64.05 - 2/16/95 - 00349

OHM Remediation
Services Corp.

FINAL
REMEDIAL ACTION WORK PLAN
TO IMPLEMENT A
SOIL VAPOR EXTRACTION SYSTEM
FOR
SITE 82, AOC-1, AREA A

Prepared for:

DEPARTMENT OF THE NAVY
Contract No. N62470-93-D-3032
Delivery Order 0015

Prepared by

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February 10, 1995

OHM Project No. 16032

04.05-2/10/95-00349

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1.0 INTRODUCTION

Soil Vapor Extraction (SVE) was selected as the remedial technology to clean soils at MCB Camp Lejeune Site 82, Area of Concern - 1 (AOC-1) in the U.S. EPA Record of Decision (ROD) signed in September, 1993. OHM submitted a written proposal and revised cost estimate to implement a SVE system in AOC-1, Area "A" on November 7, 1994. The proposal was approved, and notice to proceed with preparation of a Remedial Action Work Plan (RAWP) was received on December 29, 1994. This RAWP reviews the approach recommended by OHM Remediation Services Corporation (OHM) to implement an SVE system to remediate soils at MCB Camp Lejeune Site 82, AOC-1, Area "A" under Delivery Order No. 15. Several other plans have been previously developed under this delivery order and are considered supplementary to this work plan:

- Health and Safety Plan
- Construction Quality Control Plan
- Sampling and Analysis Plan
- Transportation and Disposal Plan
- Environmental Protection Plan

1.1 BACKGROUND

MCB Camp Lejeune was placed on the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), National Priorities List (NPL) effective October, 1989 (54 Federal Register 41015, October, 1989). Subsequent to this listing, the United States Environmental Protection Agency (USEPA) Region IV, the North Carolina Department of Environment, Health and Natural Resources (NCDEHNR) entered into a Federal Facilities Agreement (FFA) for MCB Camp Lejeune. The primary purpose of the FFA was to ensure that environmental impacts associated with past and present activities at MCB Camp Lejeune were thoroughly investigated and appropriate CERCLA response/Resources Conservation and Recovery Act (RCRA) corrective action alternatives were developed and implemented as necessary to protect the public health and the environment.

The areas to be remediated at Site 82, AOC-1 are identified in the CERCLA Remedial Investigation (RI) and Feasibility Study (FS) Reports prepared by Baker Environmental, Inc. Preliminary system design and specifications were provided in the Final Design - Basis of Design Report (BODR) issued by Baker Environmental, Inc. on May 10, 1994. Included in the BODR were the results and report of a one day soil permeability test conducted at the site by Target Environmental Services, Inc. Further delineation of the soil contamination was required to provide a basis for accurate and cost effective remedial design. In July, 1994, OHM conducted direct push soil sampling with confirming laboratory analysis to determine the extent of contamination in the two areas outlined by Baker Environmental. The results were presented in the Draft Report of Additional Investigation in Portions of AOC-1, Site 82 MCB Camp Lejeune (hereinafter referred to as the OHM Contamination Report) issued by OHM on August 23, 1994. The larger area to the south, denoted as AOC-1, Area "A", was found to contain less widespread contamination than originally believed. Soil contamination in the smaller area to the north, denoted as AOC-1 Area"B" was found to extend beyond that area previously identified and had an unsaturated zone thickness of less than three feet.

During a meeting with LANTDIV in Norcross on September 15, 1994 and a subsequent discussion on September 26, 1994, it was agreed that OHM would produce a technical approach and revised estimate for remediating Area "A". Following LANTDIV review and approval of the Proposal, OHM would subsequently submit a Remedial Action Work Plan and commence remediation of AOC-1, Area "A" upon approval. Baker Environmental, Inc. was tasked to complete investigatory work in AOC-1, Area "B". It was agreed that remedial activities to address Area "B" would be deferred until soil contamination in this area is further delineated.

1.2 REMEDIAL ACTION OBJECTIVES

The primary objective of this portion of Delivery Order No. 0015 is to design, install, and operate a soil vapor extraction system to remediate soils contaminated with Volatile Organic Compounds (VOCs) in AOC-1, Area "A", to the soil Remedial Action Objectives (RAOs). These RAOs are specified in the ROD and BODR as follows:

Contaminant	Soil Cleanup Level (µg/kg)
Trichloroethene	32.2
Tetrachloroethene	10.5
Benzene	5.4

1.3 SCOPE OF WORK

In order to meet the project objectives, the following scope of work will be implemented:

- Complete the SVE system design and technical approach to a level which facilitates field construction and operation (included in this Remedial Action Work Plan)
- Select, procure and deliver remediation equipment and materials to the site
- Procure subcontract services
- Obtain well permits
- Establish work zones in accordance with the Health and Safety Plan
- Perform site preparation including clearing and grubbing, construction of access road, concrete equipment pad, and site security
- Install 8 vertical soil vapor extraction wells and associated piping
- Install 1 horizontal air injection well and associated piping
- Install 32 soil probes for performance monitoring (16 clusters)

- Install SVE equipment, including piping, electrical wiring, and instrumentation

- Conduct system monitoring including air and water sampling and analysis to determine performance

- Operate and maintain the system

The sections that follow detail the steps completed or planned to implement the scope of work summarized above.

2.0 REMEDIAL SYSTEM DESIGN

The following section includes a general discussion of the basis of design, process description, and major system components to be implemented at MCB Camp Lejeune Site 82, AOC-1, Area "A".

2.1 BASIS OF DESIGN

As mentioned previously, the area to be remediated as well as preliminary system design and specifications were identified in the Final Design - Basis of Design Report (BODR) issued by Baker Environmental, Inc. on May 10, 1994. Included in the BODR was a report detailing the results of a one day soil permeability test conducted at the site by Target Environmental Services, Inc. Contaminant conditions in AOC-1, Area "A" are identified in the Contamination Report issued by OHM in August, 1994. These documents and the site specific remedial objectives form the basis of design and have been used to develop the technical approach to be implemented by OHM.

The horizontal extent of contamination exceeding the RAOs and to be remediated by the SVE system is shown in Figure 1. The vertical extent of contamination to be remediated has been defined as the vadose zone from ground surface to the top of the seasonal high water table within this area.

Limited data has been obtained to identify the depth to groundwater and the nature of seasonal water table fluctuations in AOC-1, Area A. These data are necessary to define the vertical extent of remediation and to design well completion depths. Depth to groundwater measurements from direct-push borings and a temporary well were recorded in AOC-1, Area A in July, 1994 during site investigation activities. During this investigation, the depth to groundwater ranged from 16 to 18.5 feet below land surface (bls). Based on these measurements, a depth to groundwater of 17 feet bls has been assumed for the basis of design and used to design well completion depths. Using this basis, the quantity of contaminated soil exceeding RAOs in the treatment area is approximately 17,800 cubic yards.

OHM will verify the assumed well completion depths based on water levels observed during well installation activities. Eight vertical extraction wells will be installed in the locations shown on the Site Plan included as Figure 2. At the beginning of extraction well installation, the boreholes for extraction wells SVEW-4 and SVEW-8 will be advanced approximately 1 to 2 feet into the water table to allow determination of the depth to water at the northern and southern extent of the treatment area. A grout plug will then be installed from the bottom of the boreholes to 1 foot above the water table prior to well installation. Properly placing the screened interval above the water table will minimize the negative affects of vacuum lifting the water table in the boreholes during system operation. Once the depth to groundwater has been verified, the remaining six extraction wells will be drilled and installed to a depth of approximately 1 foot above the water table.

A single horizontal injection well will be installed in the location shown on the Site Plan. Drilling and installation of the horizontal well will take place after the vertical wells have been installed and the depth to groundwater at the site has been verified. The horizontal well will be

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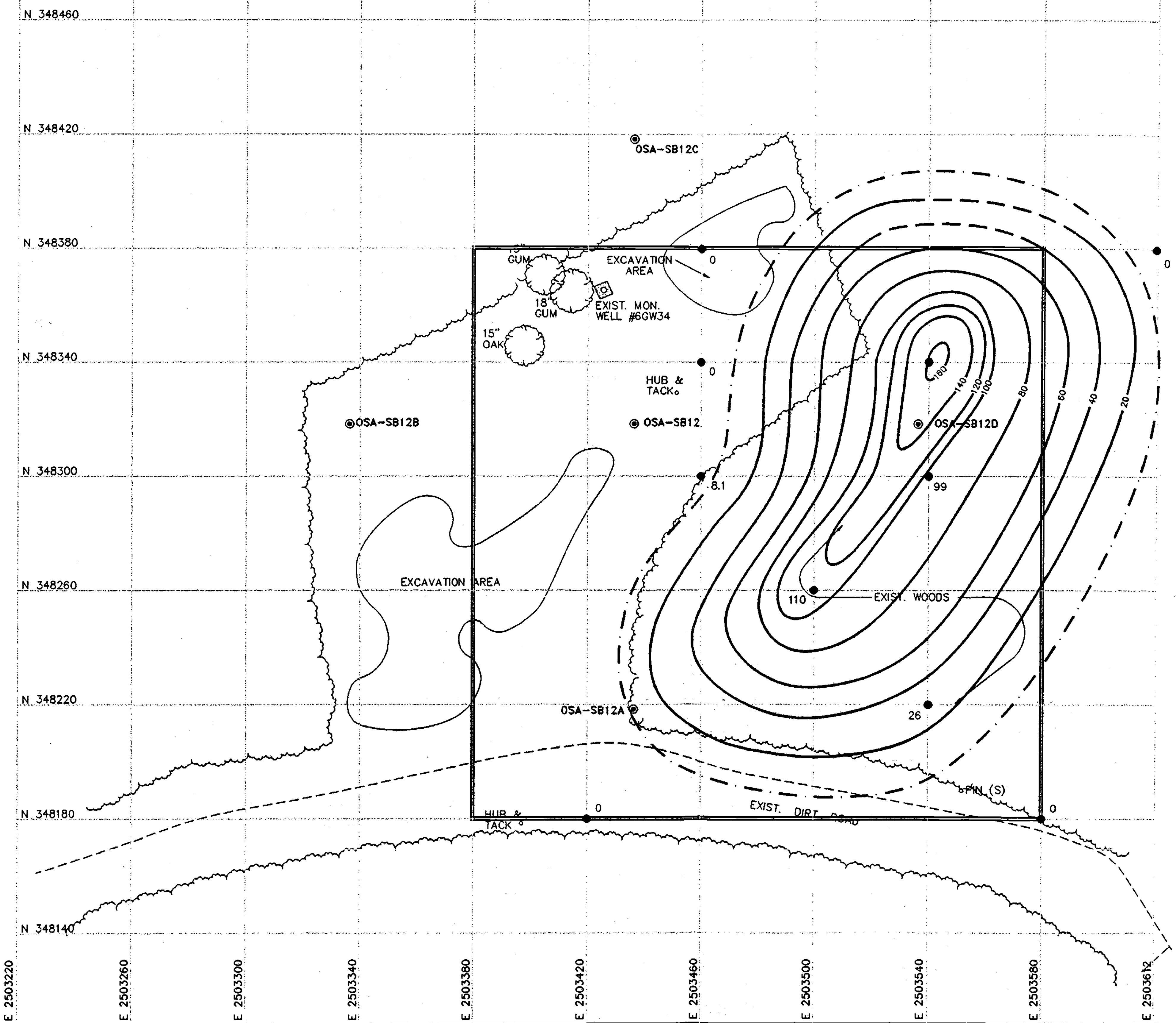
AREA "A"



LEGEND

- SAMPLE LOCATION
- VOLATILE ORGANICS CONCENTRATION MEASURED FROM LABORATORY ANALYTICAL (3)
- ISO-CONCENTRATION LINE (µg/Kg) (20)
- CONTOUR INTERVAL (20 µg/Kg)
- APPROXIMATE EXTENT OF 10.5 µg/Kg CONCENTRATION LEVEL (REMEDIAL GOAL)
- OSA-SB12 — PREVIOUS BAKER ENVIRONMENTAL SAMPLING LOCATIONS

-20 0 20 40 60

SCALE IN FEET
SCALE : 1" = 40'-0"

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FIGURE No. 1
SAMPLE LOCATIONS AND TETRACHLOROETHENE (PCE) CONCENTRATIONS IN AREA "A"; LOWER DEPTH ZONE (14-16 ft. BLS)

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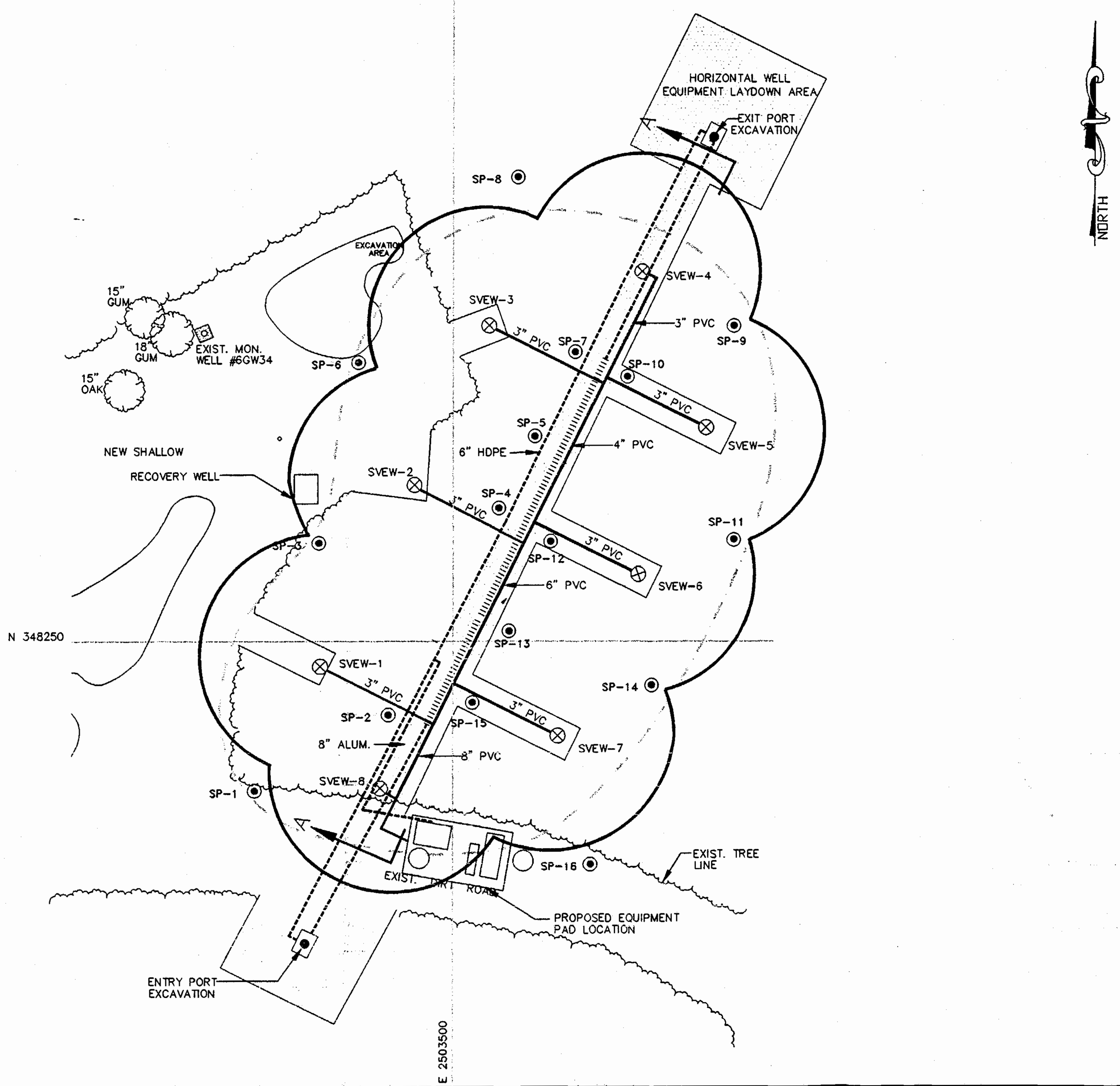

LEGEND

- APPROXIMATE EXTENT OF PCE EXCEEDING 10.5 $\mu g/kg$ (REMEDIAL GOAL)
- GRAVELED AREA
- ⊗ PROPOSED SVE WELL
- HORIZONTAL INJECTION SCREENED INTERVAL
- VACUUM PIPING
- INJECTION PIPING
- TREATMENT AREA BASED ON 40' RADIUS OF VACUUM INFLUENCE
- CLEARED AREAS FOR DRILL RIG ACCESS

NOTES:

1. ACCESS ROAD ALONG AXIS OF HORIZONTAL WELL WILL BE CLEARED, GRUBBED, AND SMOOTHED. A 200 FOOT LONG IMPERMEABLE LINER WILL BE INSTALLED ABOVE THE SCREENED SECTION OF THE WELL. SIX TO EIGHT INCHES OF GRAVEL WILL BE PLACED FROM THE EXISTING DIRT ROAD TO THE EQUIPMENT LAYDOWN AREA.
2. THE EQUIPMENT LAYDOWN AREAS WILL BE CLEARED AND COVERED WITH 6" TO 8" OF GRAVEL.
3. ACCESS WAYS TO THE VERTICAL WELLS WILL BE CLEARED.

-20 0 20 40 60
SCALE IN FEET
SCALE : 1" = 40'-0"

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FIGURE 2

AOC-1 AREA A PROPOSED SVE SYSTEM LAYOUT AND MECHANICAL LAYOUT

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completed at the water table so that injected air flow is directed at the top of the water table and to inhibit short-circuiting of the injected air to the surface. The horizontal well will be installed along the axis of the contaminant plume where contaminant concentrations are highest to induce maximum air flow and treatment in this area.

Soils at the site are described as silty, clayey, fine-grained sands. Air permeability of these soils was calculated from data obtained during the one day pilot test and ranged from 1.2×10^{-7} cm^2 to 2.8×10^{-7} cm^2. During the pilot test, a vacuum influence was observed at a maximum distance of 34.5 feet from the SVE well when the SVE test equipment was operated at an air flow rate of 25.1 standard cubic feet per minute (SCFM) and a vacuum of 1.3 inches of Mercury (" Hg).

OHM has based the spacing of extraction wells on an estimated radius of vacuum influence of 40 feet. The estimated radius of vacuum influence should be greater than what was observed during pilot testing operations because OHM intends to use significantly higher applied vacuum levels. OHM intends to operate the SVE system with applied wellhead vacuum levels of 6 to 10 inches Hg, whereas a maximum wellhead vacuum of 1.3 inches Hg was evaluated during pilot testing. Higher applied vacuum levels were not evaluated during pilot testing due to vacuum and flow limitations of the vacuum blower utilized. OHM's experience at sites with similar soil conditions suggests that with a higher applied vacuum level augmented with the injection of air, the radius of vacuum influence will develop significantly beyond 40 feet during operation of the system. However, in the absence of actual full-scale pilot data, a conservative estimate of a 40-foot radius of vacuum influence was used to determine extraction well spacings and provide total coverage for treating soils exceeding RAOs within the contaminated area.

The vacuum blower was selected based on anticipated air flow rates from the extraction wells, applied wellhead vacuum levels, assumed air injection pressure, and estimates of piping pressure losses. OHM estimates that airflow rates from each well will range from 75 to 125 Actual Cubic Feet per Minute (ACFM), using applied vacuum levels of 6" to 10" Hg and assuming injection pressures of 4" to 6" Hg and line pressure losses of 2" Hg. This estimate is based on the system head curve and alternate well configuration graphs included in the pilot test report which depict airflow rates at varying applied vacuum levels. Therefore, OHM has selected a vacuum blower that has the capacity to produce 1500 ACFM at 15" Hg.

Vapor phase carbon will be used to remove VOCs from the extracted airflow prior to re-injection or discharge to the atmosphere. Based on a four second empty bed contact time in an OHM vapor phase granular activated carbon (GAC) adsorber (cell) and a flow of 1500 ACFM, 4000 pounds vapor phase GAC is required. The total volume of target contaminants in the treatment area has been estimated to be between 20 to 30 pounds of VOCs. Since the majority of contaminants will be removed in the air phase, this GAC design yields 100 percent removal of the estimated adsorbable VOCs.

The network of SVE wells will produce a quantity of liquids from vadose zone soils. Liquids entrained in the extracted vapor flow will collect in a vapor/liquid separator located on the SVE skid before the vapor phase GAC and vacuum blower. These liquids will be pumped to a 5,000-

gallon storage container and transported to the on-site groundwater treatment facility for disposal. The groundwater production rate is estimated to be less than 30 gallons per day or approximately 3,600 gallons during four months of operation.

The design and configuration of the SVE system are intended to satisfy the soil treatment requirements outlined on the ROD. OHM will conduct performance monitoring during system operations to verify that the system is functioning properly and to optimize performance. Performance monitoring will include verification of subsurface zones of vacuum influence, measurements of air flow and vacuum levels from individual extraction wells and the system total, measurement of injected air flow and pressure in the horizontal injection well, analysis of extracted vapor and water samples, recording the volume of extracted liquids, and testing and calibration of process controls and equipment. These data will be used to determine and maximize contaminant extraction rates, verify compliance with air and water discharge requirements, and make necessary adjustments to optimize performance of the system.

2.2 GENERAL PROCESS DESCRIPTION AND IMPLEMENTATION

The proposed SVE system has six primary components which include: 1) an array of eight vertical extraction wells, 2) one horizontal injection well, 3) a piping and manifold system, 4) a vapor/liquid separator, 5) a vacuum blower, and 6) vapor phase carbon cells. A process flow schematic illustrating the configuration of these components is included as Figure 3.

A positive displacement vacuum blower is used to apply a vacuum to the eight vertical extraction wells. The vacuum causes a pressure gradient to propagate through the subsurface and induces airflow to the wells. The extracted airflow is routed through a piping and manifold system to the vapor/liquid separator that is designed to remove entrained liquids produced in the vapor stream. Extracted liquids are pumped to 5,000-gallon storage tank. Extracted vapors are treated in a vapor phase GAC vessel prior to passing through the vacuum blower. Treated vapors are then either re-injected into the subsurface through the horizontal well or discharged to the atmosphere.

Once clearing and grubbing is completed, and the access road is constructed, drilling and well installation will be conducted and will require approximately two weeks to complete. A drilling subcontractor will mobilize to the site to install the eight vertical extraction wells. After the extraction wells are installed, a separate drilling contractor will mobilize to install the horizontal injection well. Concurrent with drilling and well installation activities, 16 nested clusters of soil probes will be installed to aid evaluation of system performance.

Construction and installation will follow well installation activities and will include construction of the equipment pad, mobilization and installation of process equipment, installation of the piping and manifold system, construction of the drain field, and initial testing of equipment. OHM will

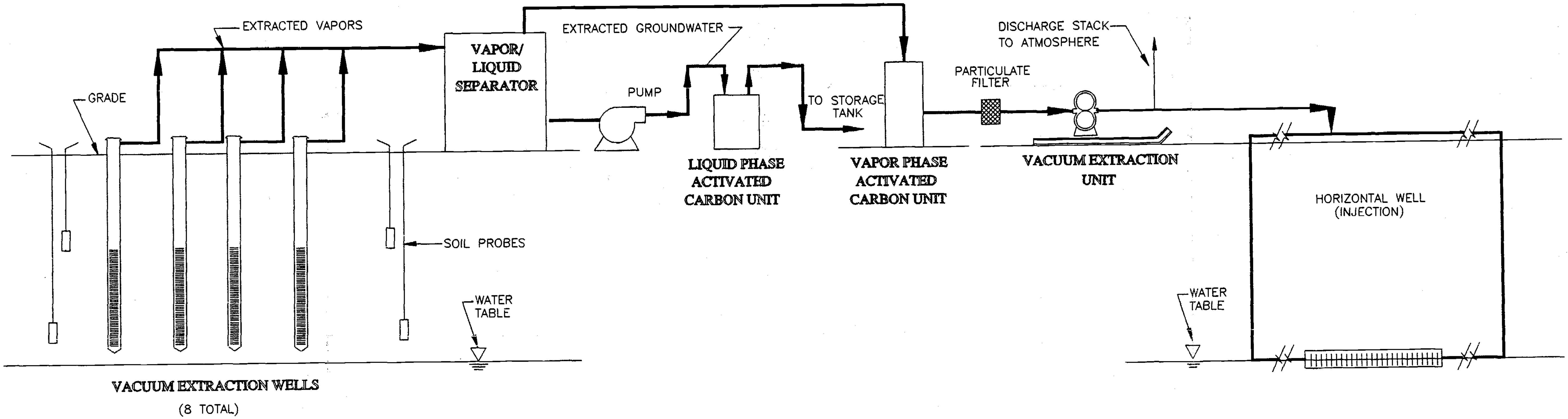

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FIGURE 3
PROCESS FLOW SCHEMATIC
AOC-1 AREA "A"

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provide necessary personnel to supervise and effect construction and installation of the remedial system. It is estimated that installation of the system will require approximately 3 to 4 weeks.

An equipment pad will constructed adjacent to the existing dirt road for staging of process equipment. Equipment will be mobilized to the site, staged on the equipment pad, and connected to electrical service. Piping and manifold between system components on the equipment pad will be installed. System controls and instrumentation will be installed and tested.

Wellheads will be constructed for each of the extraction wells with fittings for measuring airflow, temperature, vacuum levels, and for collecting vapor samples. A 3-inch diameter PVC pipe will extend above-ground from each vacuum well to a main vacuum pipe constructed of 3 to 6-inch and 8-inch diameter PVC. The main vacuum header will be connected to a vapor/liquid separator connected to remove any entrained liquids from the vapor stream. A transfer pump activated by level controls in the separator tank will pump extracted water to the on-site storage tank. Extracted vapors will be routed through vapor phase carbon vessels and through the vacuum blower prior to injection or atmospheric discharge.

An injection header pipe will be installed from the vacuum blower to the entry and exit ports of the horizontal well. The injection pipe will be constructed of aluminum and HDPE materials at the discharge end of the vacuum blower to allow for heat dissipation and pipe expansion prior to injection into the subsurface. Fittings for measuring pressure, airflow, and temperature will be installed on the injection header to allow determination of injection flow rates.

Start-up and optimization of the SVE system will be conducted over a two-week period. OHM will provide a hydrogeologist and engineer for start-up activities. Process equipment and instrumentation will be tested, calibrated and adjusted. Air flow will be developed individually from each extraction well. After all of the extraction wells are placed in operation, air flow into the horizontal injection well will be developed and balanced. Zones of vacuum influence will be monitored using the soil probes to verify system performance and coverage of the treatment area. Initial maintenance will be performed on the equipment. The system will be placed in full-scale operation and data will be collected to document system performance. Adjustments will be made to optimize performance of the system components.

The system will be checked daily on weekdays by the site supervisor (or designee) to verify that the system is operating. An OHM geologist will visit the site every two weeks for the first four months to verify and optimize system performance and conduct routine operation and maintenance. Routine maintenance of process equipment will be performed. Should the system controllers shut the system down, remote telemetry will notify OHM to mobilize and restart the system.

2.3 SVE SYSTEM COMPONENTS

Extraction Wells

A typical vertical extraction well is shown in Figure 4. The vertical wells will be constructed of 4-inch, Schedule 40 PVC riser and 0.020 inch slotted screen conforming to ASTM 1785. A 10 to 12 foot screened interval is planned and will be determined in the field by the supervising hydrogeologist based on site conditions at the time of installation. Each vertical well will be equipped with a vacuum extraction wellhead with ports for measuring wellhead vacuum levels, measuring airflow from the well, and for extracting vapor samples for analysis.

Injection Well

A cross section of the horizontal air injection well is shown on Figure 5. The horizontal well will be approximately 300 feet in length and constructed of 4- and 6-inch diameter, schedule 40 HDPE with 140 feet of 0.020-inch well screen. In order to prevent the formation from collapsing against the interior screen, the screened interval will be constructed of pre-packed HDPE slotted well screen. This directionally drilled well will be installed at a depth of approximately 17 feet below ground surface.

Soil Probes

Sixteen clusters of soil probes will be installed in the locations shown on Figure 2. Soil probe construction details are shown on Figure 4. Each soil probe cluster will include a shallow probe installed at a depth of 3 to 7 feet and a deep probe installed to a depth of 12 to 16 feet.

SVE Skid

The SVE skid contains the vapor/liquid separator, vacuum blower, particulate filter, transfer pump and control panel. It requires only power and system connections to be fully operational. The vapor/liquid separator has a capacity of approximately 50 gallons and is constructed from 1/4" carbon steel. Air enters the vapor/liquid separator through a ten inch diameter pipe in a tangential arrangement to assist the separation process. Prior to the vacuum blower, a Stoddard F65-10 filter is installed to eliminate particulate matter that could accumulate inside of and damage the vacuum blower. The vacuum blower is an MD-Pneumatics Model 7021, lobe type, positive displacement blower capable of moving 1500 ACFM at a vacuum level of 15" Hg. It is powered by an 1800 rpm, 100 HP Seimens explosion proof motor. Air discharges through a Universal SU10 Annular Flow silencer to a tee that separates flow to the horizontal well and discharge stack. An Oberdorfer 1" bronze gear pump transfers water from the separator tank to the discharge point.

Vapor Phase GAC

One standard OHM vapor phase GAC filter vessel will be used. This vessel is 8 feet in diameter and can hold up to 6000 pounds of GAC. For this system, it will be loaded with 4000 pounds of GAC. It will be installed between the vapor/liquid separator and vacuum blower.

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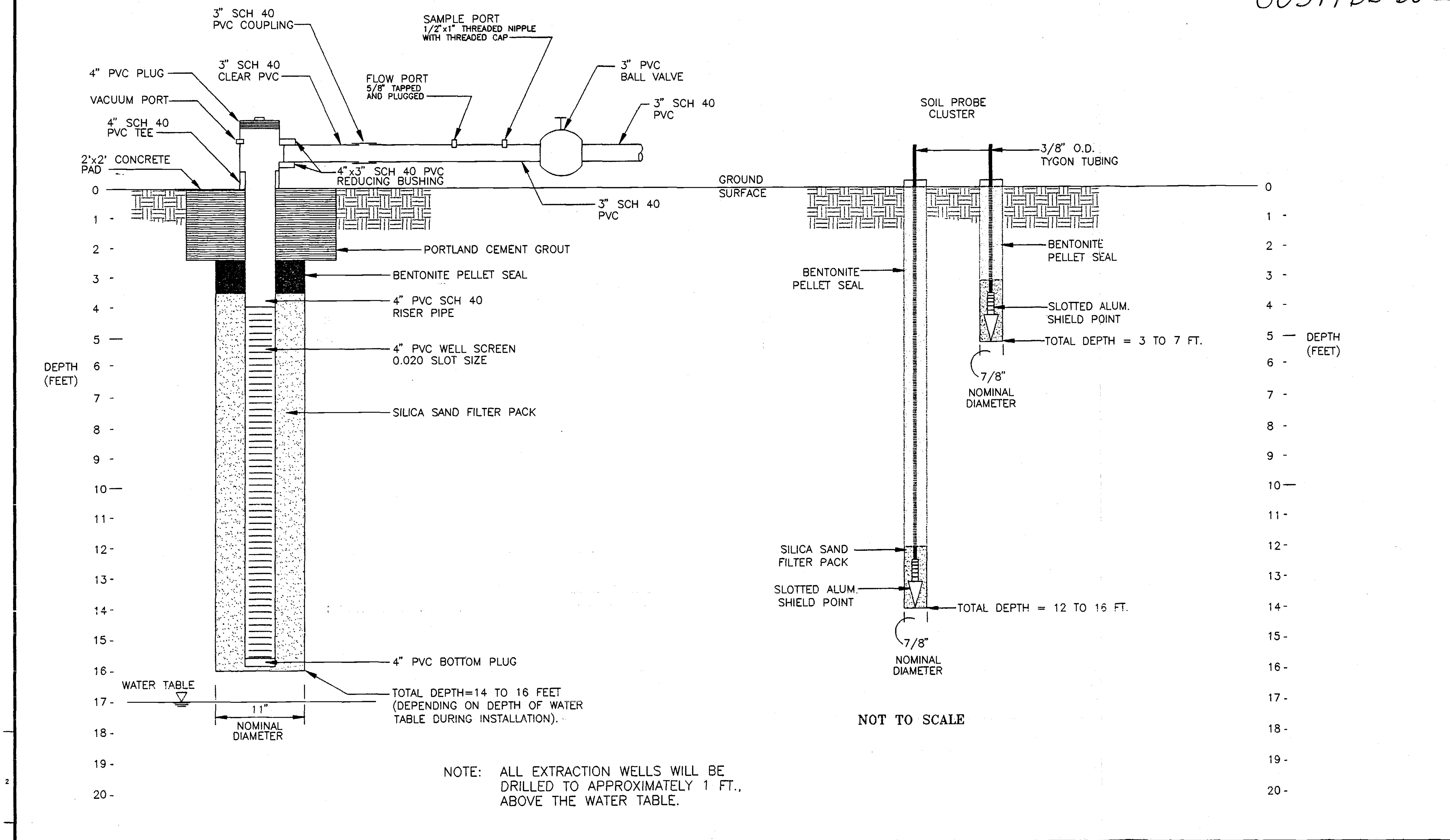

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FIGURE 4

VERTICAL EXTRACTION WELL & SOIL PROBE CONSTRUCTION DETAILS

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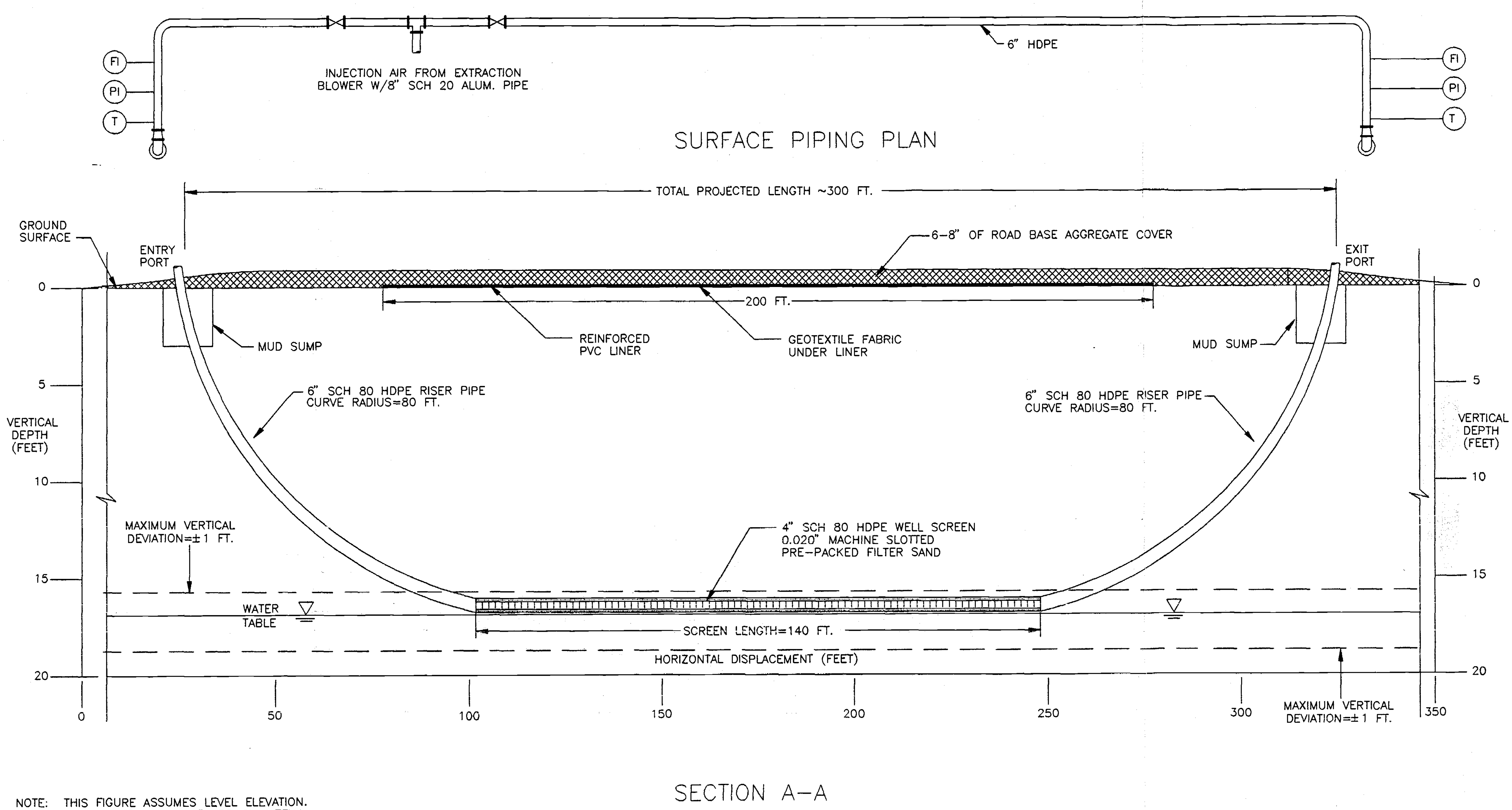

NOTE: THIS FIGURE ASSUMES LEVEL ELEVATION. ACTUAL DEPTH WILL BE APPROXIMATELY AT THE WATER TABLE.

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FIGURE 5

HORIZONTAL WELL CONSTRUCTION DETAIL

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Piping and Manifold System

Extraction piping will be SCH 40 PVC bell and spigot compression joint pipe. Extraction line sizes are based on a velocity between 40 and 80 feet per second and are shown on the Site Plan, Figure 3. Injection piping will be constructed of 8-inch aluminum and 6-inch HDPE materials. Piping valves and fittings are rated to resist external and operating forces. Materials selected are resistant to corrosion by the contaminants and conditions at the site. PVC piping and fittings will conform to ASTM 1785 and ASTM 2466. All extraction piping and manifold will be installed above ground.

Electric Generator

A trailer mounted 225 KW electric generator powered by a diesel engine with a 300-gallon fuel day tank will provide power the for the equipment. An additional fuel tank will be used to provide sufficient storage capacity for one week's unmanned operation. Fuel consumption is conservatively estimated at 10 gallons per hour. A fuel truck will be scheduled to refill the tanks every 6 to 7 days. A low-level fuel indicator will be connected to the remote telemetry system.

Water Storage Tank

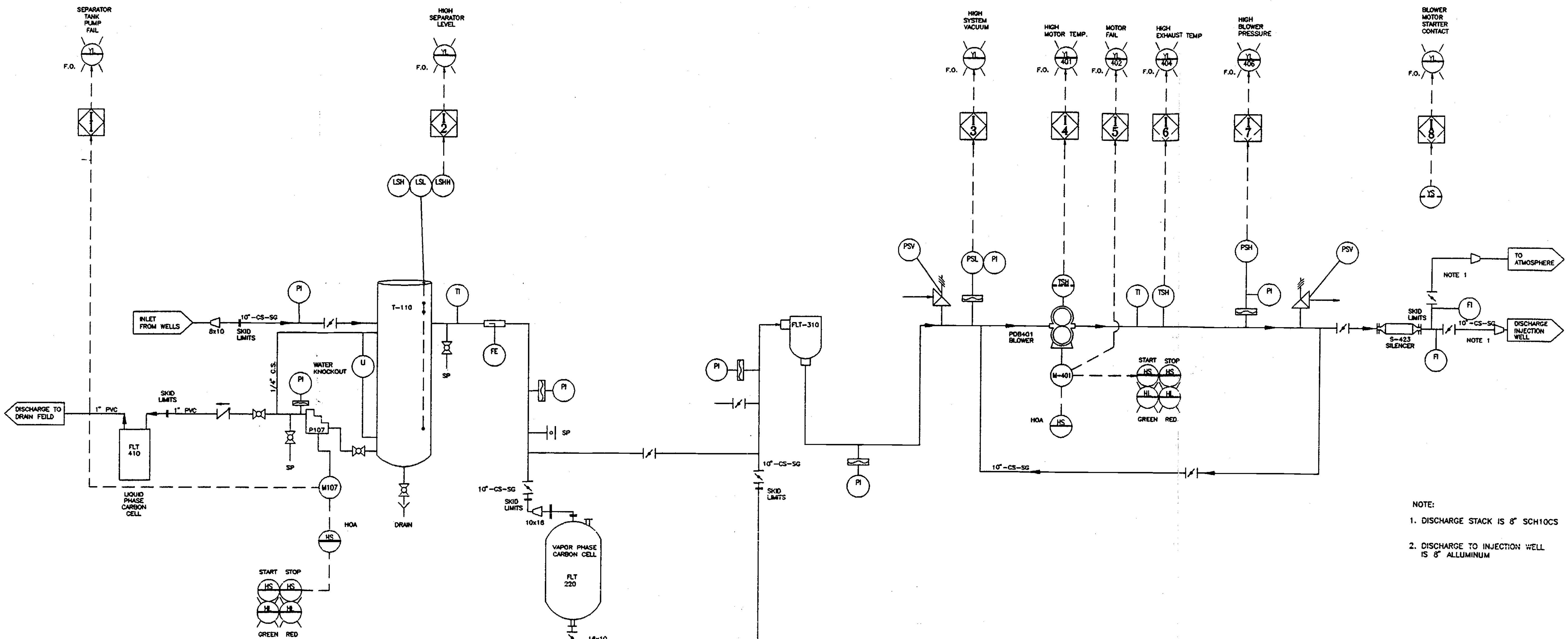
One 5,000-gallon polyethylene storage tank will be used to contain liquids entrained by the SVE system. Liquids will be sampled and analyzed for contaminants prior to discharge to the groundwater treatment plant.

2.4 INSTRUMENTATION AND CONTROLS

The system process instrumentation and controls are shown in Figure 6. The SVE system is equipped with controls and interlocks to provide safe operation. Should the system controls shut down the system, indicator lights on the control panel will signal the cause of the failure. An autodialer capable of calling up to three different numbers via cellular telephone will be installed to alert the site supervisor, project manager, or technical coordinator of any system shut downs. The SVE system has controls to shut down operation of the process equipment should any of the following conditions occur:

- Failure of the vapor/liquid separator pump
- High/High level in the vapor/liquid separator
- High system vacuum level at the vacuum blower inlet
- High motor temperature on the vacuum blower motor
- Vacuum blower motor failure
- High exhaust temperature at the vacuum blower outlet
- High vacuum blower outlet pressure

Instrumentation is included to allow documentation of system performance and to monitor operating conditions of the vacuum blower, vapor/liquid separator, vapor phase carbon vessel, and the discharge pump. A flow indicator port, pressure indicator port, and vapor sampling port are located at the outlet of the vapor/liquid separator to allow monitoring of system total



P-107	T-110	FLT-220A	FLT-410
OBERDORFER 9000-R LIQUID TRANSFER PUMP 10 GPM 20 PSIG 1 HP	VAPOR/LIQUID SEPARATOR 36" O.D. x 59" 50 GAL. CAP.	VAPOR PHASE CARBON CELL OHM 8' DIAMETER x 8' OAH STEEL	LIQUID PHASE CARBON CELL STEEL OHM 2'-6" DIAMETER x 3'-6" OAH 300 lb CAPACITY

FLT-310	PDB-401	S-423
PARTICULATE FILTER STODDARD F65-10	MD PNEUMATICS LOBE BLOWER 7021 1500 CFM -15" Hg 1800 RPM, 100 HP @ 190°F TEMP. RISE	UNIVERSAL SU-10 32 dBa REDUCTION

UTILITY CONNECTION

PROCESS INLET	10" 150# SCH 40 FLANGE
PROCESS OUTLET	10" 150# SCH 40 FLANGE
CARBON CELL INLET/OUTLET	10" 150# SCH 40 FLANGE
KNOCKOUT TANK DRAIN OUTLET	1" SCH 40 CS
ELECTRICAL SERVICE ENTRANCE	200 AMPS, 480/277V, 3Φ, 60Hz

NOTE:

1. DISCHARGE STACK IS 8" SCH10CS
2. DISCHARGE TO INJECTION WELL IS 8" ALLUMINUM

00349BB02Z

OHM Remediation Services Corp.
Norcross, Georgia
A Subsidiary of OHM Corporation

SUBMITTED: [signature] PROJECT MANAGER DATE: 2/3/95
APPROVED: [signature] SR. PROJECT ENGINEER DATE: 2/3/95
APPROVED: [signature] DEPT. MANAGER DATE: 2/3/95

AT FULL SCALE (IF NOT 2"-SCALE ACCORDINGLY)
CADD FILE: FIG6.DWG
DRAWN: J. LANGE
DESIGNED: D. RUBIN
CHECKED: A. COLLINS
CHECKED: G. GILLES

REVISIONS

ZONE	REV.	DESCRIPTION	BY	DATE	APP.
	1	INCORPORATING REVIEW COMMENTS	J.C.	2/3/95	J.D.

DEPARTMENT OF THE NAVY — NAVAL FACILITIES ENGINEERING COMMAND

ATLANTIC DIVISION

NAVAL STATION — NORFOLK, VIRGINIA

LANTDIV RAC CONTRACT N62470-93-D-3032 — DELIVERY ORDER NO. 0015

OPERABLE UNIT NO. 2 — MARINE CORPS BASE, CAMP LEJEUNE, N.C.

FIGURE 6

PIPING AND INSTRUMENTATION DIAGRAM AOC-1 AREA "A"

DRAWING NUMBER:

SHEET NUMBER: _ of

DATE: 2/3/95

operating parameters. Level controls in the vapor/liquid separator activate the transfer pump. A pressure indicator located between the transfer pump and the liquid phase GAC cell will indicate high pressure and possible fouling in the liquid phase carbon. The transfer pump is equipped with controls to allow manual pump out of the separator tank. Pressure relief valves are installed at the vacuum blower inlet and outlet. Temperature and pressure indicators are located at the outlet of the vacuum blower.

3.0 REMEDIAL TASKS

3.1 PRE-CONSTRUCTION ACTIVITIES

To accelerate the schedule, bid specifications to procure horizontal and vertical drilling subcontractors have been completed and issued. LANTDIV consent packages will be submitted for horizontal and vertical well drilling subcontracts. Following approval of this Work Plan and notice to proceed, OHM will meet with the RPM and NTR to arrange a start date for field activities.

Subcontractors and equipment will be procured. State of North Carolina permit applications for well construction will be submitted. Permit numbers, if required, will be secured by OHM prior to drilling and well installation activities. Air and water discharge permits for the SVE system will not be required. However, OHM has assumed that the NCDEHNR will require registration of these sources similar to the groundwater treatment plant air stripper discharge.

3.2 MOBILIZATION

OHM will use existing on-site trailers for office space and the existing support trailers for decontamination and sanitary needs. To the extent possible, existing on-site personnel will be used for all construction activities. The project geologist and other technical support personnel as necessary will mobilize concurrent with the start of drilling activities and remain on-site through system start-up and optimization. Security against unauthorized site entry will be established by use of safety barriers and caution tape.

Nearly all OHM owned equipment will be mobilized on a lowboy trailer from Findlay, Ohio. The vapor phase carbon cell may mobilize from another operations center. Piping, valves, and other materials needed for construction will be procured in the field.

3.3 CLEARING AND GRUBBING

On-site work will begin with clearing and grubbing to allow access for drilling rigs and support vehicles, installation of a geomembrane, and for construction and installation of the process equipment. The areas to be cleared will include a 15 foot wide path along the axis of the horizontal well, a 50 by 50 foot square area at each end of the horizontal well, and twelve foot wide five feeder roads extending to vertical extraction wells. Following clearing, the length of the horizontal well will be grubbed and smoothed to remove all sharp objects. These areas are shown as shaded areas on Figure 2. All deforestation activities will be coordinated with the Base Forestry Department. Dense underbrush will be cleared with a bulldozer. OHM will employ care during clearing activities so as to minimize the amount of vegetation disturbed and avoid generation of any debris that would require off-site disposal. Dust and erosion control measures will be initiated as necessary in accordance with the approved Environmental Protection Plan.

3.4 ACCESS ROAD CONSTRUCTION

An access road will be constructed along the axis of the horizontal well. A 15 feet wide by 200 feet long geotextile will be laid covering the approximate area of the screened interval of the horizontal well. A Gryfolin (or equal) reinforced PVC liner will be installed over the geotextile to serve as a vapor barrier. This will minimize short circuiting of the injected air. The access road, including the geomembrane barrier, will be covered with approximately six to eight inches of road base aggregate mix. The same aggregate mix will be installed on the equipment pad at both ends of the horizontal well.

3.5 DRILLING AND WELL INSTALLATION

Eight vertical vapor extraction wells designated located at the periphery of the contaminated area and one horizontal air injection well located longitudinally through the AOC will be installed by drilling subcontractors. The proposed locations of the wells are shown on the Site Plan included as Figure 2. Oversight of drilling and well installation activities will be performed by an OHM Professional Geologist registered in the State of North Carolina. OHM personnel and drill crews will be OSHA Health and Safety trained in accordance with 29 CFR 1910.120.

The vertical extraction wells will be installed with a truck-mounted, all terrain drill rig using hollow stem augers. It is estimated that drilling and installation of all eight vertical wells will require 5 days to complete. Each vertical well will be initiated with a hand auger advanced to approximately four feet to check for the presence of subsurface obstructions. Drilling equipment and location will be off-set if buried objects or obstructions are encountered.

The vertical boreholes will have a nominal diameter of 11 inches and will be completed above the water table at an average depth between 14 and 16 feet depending on the depth to water. The extraction wells will be constructed of 4-inch diameter, Schedule 40 PVC. Each well will have 10 to 12 feet, depending on the depth of completion, of 0.020 inch, slotted well screen. A filter pack consisting of clean silica sand will be placed in the borehole in the annular space adjacent to the well screen. One to two feet of hydrated bentonite pellets will be installed on top of the filter pack. A 2 foot by 2 foot square area will be hand excavated to a depth of 2 1/2 feet around each well. The remainder of the borehole and the excavated area will be filled with a Portland cement grout to maintain an adequate well seal. The extraction wells will be completed with fittings for measuring vacuum, temperature, airflow, and for collecting vapor samples. Construction details for the vertical wells are provided in Figure 4 .

The horizontal well will be drilled after the vertical wells are installed . The horizontal drill crew will work 24 hours a day in two 12 hour shifts to minimize problems associated with maintaining a stable borehole. Based on this work schedule, it is estimated that installation of the horizontal well will require 4 to 5 days.

The horizontal borehole will have a nominal diameter of 8 to 10 inches and will be drilled using mud rotary techniques. The borehole will be completed at a target vertical depth at the water table (approximately 17 feet) with a vertical drilling accuracy of $\pm$ 1 foot. The borehole design requires approximately 80 feet of lateral displacement at each end along the curve radius to reach horizontal at the target depth. The total horizontal length of the borehole will be approximately 300 feet including the entry and exit ports.

The horizontal injection well will be constructed of 4-and 6-inch diameter, Schedule 40 HDPE. The well will include 140 feet of 0.020-inch, machine slotted well screen with a pre-packed filter sand. The outside diameter of the pre-packed screen will be approximately 6.65 inches. The borehole on either end of the well screen will be sealed to the surface with a Portland cement/bentonite grout. After the grout has set, the well will be developed by jetting potable water through the screened interval . The purpose of developing the horizontal well is to remove as much of the drilling fluids and cuttings as possible from the borehole and pre-packed screen prior to operation.

Prior to leaving the site, drill rigs and downhole drilling tools will be decontaminated by pressure cleaning at the equipment decontamination area.

3.6 SOIL PROBES

The soil probes will be installed in a 7/8 inch diameter hole completed by advancing 7/8 inch O.D. stainless steel rods with an electric percussion hammer and then extracting the rods, leaving an open hole. An aluminum slotted shield point connected to tygon tubing is then placed at the bottom of the hole and functions as a screened interval. Silica sand is placed adjacent to the shield point allowing hydraulic communication with the formation. Bentonite is placed from the top of the sand to the surface to seal the target zone. Approximately 1 to 2 feet of the tygon tubing extends above the surface to allow soil probe measurements and sampling. Soil probe locations are indicated on Figure 2.

3.7 SVE SYSTEM INSTALLATION

Prior to SVE equipment delivery, a 6 inch thick, 20 foot by 30 foot concrete pad will be constructed. Concrete will be allowed to cure prior to equipment placement. The process equipment mounted on the pad will include an SVE skid, vapor phase GAC cell, a diesel generator and fuel tank. A 5,000-gallon water storage tank will be located in the vicinity of the pad.

Process equipment and piping will be unloaded from the delivery vehicles with a boom truck and placed on the pad. After the equipment is set, the pad will be surrounded by a six foot high chain link fence installed by a local fence contractor. After all piping inside the fence is complete, OHM will construct a roof over the SVE system to provide weather protection. The roof will be single slope frame utilizing pressure treated lumber. Fiberglass panel roofing will be nailed to the rafters. The location of the equipment compound is shown on Figure 2. The configuration of equipment on the equipment pad, and slab details are shown on Figure 7.

The piping and manifold system will be installed concurrently with equipment installation. Above ground extraction and injection piping will be placed on the ground. OHM will install an exhaust stack for vapor discharge to atmosphere. The first few feet will be constructed of metal and will be insulated with fiberglass for personnel protection.

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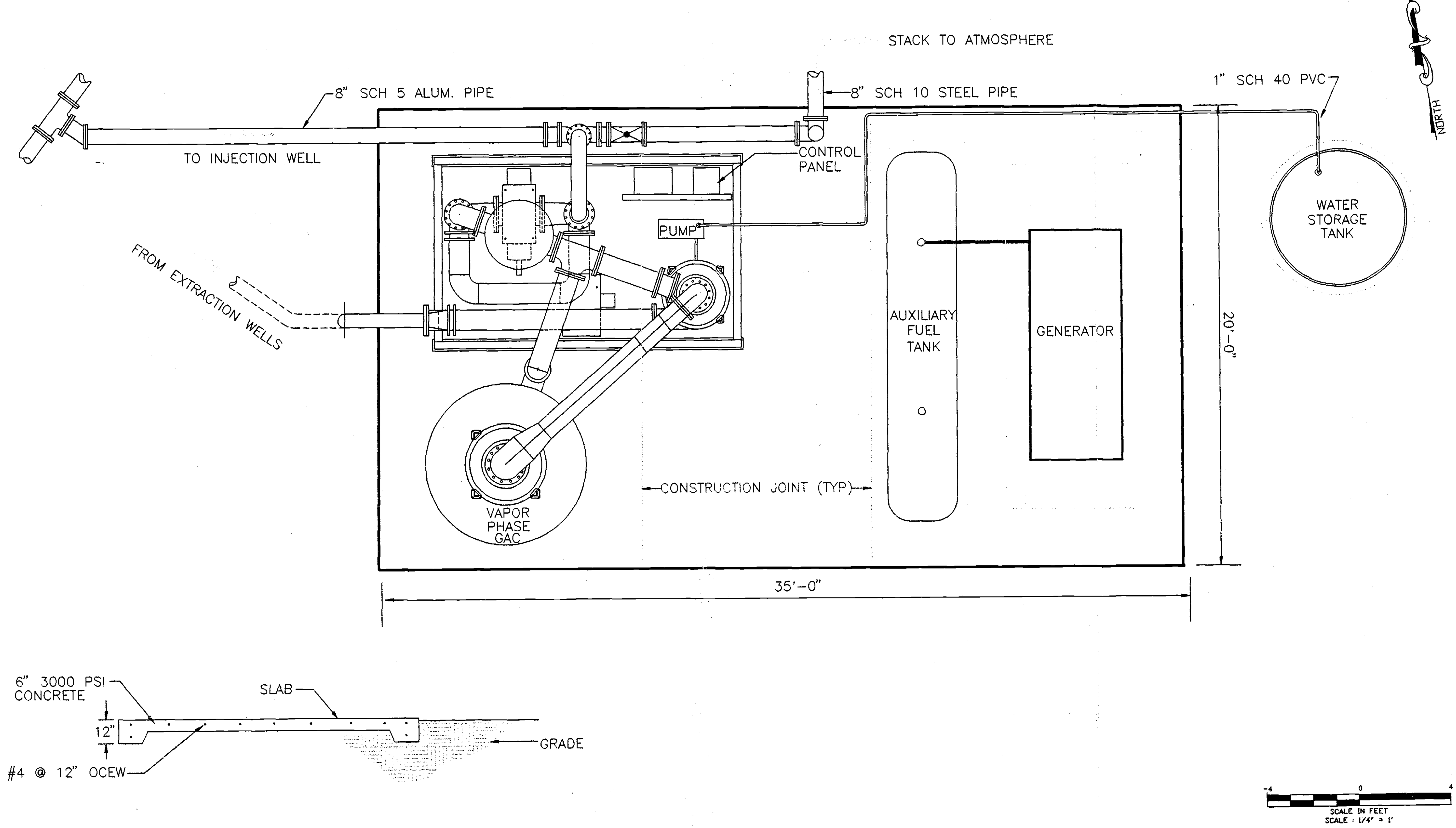


OHM Remediation Services Corp.
Norcross, Georgia
A Subsidiary of OHM Corporation

SUBMITTED: [signature] PROJECT MANAGER DATE: 2/3/95
APPROVED: [signature] SR. PROJECT ENGINEER DATE: 2/3/95
APPROVED: [signature] DATE: 2/3/95

AT FULL SCALE (IF NOT 2"-SCALE ACCORDINGLY)
CADD FILE: FIG7.DWG
DRAWN: J. COLLINS
DESIGNED: D. RUBIN
CHECKED: G. GILLES
CHECKED: G. GILLES

REVISIONS

ZONE	REV.	DESCRIPTION	BY	DATE	APP.
	1	INCORPORATING REVIEW COMMENTS	J.C.	2/3/95	J.D.

DEPARTMENT OF THE NAVY — NAVAL FACILITIES ENGINEERING COMMAND
ATLANTIC DIVISION
NAVAL STATION — NORFOLK, VIRGINIA
LANTDIV RAC CONTRACT N62470-93-D-3032 — DELIVERY ORDER NO. 0015
OPERABLE UNIT NO. 2 — MARINE CORPS BASE, CAMP LEJEUNE, N.C.

FIGURE 7
EQUIPMENT LAYOUT

DRAWING NUMBER: —
SHEET NUMBER: — of
DATE: 2/3/95

3.8 RESIDUALS MANAGEMENT

All clearing and grubbing vegetation and incidental debris encountered during these activities will be considered non-hazardous and routed to the Base landfill. Inorganic debris, if encountered, will be staged in Lot 203 and sampled to determine waste characterization.

Soil cuttings and drilling mud generated from the vertical and horizontal well drilling (approximately 20 cubic yards) will be collected and spread on the surface within the AOC-1 Area "A" SVE treatment zone. These residuals, which may contain low levels of VOCs, will be treated on the surface with the network of vertical SVE wells. OHM will therefore minimize to the extent possible, off-site transportation and disposal of solid or hazardous waste. Contaminated PPE will be collected in drums and consolidated with other contaminated PPE that is to be disposed of as solid industrial waste.

Waste oil generated from O&M activities (diesel generator) will be containerized and stored temporarily in Lot 203 pending off-site recycling.

3.9 SYSTEM START-UP AND OPTIMIZATION

Remedial system start-up will be conducted for a two week period. This will include testing, calibration, adjustment, and initial maintenance of all process equipment. During this time the system will be placed in full-scale operation. The operating systems will be tested and adjusted to document and optimize performance. System start-up and optimization phase activities include:

- Develop and quantify airflow from the extraction wells
- Quantify subsurface vacuum levels and effective radius of influence for each extraction well and system total
- Measure wellhead and system total vacuum levels
- Quantify airflow from individual extraction wells and the total system
- Obtain baseline soil vapor samples from soil probes and analyze for VOCs
- Record temperature readings of extracted vapor flow
- Develop and balance air injection flows and pressures
- Collect and analyze vapor samples from individual extraction wells, system total, and vacuum blower outlet
- Quantify and maximize contaminant extraction rates

- Quantify liquid extraction rate and VOCs in the water phase

- Test and calibrate process controls and equipment

Airflow will be developed from the extraction wells by incrementally increasing applied wellhead vacuum levels. An initial vacuum level of 0.5"Hg will be applied to each well and maintained for approximately one hour. Wellhead vacuum levels will then be increased by increments of 1.0" Hg every hour until the target vacuum level of 6" to 10" Hg is obtained. Airflows from each extraction well and the system total will be measured. Wellhead vacuum levels will be adjusted to balance the quantity of extracted airflow from each well.

Air injection flow rates will be developed by incrementally increasing injection air pressure and flow. An attempt will be made to recycle and inject all of the extracted airflow following VOC treatment. If conditions allow, additional airflow for injection will be added by bleeding in air at the inlet of the vacuum blower. If all of the extracted airflow can not be re-injected, the excess air will be exhausted to atmosphere.

Subsurface vacuum levels will be monitored in soil probes to verify the effective radius of vacuum influence throughout the treatment area as air flow is developed individually from each extraction well. Vacuum measurements will be taken in probes between the extraction and injection wells, and the extraction well and periphery of the treatment area. These measurements will be used to verify vacuum coverage and balance air flows for maximum contaminant transfer. After all extraction wells are operating, air injection will be commenced. Once the entire system is in operation, vacuum measurements will be taken at the margin of the treatment area to confirm pressure gradients induced by vacuum influence and that injected air is captured by the extraction system.

Vapor samples will be collected from each extraction well and the system total to allow quantification of contaminant extraction rates. System adjustments will be made to maximize the rate of contaminant extraction. An accurate log of all start-up test procedures and results will be maintained.

3.10 OPERATION AND MAINTENANCE

After system start-up, the SVE system will be placed in a continuous, unattended mode of operation. OHM personnel will operate and maintain the system for a minimum period of four months. For the first four months of operation, the system will be monitored bi-weekly to evaluate and optimize system performance. Qualified OHM personnel will monitor the vacuum extraction system's operation and provide monthly progress reports containing hours of operation, volume to water recovered, laboratory analyses, mass of contaminants removed, and other relevant operational information.

Activities conducted at the site during the operation and maintenance phase include:

- Measure wellhead and system total vacuum levels
- Measure vacuum levels in soil probes to verify zones of vacuum influence
- Record temperature readings
- Collect and analyze samples of extracted vapor from individual extraction wells, the system total, and the discharge stack (if applicable)
- Quantify contaminant extraction rates
- Adjust controls to maximize contaminant extraction rates
- Monitor compliance with air emission requirements
- Record volume of extracted liquids
- Conduct vacuum extraction unit and generator maintenance including oil change, particle filter change, and inspection and replacement of belts as needed
- Provide training for designated MCB Camp Lejeune personnel or contractors on SVE system operation and maintenance

It is anticipated that the system will achieve the soil clean-up goals in less than one year. Routine maintenance by OHM including adjustment of controls and balancing of the system could extend beyond the initial 4 month O&M period as directed by the Marine Corps .

3.11 OPERATIONS TRAINING

Following the initial four months of operation by OHM, at the discretion of LANTDIV, the Marine Corps may assume operation of the SVE system. OHM will provide up to four, eight hour days of training for personnel on SVE system operation and maintenance at the Base. If O&M training is requested, an Operation and Maintenance manual for the system as a complete and operable unit will be prepared.

4.0 SAMPLING AND ANALYSIS

The Sampling and Analysis Plan (SAP) describes analytical program to be used to monitor and document system performance. The plan identifies the types of samples to be collected, the sampling location points, the sampling frequency, the parameters to be analyzed, and the sampling devices and procedures to be used for collection. Sampling and analysis requirements for system start-up, optimization, and O&M are summarized in the Sampling and Analysis Matrix included as Table 1. This table is a supplement to the LANTDIV approved SAP.

Table 1
Sampling and Analysis Matrix

Sample Type	Sample Locations	Analytical Parameters	Sampling Frequency	Sample Device	Purpose of Samples	QA/QA Samples
Vapor	8 Extraction Wells	EPA Method 8240 Volatile Organic Compounds	5 times each measured on-site during start-up	Vacuum pump and tedlar bags	Quantify mass of contaminants extracted	1 field blank and 1 duplicate per set
	VL Separator Inlet VEU Outlet Soil Probes	EPA Method 8240 Volatile Organic Compounds	Monthly during O&M visits sent to off-site laboratory One sample from each of the 32 soil probes during system start-up	Vacuum pump and tedlar bags	Supply operational data needed to document and optimize system performance Determine baseline soil gas contaminant concentrations to allow comparison with future samples and evaluation of system performance	1 field blank and 1 duplicate per set 1 field blank and 2 duplicates
Water	V/L Separator Outlet	EPA Method 8240 Volatile Organic Compounds	Monthly during O&M visits sent to off-site laboratory	40-ml VOA bottles	Determine contaminant levels in extracted liquids	1 field blank and 1 duplicate per set

Vapor Samples

Vapor samples will be collected from each of the eight extraction wells, the inlet to the vapor/liquid separator, and the outlet of the vacuum extraction unit during system start-up and monthly operation and maintenance visits. Five vapor samples will be collected from each sample location during system start-up and analyzed on-site using gas chromatography. On-site analytical capabilities during system start-up allows for rapid sample analyses, quick response to changing conditions, and provides an economical method to evaluate and optimize system performance. Vapor samples will be collected from each sampling location during monthly operation and maintenance visits and sent to an off-site laboratory for analyses.

Vapor samples will be collected in Tedlar bags. To collect the vapor samples, the Tedlar bags are placed in a sample chamber which is connected to the vapor sampling port. A vacuum pump is used to apply sufficient vacuum to the sample chamber to overcome the vacuum in the process line and draw vapor into the Tedlar bag. Once collected the vapor samples will be analyzed for trichloroethene, tetrachloroethene, and benzene.

Water Samples
Water samples will be collected from the outlet of the vapor/liquid separator and the outlet of the liquid-phase granular activated carbon vessels. Samples collected from the outlet of the separator will be used to document contaminant levels in the extracted water. Samples collected from the outlet of the carbon vessels will be used to document contaminant removal prior to discharge. Water samples will be collected during the first and fourth operation and maintenance visits and sent to an off-site laboratory for analysis of volatile organic compounds using EPA Method 8240.

Performance Sampling
As stated earlier in Section 1.2, the remedial goals are to treat VOC contaminated soils to below the established RAOs. To determine when project objectives are achieved, and hence when the system can be shut down, OHM proposes the following approach:

1. OHM will monitor individual wellheads and total system VOC concentrations and mass removal during the initial four month O&M period. OHM anticipates that VOC removal rates will decrease exponentially with time. When inlet concentrations of VOCs indicate that remedial objectives may be nearly achieved, Step 2 will be initiated.

2. OHM will obtain quantitative soil gas samples from soil probes placed strategically within the zones of contamination to serve as a secondary screening tool to determine system performance. These probes will be installed during the construction phase. Baseline soil gas VOC levels will be established. Results of soil gas samples will be compared with the baseline vapor levels. If the soil gas results agree in principle with system air sampling data, then a confirmation testing program as described in Step 3 is appropriate.

3. Confirmation test borings should be performed to definitively determine whether soil cleanup objections have been achieved in AOC 1 Area "A". Although not estimated as part of this scope of work, OHM would recommend a minimum of six confirmation soil borings, two within the zone of highest initial VOC concentrations, and four at the periphery. Split spoon soil samples should be obtained at two different depths per location and tested for VOCs using EPA Method 8240. The results can then be compared against the RAOs for compliance with the project objectives.

5.0 HEALTH AND SAFETY

This installation will be executed under the comprehensive Site Specific Health and Safety Plan submitted with the OHM RAWP in November 1994. The following tasks have been identified as unique to this portion of the work:

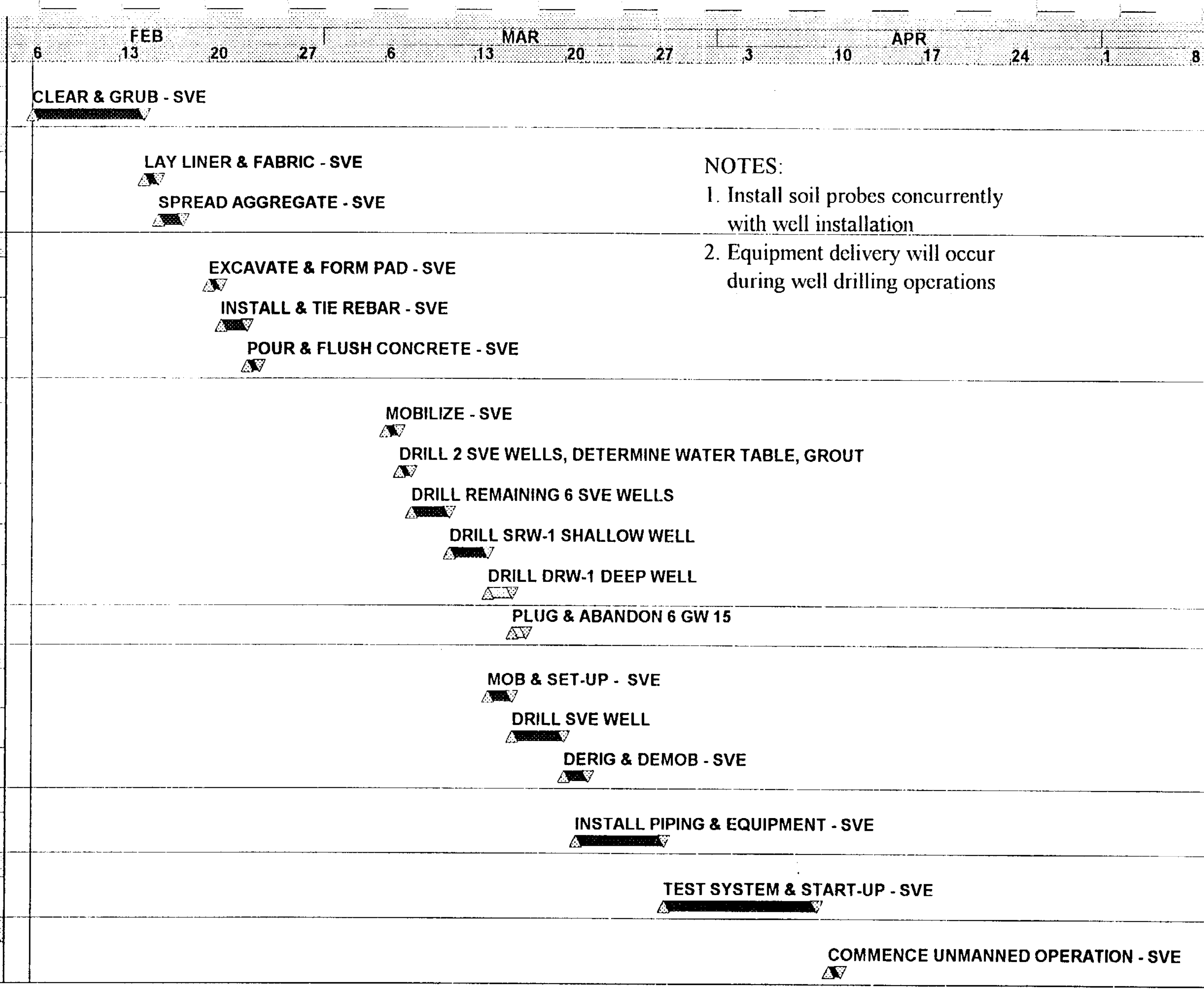
1. Horizontal Well Installation
2. PVC plastic pipe installation
3. Gravel placement

The SSHSP has been amended to contain the hazards analysis and controls associated with these tasks in Section 3.3 and the PPE required for each task in Section 5.5. The amended SSHSP has been provided under separate cover.

6.0 PROJECT SCHEDULE

The revised project schedule for Delivery Order No. 0015 contains Work Plan tasks for this effort which have been consolidated into four remedial activities: (1) AOC-1 pre-construction activities; (2) installation of SVE system; (3) start-up and optimization; and (4) operation and maintenance . OHM will initiate the pre-construction tasks immediately upon approval of this Work Plan.

Activity ID	Orig Dur	Early Start	Early Finish
CLEAR & GRUB			
141451	8	06FEB95	14FEB95
BUILD ROAD & PADS			
141452	1	15FEB95	15FEB95
141453	2	16FEB95	17FEB95
BUILD EQUIP. PAD			
141454	1	20FEB95	20FEB95
141455	2	21FEB95	22FEB95
141456	1	23FEB95	23FEB95
DRILL VERTICAL WELLS			
141526	1	06MAR95	06MAR95
141527	1	07MAR95	07MAR95
141528	3	08MAR95	10MAR95
141529	2	11MAR95	13MAR95
141530	2	14MAR95	15MAR95
141531	1	16MAR95	16MAR95
DRILL HORIZONTAL WELL			
141532	2	14MAR95	15MAR95
141533	4	16MAR95	19MAR95
141534	2	20MAR95	21MAR95
INSTALL PIPING & EQUIP.			
141500	6	21MAR95	27MAR95
TEST SYSTEM START-UP			
141550	11	28MAR95	08APR95
COMMNECE UNMANNED OPER.			
141600	1	10APR95	10APR95



NOTES:

1. Install soil probes concurrently with well installation
2. Equipment delivery will occur during well drilling operations

Project Start	06FEB95
Project Finish	10APR95
Data Date	06FEB95
Plot Date	10FEB95

Early Bar
Progress Bar
Critical Activity

AOC1

Sheet 1 of 1

OHM REMEDIATION SERVICES CORP J16032
LANTDIV - LEJEUNE DO #0015
AOC - 1 DETAIL