTRATION GALLERY
DEPARTMENT OF THE NAVY
NAVAL AIR STATION
KEY WEST, FLORIDA

gravel (approximately 18 cubic yards) while the outer edges (12 inches on each side) will be composed of washed medium to coarse-grained sand (approximately 12 cubic yards). The sand will minimize the infiltration of fine soil, which may clog the system, but will allow the liquid-phase hydrocarbon and contaminated ground water to flow freely into the gallery and recovery well. If dewatering is necessary for construction of the infiltration gallery, the ground water will be pumped into a tanker truck, tested for EP Toxicity metals and volatile organics (U.S. Environmental Protection Agency [EPA] Methods 601, 602, and 625), and properly disposed. Soil produced during construction will be placed in 55-gallon drums, analyzed for EP Toxicity metals and volatiles (EPA Methods 8010, 8020, and 8250), then properly disposed of by Navy personnel.

The collection/recovery well will serve as a sump for liquid-phase hydrocarbon that accumulates in the infiltration gallery. The well will be constructed of 24-inch-diameter, 12-ft long perforated galvanized steel culvert pipe capped at the bottom. The diameter of the well was chosen to facilitate the installation and operation of a Scavenger® pump. The well will be installed to a depth of approximately 12 feet by the mud-rotary method of drilling. Initially, the collection/recovery well will be utilized to recover liquid-phase hydrocarbon. Eventually, it will be utilized to perform a pumping test and will be incorporated into the full-scale system to recover contaminated ground water.

After the system has been constructed, the collection/recovery well will be outfitted with the Scavenger® pump. The recovered liquid-phase hydrocarbon will be pumped into an above-ground tank. At this time, it is anticipated that a 5,000-gallon tank will be necessary to store the recovered liquid-phase hydrocarbon. The exact location of the tank will be determined during the preparation of plans and specifications. The recovery system will be provided with an automatic shut-off mechanism to prevent tank overflows. Disposal of the recovered liquid-phase hydrocarbons will be performed by the Navy.

About four 2-inch-diameter PVC observation wells (2 feet of blank casing with 10-feet of 0.01-inch slot screen) will be installed using the hollow-stem auger method to a depth of about 12 feet in the vicinity of the infiltration gallery. The thickness of liquid-phase hydrocarbon in the observation wells will be monitored to determine if it could be effectively recovered without water-table depression achieved by concurrent pumping of the ground water. Additionally, these wells will be monitored to evaluate recovery of the liquid-phase hydrocarbon and to determine the zone of influence from recovery operations.

SYSTEM OPERATION AND MAINTENANCE

After initial recovery system start-up and operation, G&M or an independent contractor will check the system once per week to evaluate and monitor the performance of the system. During each visit, ground-water level and liquid-phase hydrocarbon thickness measurements will be obtained from the observation wells and from the collection/ recovery well. This information will be used to evaluate the effectiveness of the recovery system. In addition, the operation of the recovery system will be monitored and any problems or equipment failures will be corrected. The amount of liquid-phase hydrocarbon that has been recovered in the storage tank will be monitored and, if requested by the Navy, arrangements for disposal will be coordinated.

After most of the liquid-phase hydrocarbon has been recovered or after a period of three months (which ever occurs first), a submersible ground-water pump will be installed in the recovery well and a pumping test will be performed to determine the zone of influence (drawdown) due to pumping. At this point, a method for long-term disposal of the contaminated ground water will be proposed. In some instances, this water must be treated to reduce contaminant concentrations in order to receive permission to discharge. In addition, available points for sewage hook-up or other treatment and disposal options will be evaluated and discussed with the Navy. Prior to designing this treatment system or choosing a ground-water recovery pump, additional hydrogeologic data will be necessary. The hydraulic conductivity of the aquifer, ground-water quality, plume size, and plume location will need to be determined for effective final design of the ground-water pumping and treatment system.

SAFETY CONSIDERATIONS

Because of the flammable nature of liquid-phase hydrocarbon, extreme care will be taken when installing the recovery system to minimize the chance of fire or explosion. Underground pipes and electrical lines will be located so that they are not encountered during construction activities. In addition, personnel working in the area during construction will be made aware of these risks and will work in accordance with the Safety Plan and Training Plan prepared for this project by G&M at the request of the Navy.

The equipment used for recovery will be explosion-proof and appropriate for recovering hydrocarbon products. All parts and equipment, including pumps, wiring, and hoses, will be explosion proof and resistant to the effects of hydrocarbons. To further reduce the risk of spark or fire, care will be taken to ensure that wiring is not frayed or damaged during installation or routine maintenance.

SUMMARY

In summary, the following tasks will be performed to ensure the proper execution of this project:

1. Obtain approval of this plan from the State of Florida Department of Environmental Regulation;

2. Prepare construction plans and specifications of the infiltration gallery/pumping system;

3. Solicit contractor bids for plans and specifications;

4. Select a contractor for construction of the recovery system;

5. Commence start-up operations and conduct pilot test;

6. Monitor Pilot Program; and

7. Evaluate test data.

Prior to preparing plans and specifications of this work plan, underground utilities and piping should be located. It would also be helpful if a preliminary assessment of liquid-phase hydrocarbon thickness was performed to identify the areas with the largest amount of liquid-phase hydrocarbons. To minimize cost, this could be performed by digging holes with a post-hole digger in various areas of the site. This way not only will the pilot study be used to obtain data for design of a full scale system, but would also remediate the most contaminated area.

CLOSING COMMENTS

When the draft Pilot Study work plan has been approved by the Navy, it will be finalized and G&M and G&M Consulting Engineers, Inc. (GMCE) staff members will meet with Navy representatives to present the work plan to the Florida Department of Environmental Regulation and/or other appropriate regulatory personnel. Subsequently, a final work plan will be prepared addressing any comments or questions raised at this meeting. During Phase II, construction plans and specifications will be prepared by GMCE outlining the construction of the pilot system prior to the initiation of activities. All documents will be submitted according to Section III - Submittal and Schedules of the Request of Proposal for Amendment Number 2.

REFERENCE

Davis, S.N., and R.J.M. DeWiest, 1966. Hydrogeology. John Wiley and Sons, Inc., New York, NY. 463 pg.