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September 10, 1997

Mr. Ken Glatz
Work Assignment Manager
U.S. Environmental Protection Agency
Remedial Response Branch (SR-6J)
77 West Jackson Boulevard
Chicago, IL 60604-3590

Dear Ken:

Subject: RI/FS Treatability Study Work Plan
Penta Wood Products Site
Town of Daniels, Wisconsin
Work Assignment No. 001-RICO-05WE
Contract No. 68-W6-0025

Enclosed please find two copies of the RI/FS Treatability Study Work Plan. The associated LOE and estimated costs will be presented in Work Plan Revision Request (WPRR) No. 1, which will be submitted next week. The WPRR submittal delay was necessitated due to the MPCS deadzone.

Please call me if you have questions or concerns.

Sincerely,

CH2M HILL

Regina Bayer

Regina Bayer

Site Manager

c: Stephen Nathan/PO/USEPA, Region 5
Peggy Hendrixson/CO/USEPA, Region 5
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TREATABILITY STUDY WORK PLAN
Remedial Investigation/Feasibility Study

Penta Wood Products
Town of Daniels, Wisconsin
Prepared by: CH2M HILL
WA No. 001-RICO-05WE/Contract No. 68-W6-0025
September 10, 1997

Contents

1.0 Introduction

This Treatability Studies Work Plan presents a description of the work to be completed during the performance of treatability studies (TS) at the Penta Wood Products (PWP) site in Town of Daniels, Wisconsin. These TS are being performed to obtain site-specific data related to the feasibility of using in situ treatment technologies (i.e.,. Bioventing) for the cleanup of wood-preserving-product-contaminated soils and water treatment technologies (i.e.,. Photoxidation, UV oxidation, biological treatment, granular activated carbon (GAC)) for the cleanup of wood-preserving-product-contaminated groundwater at the PWP site. The nature and extent of contamination present at the PWP site is described in the Remedial Investigation/Feasibility Study (RI/FS) Work Plan (CH2M HILL, July 1997).

Preliminary remedial technologies and process options potentially applicable to the presence of pentachlorophenol (PCP) contaminated soil and groundwater present at the PWP site are described in the RI/FS Work Plan. A summary of the need to conduct treatability studies for the identified remedial technologies was also presented.

The general objectives for the treatability studies are:

- Provide information to aid in the preparation of the FS. In particular:
  - Evaluate the effectiveness of bioventing to remediate soils; and photoxidation, UV oxidation, biological treatment, and GAC to remediate groundwater at the PWP site.
  - Evaluate the time required for these technologies to achieve treatment goals.
  - Evaluate the design and operating parameters necessary to prepare a feasibility-level cost estimate.

The Level of Effort (LOE) hours and costs associated with performance of these treatability studies are presented in PWP Work Plan Revision Request No. 1, which will be submitted under separate cover.

2.0 Technology Descriptions and Application to the Penta Wood Products Site

2.1 Bioventing

Bioventing is an in situ process that involves oxygenating subsurface soils by passing air through the unsaturated zone. The air stimulates in situ biological activity and promotes the bioremediation of residual organic contamination sorbed to the soils in the vadose zone. The intent is to provide the necessary oxygen to maximize the indigenous microorganisms' use of the contaminants and thereby reduce the mass of contaminants in the soils. The bioventing process is limited by how well air can be transported and distributed into the soil matrix and the inherent degradability of the compound.

Bioventing studies have been conducted at wood treating facilities similar to PWP to treat organic contaminants associated with creosote and PCP-based wood-treating preservatives. Bioventing is a proven technology for the remediation of hydrocarbon-contaminated sites.

The areas of the PWP site at which bioventing could be performed include those with relatively high levels of contamination, such as the oil/water separator, gully, and lagoon areas. Bioventing could also be performed in areas with lower levels of contamination, such as the log storage/peeler areas. The difficulty with performing bioventing studies in areas of relatively low contamination is that the rate of biodegradation may be so low and/or variable (due to spotty subsurface contamination), that it is difficult to monitor the biodegradation taking place (i.e., to demonstrate that biodegradation is occurring). For example, it may appear that oxygen is not being consumed in the subsurface because the sample of air that is being collected is actually a composite sample that includes air from soils that are relatively clean (thus high in oxygen) and air from soils that are contaminated (and lower in oxygen). The resulting composite air sample may only show very low rates of oxygen consumption. There may also be sufficient natural "recharge" of oxygen into the vadose zone in these areas so that bioventing would not provide any benefit over natural oxygenation.

The critical uncertainties with bioventing are: (1) its ability to effectively oxygenate the vadose zone; (2) the extent of contaminant removal that can potentially be achieved; and (3) the time required to reach the ultimate remedial goal. The ability of bioventing to effectively deliver oxygen to the vadose zone can be evaluated in a treatability study. It is not feasible to evaluate the contaminant removal that can be achieved by performing a short-term bioventing test, but this can be estimated from the rates of biodegradation observed in short-term bioventing tests. However, the rates of biodegradation are likely to decrease with time, so the longer the test is conducted, the more accurate the prediction will be. The duration of the treatment and other design and operational factors will directly influence the cost of the system.

A laboratory, or bench-scale, soil column study can also be performed to investigate the feasibility for the degradation of PCP under simulated in situ soil bioventing conditions. The advantages of performing this test in conjunction with the in situ bioventing study are: (1) conditions can be better controlled in the laboratory, (2) the column study allows for the ability to test the effectiveness of soil venting on different types of soil (i.e., sand, wood shavings) and different PCP concentration ranges, and (3) PCP degradation can be more accurately evaluated.

2.2 Photoxidation

Extracted groundwater can potentially be treated using sunlight to photolytically degrade PCP. While this is not a typical treatment process used for treating PCP in water, the presence of the 3.5-acre concrete pad onsite makes this a potentially cost effective option by minimizing the initial construction costs of the pond necessary to allow photolysis of PCP.

Photolytic degradation of dissolved PCP in water is initiated by the ultraviolet wavelengths in sunlight. Photolytic half lives for PCP in water have been measured at 24 minutes for midday sunlight in 1.6 cm diameter test tubes (Donaldson and Miller, 1997), 180 minutes in surface estuarine water in December (Hwang et. al., 1986) and 110 hours in a pond at midday in the fall (Howard et. al., 1991). The wide range of half lives may be a result of variations in the depth of the water and the presence of dissolved and suspended solids. The rate of degradation is decreased by the attenuation of light by natural chromophores present in the water (Pignatello et. al., 1983).

A preliminary evaluation of the feasibility of photolysis at the PWP site was performed. First, the time necessary for the removal of PCP, assuming an influent concentration of 100 ug/l and an effluent concentration of 1 ug/l, was estimated . First order decay was assumed and time periods of 5 to 700 hours were estimated for 99 percent removal using the range of literature half lives. The necessary pond size was estimated using the range of times, assuming a 6-inch depth of water and a 100 gpm groundwater extraction rate. The half life of 110 hours (700 hour treatment duration) results in a pond size of 25 acres, far larger than the size of the existing pad. At this half life photolytic degradation is not feasible. The half life of 24 minutes however results in a pond size of only 0.2 acres, well within the size available. The entire existing pad could be used to allow retention during evening hours and for at least one cloudy day. Because the existing pad has an estimated slope of 0.04, it would need to be subdivided into a series of cascading ponds to maintain the necessary shallow depth.

In summary photolytic degradation is potentially feasible if half lives are on the order of 1 hour at pond depths of 1- to 6-inches. The main limitations of this technology are that it would be limited to the warm weather months of May through November and may not be sufficiently efficient during consecutive cloudy days. The groundwater extraction system could either be turned off during these periods, or an alternate groundwater treatment system such as GAC could be used to treat the groundwater. Alternatively, if the extracted groundwater is discharged to a reinfiltration basin overlying the contaminated soil area and entirely recaptured by a groundwater collection system, a higher effluent limit may be possible that takes into account the in situ degradation of PCP in the unsaturated zone.

The main uncertainties to be investigated by the treatability study are the PCP photolytic degradation half lives at varying pond depths. The amount of additional PCP losses occurring during evening and cloudy periods as a result of photolysis, volatilization, biological degradation and hydrolysis will also be investigated.

Dissolved iron has been reported to range from 10 to 43 mg/l in the groundwater plume. The iron together with other inorganics such as manganese are expected to precipitate in the pond as oxygen naturally diffuses into the extracted groundwater. The degree of metal removal will be investigated. Because iron may also cause GAC fouling if used in conjunction with pond photolysis, at the end of the photolysis TS a sample of the groundwater will be submitted to a carbon treatment vendor.

2.3 Other Groundwater Treatment Technologies

In addition to photolysis, there are several other groundwater treatment technologies that are potentially feasible at the PWP site. These include UV oxidation, biological treatment (e.g., Biotrol process) and GAC treatment. UV oxidation is similar to photolytic oxidation in that UV wavelengths are used to initiate degradation of PCP, although the light is supplied by UV lamps rather than using sunlight. The advantage of UV oxidation is greater process control and continuous treatment. UV oxidation has been used successfully for treatment of PCP in groundwater. Disadvantages include potential for fouling of the lamps because of high iron concentrations and relatively high operational costs,,primarily for electricity. Uncertainties associated with use of UV oxidation at PWP site include the potential for reduced treatment efficiency as a result of lamp fouling and the energy costs necessary for treatment. To address these uncertainties a sample of groundwater will be collected and submitted to a UV oxidation vendor for bench scale testing. The vendor will perform the testing at no cost.

Biological treatment processes such as the Biotrol treatment unit have also been used to treat PCP in groundwater. The Biotrol unit was used at this site for treatment of heavily contaminated water. However the concentrations of PCP in groundwater are considerably lower and sufficient organic substrate to sustain PCP-degrading microbiological growth may not be present in the groundwater. To address this uncertainty a sample of groundwater will be collected and submitted to Biotrol for bench scale testing. Biotrol will perform the testing at no cost.

Granular activated carbon is most often used for treatment of PCP in groundwater. The contaminated groundwater would be pumped through GAC columns in series where PCP as well as other organic contaminants would be adsorbed. Prior to PCP breakthrough, the GAC would be replaced. Uncertainties of GAC use at the PWP site include the potential for iron fouling of the carbon, the need for iron prefilters or other iron removal treatment, and the carbon usage rate. To address the uncertainties a sample of groundwater will be collected and submitted to a carbon treatment vendor for bench scale testing. As discussed earlier, a sample of groundwater from the most promising photolysis TS cell will also be submitted to a carbon treatment vendor. The vendor will perform the tests at no cost.

3.0 Treatability Study Designs

The treatability study designs for each technology to be evaluated are described in this section.

3.1 Bioventing

The section details the system layout, construction, and operation of the bioventing treatability study.

3.1.1 System Layout

Bioventing will be evaluated at the proposed location shown on Figure 3-1. The study will be conducted for a period of approximately 12 weeks using a test system located in an area of high subsurface contamination. The bioventing test system will consist of a 4-inch bioventing well installed at 90 feet depth and screened from 5 to 90 feet in the vadose zone (see Figures 3-2 and 3-3). The well will be constructed with Schedule 40 PVC and sealed at the surface and at intervals to isolate geological strata zones with bentonite grout. The intervals are sealed with bentonite grout to give the flexibility of directing flow to specific zones during the TS.

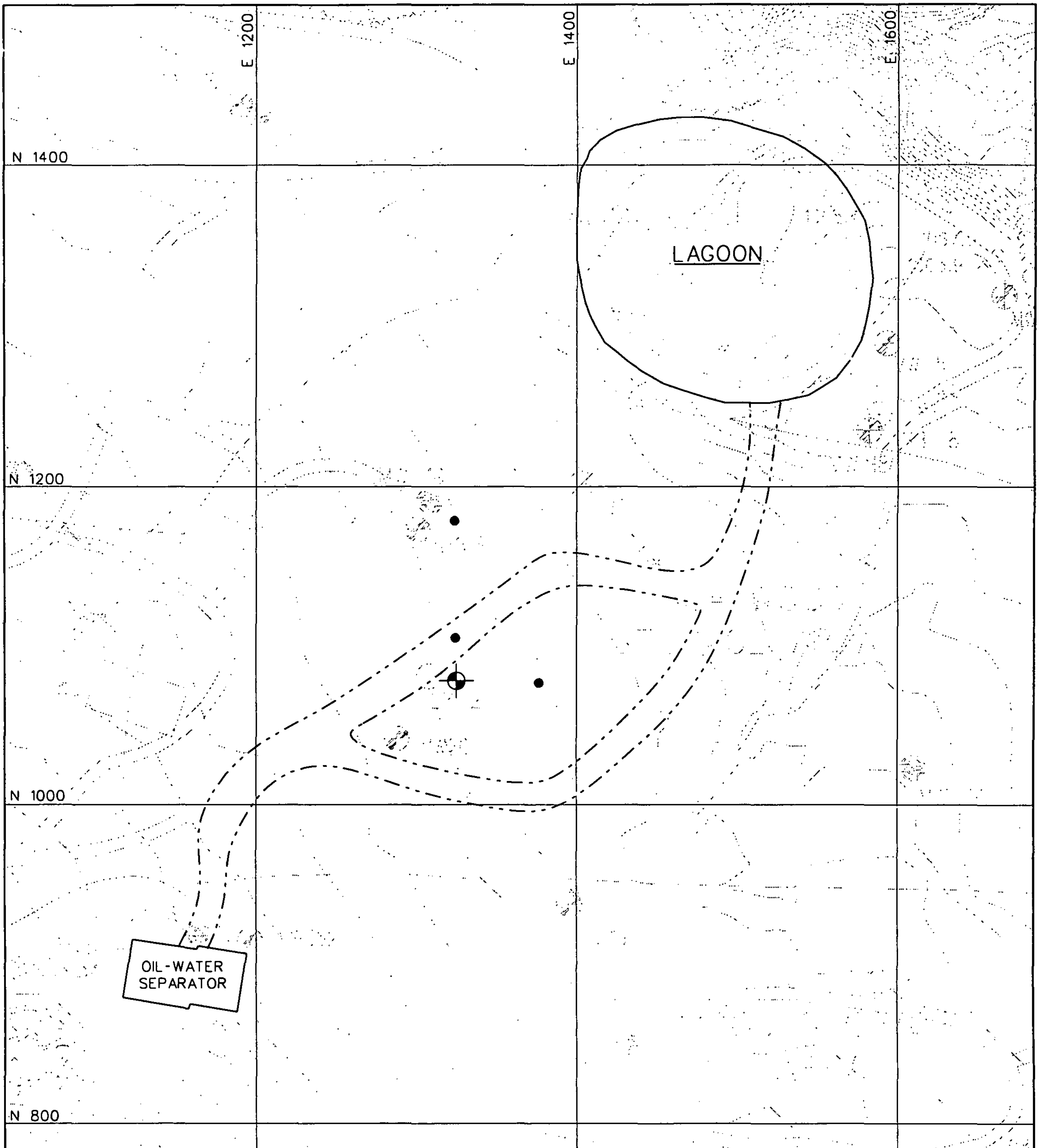
Three piezometer nests will be installed at 25, 50, and 100 feet distances from the bioventing injection well to monitor changes in soil gas concentrations to test effectiveness of biodegradation and radius of influence. Each nest will contain piezometers at approximate 80, 40, and 5 foot depths. The actual depths will be determined in the field based on soil stratigraphy data collected during cone penetrometer testing in a location near where the bioventing well will be located. Each piezometer will be installed with 1-foot screens and sealed at the surface with bentonite grout.

3.1.2 Construction

The specifications for construction of the bioventing test well are detailed in Figure 3-3. The depths shown are approximate and will be based on actual subsurface conditions from a boring that will be conducted in the location of bioventing well.

Figure 3-4 shows a schematic of the blower hook-up. The equipment includes a compressor blower rated for 500 scfm, flow meters, pressure indicators, and piping and fittings.

The blower will require a 3-phase power source, which is already available at the PWP site. Arrangements will have to be made to have the power turned on. An electrical contractor will need connect the source to the blower.



LEGEND

PROPOSED BIOVENTING INJECTION WELL LOCATION

● PROPOSED NESTED PIEZOMETER LOCATION

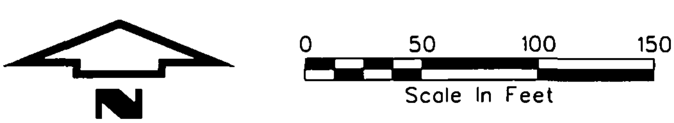


FIGURE 3-1

IN-SITU BIOVENTING TEST LOCATION

PENTA WOOD, TS WORKPLAN

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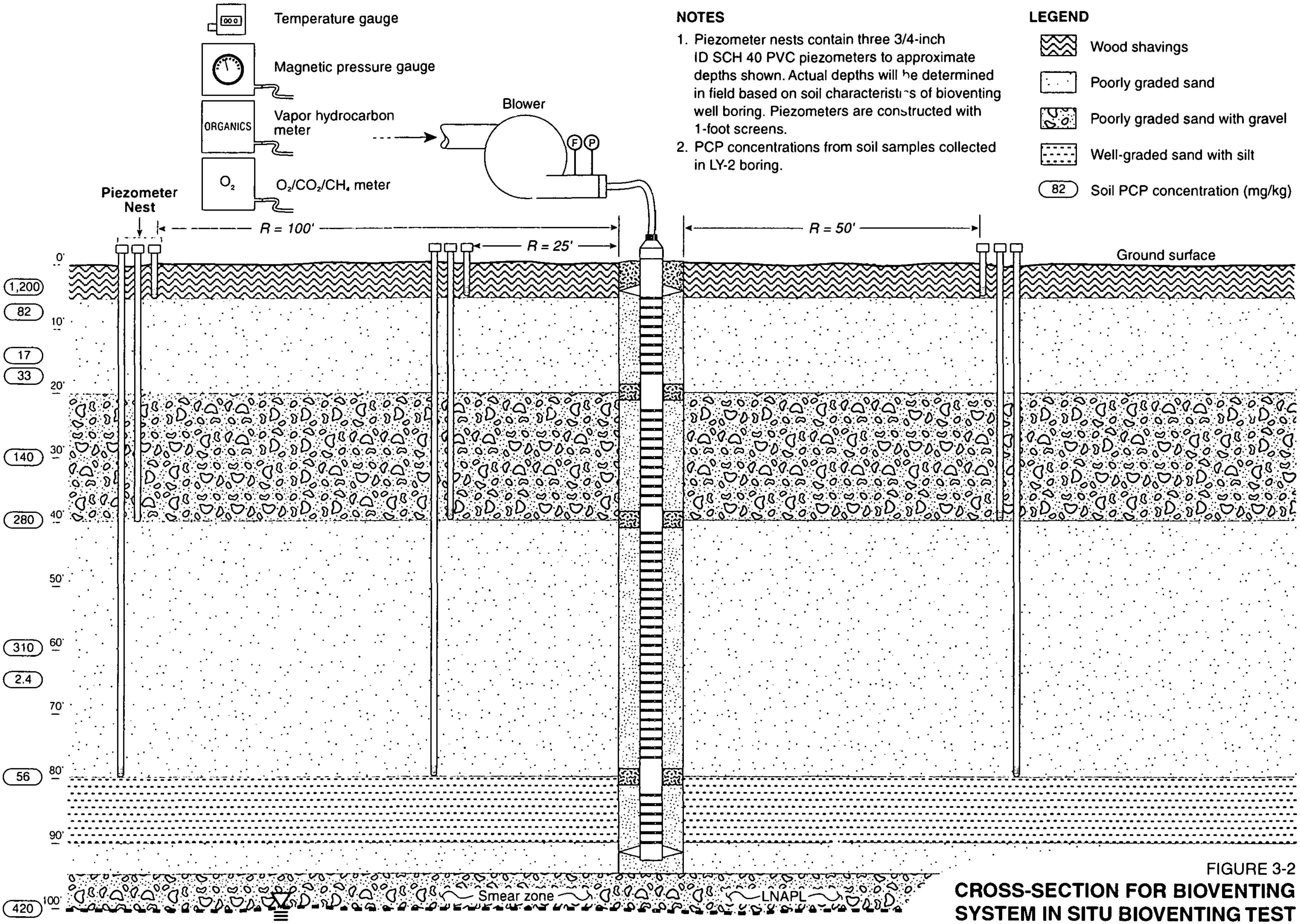

FIGURE 3-2
CROSS-SECTION FOR BIOVENTING SYSTEM IN SITU BIOVENTING TEST
PENTA WOOD, TS WORKPLAN
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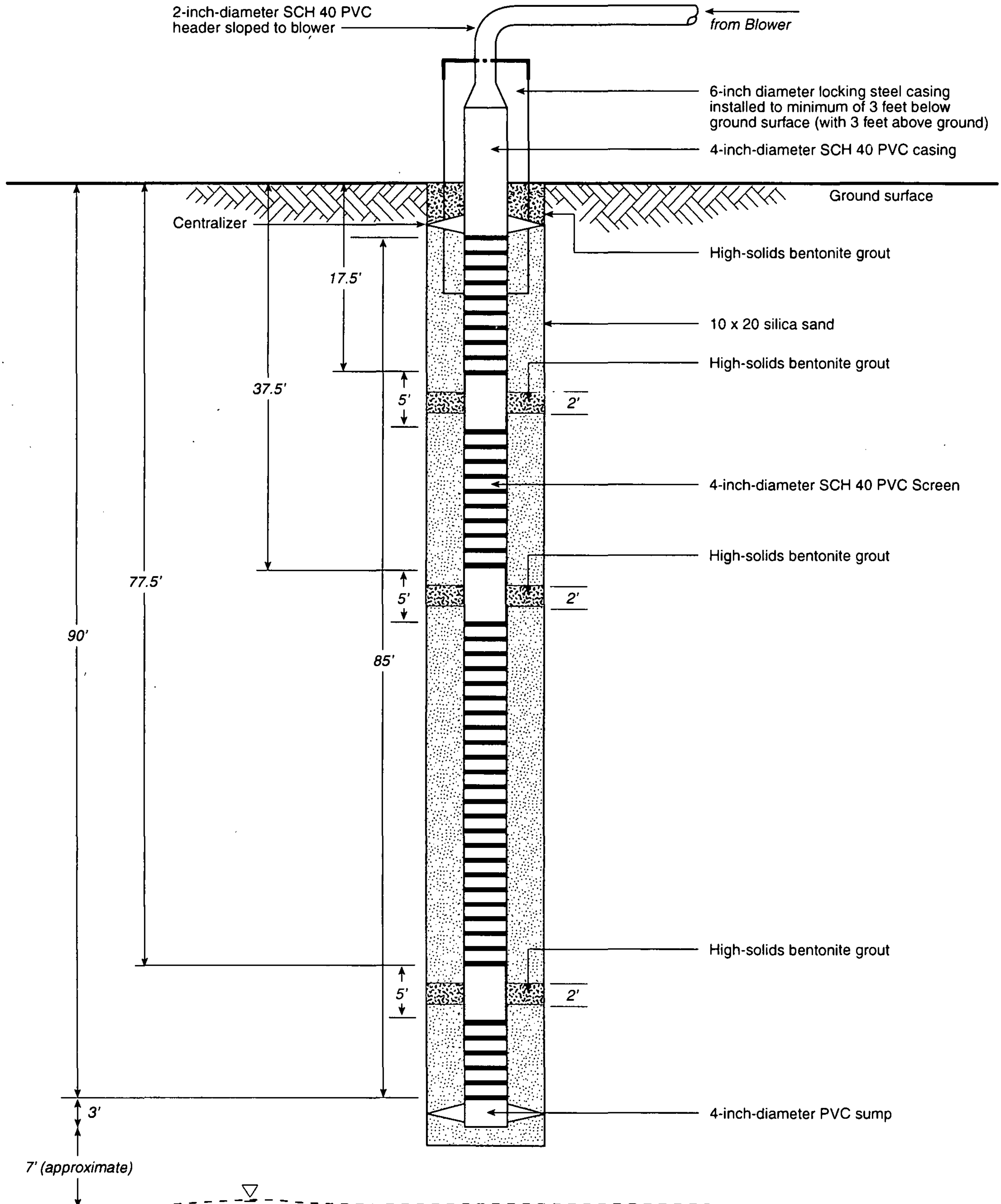

FIGURE 3-3
IN SITU BIOVENTING SYSTEM INJECTION WELL CONSTRUCTION SPECIFICATIONS
PENTA WOOD, TS WORKPLAN
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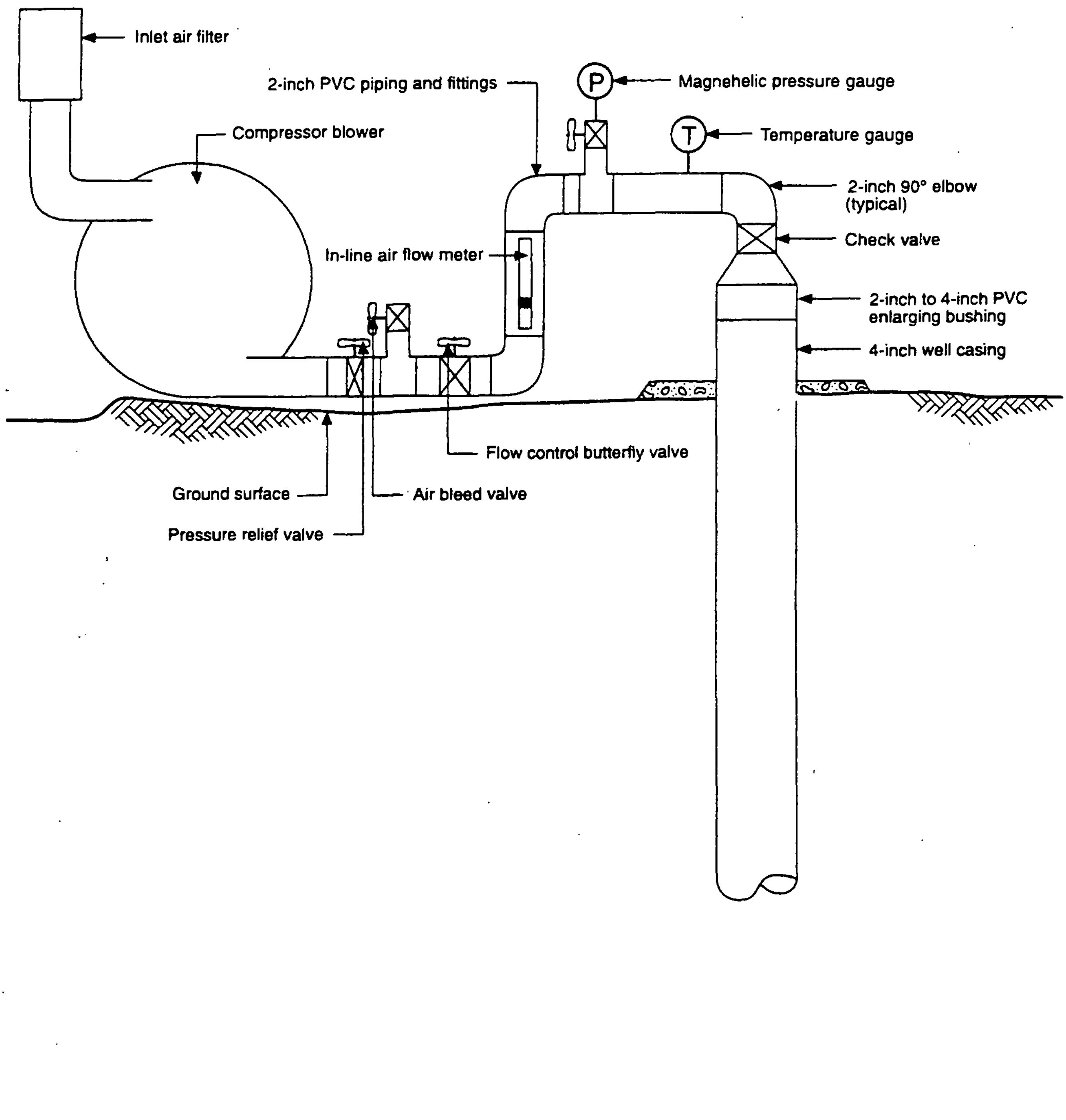

FIGURE 3-4
BLOWER SETUP SCHEMATIC
IN SITU BIOVENTING TEST
PENTA WOOD, TS WORKPLAN
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The noise associated with the operation of the blower may be high. To reduce this noise, the equipment will be placed in a small insulated equipment building. Modifications to the blower to reduce noise may also be evaluated before equipment procurement.

3.1.3 Operation

This subsection describes the detailed procedures for operating the bioventing treatability study. Included are operation plans for the following tasks:

- Soil gas monitoring
- Soil gas permeability test
- In situ respiration test
- Helium/air injection test (optional)

3.1.3.1 Soil Gas Monitoring

Soil gas concentrations of oxygen, carbon dioxide, methane, and total vapor hydrocarbons will be measured in the piezometers to evaluate the soil gas in the vadose zone. The soil gas survey involves direct measurement of oxygen, carbon dioxide, methane, and total vapor hydrocarbons in gas that is extracted from the monitoring points using an air sampling pump. In addition, soil gas temperature and moisture will be measured.

Oxygen, carbon dioxide, methane, and soil gas temperature are measured with a Gastech GA90 soil gas analyzer or equivalent. The analyzer directly measures the gas concentrations in percent and the soil gas temperature in degrees Celsius. Total vapor hydrocarbons are measured directly with a photoionization detector (PID). Moisture is measured by weighing a known amount, drying it, and re-measuring. The difference divided by the initial weight is the percent moisture.

3.1.3.2 Soil Gas Permeability Test

A soil gas permeability test will be performed using the bioventing test system. Soil gas permeability is a soil's capacity for fluid flow, and varies according to grain size, soil uniformity, porosity, and moisture content. The soil gas permeability test provides data to determine the soil gas permeability, required air flow rate, and radius of influence.[1] The soil gas permeability test will be performed using three different air flow rates in order to determine the optimum air flow rate for a full-scale system.

Startup. Connect the blower to the bioventing well and fit it with an air flow bleed valve, a pressure gauge, an air flow rate meter, and a temperature gauge.

[1] The radius of influence is the maximum distance from the air extraction or injection well where measurable soil gas movement (i.e., measurable vacuum or pressure occurs.

Operating Procedure. The soil gas permeability test will be performed using three different air flow rates. The following procedures will be followed for the three air flow rates:

1. Turn the blower unit on, set the air flow rate, and record the air flow rate and starting time to the nearest second.
2. A field crew of two is necessary for this procedure, one for each leg of monitoring points. Each person will use a panel of Magnehelic gauges and quickly move from one vadose zone monitoring point to another, measuring the pressures. At 1-minute intervals, record the pressure at each vadose zone monitoring point beginning at t = 60 seconds. To measure the pressure, connect the pressure gauge panel to the vadose zone monitoring point using the quick-connect fittings. Using the switch panel, select the proper pressure range and record the reading.
3. After 10 minutes, extend the interval to 2 minutes. Record the pressure at each vadose zone monitoring point every 2 minutes. Return to the blower unit and record the air flow rate and pressure at the well head. In addition, take the temperature reading from the thermocouple at the monitoring point.
4. After 20 minutes, extend the interval to 3 minutes. Record the pressure at each vadose zone monitoring point every 3 minutes. Continue to record blower data at 3 minute intervals during the first hour of the test.
5. Continue to record vadose zone monitoring point pressure data at 3-minute intervals until the 3-minute change in pressure is less than 0.1 inch of water. At this time, 5- to 20-minute interval can be used. Review the data the ensure that accurate data were collected during the first 20 minutes. If the quality of these data is in question, turn off the blower, allow all monitoring points to return to zero pressure, and restart the test.
6. Once the interval of pressure data collection has increased, monitor soil gas samples from vadose monitoring points for oxygen, carbon dioxide, methane and total vapor hydrocarbons. Continue to gather pressure data for up to 8 hours. The test will continue until the outermost vadose zone monitoring point with a positive pressure reading does not increase by more than 10 percent over a 1-hour interval.

3.1.3.3 In Situ Respiration Test

The in situ respiration test will be performed at the beginning of the TS, in the middle, and at the end of the in situ bioventing study. The in situ respiration test is performed to assess the degradation rate and the effect of time on the degradation rate.

The in situ respiration test is performed by measuring oxygen depletion versus time in the monitoring points. The oxygen consumption rate is calculated from the slope of the plotted data. Based on stoichiometry, this rate can be used to calculate the corresponding degradation rate.

Operating Procedure. At the start of the test, measurements of oxygen, carbon dioxide, methane, and total vapor hydrocarbons will be made in the monitoring points to confirm that the soil gas composition has stabilized. Oxygen levels should be above 10 percent in the monitoring points so that a good oxygen depletion versus time plot can be created.

Turn off the blower and measure oxygen, carbon dioxide, methane, and total vapor hydrocarbons at set time intervals depending on the rate at which oxygen is used. The in situ respiration test will be terminated when the oxygen level has stabilized, or reached zero percent.

3.1.3.4 Helium/Air Injection Test (Optional)

The helium/air injection test will be performed only if, after the in situ respiration test is conducted, the construction quality of the monitoring points is questionable. For example, if the oxygen consumption rate is significantly lower than expected and the quality of the monitoring point bentonite seal is suspect for air leakage to the atmosphere, the helium/air injection test will be performed.

Helium will be measured using a Marks Helium Detector Model 9821 or equivalent with a minimum sensitivity of 100 ppm (0.01 percent).

Startup. The helium/air injection test setup is shown in Figure 3-5. The blower and helium tank will be connected with tubing and a tee upstream of the connection to the monitoring point. Both lines will be fitted with a rotameter and a pressure gauge to measure individual supplies. The helium tank will be regulated to supply approximately 2 percent helium by volume to the air injection point.

Operating Procedure. The air/helium mixture will be injected into the monitoring point for a sufficient time that allows for the area around the well to be saturated with the air/helium mixture. The flow rate of helium will be adjusted to obtain about 2 percent in the final air mixture that will be injected into the contaminated area. For example, if the blower air flow rate is set at 100 cfh, the helium flow rate will be set at 2 cfh. After air and helium injection is complete, the soil gas at the monitoring point will be measured for oxygen, carbon dioxide, helium, and total vapor hydrocarbons. A measurement of helium under 2 percent indicates that some leakage is occurring.

3.2 Bioventing Column Study

3.2.1 Introduction

A laboratory, or bench-scale, soil column study will be performed to investigate the feasibility for the degradation of pentachlorophenol (PCP) under simulated in situ soil bioventing conditions. The critical uncertainties with bioventing are: (1) its ability to effectively oxygenate the vadose zone; (2) the degree of contaminant removal that can potentially be achieved; and (3) the time required to reach the ultimate remedial goal. The goal of this column study is to focus on the degree of contaminant removal that can potentially be achieved.

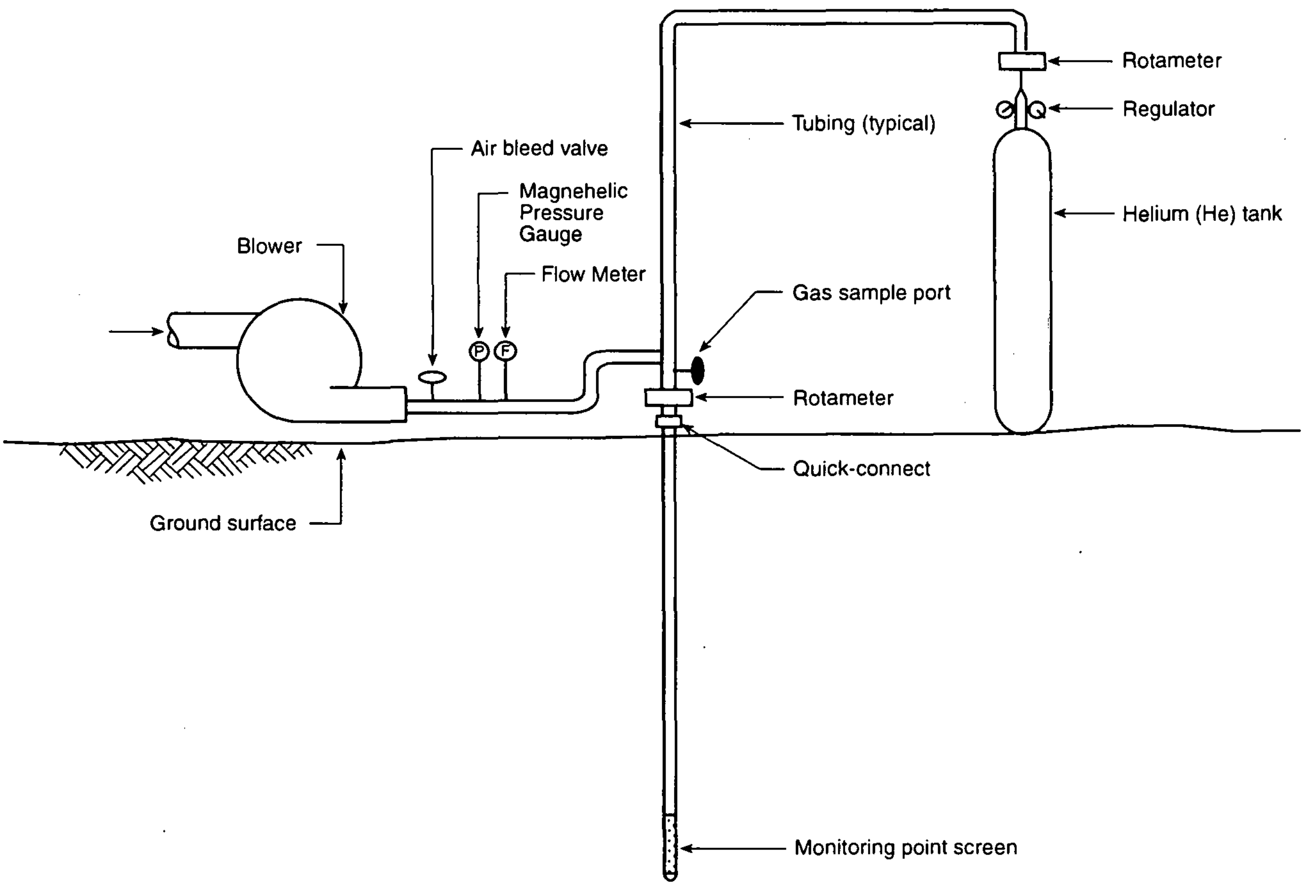

FIGURE 3-5
SETUP FOR HELIUM/AIR INJECTION TEST
IN SITU BIOVENTING TEST
PENTA WOOD, TS WORKPLAN

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3.2.2 Objectives of Column Study

Laboratory contaminant degradation and respiration tests will be performed to evaluate the oxygen requirements and the extent and/or rate of contaminant removal achievable under optimum soil moisture and oxygen content conditions. These results will be used to determine the in situ bioventing full-scale system design and operating conditions and to estimate the length of time required to achieve adequate PCP degradation.

3.2.3 Soil Column Description

Four clear acrylic or PVC plastic cylinders, approximately 18 inches tall and 8 inches in diameter, will be filled with the contaminated soil/wood debris and treated as follows:

1. Contaminated soil with PCP concentrations ranging from 100 to 200 ppm which will not be aerated (to simulate anaerobic conditions and serve as an experimental control column)
2. Contaminated soil with PCP concentrations ranging from 100 to 200 ppm which will be aerated
3. Contaminated soil with PCP concentrations ranging from 700 to 1000 ppm which will be aerated
4. Contaminated wood debris with PCP concentrations ranging from 700 to 1000 ppm which will be aerated

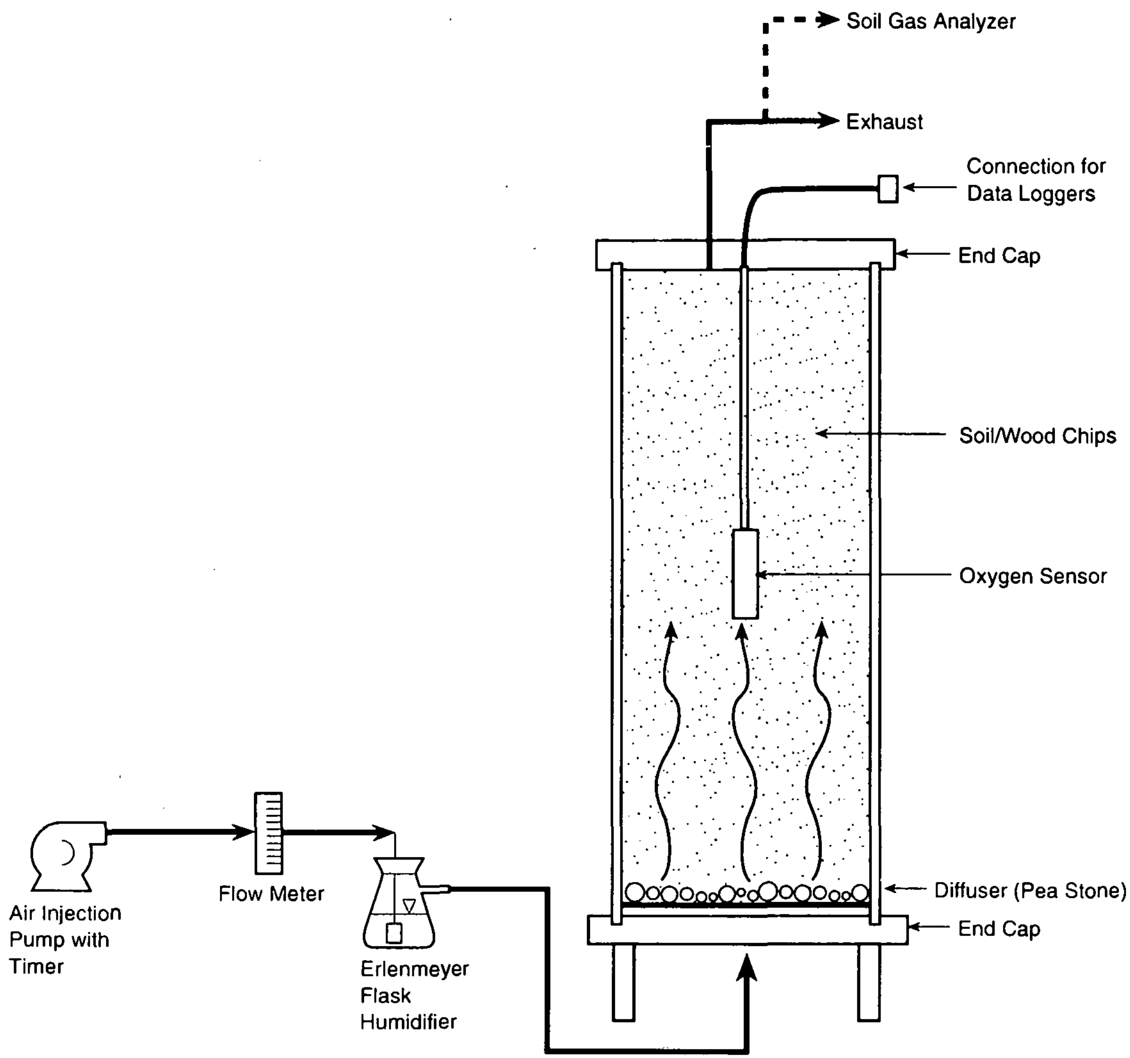
The soil columns will be placed in a dark enclosed refrigerated area to represent the dark and cooler in situ soil conditions. At the bottom of each column will be an air diffuser system (pea stone) to distribute the air into the column. The air injection system will be controlled by a timing/control device. The length of time required for air injection will depend upon the amount of time required to fully oxygenate the soil column (achieve approximately a 20 percent oxygen concentration). The time required for air injection will be determined during a respiration test (described in Section 3.2.5.1 below). Figure 3-6 shows a schematic of the soil column study apparatus.

3.2.4 Column Study Setup

3.2.4.1 Sample Collection

Subsurface soil/wood debris samples will be collected from the area of PCP contamination near LY-02 or near IT-01. The samples will be collected during drilling of the bioventing well and/or piezometers. Approximately 12 gallons of soil and 4 gallons of wood debris are required for the laboratory study. Each of these three field samples will be completely mixed to ensure homogenous conditions.

In addition, a sample will be collected by driving a shelby tube into the ground and extracting a core sample. The core sample will be used to visually compare the extent of compaction needed for the columns.



Column 01: Soil @ 100-200 ppm PCP (no aeration)

Column 02: Soil @ 100-200 ppm PCP

Column 03: Soil @ 700-1,000 ppm PCP

Column 04: Wood Chips/Soil @ 700-1,000 ppm PCP

NOT TO SCALE

FIGURE 3-6
IN SITU ENHANCED BIODEGRADATION TREATABILITY STUDY - SOIL COLUMN SCHEMATIC
PENTA WOOD, TS WORKPLAN
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A sample from each media will be analyzed by a laboratory for moisture content, diesel-range organics (DRO), total organic content (TOC), PCP and total petroleum hydrocarbons (TPH). The pH, temperature and in situ bulk density for each sample will also be collected.

3.2.4.2 Column Setup

After the samples are collected, the media will be compacted into the four soil columns in an attempt to establish conditions comparable to the in situ soil. This can be achieved by visually comparing the shelby tube sample with the soil column.

All columns will initially be sealed to test for leakage. After being sealed, each column will be purged with nitrogen. Oxygen levels will be measured with the oxygen sensors, which are packed into each column. Detectable oxygen readings indicate leakage.

After the test, three of the four columns will be unsealed at the bottom and top ports. The fourth will remained sealed to be used as a control and to simulate subsurface conditions without oxygen.

3.2.5 Column Study Procedures

3.2.5.1 Respiration Test

Several respiration tests will be performed on the three aerated soil/wood debris columns. An initial respiration test will be performed immediately after the columns are setup to determine the appropriate aeration interval and the oxygen uptake rate. The aeration system will be turned on until the soil reaches oxygen saturation (approximately 20 percent oxygen). The aerator will be turned off and oxygen will be directly measured with an oxygen sensor connected to a data logger until the concentrations stabilize.

3.2.6 Long Term Operation

Following the initial respiration test, the columns will be aerated/maintained for a period of at least 6 months.

3.2.6.1 Operating Conditions

The operating conditions for the soil columns have been determined through literature review of previous bench-scale biological degradation studies. The operating conditions are selected to provide conditions similar to in situ subsurface conditions. The soil column operating temperature will be controlled by maintaining the storage area temperature between 52 and 58 °F. The soil moisture content will be maintained within 20 percent of the initial moisture content. The moisture content can be assessed simply by weighing the soil column and adding distilled water as necessary to maintain a weight range that corresponds to the desired moisture content. The weight range will be extrapolated by determining the weight of the soil filled column at a known moisture content (i.e., when the initial moisture content sample is taken).

3.2.6.2 Soil Gas Monitoring

Once per week a gas analyzer will be connected to the outlet of the offgas manifold to record temperature, oxygen, carbon dioxide, and methane concentrations in the soil gas. The gas measurements will be taken immediately prior to the cycled aeration.

3.2.6.3 Laboratory Analyses

Composite soil samples will be collected from each column after three months and six months. The samples will be analyzed for pH, moisture content, DRO, TOC, PCP and TPH. After each sampling event, the columns will be re-sealed and tested for leakage (described in Section 3.2.4.2).

The results of the tests will be analyzed to assess if PCP degradation is occurring. The additional analyses will be used to determine if the aerated soil conditions are appropriate for biological degradation.

3.3 Photoxidation

The objectives of the photolysis treatability study are to determine:

- the PCP photolytic degradation half lives at varying pond depths
- the amount of PCP losses occurring during evening and cloudy periods as a result of volatilization, biological degradation and hydrolysis
- the amount of metal removal and whether pond photolysis reduces GAC usage

These objectives will be investigated in a set of three cells filled with contaminated groundwater to depths of 1 inch, 3 inches and 6 inches (Figure 3-7). The cells will constructed on a 4 foot by 8 foot sheet of 0.75 inch plywood (used for cell floor and walls) lined with black polyethylene plastic. The cells will be placed on the existing concrete pad to most closely simulate the angle of incidence of sunlight and the wind conditions that would occur under full scale operation.

The TS test will begin in the morning of a day predicted to be sunny throughout the day. Groundwater will be obtained from MW 6 (PCP concentration of 4600 ug/l) and immediately placed in the TS cells to avoid aeration and precipitation of inorganics prior to the start of the test. Once the cells are filled, a composite sample will be obtained for PCP and metals analysis by sampling each of the three cells. Metals samples will be for total metals (unfiltered). In addition, pH, temperature, oxygen and ORP will be measured. Samples for PCP analysis and the field parameters will be obtained from each cell thereafter over the course of two days according to the following scheduie.

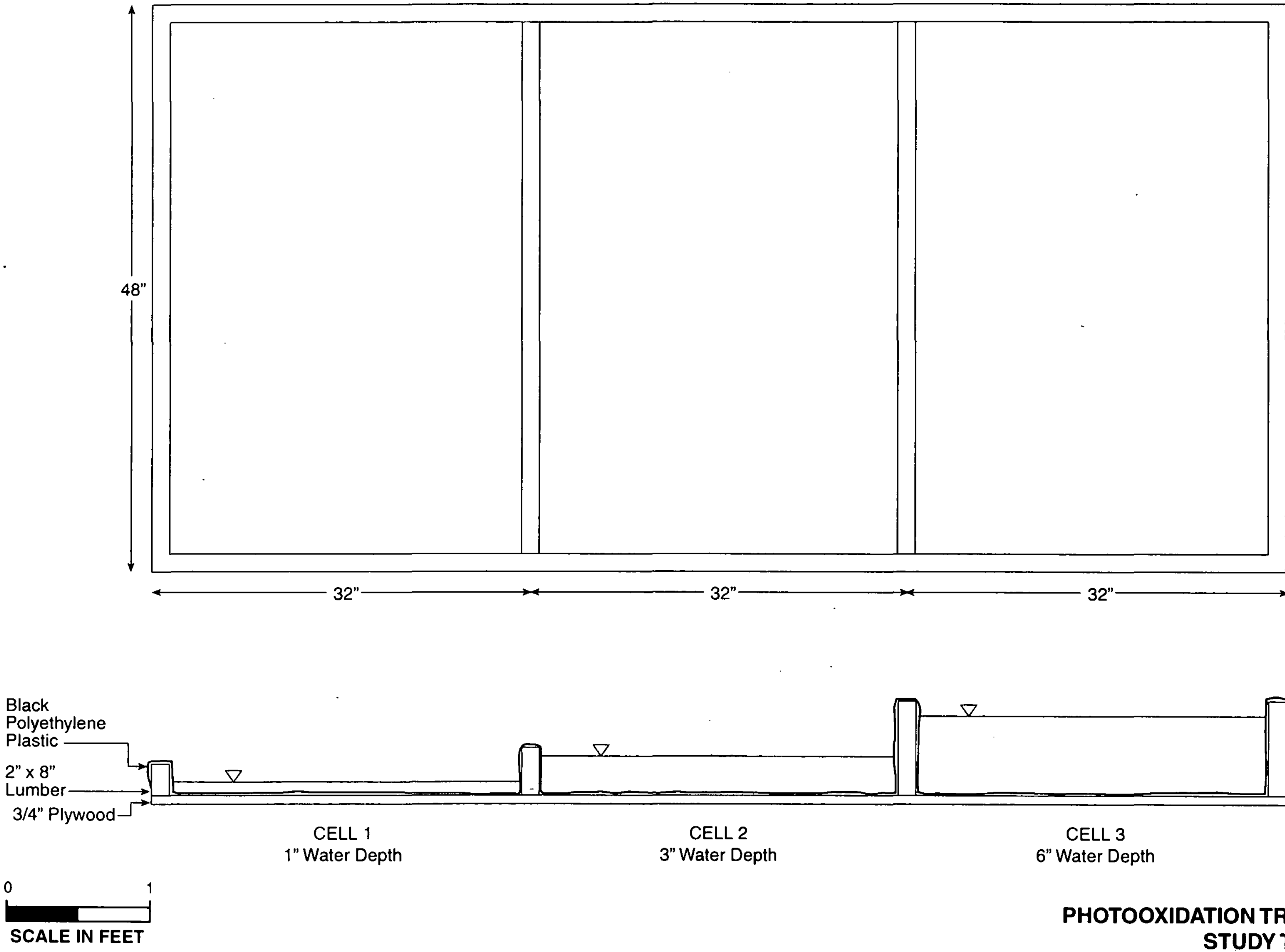


FIGURE 3-7
PHOTOOXIDATION TREATABILITY STUDY TEST CELLS
PENTA WOOD, TS WORKPLAN
CH2MHILL

E141158.TT.02 Photo Treat 9-10-97 lmh/tll

Sample Number	Time of Day	Conditions	Analysis	Number of Samples
1	0800 day 1	Sunny	PCP, total metals, pH, Temp, O2, ORP	1 composite
2	0900 day 1	Sunny	PCP, pH, Temp, O2, ORP	3
3	1000 day 1	Sunny	PCP, pH, Temp, O2, ORP	3
4	1200 day 1	Sunny	PCP, pH, Temp, O2, ORP	3
5	1400 day 1	Sunny	PCP, pH, Temp, O2, ORP	3
6	1800 day 1	Sunny	PCP, pH, Temp, O2, ORP	3
7	2400 day 1	Sunny	PCP, pH, Temp, O2, ORP	3
8	0600 day 2	Cloudy	PCP, pH, Temp, O2, ORP	3
9	1200 day 2	Cloudy	PCP, pH, Temp, O2, ORP	3
10	1800 day 2	Cloudy	PCP, pH, Temp, O2, ORP	3
11	0800 day 3	Cloudy	PCP, total metals, pH, Temp, O2, ORP; Sample from 1 cell submitted to GAC vendor	3

As shown on the table the last samples from each cell will also be analyzed for total metals. Also a sample from the most promising cell will be submitted to a vendor for GAC bench scale testing.

The testing will be discontinued at the end of the first day if the half lives of PCP exceed 5 hours in all cells. Sampling of a particular cell may also be discontinued if half lives greater than 5 hours are consistently found.

If conditions are sunny or partly sunny on the second day, the test cells will be covered with black plastic until cloudy conditions again occur. An additional sample will be taken in each cell the morning of the cloudy day.

Samples will be obtained from mid-depth at the center of each cell. PCP analysis will be performed onsite using the immunoassay method specified in the RI/FS Sampling and Analysis Plan.

Climatic conditions will be recorded during the TS study at the time of each sample collection and will include air temperature, wind speed and direction, and cloud cover. This information will be obtained by observation, and from a weather station located at the Duluth Airport. Also any visible characteristics of the water will be noted such as the presence of oil droplets or iron precipitation.

4.0 Data Evaluation and Reporting

The progress and preliminary results of the treatability studies will be presented in technical memoranda during the operation of the studies. It is currently envisioned that two memoranda will be prepared: one after the startup of the studies, and the second about two-thirds of the way through the studies. The objective of these memoranda will be to briefly summarize the progress made, the preliminary findings, and any adjustments made to TS operation.

A final report on the treatability studies will also be prepared after the studies are complete. This report will include the following:

- Summary of field activities and TS operations
- Presentation and discussion of the monitoring data for each study
- Presentation and discussion of analytical data for each study
- Evaluation of the results of each study with respect to the study objectives

Since the TS results will be needed for preparation of the PWP Feasibility Study and is therefore time-critical, it will have some overlap with the Feasibility Study.

Data evaluations that will be performed include the following.

4.1 Bioventing

1. In situ respiration results observed versus time and temperature
2. Spatial variation in respiration rates
3. Radius of influence—spatial variation in oxygen and pressure during operation
4. Soil gas permeability test data (pressure with time and distance versus flow rate), dynamic or static

4.2 Bioventing Column Study

1. Changes in PCP contamination in each column.
2. The effect of anaerobic degradation of PCP.
3. Changes in TOC, TPH, pH, moisture content, and DRO in each column.

4.3 Photoxidation

1. Photolytic degradation rate and half live of PCP during sunny conditions in each cell
2. Decay rate and half live of PCP during cloudy or shaded conditions in each cell

3. Change in concentration of total metals for each cell
4. Change in temperature, oxygen concentration, pH and oxidation reduction potential with time in each cell

4.4 Other Studies

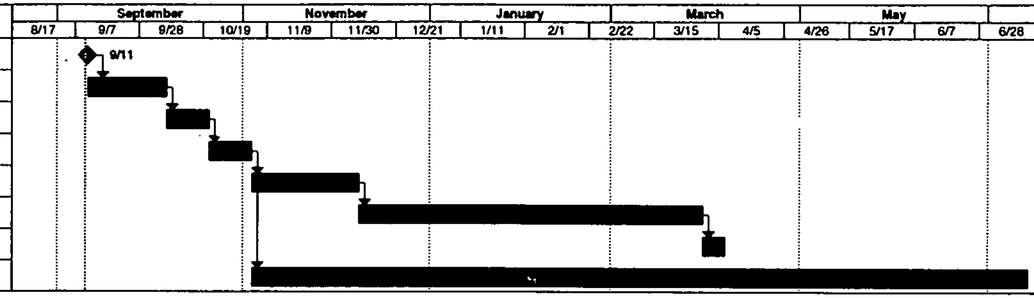
1. Bench-scale vendor testing results for UV oxidation, biological treatment, and GAC
2. Sizing and design criteria for installing a full-scale system
3. Cost information for implementing a full-scale system

5.0 Schedule

The proposed schedule for the TS is attached as Figure 5-1.

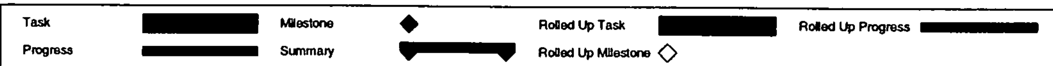
FIGURE 5-1
TREATABILITY STUDY SCHEDULE

ID	Task Name	Duration	Start	Finish
1	Submit TS Work Plan	0d	9/11/97	9/11/97
2	EPA Review of TSWP & WPRR#1	18d	9/11/97	10/6/97
3	Process Change Order (lab and driller contracts)	10d	10/7/97	10/20/97
4	Bioventing well and piezometer installation	10d	10/21/97	11/3/97
5	System Install and Start-up	25d	11/4/97	12/8/9 /
6	TS Operation	80d	12/9/97	3/30/98
7	Dismantle System	5d	3/31/98	4/6/98
8	Column Study Operation	180d	11/4/97	7/13/98



NOTES: 1. Photoxidation study to be conducted in conjunction with in situ bioventing study.

Project: TSSCHED1
Date: 9/10/97



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