Corrective Action Plan
3700 Fuel Yard Underground Storage Tank Site
Tinker AFB, Oklahoma

Department of the Air Force
Oklahoma City Air Logistics Center
Tinker Air Force Base, Oklahoma

December 1994

CORRECTIVE ACTION PLAN

3700 FUEL YARD UNDERGROUND STORAGE TANK SITE

TINKER AIR FORCE BASE

Prepared For

OKLAHOMA CITY, AIR LOGISTICS CENTER

TINKER AIR FORCE BASE, OKLAHOMA

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CONTENTS

TABLES

FIGURES

EXECUTIVE SUMMARY

Petroleum hydrocarbon contamination was detected in 1990 in soils at the Tinker Air Force Base 3700 Fuel Yard petroleum, oil, and lubricants (POL) underground storage tank site. The site is also referred to as POL area C. The six 25,000-gallon underground tanks previously storing JP-4 jet fuel were subsequently removed from service and closed. Additional soil and groundwater investigation determined significant contamination had occurred; however, the extent of this contamination was confined to the 3700 Fuel Yard.

This corrective action plan addresses the *in situ* remediation of hydrocarbon-contaminated soils occurring above the shallow aquifer at this site. Deeper soils or groundwater that may be contaminated will be addressed separately as a base-wide Resource Conservation and Recovery Act (RCRA) solid waste management unit (SWMU) investigation.

In situ remediation of the soils in the subject area will be accomplished by using a full-scale bioventing system. Initial bioventing pilot tests have produced excellent results and valuable information for full-scale design. This system will consist of six air injection wells coupled to two regenerative blowers. Through these wells, oxygen will be delivered to the entire soil profile to enhance natural biodegradation of hydrocarbons. The system will operate for at least 1 year or until concentrations of total petroleum hydrocarbons are below the regulatory limits for this site of 500 milligrams per kilogram.

Soil gas and soil samples will be collected at system startup to determine initial hydrocarbon concentrations. Soil gas sampling will also be conducted at 4-month, 8-month, and 1-year intervals to evaluate removal of contaminants from the subsurface soils over time. Soil sampling will also be performed after 1 year of remedial activities to determine the overall effectiveness of bioventing treatment. In addition, soil flux testing will be conducted to monitor for any potential volatile organic emissions that may occur from air injection into contaminated soils at this site.

According to the previous site investigation data indicating confinement of hydrocarbons in the soil inside the fuel storage area, risk to potential receptors is low because no exposure pathways are complete. Tinker AFB personnel will provide public notification as appropriate.

The full-scale bioventing system to be installed in the 3700 Fuel Yard will achieve cost-effective *in situ* remediation with minimal disruption of base activities.

SECTION 1.0
INTRODUCTION

This corrective action plan addresses soil contamination at the 3700 Fuel Yard site, also referred to as POL area C site located at Tinker Air Force Base (AFB), Oklahoma City, Oklahoma (Figure 1). A work plan for a bioventing treatability study has been prepared by Parsons Engineering Science (1994) as a companion document to this corrective action plan, which provides the details necessary to complete the activities to be performed to remediate this site. Results of past and planned treatability studies will be evaluated to determine the potential use of bioventing to remediate other fuel-contaminated sites at Tinker AFB. The base contact is Jerry Forste; and the point of contact for Parsons Engineering Science, the remediation contractor, is Brian Vanderglas. Their addresses and phone numbers are given below.

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SECTION 2.0
PREVIOUS INVESTIGATIONS

An initial site investigation was conducted in 1990 by Environmental Recovery, Inc. (ERI). Conclusions from this investigation suggested significant fuel contamination derived from tank leakage and/or surface spills (WSCI, 1992). Four of seven soil boreholes drilled for the investigation had total petroleum hydrocarbon (TPH) concentrations ranging from 97 milligrams per kilogram (mg/kg) to 1,500 mg/kg. The highest TPH concentrations were detected between 4 to 6 feet below ground surface (bgs), indicative of leakage from tank piping or surface spills. The volatile organic compounds (VOCs) benzene, toluene, ethyl benzene, and total xylenes (BTEX) were detected at concentrations ranging from below the detection limit to 55.5 mg/kg.

In 1991 tank closure was performed for the six underground storage tanks (USTs) and approximately 1,500 cubic feet of petroleum-contaminated backfill were removed and disposed of in accordance with appropriate regulations. Concentrations of TPH in soil samples collected from the excavated material ranged from 21 mg/kg to 338 mg/kg. The former UST site was restored with clean backfill to grade.

A remedial investigation was conducted at this site by Water and Soil Consultants, Inc., from September through December 1991. During phase I of this investigation, three soil boreholes were advanced and continuously sampled. Each borehole was then completed as a monitoring well/piezometer for evaluation of local groundwater conditions. Based on analytical results from this initial phase of field work, a second phase of field investigation was performed.

During phase II of this investigation, an additional five soil boreholes were advanced at selected locations to define the full aerial extent of soil contamination. Soil samples were collected from each borehole at 5-foot intervals to a total depth of approximately 35 feet and were analyzed for TPH. Results indicated that the majority of the contamination is limited to the immediate vicinity of the UST excavation. Contamination was also detected at depths of 30 and 35 feet bgs in borehole C-B-7 (WSCI, 1992). This borehole is located northeast of the contaminant plume. The depths of these soil samples is below the water table for the uppermost water-producing zone.

Groundwater samples were initially collected from monitoring wells MW-1 (2-8), MW-2 (2-9), and MW-3 (2-10), which were installed in a triangular configuration around the area of the former excavation. TPH was not detected in any well. Total BTEX constituents were detected in MW-1 and MW-3 at concentrations of 0.04 and 0.12 milligrams per liter (mg/l), respectively (WSCI, 1992).

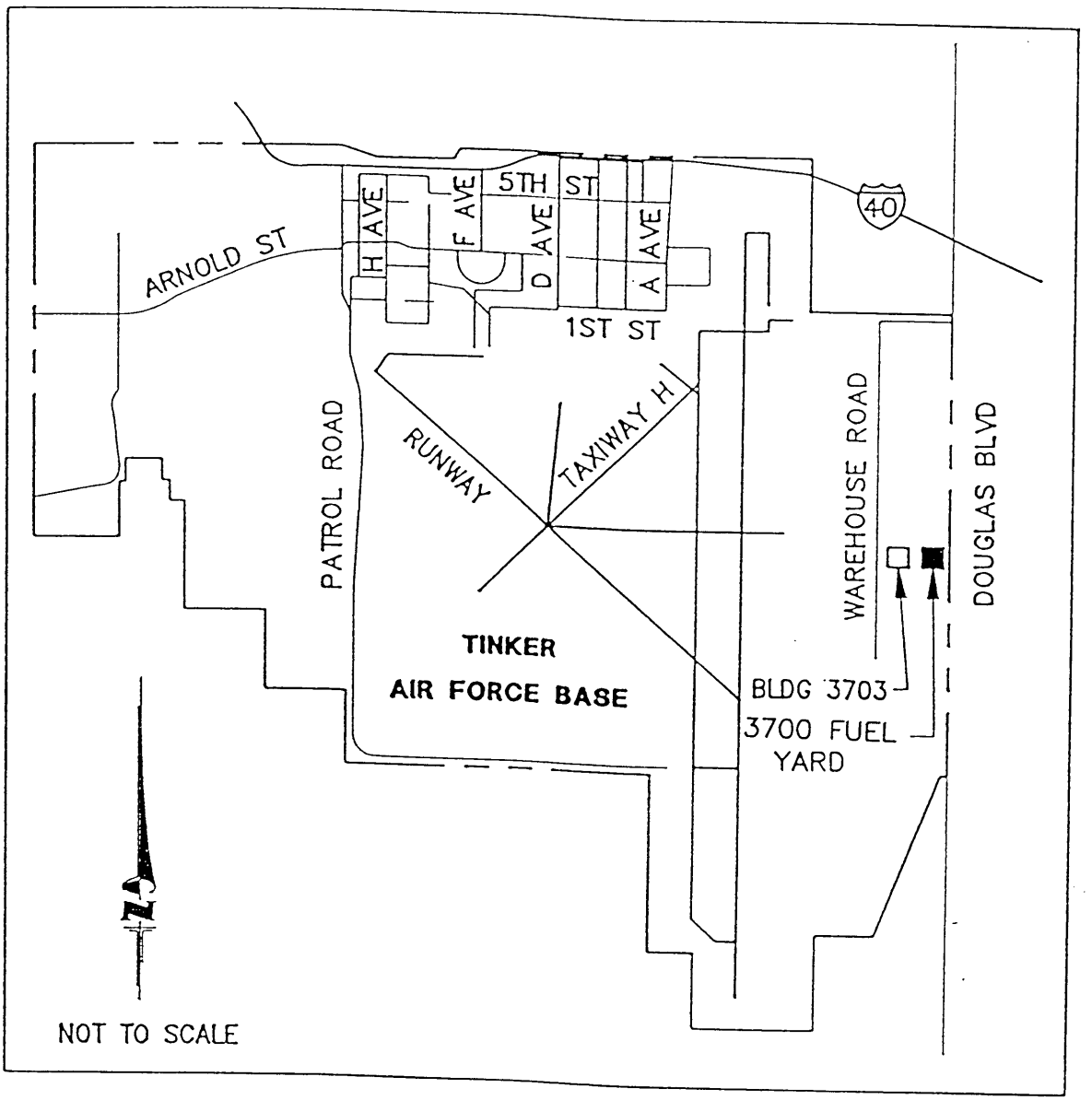

FIGURE 1
3700 FUEL YARD
LOCATION

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WPTKLOC 10/3/94

Two more recent groundwater sampling events were conducted at MW-1, MW-2, and MW-3 in January and February 1994. Total BTEX constituents were detected in MW-1 and MW-3 at 0.0034 and 0.0076 mg/L in the samples collected in January. These levels were significantly lower than those reported in 1992 (WSCI, 1992). No BTEX constituents were detected in the February sampling event.

The analytical results indicate several contaminants were detected in each well (Tinker AFB, 1994). The contaminants include 1,1-dichloroethene, 1,1-dichloroethane, 1,1,1-trichloroethane, trichloroethene, tetrachloroethene, and cis-1,2-dichloroethene. This list represents the primary constituents detected, although other compounds were identified in some of the analyses. None of these constituents in groundwater resulted from activities associated with the excavated UST in the 3700 Fuel Yard. The concentrations of each contaminant detected in the groundwater samples are generally below 500 micrograms per liter.

Groundwater was encountered at depths ranging from approximately 18 to 20 feet bgs. During phase II of this investigation, regional groundwater flow was determined to be approximately due east toward MW-1 (2-10) with a hydraulic gradient of 0.013 foot per foot.

Detailed descriptions of the local and regional geologic and hydrogeologic conditions can be found in the above referenced reports, and in the bioventing work plan (Parsons ES, 1994).

SECTION 3.0
CLEANUP GOALS

Cleanup goals for this site are based on the Oklahoma Corporate Commission's (OCC's) soil and groundwater remediation index and soil cleanup levels presented as appendix J and appendix K, respectively, within Oklahoma Administrative Code (OAC) Chapter 25, section 165:25. The scope of work for this full-scale bioventing installation is to address remediation of soils above the level of groundwater in the shallow aquifer at this site. Groundwater contamination and deeper soil contamination at this site will be addressed separately as a base-wide Resource Conservation and Recovery Act solid waste management unit investigation.

The 3700 Fuel Yard full-scale bioventing system is designed to operate for at least 1 year or until TPH concentrations in the soil are below 500 mg/kg.

SECTION 4.0
HEALTH AND ENVIRONMENTAL IMPACT

4.1 VOLUME OF CONTAMINATED MATERIAL

Based on previous site investigation data, and using the 500 parts per million estimated contour line (Figure 2) for TPH contamination and an average 10-foot thickness of contaminated subsoils at this site, the estimated volume of contaminated soil at the 3700 Fuel Yard site is 8,100 cubic yards. This is a conservative estimate for the plume assuming a 120-foot width and 185-foot length.

4.2 QUANTITY, TYPE, AND SOURCE OF PRODUCT RELEASED

The most recent and only reported product stored in the removed USTs was JP-4 jet fuel. The six tanks were installed in the late 1950s and were in service until 1991. The quantity of fuel to have spilled or leaked from the tank and associated piping is unknown. Free product has not been detected on the groundwater in the area of the removed USTs. Analytical results from soil and groundwater samples suggest the source of fuel contamination is likely to have been a combination of spills from fueling operations and leaks from the tanks or product piping.

4.3 MOBILITY, PERSISTENCE, TOXICITY, AND DEGRADABILITY OF RELEASED PRODUCT

JP-4 hydrocarbons are relatively mobile and nonpersistent in most soil systems. Persistence in deep soils and groundwater may be higher. Benzene is the compound of greatest toxicity in JP-4. The EPA has established a conservative, risk-based screening level of 3.2 mg/kg for benzene in soil. Concentrations below this level should not pose an inhalation risk assuming industrial or residential land use (EPA, 1993). Biodegradation of JP-4 based hydrocarbons is expected to be significant under environmental conditions favorable to microbial oxidation (IRP Guide, 1985). Availability of oxygen; soil temperature; and levels of soil pH, salinity, moisture, and nitrogen are all factors that contribute to determining the degradability of hydrocarbons at a given site. Most hydrocarbon biodegradation is limited by a lack of oxygen. Bioventing will supply oxygen to enhance natural biodegradation.

4.4 EXPOSURE PATHWAYS

A preliminary identification of potential receptors and pathways has been completed to aid in the identification of data needs and uses. Receptors and pathways will be

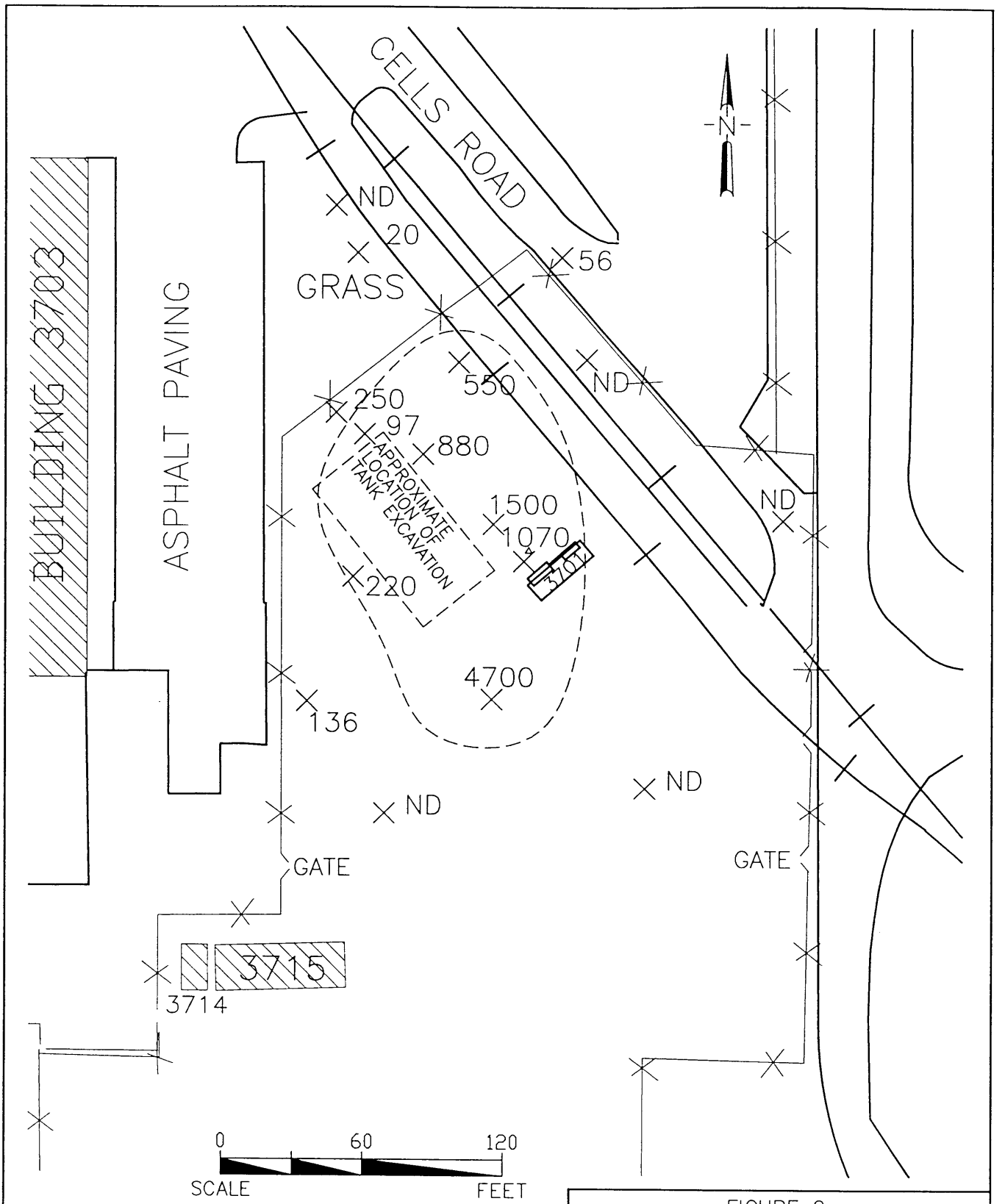

FIGURE 2
SITE LAYOUT AND ESTIMATED EXTENT OF TPH CONTAMINATION PLUME
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evaluated during the treatability study at the site. Soil samples, air emission surveys, and groundwater sampling are planned as part of this study.

A preliminary identification of potential receptors had been conducted based upon the location of the 3700 Fuel Yard and its current use and operation. Potential human receptors include:

- workers such as operators, construction, or remediation workers at the 3700 Fuel Yard
- workers at other areas of Tinker AFB if significant air emission exist.

No environmental receptors are in the industrial are which surrounds the 3700 Fuel Yard.

For a potential pathway to be considered, there must be a potential for the exposure of receptors from contaminated media such as air, soils, surface water, or groundwater. Groundwater is not included in the following evaluation, since it is being addressed in the ongoing RCRA facility investigation of the groundwater. Potential releases to the air and soils must be considered during the performance of this remedial action. Surface water runoff from the 3700 Fuel Yard is not considered to be a potential exposure pathway for contaminants at the site. Soil and air emission sampling will be performed to evaluate potential release via soil and air exposure pathways.

Based on the limited extent of the currently defined hydrocarbon contamination at this site, none of the indicated pathways are likely to deliver hydrocarbon contamination to potential offsite receptors. Potential receptors located on site include only Tinker AFB personnel or remediation workers who routinely occupy or work in the immediate vicinity of the 3700 Fuel Yard.

4.5 AIR EMISSIONS

The potential for air emissions during remediation by *in situ* bioventing is generally low. During initial startup of the system, air is dispersed through the contaminated soil horizon. This introduction of air displaces the hydrocarbon vapor that may be occupying the pore spaces of the soil. Bioventing systems operate at low flow rates, and bacteria receive oxygen to biodegrade available vapors as well as the less volatile hydrocarbon constituents. Soil flux testing will be conducted at this site to measure any potential hydrocarbon emissions at the soil-air interface. Additional details are in the work plan.

SECTION 5.0
REMEDIAL DESIGN

The purpose of the full scale *in situ* bioventing system is to enhance the natural bioremediation of contaminated soil, utilizing naturally occurring petroleum-degrading bacteria, with minimal disruption of base operations.

5.1 INITIAL PILOT TESTING

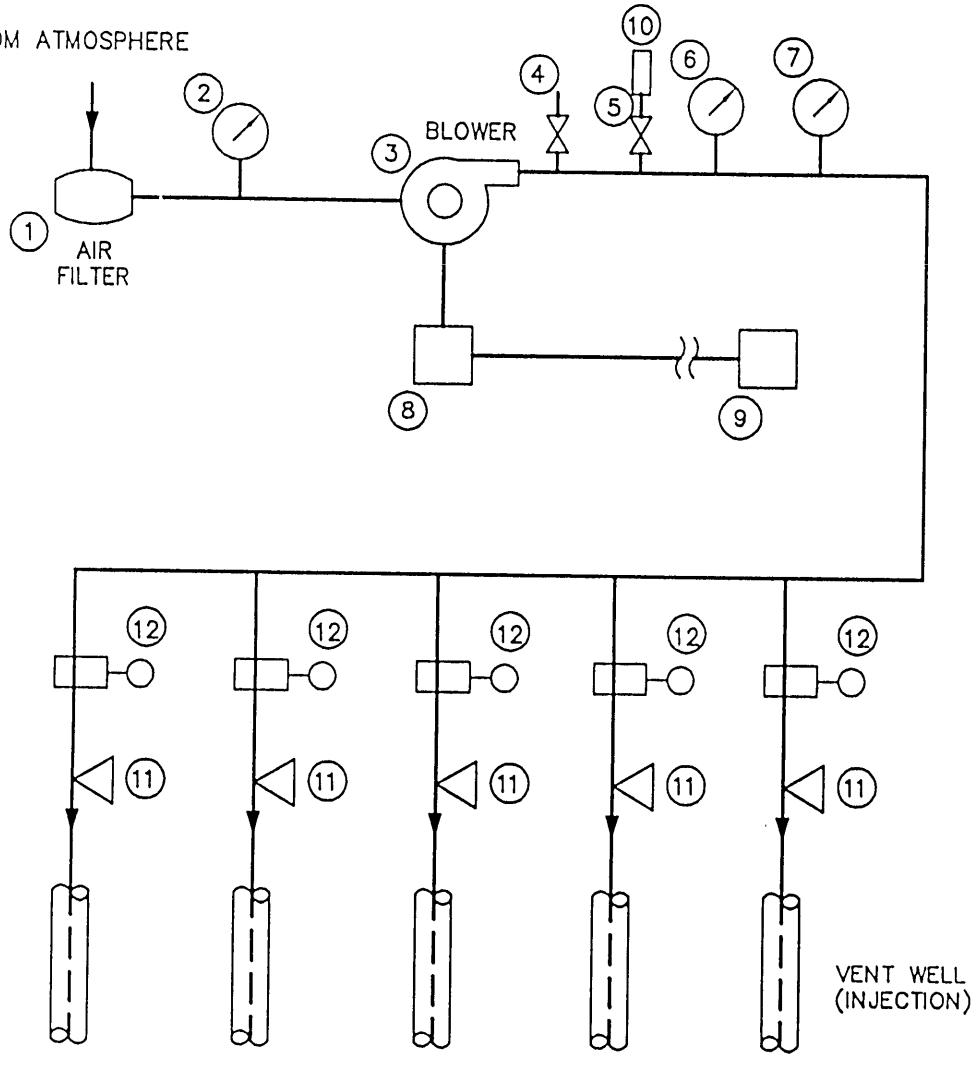
A single air injection well was used to conduct an initial bioventing pilot test. Air was injected at a rate of 34 scfm and produced a radius of oxygen influence in excess of at least 28 feet. *In situ* respiration testing was used to determine oxygen-enhanced biodegradation rates. Fuel biodegradation rates of 420 to 900 milligrams TPH per kilogram of soil per year were measured in the test area. The full-scale system has been designed using pilot test results.

5.2 EQUIPMENT AND INSTALLATION

The full-scale bioventing system will consist of a regenerative blower connected by manifold to five air injection wells. An instrumentation diagram for the five-vent well blower system is shown on Figure 3. The pilot system currently in place will operate as part of the full-scale system but will maintain its direct hookup to a separate regenerative blower. The tentative blower selected for the full scale system is a Gast 2.5-horsepower regenerative blower. The maximum power requirement for this system is 230-volt, single phase, 30-amp service. The blower will be placed in an enclosure central to a power supply and the air injection wells. The existing single blower system is a Gast 1-horsepower regenerative blower wired to a 230-volt, single phase, 30-amp service. The proposed vent well air delivery system configuration is presented in Figure 4. The spacing and well location are based on available results of the existing pilot test already performed at the site, and the anticipated extent of contamination and radius of oxygen influence determined from each injection well.

The air injection wells, or vent wells (VWs), will be located throughout the site such that their radius of oxygen influence will encompass the delineated extent of hydrocarbon contamination (Figure 2). Figure 5 is a vent well construction diagram.

Twelve multidepth vapor monitoring points (VMPs) will be installed near the VWs as shown on Figure 4. Soil gas oxygen, carbon dioxide, and total hydrocarbons will be monitored at depth intervals of 5 to 6 feet, 10 to 11 feet, and 15 to 16 feet. Monitoring of these points will confirm that the entire soil profile is receiving oxygen and will provide data on fuel biodegradation rates at each depth. Figure 6 is a VMP construction diagram.



LEGEND

1. INLET AIR FILTER – SOLBERG F-18P-150
2. VACUUM GAGE (in H_2O)
3. 2.5 HP BLOWER – GAST® R5
4. AUTOMATIC PRESSURE RELIEF VALVE
5. MANUAL PRESSURE RELIEF (BLEED) VALVE – 1 1/2" GATE
6. PRESSURE GAGE (in H_2O)
7. TEMPERATURE GAGE (°F)
8. STARTER – FURNAS 14CSD33DA NEMA 3
9. BREAKER BOX – 230V/SINGLE PHASE/ 30 AMP
10. BLEED VALVE MUFFLER
11. FLOW MEASUREMENT PORT
12. MANUAL PRESSURE BLEED VALVE

FIGURE 3

BLOWER SYSTEM INSTRUMENTATION DIAGRAM

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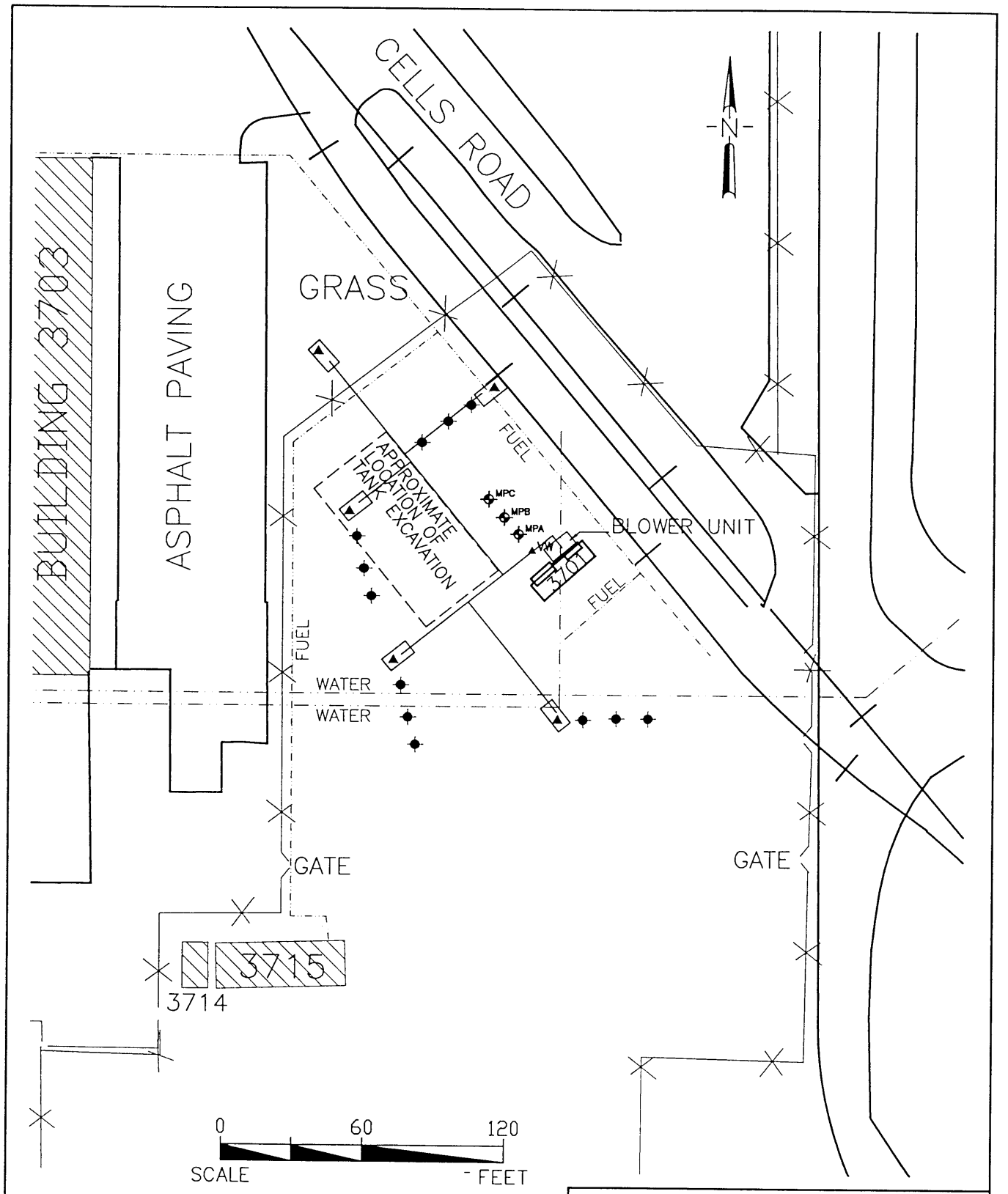

FIGURE 4
PROPOSED VENT WELL
AIR DELIVERY SYSTEM
CONFIGURATION
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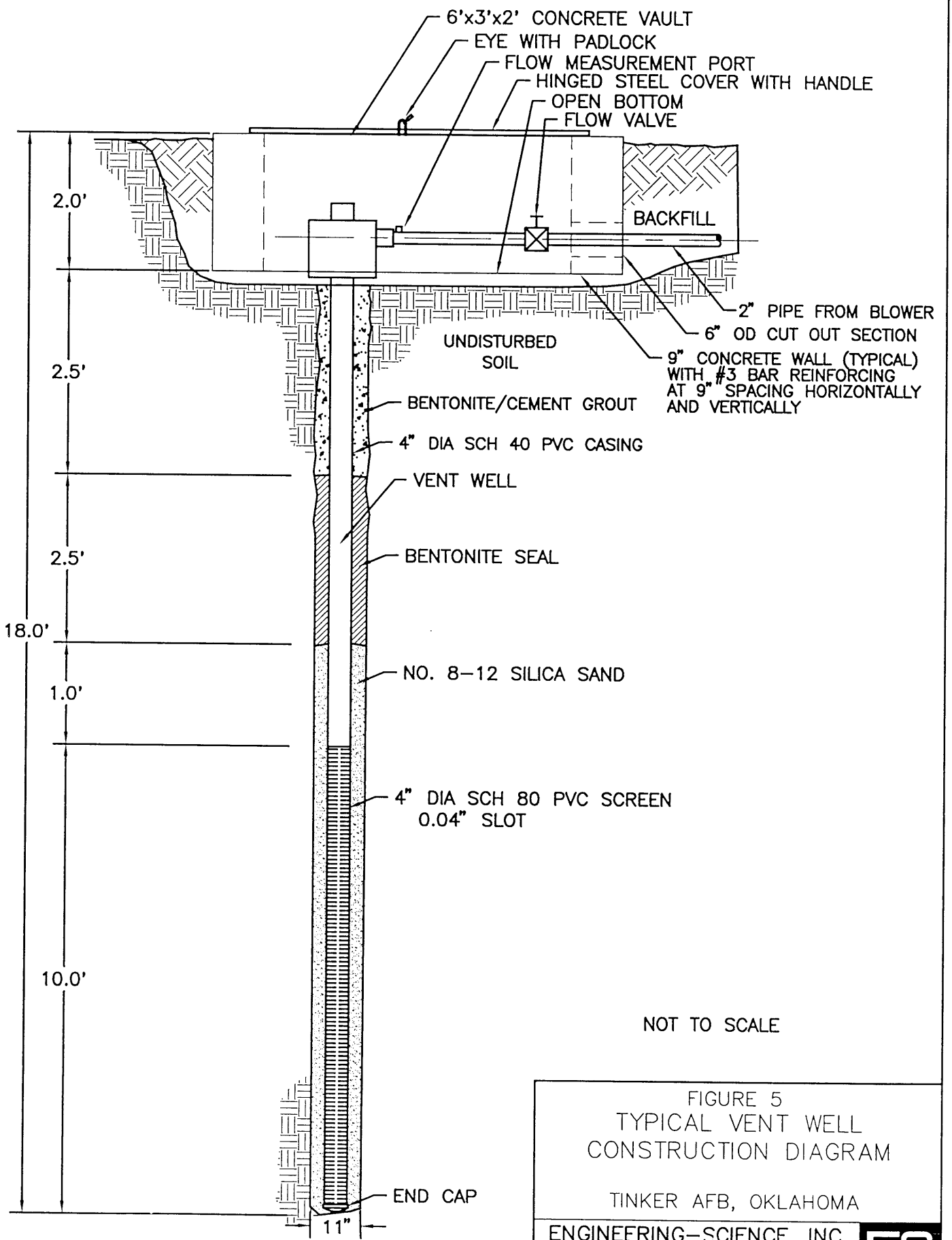

FIGURE 5
TYPICAL VENT WELL
CONSTRUCTION DIAGRAM

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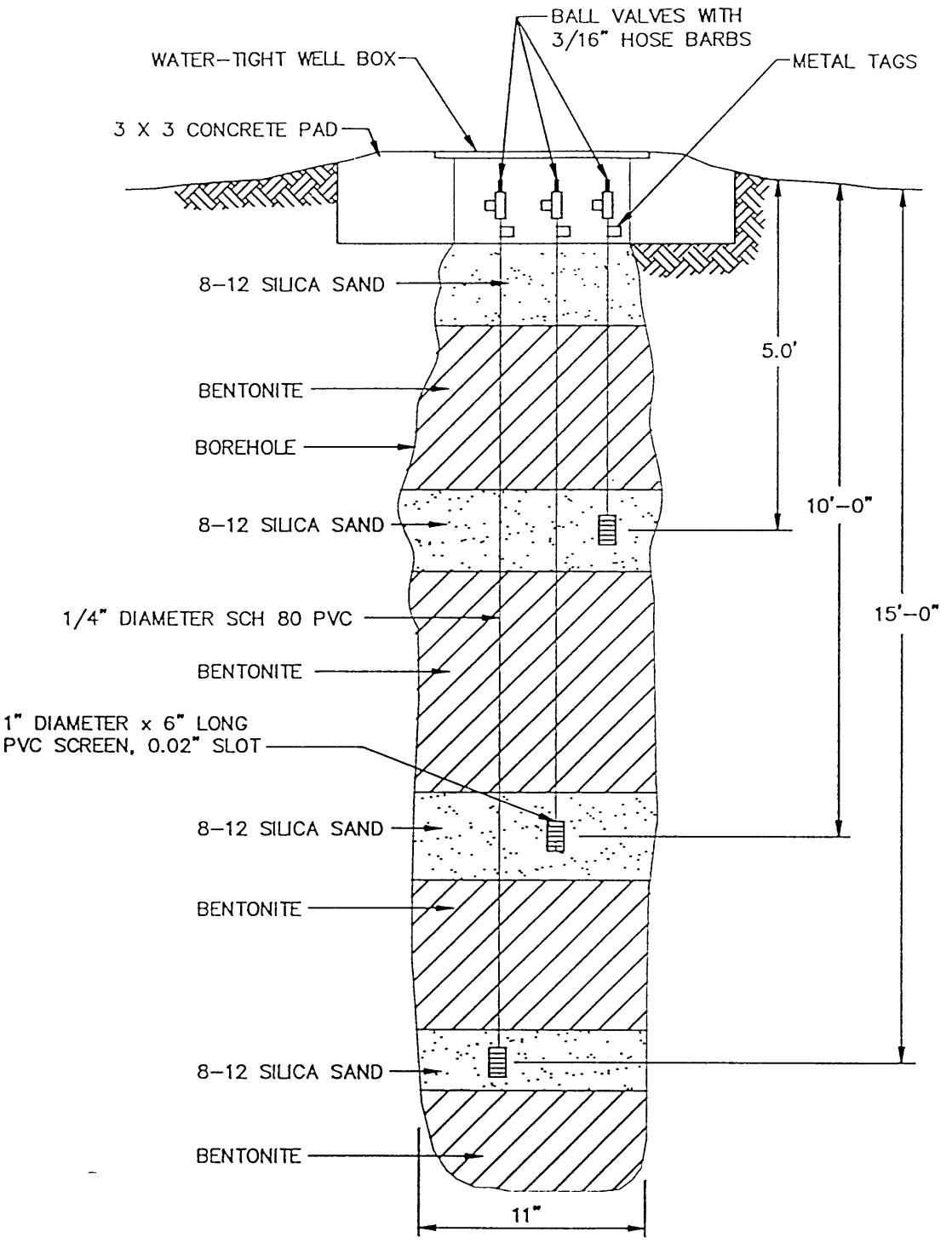

FIGURE 6

VAPOR MONITORING POINT CONSTRUCTION DIAGRAM

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AUSTIN, TEXAS

ES

5.3 CHRONOLOGY

Table 1 is the proposed schedule for implementation of the full-scale system. For a more detailed description of the individual tasks, refer to the "*In-situ* Bioventing Treatability Work Plan for 3700 Fuel Yard, Tinker AFB" (Parsons ES, 1994).

5.4 CORRECTIVE ACTION

As stated under "Cleanup Goals," the full-scale bioventing system will operate at least 1 year or until concentrations of TPH in the soils are below the Oklahoma State regulatory limit for this site of 500 mg/kg. Bioventing will provide necessary oxygen to enhance fuel biodegradation.

The rate at which oxygen is being utilized by the bacteria at the time of startup of the bioventing system will be calculated from data obtained in the initial respiration test. Data collected from physical and chemical analyses of soil samples, along with respiration data, will be used to calculate an initial hydrocarbon degradation rate. A final respiration test will be performed to evaluate the hydrocarbon degradation rate after 12 months of air injection. Three rounds of soil gas samples will be collected from the monitoring points, and the results will be compared to initial soil chemistry to evaluate the relative rate of hydrocarbons removed with time. Analytical data obtained from the soil gas and final soil sampling will be compared with results from initial sampling to assess the effectiveness of the system at this site, and to quantify the reduction in hydrocarbon contamination in the soils.

5.5 SCHEDULE OF CONSTRUCTION AND IMPLEMENTATION

See Table 1.

5.6 SAMPLING SCHEDULE AND METHODS

Soil and air sampling will be conducted according to the schedule in Table 1. Details of sampling protocol are presented in the "*In-situ* Bioventing Treatability Study Work Plan for 3700 Fuel Yard, Tinker AFB" (Parsons ES, 1994). Air samples collected from the VMPs will be analyzed by US Environmental Protection Agency (EPA) method TO-14 which analyzes for BTEX compounds plus various other chlorinated volatile compounds. Soil samples collected from the boreholes for the air injection wells and organic MPs will be analyzed for those parameters listed in Table 2.

5.7 HANDLING OF CONTAMINATED SOIL

Soil cuttings generated during the drilling of boreholes for the VWs and VMPs will be drummed onsite, properly labeled, and staged onsite for a period not greater than 90 days. Soil in the drums will be characterized and properly disposed of based on analytical results. Tinker AFB will be the designated generator of the soils and will be responsible for signing transport and disposal manifests.

Table 1. Proposed Schedule

Task	Completion Date
Final work plan	12/30/94
Vent well and monitoring point construction	01/27/95
Initial air sampling	01/27/95
Optimization testing	02/09/95
System construction	02/09/95
Final soil flux testing on operating system	02/09/95
Final installation report	05/31/95
First round of soil gas sampling	05/19/95
Second round of soil gas sampling	09/15/95
Final round of soil gas sampling	02/09/96
Final soil sampling	02/09/96
Final treatability report	05/15/96

Table 2. Parameters for Soil Samples Collected as Part of Site Remediation

Parameter	Method(s)
TPH	Modified 8015 (gasoline range)
TPH	Modified 8015 (diesel range)
VOCs	SW8260
SVOCs	SW3520/SW8270
Metals	SW3050/SW6010 (barium, beryllium, cadmium, chromium, iron, and silver) SW3050/7421 (lead) SW3050/7740 (selenium)
Grain size	ASTM D422
Moisture content	ASTM D2216
Alkalinity	Colorimetric
pH	E150.1
Total Kjeldahl nitrogen	E351.2
Phosphates	E365.4

SECTION 6.0
ALTERNATIVE METHODS FOR REMEDIATION

Alternative methods for soil remediation at this site include excavation of the contaminated soil and disposal at a permitted landfill, excavation and onsite landfarming, and excavation and onsite thermal treatment.

All three options involving excavation of the soil would be highly disruptive to base operations over an unacceptable period of time. This is especially true if the soil is to be returned to the excavation after treatment. Excavating the soil and hauling to a permitted landfill would also leave open the possibility of future liability. Landfarming of soil would require a large portion of space which the base may not have available. Thermal treatment of excavated material may be cost prohibitive. In addition, each of these alternatives increase the risk of release of contaminants to the surrounding environments.

SECTION 7.0
PUBLIC NOTIFICATION

7.1 OVERVIEW

The State of Oklahoma requires that, for all confirmed releases requiring a corrective action plan, owners provide notice to the public by means designed to reach those individuals directly affected by the release and the planned corrective action (rule 1308.A). In addition, RCRA and CERCLA have specific requirements for community relations planning and implementation. Tinker Air Force Base is committed to ensuring that individuals who may be affected by contamination at the 3700 Fuel Yard or by corrective actions planned for this area are adequately notified and informed of current conditions and planned activities. The community relations effort for the 3700 Fuel Yard corrective action will be conducted as a part of, and consistent with, the base community relations plan. This section presents community relations information and activities specifically relevant to the corrective action described in this plan.

7.2 IMPLEMENTATION

A spokesperson from the Directorate of Environmental Management has been designated as Tinker AFB's program manager for environmental matters. The Public Affairs Office (PAO) has designated staff with specific responsibilities to support this spokesperson. Tinker AFB will coordinate with the US Environmental Protection Agency (EPA), State of Oklahoma, and local agencies to identify and communicate, as appropriate, with representatives who will be responsible for oversight and review of the corrective action at the 3700 Fuel Yard. Information on Tinker AFB and agency representatives is available from the Directorate of Environmental Management.

7.3 PUBLIC INFORMATION PROGRAM

Tinker AFB has conducted extensive interviews with community representatives to ascertain the level of interest in and concern with environmental issues at Tinker AFB and the community as a whole. The PAO will use information collected during this process, and in subsequent communications with the community, to tailor the community relations effort related to the 3700 Fuel Yard corrective action. These activities may include, as appropriate, public meetings, small discussion groups, informational publications, press releases to the local media, and placing key plans and reports in the repositories established as part of the base community relations effort.

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