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FINAL

Remedial Action Plan for Expanded Bioventing System PS-4, Bulk POL Storage Area

Malmstrom Air Force Base
Montana

Prepared For

Air Force Center for Environmental Excellence
Technology Transfer Division
Brooks Air Force Base
San Antonio, Texas

and

341 CES/CEVR
Malmstrom Air Force Base
Montana

September 1996

PARSONS
ENGINEERING SCIENCE, INC.

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AQ M01-03-0721

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FINAL REMEDIAL ACTION PLAN FOR EXPANDED BIOVENTING SYSTEM AT PS-4, BULK POL STORAGE AREA MALMSTROM AIR FORCE BASE, MONTANA

Prepared for

Air Force Center For Environmental Excellence
Brooks Air Force Base, Texas

and

341 CES/CEVR
Malmstrom Air Force Base, Montana

September 1996

Prepared by:

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SECTION 1

INTRODUCTION

This remedial action plan (RAP) presents the scope of work for an expanded bioventing system for *in situ* treatment of fuel-contaminated soils at PS-4, the Bulk Petroleum, Oils, and Lubricants (POL) Storage Area, at Malmstrom Air Force Base (AFB), Montana. Site PS-4 is also referred to as Site ST-05. The proposed expanded system activities will be performed by Parsons Engineering Science, Inc. (Parsons ES) for the Air Force Center for Environmental Excellence (AFCEE) Technology Transfer Division (ERT) under contract F41624-92-D-8036, 0017. The primary objectives of the bioventing system upgrade are to:

- Continue aerobic *in situ* bioremediation of fuel-contaminated soils by injection of atmospheric air (oxygen) into contaminated soil throughout affected portions of the site; and

- Sustain aerobic *in situ* biodegradation until hydrocarbon-contaminated soils within the unsaturated zone are remediated to below regulatory approved clean up goals.

Extended bioventing pilot tests were performed at PS-4 from October 1993 through November 1994 to determine if *in situ* bioventing would be a feasible cleanup technology for the fuel-contaminated soils within the unsaturated zone. A radius of oxygen influence of at least 28 feet was observed at the site during pilot testing. Further detail on the pilot test procedure and results can be found in the Interim Pilot Test Results Report (Engineering-Science, Inc. [ES], 1993).

Following the extended pilot test, soil and soil gas data confirmed significant contaminant removal in the pilot test area. Based on laboratory results for soil and soil gas samples, significant reductions in total volatile hydrocarbons (TVH), benzene, toluene, ethylbenzene, and xylenes (BTEX) were observed in soil gas, and significant reductions in total recoverable petroleum hydrocarbon (TRPH) and BTEX concentrations were observed in soil over the extended pilot test period. In addition, the extended pilot test demonstrated that significant oxygen utilization and biodegradation are continuing at the pilot test location, and that continued bioventing will sustain biodegradation. Further detail on the pilot test results is presented in Section 3. The success of bioventing at this site supports the recommendation of an expanded (full-scale) bioventing system as the most economical approach to remediating the hydrocarbon-contaminated soils associated with the former underground storage tanks (USTs) at PS-4, the Bulk POL Storage Area.

Pilot test data have been used to design an expanded bioventing system to remediate contaminated soils. The expanded system will involve air injection into the existing vent well (VW) and 12 newly constructed VWs to deliver oxygen throughout the area of unsaturated fuel-contaminated soil in the vicinity of the former USTs. In addition to the three existing vapor monitoring points (MPs), six new MPs will be constructed to monitor contaminant reduction and oxygen influence in the soil gas.

This document is divided into eleven sections, including this introduction, and three appendices. Section 2 discusses site background and reviews available site characterization data. Section 3 provides the results of the 1-year bioventing pilot test conducted at PS-4. Section 4 identifies the treatment area of the proposed expanded system; provides construction details for the expanded system; and recommends a proven, cost-effective approach for the remediation of the remaining hydrocarbon-contaminated soils at the site. Procedures for handling investigation-derived waste are described in Section 5, and Base support requirements are listed in Section 6. Section 7 provides key points of contact at Malmstrom AFB, AFCEE, and Parsons ES; and Section 8 provides the references cited in this document. A design package for the expanded bioventing system is provided in Appendix A. Appendix B contains the site-specific field sampling plan, and Appendix C contains the site-specific health and safety addendum

SECTION 2

SITE BACKGROUND

2.1 SITE HISTORY

Malmstrom AFB is located at the eastern edge of Great Falls, Montana. The Bulk POL Storage Area is located near the northeastern corner of the Base. The area targeted for expanded bioventing is in the vicinity of the former USTs at the site. Figure 2.1 presents the layout of this portion of the Bulk POL Storage Area. Seven 25,000-gallon USTs and five associated 500-gallon USTs were originally used for fuel storage and distribution. It has been documented that these tanks historically contained aviation gasoline (AVGAS) until they were taken out of service in the 1960s. It is suspected that these USTs also were used to store diesel and jet fuels after they were taken out of service as part of the AVGAS distribution system. The larger USTs were used for bulk fuel storage, while the smaller USTs were part of the aqua-pump system used to distribute the fuel from the larger tanks. Figure 2.1 details the former location of these tanks.

All but one of the USTs, the tank access pits, and some associated piping were removed between February and April 1995. Piping not removed was drained and plugged. Tank 7, the UST located furthest to the southeast (Figure 2.1), was abandoned in place because removal would have threatened the integrity of the berm that supports Truck Filling Stand A at the edge of the fueling apron. The USTs had been previously abandoned by filling with soil. During removal, the tanks were cut open, and the soil contents were removed and taken to the on-Base landfarm. The majority of the soil excavated during tank removal was returned to the excavation. Clean crushed gravel was imported to make up the volume lost to the tank removal and to provide a sub-base for surface paving. The crushed gravel extends to approximately 18 inches beneath the top of the asphalt pavement.

Three aboveground storage tanks (ASTs) located at the site are currently used for bulk fuel storage. Tanks 41102 and 41100 (Figure 2.1), constructed in 1988, are used for JP-4 storage and each have a capacity of 1,000,000 gallons. Tank 41101 is used for diesel fuel storage and has a capacity of 500,000 gallons (HDR Engineering, Inc. [HDR], 1994). The future of the Bulk POL Storage Area is uncertain because the flight mission of the Base ended in August 1996.

The area around the former UST location is asphalt- and gravel-covered and surrounded by a fence that also encompasses the ASTs. The area within the fence is a designated Class I, Group D hazardous location due to potential for flammable fuel vapors.

2.2 SITE GEOLOGY AND HYDROGEOLOGY

Because the bioventing technology is applied to the unsaturated soils, this section primarily addresses unsaturated soils. Based on the results of previous investigations, the general lithology in the area of the former USTs consists of glacial till (clay) overlain by eolian sands, with areas of sand, silt and gravel fill (HDR, 1994). Review of cross-sections from the Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI) (HDR, 1994) indicates that silty sands and lean clay overlie the glacial till, which was encountered between 6 and 9 feet below ground surface (bgs) in the area targeted for treatment. During installation of the bioventing pilot test components, a clayey, silty gravel fill was encountered in the top 2 feet, and a clayey, silty sand was encountered to a depth of 9 feet bgs, where glacial till was encountered.

Figure 2.2 is geologic cross-section A-A' (traced on Figure 2.1) of the pilot test site at PS-4 constructed using data from the bioventing pilot test VW and three MPs. The interpreted soil profile is shown along with field organic vapor analyzer (OVA) readings for TVH, VW and MP screened intervals, and TRPH concentrations from laboratory analysis of soil samples.

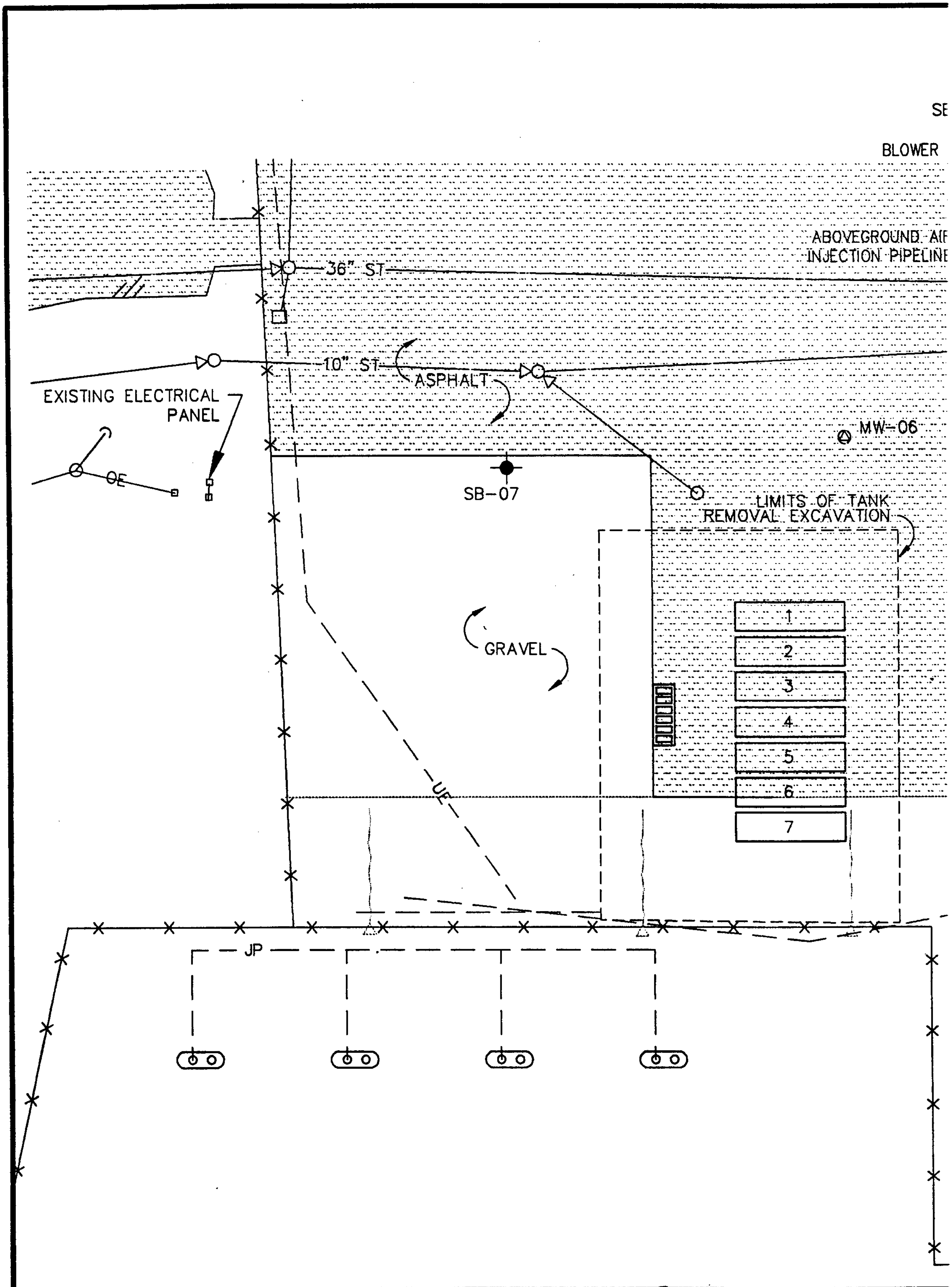
Perched groundwater has been encountered in the proposed area of treatment at depths of 4 to 5 feet bgs (Figure 2.2). To date, only two groundwater monitoring wells (wells MW-06 and MW-12) have been installed at PS-4; therefore, limited information regarding the site hydrogeology is available. The groundwater gradient is expected to follow the surface topography, which dips to the north and northeast. It has been determined that the perched groundwater in the vicinity of PS-4 is not a viable source for the development of a water supply (HDR, 1994).

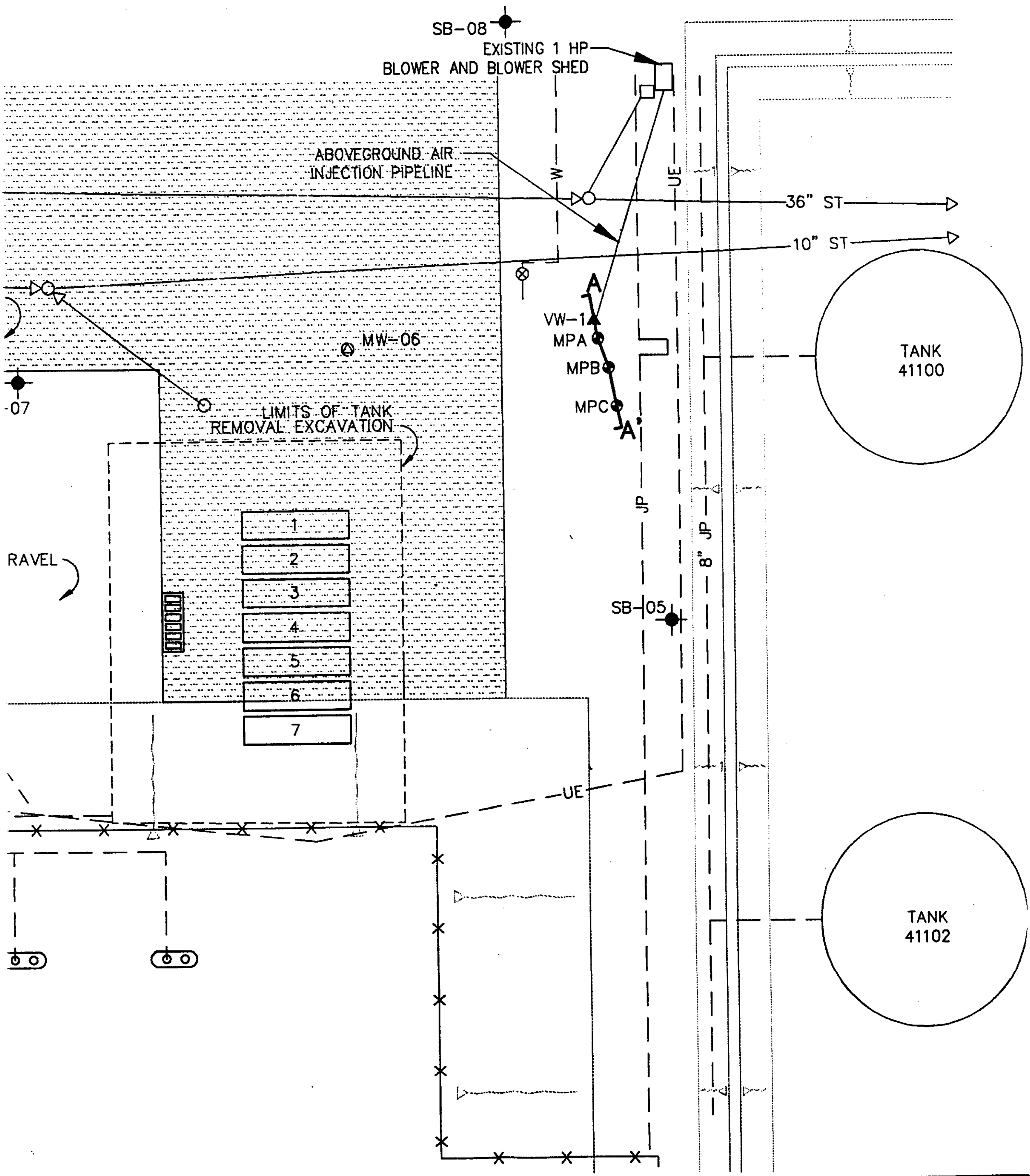
2.3 SITE CONTAMINANTS

During the RFI, soil samples were collected at 5-foot intervals from 13 different soil boreholes throughout the PS-4 site. Sample analyses included total extractable petroleum hydrocarbons (TEPH) and volatile organic compounds (VOCs). Results indicate that significant contamination is present at the 5-foot-bgs depth in soils southwest of Tanks 41100 and 41102 and between Tanks 41100 and 41101. Soil borehole SB-07 appears to define the extent of soil contamination at the 5-foot depth to the west of the former USTs at the southern end of the site. However, visual observations made during UST removal suggest that significant shallow soil contamination is present in soils immediately adjacent to the former USTs.

Samples collected from the 10-foot depth indicate soil contamination to the southwest and west of Tank 41100 (boreholes SB-04, SB-06, SB-08, and SB-10) (Figure 2.3). Samples collected from deeper soils indicate that the extent of soil contamination diminishes rapidly with increasing depth. Significant soil contamination has been detected at and below 15 feet bgs only at borehole SB-06.

During installation of the bioventing pilot test system components in 1993, additional soil sampling was performed (ES, 1993). The samples were analyzed for TRPH by US Environmental Protection Agency (USEPA) Method 418.1 and for BTEX by USEPA Method SW8020. Selection of soil samples for laboratory analysis was based on field OVA readings, visual appearance, and odor. As shown on Figure 2.2, TVH readings


SE
BLOWER
ABOVEGROUND AI
INJECTION PIPELINE
36" ST
10" ST
ASPHALT
EXISTING ELECTRICAL PANEL
OE
MW-06
SB-07
LIMITS OF TANK REMOVAL EXCAVATION
GRAVEL
1
2
3
4
5
6
7
UE
JP



SB-08
EXISTING 1 HP
BLOWER AND BLOWER SHED
ABOVEGROUND AIR
INJECTION PIPELINE
W
UE
36" ST
10" ST
A
VW-1
MPA
MPB
MPC
A'
MW-06
-07
LIMITS OF TANK
REMOVAL EXCAVATION
TANK
41100
1
2
3
4
5
6
7
RAVEL
JP
8" JP
SB-05
UE
TANK
41102

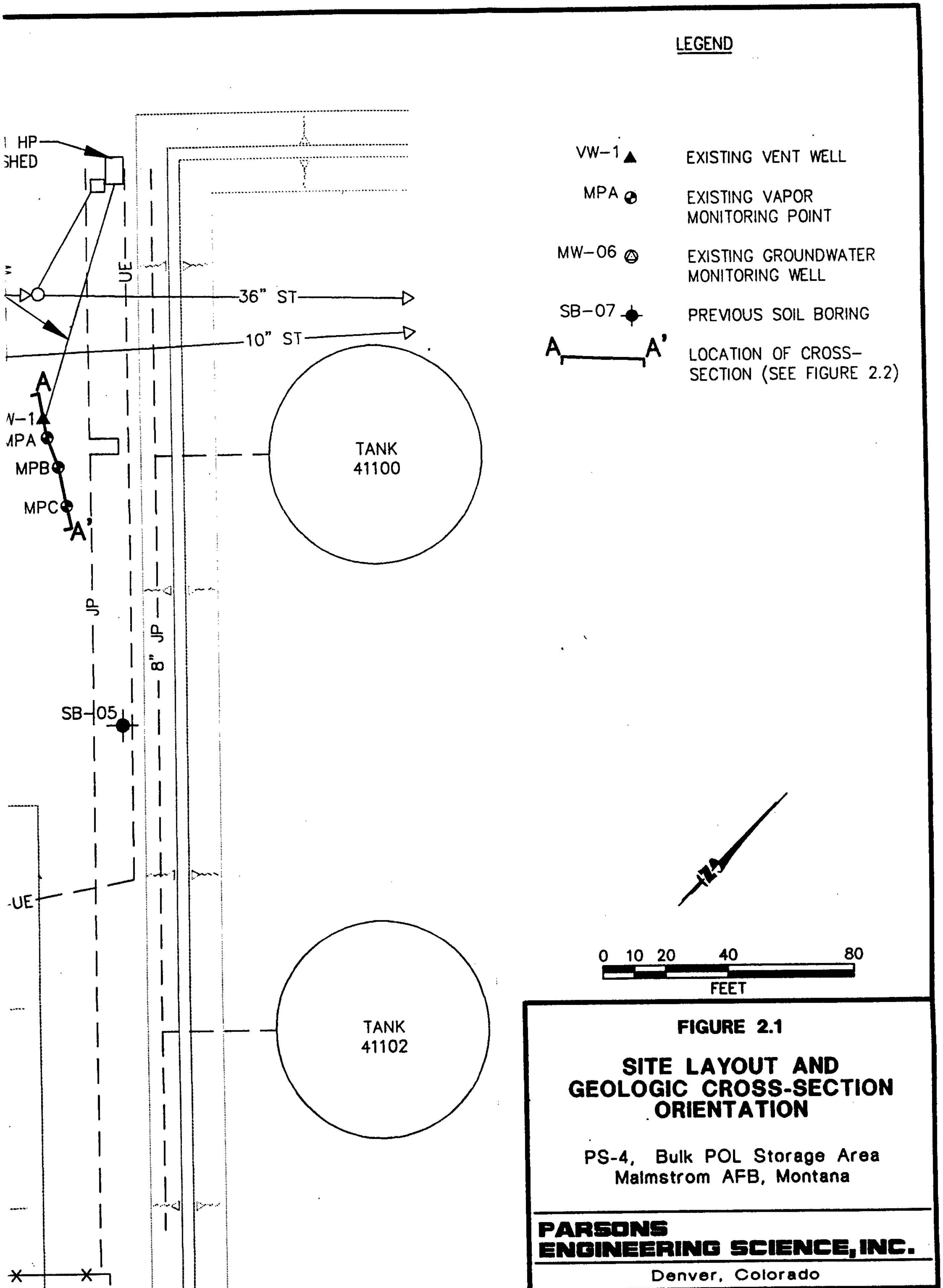


FIGURE 2.1

SITE LAYOUT AND GEOLOGIC CROSS-SECTION ORIENTATION

PS-4, Bulk POL Storage Area
Malmstrom AFB, Montana

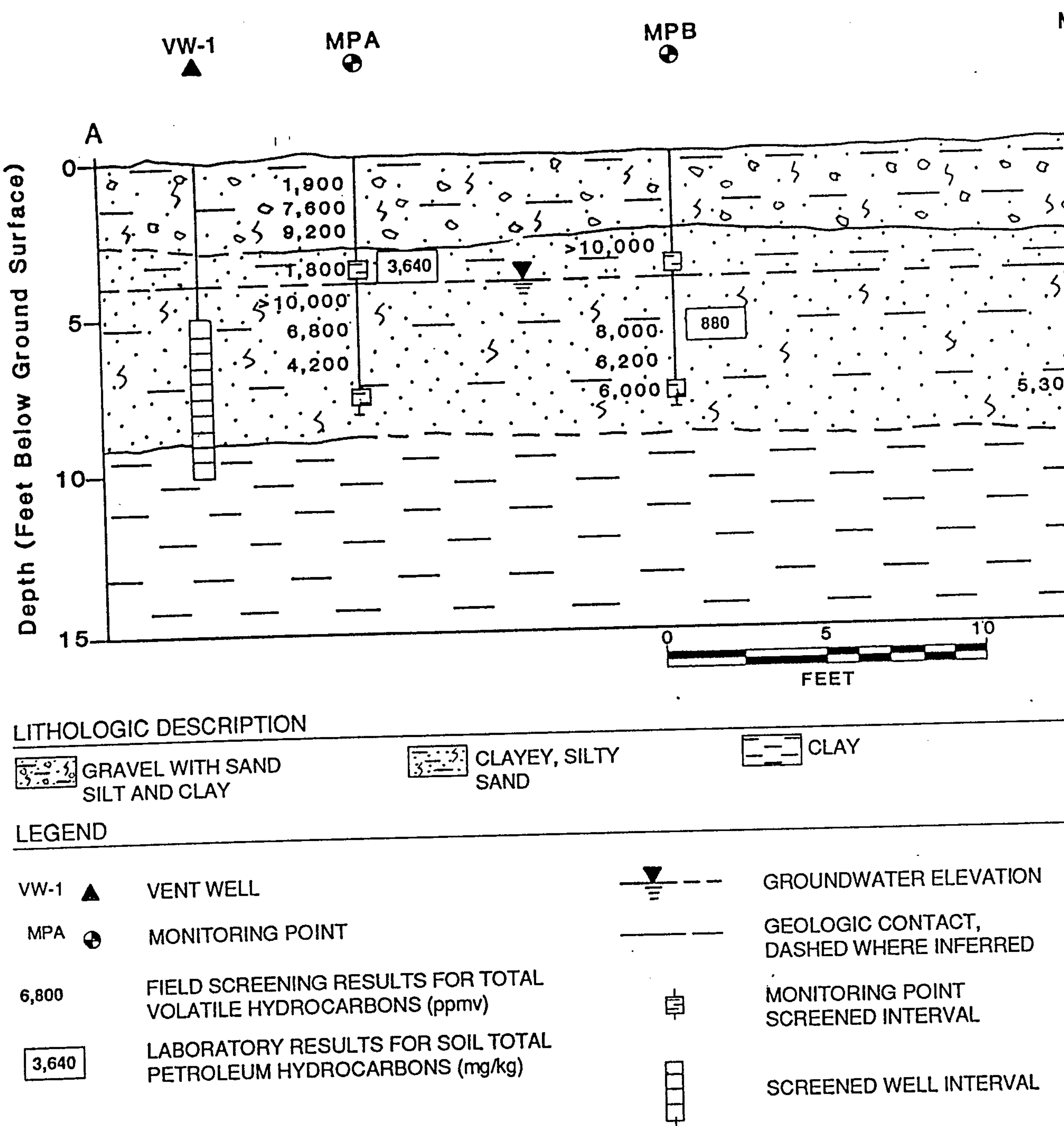
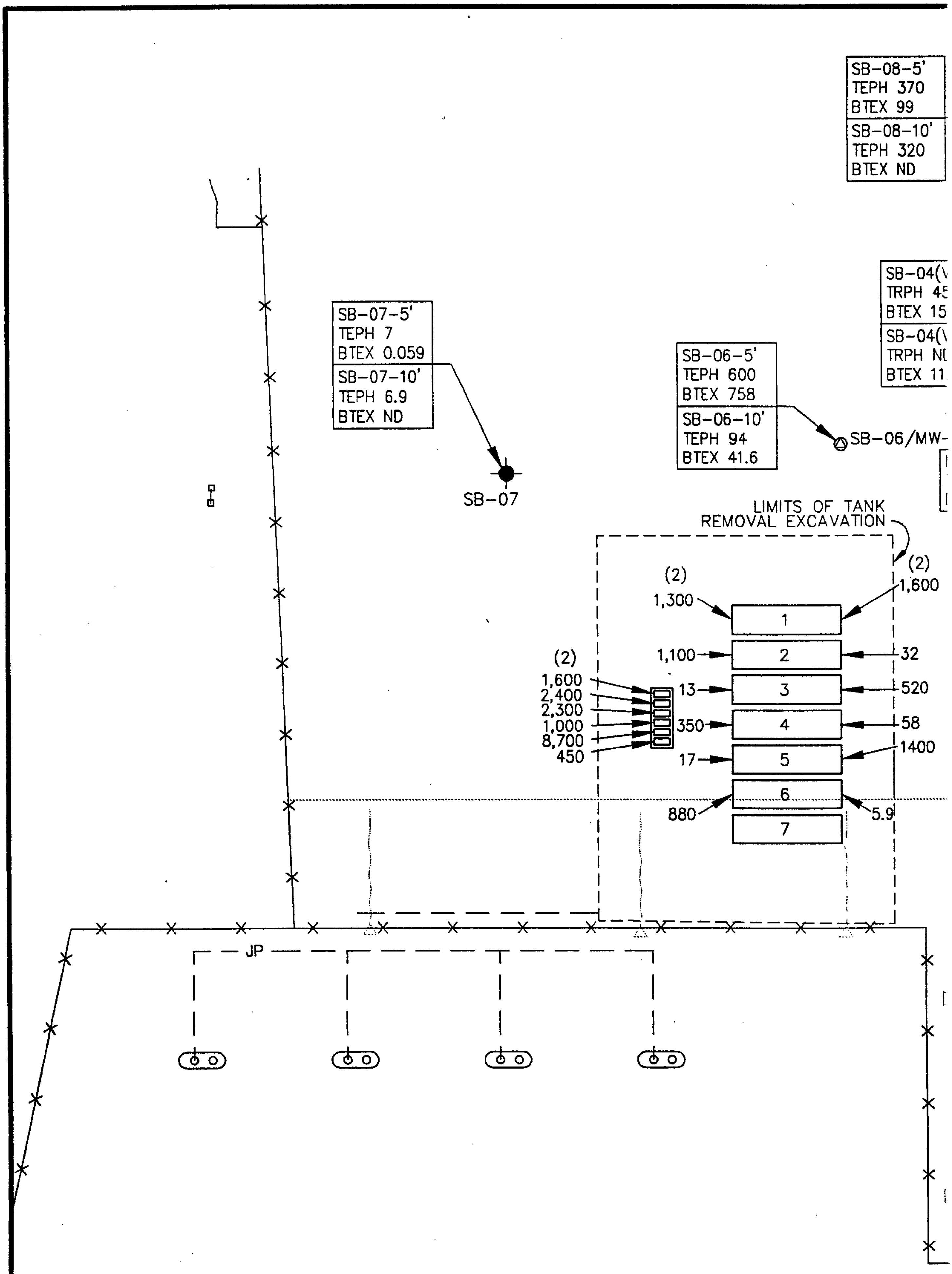


FIGURE 2.2

HYDROGEOLOGIC CROSS-SECTION

PS-4, Bulk POL Storage Area
Malmstrom AFB, Montana

PARSONS ENGINEERING SCIENCE, INC.
Denver, Colorado


SB-08-5'
TEPH 370
BTEX 99
SB-08-10'
TEPH 320
BTEX ND
SB-04(\
TRPH 4
BTEX 15
SB-04(\
TRPH NI
BTEX 11.
SB-07-5'
TEPH 7
BTEX 0.059
SB-07-10'
TEPH 6.9
BTEX ND
SB-07
SB-06-5'
TEPH 600
BTEX 758
SB-06-10'
TEPH 94
BTEX 41.6
SB-06/MW-
LIMITS OF TANK
REMOVAL EXCAVATION
(2)
1,300
(2)
1,600
1
1,100
2
32
(2)
1,600
2,400
2,300
1,000
8,700
450
13
3
520
350
4
58
17
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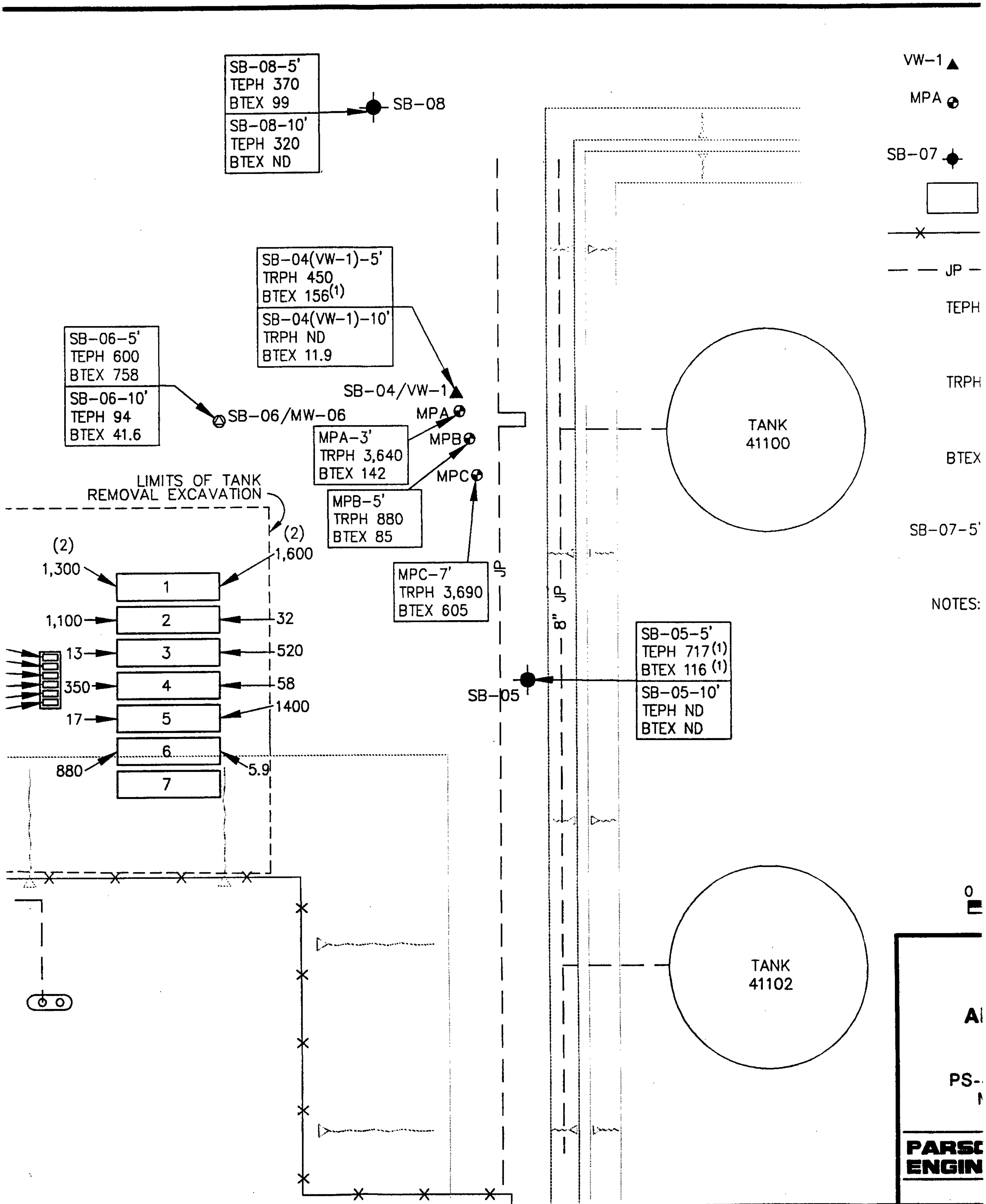
1400
880
6
5.9
7
JP


SB-08-5'
TEPH 370
BTEX 99
SB-08-10'
TEPH 320
BTEX ND
SB-08
SB-04(VW-1)-5'
TRPH 450
BTEX 156(1)
SB-04(VW-1)-10'
TRPH ND
BTEX 11.9
SB-06-5'
TEPH 600
BTEX 758
SB-06-10'
TEPH 94
BTEX 41.6
SB-04/VW-1
SB-06/MW-06
MPA
MPB
MPC
MPA-3'
TRPH 3,640
BTEX 142
MPB-5'
TRPH 880
BTEX 85
MPC-7'
TRPH 3,690
BTEX 605
LIMITS OF TANK
REMOVAL EXCAVATION
(2)
1,300
(2)
1,600
1
1,100
2
32
13
3
520
350
4
58
17
5
1400
880
6
5.9
7
JP
8" JP
TANK
41100
SB-05-5'
TEPH 717(1)
BTEX 116 (1)
SB-05-10'
TEPH ND
BTEX ND
SB-05
TANK
41102
VW-1
MPA
SB-07
JP
TEPH
TRPH
BTEX
SB-07-5'
NOTES:
0
A
PS-
PARS
ENGIN

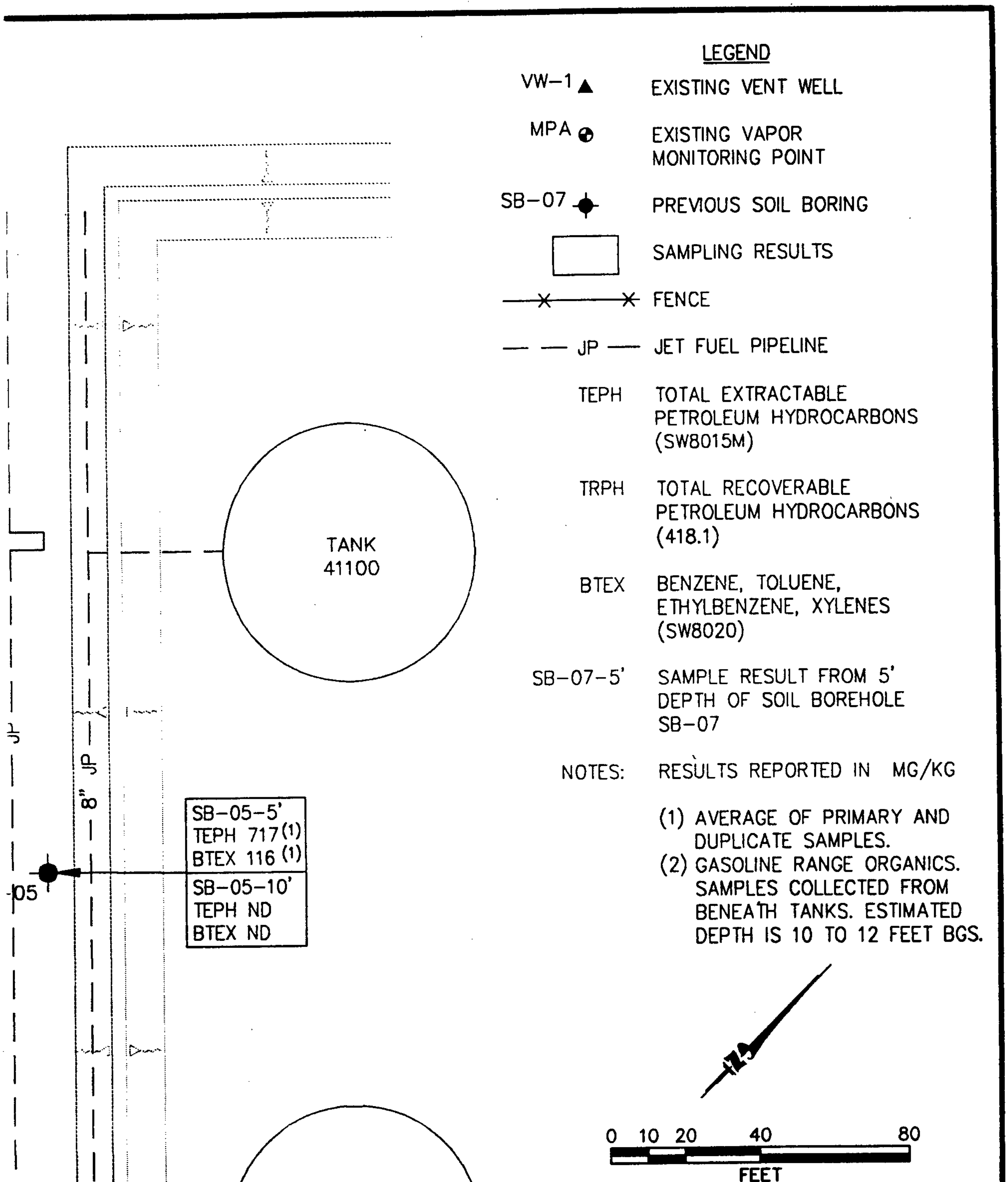


FIGURE 2.3

PREVIOUS SOIL ANALYTICAL RESULTS

PS-4, Bulk POL Storage Area
Malmstrom AFB, Montana

PARSONS ENGINEERING SCIENCE, INC.
Denver, Colorado

3

greater than 5,000 parts per million, volume per volume (ppmv) were measured in the boreholes for MPA, MPB, and MPC. Because the VW was installed by HDR (1994) during the RFI, field screening results for this borehole are not available. As shown on Figures 2.2 and 2.3, TRPH concentrations up to 3,690 milligrams per kilogram (mg/kg) were detected.

During removal of the USTs in the spring of 1995, soil samples were collected from beneath the tanks and analyzed for gasoline range organics (GRO). Two samples, one at each end of the tank, were collected from beneath each of the six 25,000-gallon USTs that were removed. No samples were collected from beneath the seventh 25,000-gallon UST, which was abandoned in place. Analytical results ranged up to 1,600 mg/kg GRO for these samples, and indicated the contamination was not evenly distributed (Figure 2.3) (DeMott, 1996).

Samples for GRO analysis also were collected from beneath the center of each of the 500-gallon USTs. The analytical results for these samples indicated GRO concentrations beneath the smaller tanks ranging up to 8,700 mg/kg. In addition, soil samples were collected from soils adjacent to fuel pipelines exposed by the excavation. Results ranged from 370 mg/kg to 4,200 mg/kg (DeMott, 1996).

Two groundwater monitoring wells, MW-06 and MW-12, were installed at PS-4 during the RFI (HDR, 1994). The wells were initially sampled in 1993 for VOCs and semivolatile organic compounds (SVOCs). Well MW-06 is located approximately 50 feet north of the former UST locations (Figure 2.1). BTEX concentrations at MW-06 were 19,000 micrograms per liter (μg/L) for benzene, 3,300 μg/L for toluene, 1,500 μg/L for ethylbenzene, and 11,000 μg/L for xylenes. These concentrations exceeded the federal maximum contaminant levels (MCLs) for each of the BTEX compounds. In addition, 2,4-dimethylphenol, 4-methylphenol, and phenol were detected at 290, 1,400, and 1,500 μg/L, respectively. At well MW-12, located approximately 200 feet northeast of soil boring SB-08, benzene, xylenes, and phenol were detected at 120, 1,700, and 77 μg/L, respectively. The benzene concentration exceeded its MCL of 5 μg/L.

SECTION 3

BIOVENTING PILOT TEST RESULTS

The objectives of the initial bioventing pilot test were to:

- Assess the potential for supplying oxygen throughout the contaminated soil profile;
- Determine the rate at which indigenous microorganisms will degrade petroleum hydrocarbons when stimulated by oxygen-rich soil gas at this site; and
- Evaluate the potential for sustaining these rates of biodegradation until hydrocarbon contamination is remediated below regulatory approved clean up goals.

Because bioventing has been demonstrated to be a feasible technology for this site, the pilot test data were used to design a full-scale remediation system (Section 4) to remediate the soils at the site, to minimize potential impacts to groundwater/surface water, and to assure that contaminant levels throughout the site are below regulatory cleanup goals (Montana Department of Health and Environmental Sciences, 1994).

3.1 PILOT TEST CONFIGURATION

The air injection vent well, VW-1 was installed by HDR (1994) on August 15, 1993 during RFI field activities. The three multi-depth MPs, MPA, MPB, and MPC, were installed on October 11, 1993 by ES (1993) personnel. Locations of the pilot-scale VW and MPs are shown on Figure 2.1. The VW-1 screen was set between 5 and 10 feet bgs. MPA, MPB, and MPC were installed at distances from the VW-1 of 5 feet, 15 feet, and 28 feet, respectively. MP screened intervals were placed 3.5 and 7.5 feet bgs. Further details on the pilot test system construction can be found in the Interim Test Results Report (ES, 1993)

VW-1 was constructed using 4-inch inside-diameter (ID), Schedule 40 polyvinyl chloride (PVC) casing and slotted screen (0.040-inch slot size). The annular space adjacent to the screen was filled with 8-12 sieve size silica sand (filter pack material) from the bottom of the screen to approximately 1 foot above the top of the screen. To prevent preferential air movement near the surface during pilot testing, a 2-foot thick annular bentonite seal was emplaced on top of the filter pack. The annulus of the well was then filled with a bentonite/cement grout. VW-1 was completed with a flush-mount well box set in a concrete collar. The VW casing was connected to the air supply pipe by a 4-inch-diameter Schedule 40 PVC 90-degree elbow (ES, 1993).

Each MP was constructed using 0.25-inch-ID, Schedule 80 PVC casing and 1-inch-ID slotted screen intervals (0.020-inch slot size). Two casing strings/screens were installed in each MP borehole to provide monitoring points at variable depths and contamination levels. Each of the 6-inch-long screened intervals is centered in a 1-foot-thick layer of 8-12 sieve size silica sand (filter pack material). These filter pack intervals were sealed above and below with bentonite. Screened MP intervals were placed at 3.5 and 7.5 feet bgs. The 7.5-foot screened intervals were placed in soils that were saturated at the time of MP construction with the expectation that the perched water table elevation would decrease during the extended testing period. A sampling valve was attached to the top of each MP casing. A thermocouple was installed adjacent to the two screens at MPC to allow measurement of soil temperature (ES, 1993).

A fixed 1.0-horsepower (HP) Gast® regenerative blower unit (model R4) was installed for the extended 1-year pilot test. The regenerative blower unit began operation in October 1993 for the extended pilot test. At the time of installation, the blower unit was reported to be injecting air at approximately 18 standard cubic feet per minute (scfm) at 46 inches of water pressure. The unit is powered via 208-volt, single-phase, 20-amp service that runs to the blower from a temporary disconnect in the electrical control room of the POL storage area. The blower motor is explosion proof and is connected to an explosion-proof disconnect mounted inside the blower enclosure. Parsons ES personnel provided an operations and maintenance (O&M) data collection sheet and blower checklist for the site to Base personnel.

3.2 INITIAL SOIL GAS CHEMISTRY

Prior to initiating air injection, the MPs in unsaturated soils were purged until oxygen levels had stabilized, and then initial oxygen, carbon dioxide, and TVH concentrations were sampled using portable meters, as described in the AFCEE bioventing protocol document (Hinchee *et al.*, 1992). Depleted oxygen levels and elevated carbon dioxide levels were found in soil gas at the MP screened intervals, indicating soil contamination and natural biological activity in contaminated soil. The initial soil gas chemistry results are summarized in Table 3.1. TVH for soil gas samples (both field instrument measurements and laboratory analytical results) and TRPH and BTEX concentrations for soil samples also are provided to demonstrate the relationship between oxygen levels and the contaminated soils.

3.3 *IN SITU* BIODEGRADATION RATES

In situ respiration testing was conducted to determine the biodegradation rates of indigenous bacteria in contaminated subsurface soils. Table 3.2 shows the results of three *in situ* respiration testing events conducted during the 1-year bioventing pilot test (initial, 6-month, and 12-month tests).

The initial *in situ* respiration test was performed by injecting ambient air (20.8-percent oxygen) at a rate of approximately 1 scfm into the unsaturated MP screened intervals for at least 20 hours in order to oxygenate surrounding soils. After air injection was stopped, oxygen, carbon dioxide, and TVH levels in soil gas at the screened intervals were monitored. The 6- and 12-month *in situ* respiration tests were performed by turning off the blower system and monitoring oxygen, carbon dioxide,

TABLE 3.1
INITIAL SOIL GAS CONDITIONS
PS-4, BULK POL STORAGE AREA
REMEDIAL ACTION PLAN
MALMSTROM AIR FORCE BASE, MONTANA

Sample Location	Depth (feet)	O_2 (percent)	CO_2 (percent)	Lab TVH-jf [a/] (ppmv) [c/]	Field TVH [b/] (ppmv)
MPA	3.5	0.0	10.5	34,000	>40,000
MPB	3.5	0.0	12.7	49,000	>40,000
MPC	3.5	0.0	12.8	54,000	>40,000

[a/] TVH-jf = total volatile hydrocarbons as jet fuel (USEPA Method TO-3);

[b/] TVH = total volatile hydrocarbons (field instrument).

[c/] ppmv = parts per million, volume per volume.

TABLE 3.2
RESPIRATION AND DEGRADATION RATES
PS-4, BULK POL STORAGE AREA
REMEDIAL ACTION PLAN
MALMSTROM AIR FORCE BASE, MONTANA

	Initial (October 1993)			6-Month [a] (April 1994)			12-Month [b] (October 1994)		
Location-Depth (feet below ground surface)	O_2 Utilization (% O_2/hour)	Degradation Rate (mg/kg/year)[c]	Soil Temperature (°C)	O_2 Utilization (% O_2/hour)	Degradation Rate (mg/kg/year)	Soil Temperature (°C)	O_2 Utilization (% O_2/hour)	Degradation Rate (mg/kg/year)	Soil Temperature (°C)
MPA-3.5	0.01	420	NS [d]	0.0032	190	NS	NS[e]	NS	NS
MPB-3.5	0.028	1100	NS	0.0074	450	NS	0.0042	300	NS
MPC-3.5	0.018	720	11.56	0.0066	400	NS	0.0041	290	11.89

[a] Assumes moisture content of the soil is average of initial and final moistures.
[b] An "area" respiration test was performed by restarting the blower for approximately 47 hours to provide oxygen to soils.
[c] Milligrams of hydrocarbons per kilogram of soil per year.
[d] NS = Not sampled.
[e] MPA-3.5 was below the water surface at the time of the 12-month sampling event.

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and TVH levels in screened intervals.

Results from the *in situ* respiration tests indicated that the VWs and all of the MP screened intervals in hydrocarbon-contaminated soils have active microorganism populations. The biodegradation rate estimates presented in Table 3.2 are based on calculated air-filled porosities (liters of air per kg of soil) and a ratio of 3.5 mg of oxygen consumed for every 1 mg of fuel biodegraded.

3.4 OXYGEN INFLUENCE/AIR PERMEABILITY

Air permeability/radius of oxygen influence tests were performed at the PS-4 bioventing pilot test site to determine the pressure response in the formation induced by injecting air at VW-1 and to determine the volume of subsurface soils that could be oxygenated via air injection into a single VW. The depth and radius of oxygen influence in the subsurface resulting from air injection into the VW is the primary design parameter for extended bioventing systems. The pilot test data determine the volume of soil that can be oxygenated at a given flow rate and VW screen configuration.

The air permeability test was conducted at PS-4 in October 1993, according to protocol document procedures (Hinchee *et al.*, 1992). Air was injected into VW-1 for approximately 14.3 hours at a flow rate of 15 scfm with an average pressure at the well head of 5.3 pounds per square inch (psi). The air injection pressure depressed the groundwater surface in the immediate vicinity of the VW and allowed air to flow through the screen, which was fully submerged prior to air injection. Due to the slow pressure response at the MPs, the dynamic method was used to calculate air permeability values, as detailed in the protocol document (Hinchee *et al.*, 1992). Using the dynamic method, an average permeability value of 18 darcys was calculated. The calculated permeability value indicates that the site soils are sufficiently permeable to air for the bioventing technology.

Table 3.3 presents the changes in soil gas oxygen levels during the air permeability test and following 6 months of air injection. Increases in soil gas oxygen levels occurred at all unsaturated MP screened intervals, indicating successful oxygen transport at a radial distance of at least 28 feet from the VW. It is expected that the actual radius of oxygen influence will exceed 30 feet, based on measured pressure response and oxygen influence at MPC. Following 6-months of pilot-scale operation, the oxygen concentration at MPC-3.5 increased from 0.0 percent to 18.5 percent.

3.5 SOIL AND SOIL GAS SAMPLING RESULTS

Soil and soil gas samples were collected during the installation of the pilot-scale bioventing systems in October 1993 to determine baseline contaminant concentrations at the MP locations. Samples were collected again in October and November 1994, after 12-months of bioventing. Soil samples were collected from the same depths as originally sampled from boreholes immediately adjacent to the original boreholes, and soil gas samples were collected from the discrete MP intervals originally sampled. The bioventing system was turned off for approximately 30 days prior to collecting soil gas samples to allow soil gas to reach equilibrium. As shown in Table 3.4, significant reductions in petroleum hydrocarbon concentrations were observed.

TABLE 3.3
INFLUENCE OF AIR INJECTION ON OXYGEN CONCENTRATIONS
PS-4, BULK POL STORAGE AREA
REMEDIAL ACTION PLAN
MALMSTROM AIR FORCE BASE, MONTANA

Monitoring Location	Depth (feet)	Distance from VW-1 (feet)	Initial O_2 (percent)	Initial Permeability Test O_2 [a/] (percent)	6-Month Test O_2 [b/] (percent)	12-Month Test O_2 [c/] (percent)
MPA	3.5	5	0.0	10.1	20.0	NS [d/]
MPB	3.5	15	0.0	10.6	20.0	NS
MPC	3.5	28	0.0	7.7	18.5	NS

[a/] Based on oxygen concentrations observed at end of initial air permeability tests performed in October 1993.
[b/] Oxygen concentrations observed at beginning of 6-month respiration test.
[c/] The blower was shut off 30 days prior to testing; therefore oxygen influence measurements were not collected.
[d/] NS = Not sampled.

022/726876/579.XLS

TABLE 3.4
SOIL AND SOIL GAS ANALYTICAL RESULTS
PS-4, BULK POL STORAGE AREA
REMEDIAL ACTION PLAN
MALMSTROM AIR FORCE BASE, MONTANA

Analyte (Units) [a]	Sample Locations-Depth (feet below ground surface)					
	MPA-3.5		MPB-3.5		MPC-3.5	
Soil Gas Hydrocarbons	Initial [b]	12-Month [c]	Initial	12-Month	Initial	12-Month
TVH (ppmv)	34,000	NS[d]	49,000	1,100	54,000	52
Benzene (ppmv)	< 1.1	NS	< 2.8	< 0.018	< 1.8	< 0.12
Toluene (ppmv)	< 1.1	NS	< 2.8	< 0.018	34	< 0.12
Ethylbenzene (ppmv)	8.6	NS	14	0.590	12	3.500
Xylenes (ppmv)	21	NS	52	1.700	40	6.700
	MPA-3		MPB-5		MPC-7	
Soil Hydrocarbons	Initial [e]	12-Month [f]	Initial	12-Month	Initial	12-Month
TRPH (mg/kg)	3,640	315	880	2,440	3,690	694
Benzene (mg/kg)	0.79	< 0.05	< 2.8	1.7	12	0.33
Toluene (mg/kg)	42	< 0.05	30	15	310	2.1
Ethylbenzene (mg/kg)	15	< 0.05	7.2	13	43	2.8
Xylenes (mg/kg)	84	< 0.099	45	66	240	13
Moisture (%)	18	16.3	12	16.6	21	15.2

[a] TVH = total volatile hydrocarbons: ppmv = parts per million, volume per volume;
TRPH = total recoverable petroleum hydrocarbons; mg/kg = milligrams per kilogram.
[b] Initial soil gas samples collected on October 12, 1993.
[c] Final soil gas samples collected on October 19 1994.
[d] NS = Not sampled, monitoring point below water surface.
[e] Initial soil samples collected on October 11, 1993.
[f] Final soil samples collected on November 9 1994.

Soil gas TVH concentrations at MPB and MPC were reduced from 49,000 and 54,000 ppmv to 1,100 and 52 ppmv, respectively, over the 1-year treatment period. Soil gas BTEX concentrations were also significantly reduced. Soil sampling results exhibited similar trends, with TRPH concentrations decreasing by an order of magnitude at MPA and MPC. BTEX concentrations were reduced by 99.8 and 97.0 percent at MPA and MPC, respectively. Soil sampling results at MPB indicate an increase in TRPH and xylene concentrations, while toluene and ethylbenzene concentrations decreased. These results are likely the result of the inherent heterogeneity of soil sampling.

3.6 RECOMMENDATION FOR FULL-SCALE BIOVENTING

Based on the positive results of the 12-month bioventing pilot test, AFCEE has provided funding for the design and installation of an expanded bioventing system that will remediate contaminated soils associated with the former USTs at PS-4. Malmstrom AFB and AFCEE have retained Parsons ES to continue bioventing services at Malmstrom AFB and to complete the design and installation of an expanded bioventing system. Based on the initial pilot test results and available analytical data, Parsons ES has prepared a conceptual full-scale upgrade design that will employ the existing VW-1 and 12 additional VWs. Six additional MPs also will be installed to verify that oxygen is being delivered to contaminated soils. Section 4 provides details on the design, construction, and operation of the expanded system. A design package has been prepared for construction of the system and is included in Appendix A of this RAP.

SECTION 4

EXPANDED BIOVENTING SYSTEM

The purpose of the expanded bioventing system is to provide oxygen to stimulate aerobic biodegradation of the soil contamination associated with the former USTs at PS-4. The existing VW and 12 additional air injection VWs will be used to provide oxygen to oxygen-depleted, unsaturated, contaminated soils at the site. Six additional MPs will also be installed to verify that oxygen is being delivered to contaminated soils. System design details are provided in Appendix A.

4.1 OBJECTIVES

Following its installation, the primary objectives for the expanded bioventing system will be to:

- Optimize the system to fully aerate the unsaturated subsurface in areas at the site designated for bioventing remediation;
- Reduce the existing contaminant levels to below acceptable regulatory cleanup goals;
- Eliminate the potential for vadose zone soil contamination to leach to groundwater by removing the contaminant source from vadose soils; and
- Provide the most cost-effective remediation alternative for this site.

4.2 BASIS OF DESIGN

Site investigation data, pilot test data, and experience at other bioventing sites provide the main elements of the basis of design. The expanded bioventing system was designed to provide oxygen to areas of significant soil contamination.

Pilot test data, such as operating pressure and radius of oxygen influence, were considered during design development. These data were considered in the spacing of VWs and sizing of a full-scale blower system. In addition to pilot test data from this site, experience at other sites with similar soil types was considered in design development. Experience at other sites was used only where there were shortcomings in the pilot test data, such as uncertainty in accuracy of the flow rate data.

The significant design parameters and considerations are as follow:

- A radius of oxygen influence of 35 feet was used resulting in the spacing of VWs 60 feet apart. An abbreviated air permeability/oxygen influence test will be conducted at MPD, which will be located 35 feet from VW-1, to verify the actual radius of oxygen influence.

- An air injection pressure of 46 inches of water was assumed in sizing the full-scale bioventing blower. This is consistent with pressures required during the extended pilot test.

- An air injection flow rate of 15 scfm per VW was assumed in sizing the blower system. However, actual flow rates may be nearer 10 scfm, based on experience at other sites.

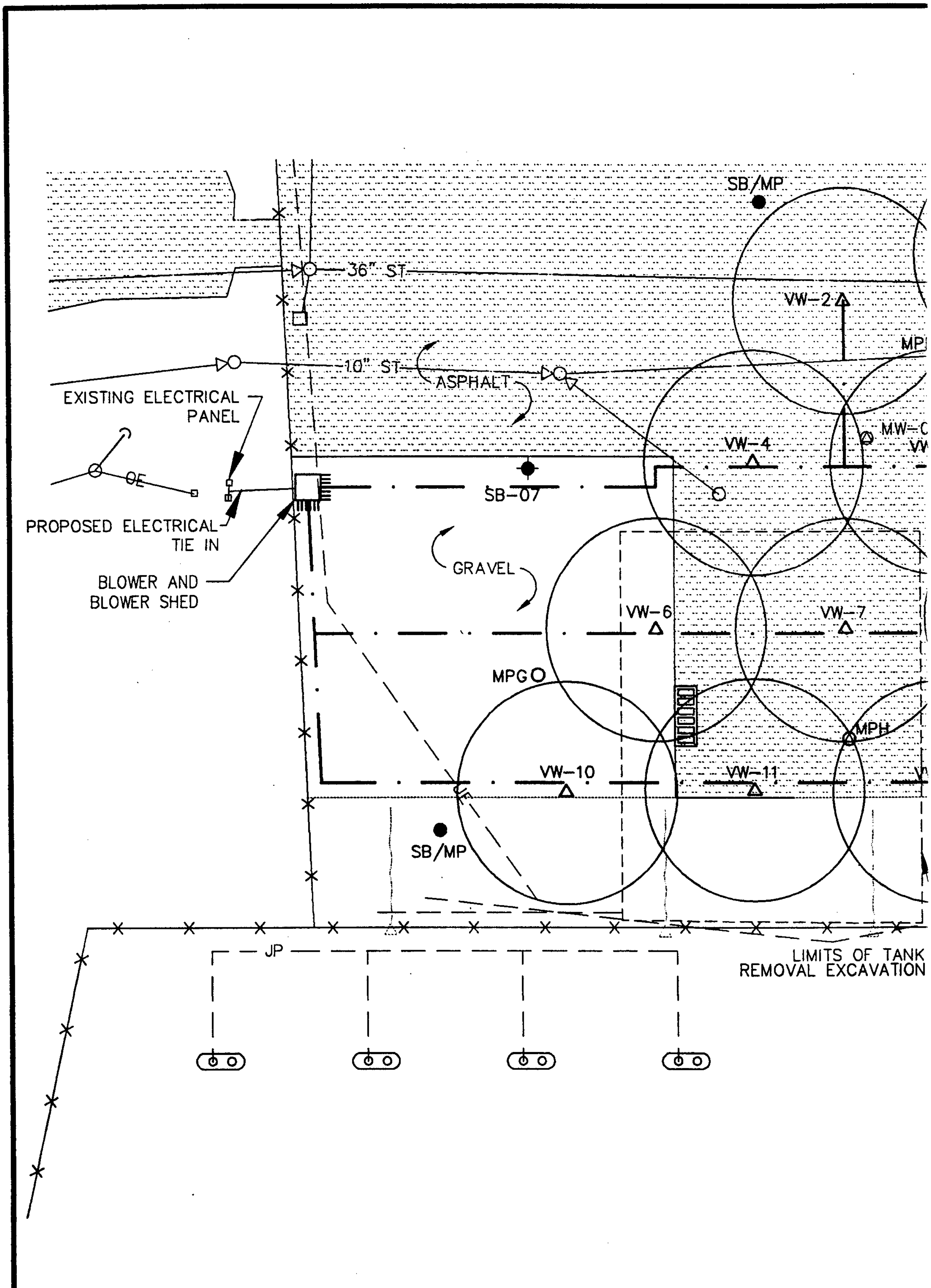
4.3 SYSTEM DESIGN

The full-scale design utilizes a single 6.0-HP Gast® regenerative blower located on a concrete pad inside the site fencing southwest of the location of the former USTs (Figure 4.1). A 208-volt, 3-phase, 100-amp power source is located within 20 feet of the proposed blower location. The proposed upgrade of the existing bioventing system will incorporate the existing VW-1 and 12 new VWs (VW-2 through VW-13). The new VWs will be 4 inches in diameter and will be screened with 0.040-inch-slot PVC screen from 4.5 to 9.5 feet bgs. Figure 4.1 shows the proposed locations of the existing and proposed VWs and MPs. Trench line configuration and other design details are included in the design package provided in Appendix A.

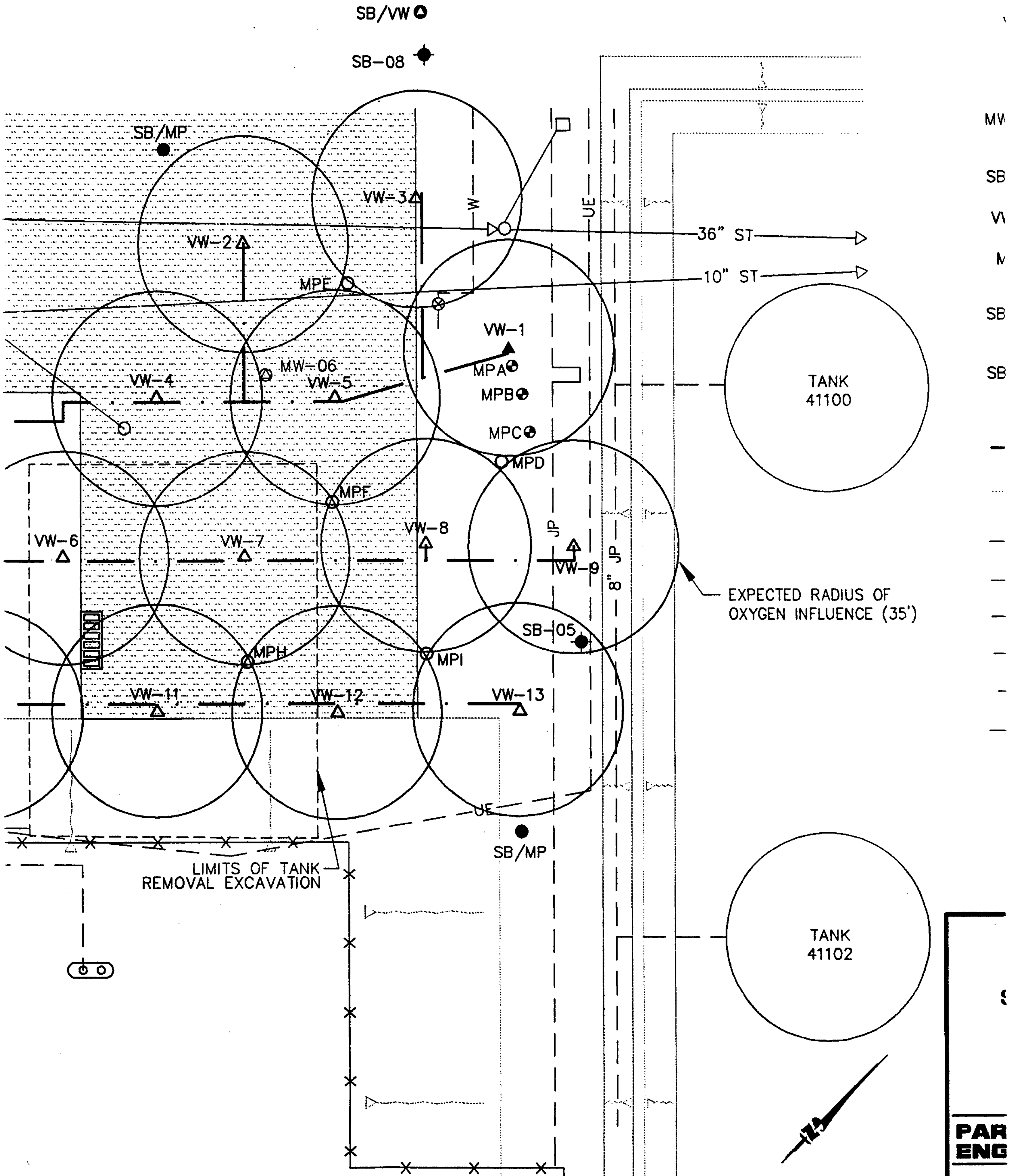
The locations of the six additional MPs were selected such that they would be useful in evaluating the magnitude of contaminant reduction through soil gas sampling and would provide important oxygen influence data. The proposed MPs will be located in potential "dead zones" outside the design zone of oxygen influence.

The VWs will be manifolded using 1.5-inch-diameter, high-density polyethylene (HDPE) pipe as the conduit for the injected air to flow from the blower to the proposed VWs. The piping will be connected to the new 6.0-HP regenerative blower, and will be set at a depth of 12 inches bgs. A separate (manual) flow control valve and flow measurement port will be included on the line connecting each VW to the header to allow for adjustment of the air flow to each VW. The blower and valving will be housed in weatherproof enclosures for protection from the elements and for security.

Based on experience at other sites, a maximum injection rate of 10 scfm at each VW should be sufficient to supply oxygen to the contaminated soils and sustain *in situ* fuel biodegradation. However, the blower system was sized assuming an injection rate of 15 scfm, which was the flow rate used during the pilot-scale air permeability and oxygen influence tests. The radius of oxygen influence around each VW was estimated to extend greater than 30 feet based on the data collected during the initial pilot testing. Prior to drilling the additional VWs, MPD will be installed approximately 35 feet from VW-1. Air permeability and oxygen influence testing will be performed at MPD while injecting into VW-1. Data obtained from this testing will assist the site engineer in



SB/MP
36" ST
VW-2
MP
10" ST
ASPHALT
EXISTING ELECTRICAL PANEL
MW-
VW-4
OE
SB-07
PROPOSED ELECTRICAL TIE IN
BLOWER AND BLOWER SHED
GRAVEL
VW-6
VW-7
MPG
MPH
VW-10
VW-11
OE
SB/MP
JP
LIMITS OF TANK REMOVAL EXCAVATION



SB/VW
SB-08
SB/MP
VW-3
W
UE
36" ST
10" ST
VW-2
MPE
VW-1
MPA
MPB
MPC
MPD
MW-06
VW-4
VW-5
TANK 41100
MPF
VW-6
VW-7
VW-8
JP
8" JP
VW-9
EXPECTED RADIUS OF OXYGEN INFLUENCE (35')
SB-05
MPH
MPI
VW-11
VW-12
VW-13
UE
SB/MP
LIMITS OF TANK REMOVAL EXCAVATION
TANK 41102

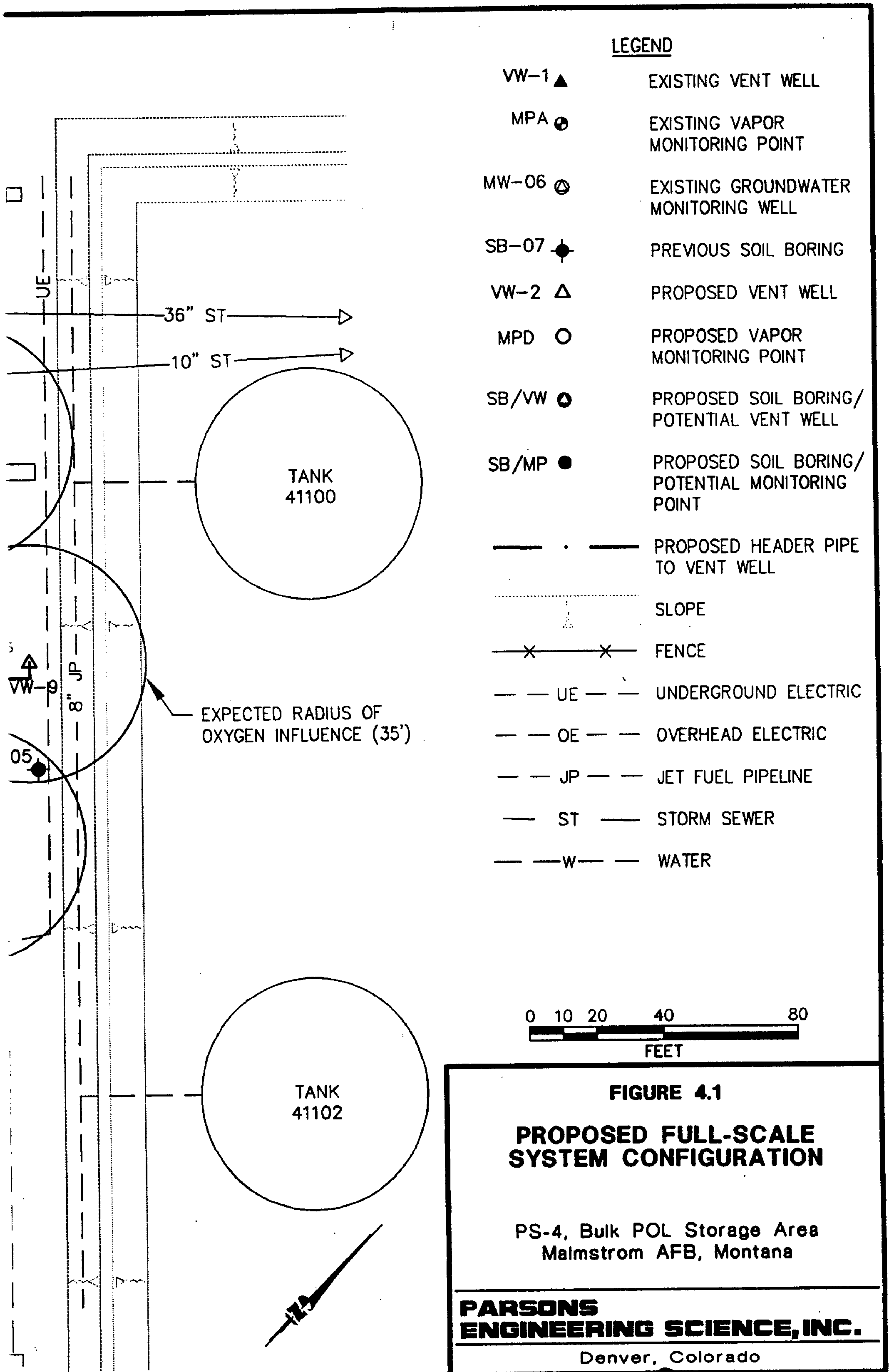


FIGURE 4.1

PROPOSED FULL-SCALE SYSTEM CONFIGURATION

PS-4, Bulk POL Storage Area
Malmstrom AFB, Montana

PARSONS ENGINEERING SCIENCE, INC.
Denver, Colorado

siting the additional VWs. If oxygen influence is observed at MPD, a VW spacing of 60 feet will be used (Figure 4.1).

Ambient air quality monitoring will be conducted during initial full-scale system operation to determine if air injection into the soil will displace volatile organic compounds (VOCs) into the atmosphere. Air quality monitoring will be conducted using a PID with a detection limit of 1 ppmv. Monitoring will be conducted across the site on an hourly basis, at a minimum, during the first four hours of full-scale system operation. Particularly, more extensive monitoring will be performed in the gravel-covered areas near the edge of the asphalt. If VOCs are detected in ambient air at concentrations exceeding safety thresholds, the full-scale system operation will be discontinued. If VOCs are detected at lower concentrations, monitoring will continue until the detections dissipate. If VOCs persist in ambient air, corrective action (i.e. decreasing the air injection flow rate, identifying and blocking preferential flow channels to the surface) will be taken. If these corrective actions are performed and VOCs still persist in ambient air, the system operation will be temporarily discontinued and an alternative remedial approach will be recommended. Past experience at this site has shown that VOCs have not been driven into the atmosphere at detectable concentrations during bioventing operations.

4.4 PROJECT SCHEDULE

The following schedule for the bioventing system upgrade is contingent upon approval of the Work Permit Request.

Event	Start Date	End Date	Duration (working days)
Submit Draft RAP and Design Package to AFCEE/ERT and Malmstrom AFB[a/]	NA	6 September 1996	NA
Draft RAP and Design Package Review Period	6 September 1996	20 September 1996	10 days
Respond to Comments on Draft	23 September 1996	27 September 1996	5 days
Final RAP and Design Package to AFCEE/ERT, Malmstrom AFB, USEPA, and Montana Department of Environmental Quality	NA	30 September 1996	NA
Construction of Expanded System/System Startup	2 October 1996	21 October 1996	18 days
Complete Construction Drawings/O&M Manual	21 October 1996	15 November 1996	20 days

a/ Malmstrom AFB will provide a copy of the Draft RAP and Design Package to the Montana Department of Environmental Quality, along with a copy of Malmstrom AFB comments.

4.5 SYSTEM OPERATION, MAINTENANCE, AND MONITORING

Following system installation, Parsons ES engineers will perform system startup and optimization. An O&M plan and as-built system drawings will be prepared and submitted to AFCEE and Malmstrom AFB. After the system has been optimized, it should operate continuously until performance monitoring indicates that remedial objectives have been reached.

4.5.1 System Operation

At startup of the full-scale system, it will be necessary to optimize the air injection rate and to ensure proper operation of the blower system. Flow rate optimization is accomplished by gradually increasing the flow rate to each VW until soil gas oxygen concentrations at all MP depth intervals reach a minimum concentration of approximately 5 percent. Oxygen levels in excess of 5 percent at the outer MPs may indicate that the volume of air passing through the soil exceeds the biological oxygen utilization. The blower will be checked to ensure that it is producing the required flow rate and pressure for air injection. Following flow rate optimization, the system will operate continuously and will require minimal maintenance, as described below.

4.5.2 System Maintenance

System maintenance requirements for the proposed bioventing system are minimal because the regenerative blower is virtually maintenance-free. The only recurring maintenance required is a monthly check of the air filter, which is generally replaced when the vacuum across the inlet filter reaches a reading 10 to 15 inches of water greater than the reading with a clean filter. The time period between filter changes is dependent on site conditions, and is typically every 3 to 6 months. The O&M manual will further detail maintenance requirements. Malmstrom AFB will be responsible for system maintenance.

4.5.3 System Performance Monitoring

Routine monitoring of the bioventing system will include system checks of blower operation, including outlet pressures, inlet vacuum, and exhaust temperature every 2 weeks. These system checks will be performed by Malmstrom AFB technicians.

To provide baseline data against which the progress of full-scale remediation can be evaluated, soil and soil gas samples will be collected during installation of the full-scale bioventing system, and an *in situ* respiration test will be performed. These data will be used along with the previous data collected throughout the pilot test project and during the RFI to provide a basis for comparison in the future. *In situ* respiration tests will be performed at new MPs exhibiting low initial oxygen concentrations and at the MPs previously tested. *In situ* respiration testing will be performed in accordance with the bioventing protocol procedures (Hinchee *et al.*, 1992).

Soil samples will be collected from all boreholes advanced during drilling activities for installation of the full-scale bioventing system components. Samples will be collected at 2.5-foot intervals, and will be screened in the field for organic vapors using an OVA. Ten soil samples will be sent to an analytical laboratory for analysis of

BTEX by USEPA Method SW8020A and for diesel range organics (DRO) and GRO in accordance with Montana Department of Environmental Quality (DEQ) guidelines (Montana Department of Health and Environmental Sciences, 1994). Soil samples will be sent to Inchcape Technologies in Richardson, Texas (if this laboratory has been approved by the Montana DEQ by the time of sampling) or to another Montana DEQ-approved laboratory.

Soil gas sampling will be conducted using field instruments at all MPs and VWs prior to system startup to establish baseline oxygen, carbon dioxide, and TVH levels. In addition, soil gas samples from 8 locations will be forwarded to Air Toxics, Ltd. in Folsom, California for analysis of TVH-gasoline and BTEX by USEPA Method TO-3. The locations of these samples will be determined based on the field screening results. The 8 intervals exhibiting the highest TVH concentrations based on field instruments will be sampled for laboratory analysis.

Malmstrom AFB will be responsible for monitoring the performance of remediation after installation, startup, and optimization of full-scale operations. It is recommended that annual respiration testing and soil gas sampling be performed to evaluate the progress of remediation.

SECTION 5

HANDLING OF INVESTIGATION-DERIVED WASTES

All soil cuttings will be containerized in a roll-off container at the site. Soil cuttings will be accumulated in the roll-off container throughout the drilling program. The roll-off container will be covered with tarps when not in use to eliminate accumulation of precipitation and windblown dust. Following completion of drilling activities, the cuttings will be hauled to the on-Base landfarm by a waste handling subcontractor. It is anticipated that 3.7 cubic yards (100 cubic feet) of soil cuttings will be generated during installation of the full-scale bioventing system VWs and MPs.

Decontamination of augers, sampling equipment, and all other items requiring decontamination will be performed at a temporary decontamination area set up at the site. Decontamination water will be placed in 55-gallon drums and stored at the site during drilling activities. After completion of drilling activities, the drilling subcontractor will spray the decontamination water onto the landfarm.

SECTION 6

BASE SUPPORT REQUIREMENTS

The following support from Malmstrom AFB is needed prior to the arrival of the drillers and the Parsons ES team:

- Assistance in obtaining a Base digging permit.
- Provide all necessary regulatory permit forms for the VWs and MPs.
- Provide a copy of any Base soils management plan.
- Provide any paperwork required to obtain gate passes and security badges for drilling personnel and two Parsons ES employees. If required by the Base, vehicle passes will be needed for two Parsons ES trucks, one drill rig, and two drilling support trucks. These passes must be valid for the expected duration of drilling operations (about 1 week) and the full-scale system installation and startup (about 3 weeks).
- A potable water supply for well construction and decontamination activities.

During full-scale bioventing, Base personnel will be required to check the blower system once every 2 weeks to ensure that it is operating properly, record air injection pressures and temperatures, and replace the air filter, as needed. Parsons ES will provide an O&M manual and a brief training session.

SECTION 7
POINTS OF CONTACT

The following individuals will serve as the points of contact during full-scale bioventing system installation and startup.

Mr. T. Dan Duff, P.E. and
Mr. James Hodges, P.E., L.S.
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Montana Department of Environmental Quality
Underground Storage Tank Corrective Action Program
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P.O. Box 200901
Helena, MT 59620-0901
(406) 444-5970
Fax: (406) 444-1499

Captain Edward Marchand
AFCEE/ERT
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Brooks AFB, TX 78235-5363
(210) 536-4364
Fax: (210) 536-4330

Mr. Dave Teets, Site Manager
Mr. John Ratz, Project Manager
Parsons Engineering Science, Inc.
1700 Broadway, Suite 900
Denver, CO 80290
(303) 831-8100
Fax: (303) 831-8208

SECTION 8

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DeMott, Bennie. 1996. Personal Communication. Data fax from Bennie DeMott of 341 CES/CEVR, Malmstrom AFB, to John Ratz (Parsons Engineering Science, Inc.), August 1, 1996.

Hinchee, R.E., S.K. Ong, R.N. Miller, D.C. Downey, and R. Frandt. 1992. *Test Plan and Technical Protocol for a Field Treatability Test for Bioventing*. January.

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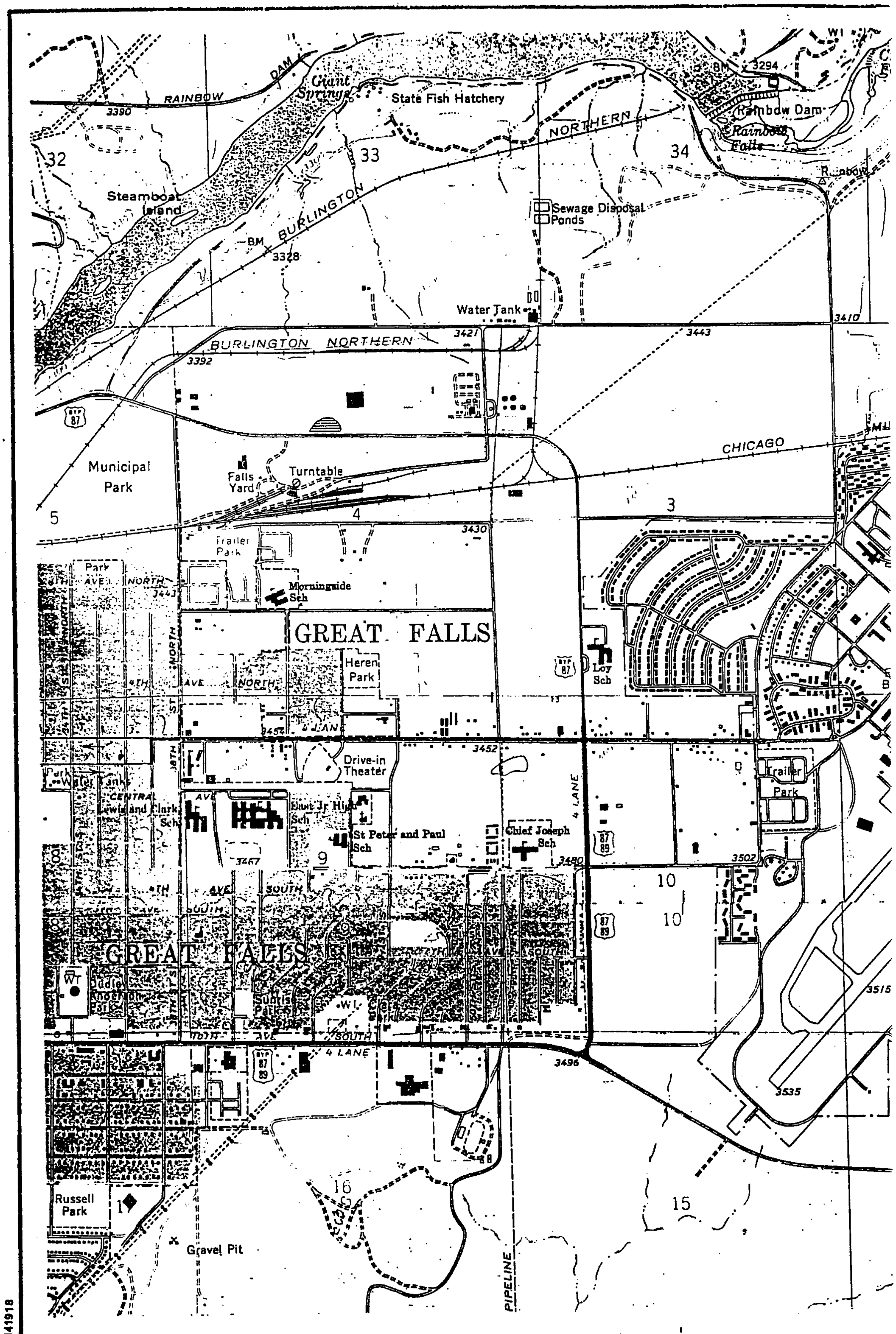
HDR Engineering, Inc. 1994. *Draft RCRA Facility Investigation Report, SWMUs PS-1, PS-2, PS-3, PS-4, PS-5, SS-22, SS-23, AND SS24. Malmstrom Air Force Base, Montana.* April.

Montana Department of Health and Environmental Sciences. 1994. *Clean-Up Guidelines for Petroleum Release Under the Montana Underground Storage Tank Program*. April

APPENDIX A

DESIGN PACKAGE



RAINBOW
DAM
Giant Springs
State Fish Hatchery
3390
NORTHERN
Rainbow Dam
Rainbow Falls
BM 3294
32
33
34
Steamboat Island
BM
BURLINGTON
3328
Sewage Disposal Ponds
Water Tank
3410
3421
3443
BURLINGTON NORTHERN
3392
87
Municipal Park
Falls Yard
Turntable
CHICAGO
5
4
3
3430
Trailer Park
Park
AVE NORTH
Morningside Sch
GREAT FALLS
Heren Park
Loy Sch
AVE NORTH
4 LANE
3452
Drive-in Theater
Trailer Park
Water Tanks
CENTRAL
Lewis and Clark Sch
St Peter and Paul Sch
Chief Joseph Sch
87
89
3480
3502
8
9
10
3467
AVE SOUTH
GREAT FALLS
WT
Sunrise Park
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4 LANE
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3515
3535
16
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Russell Park
Gravel Pit
PIPELINE

141918

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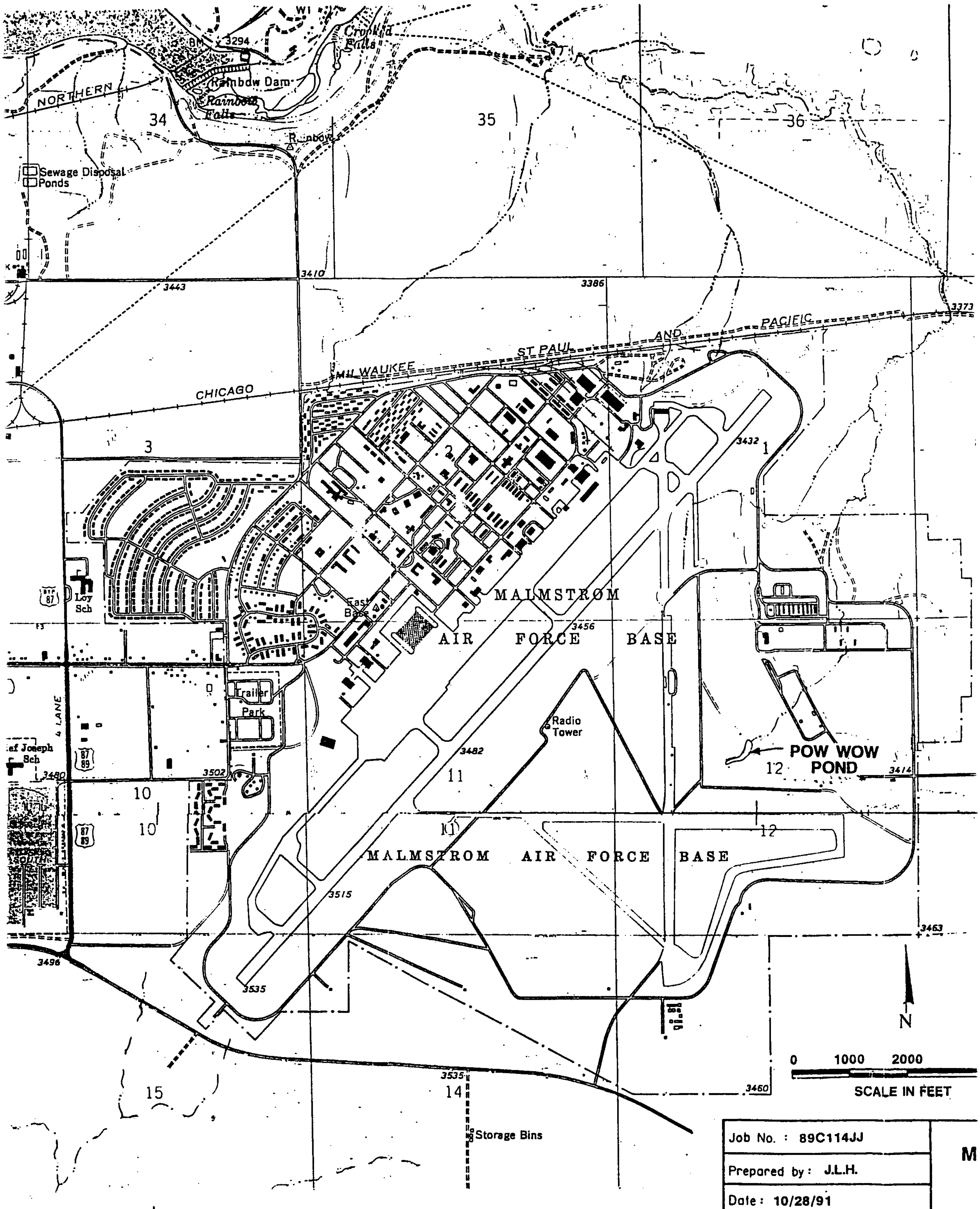

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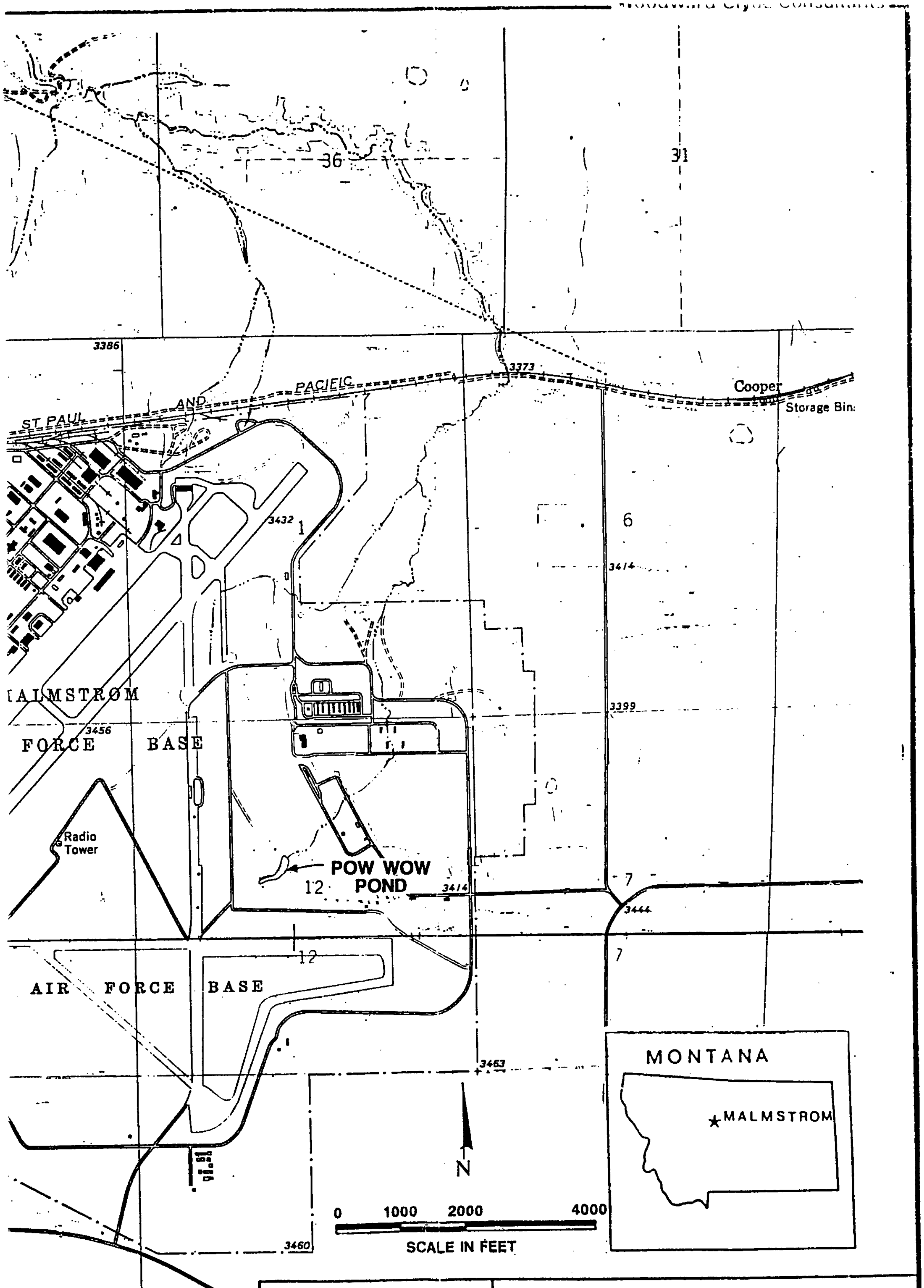
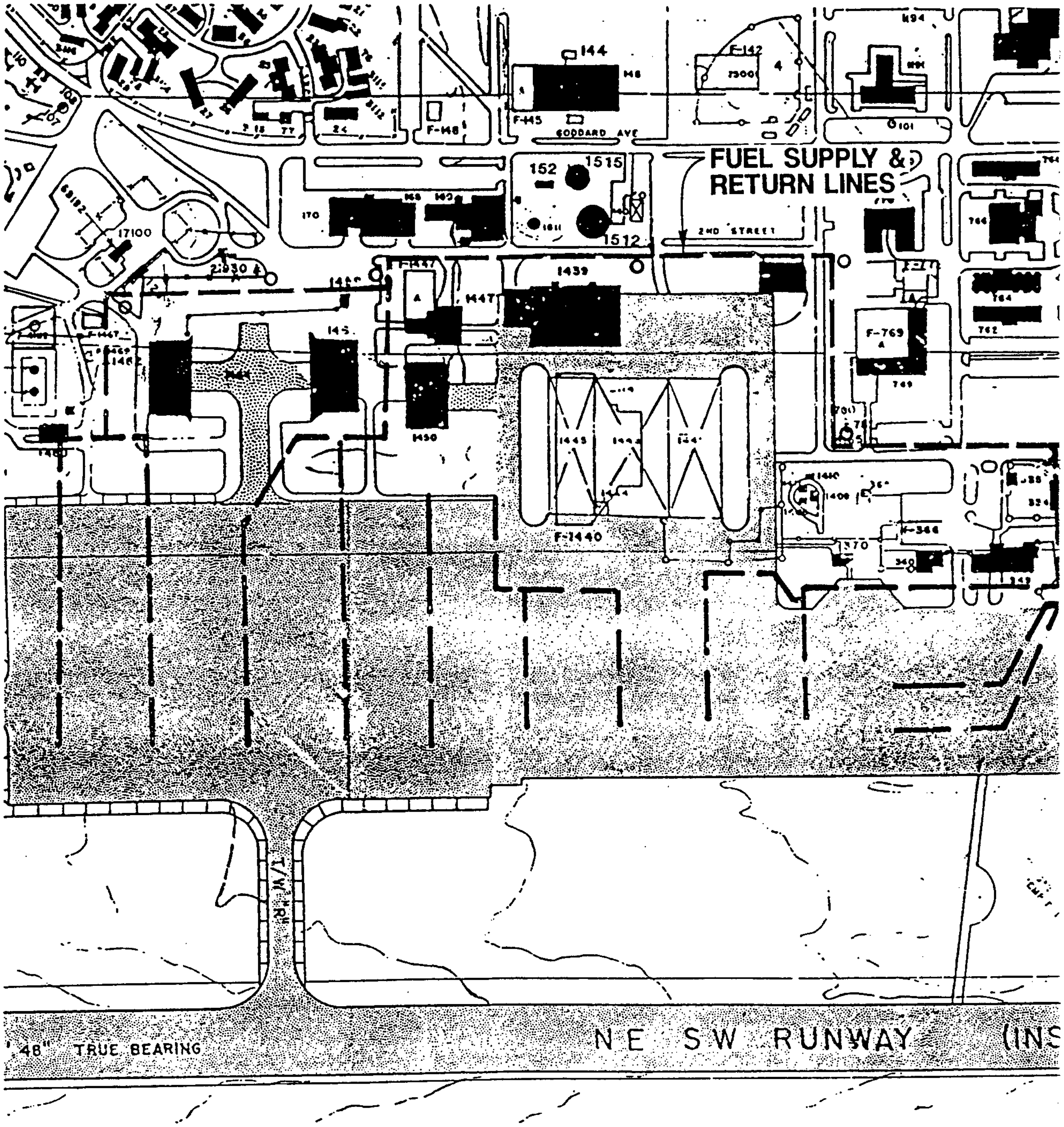
Date : 10/28/91	



ige Bins

Job No. : 89C114JJ	MALMSTROM AIR FORCE BASE LOCATION MAP
Prepared by : J.L.H.	
Date : 10/28/91	

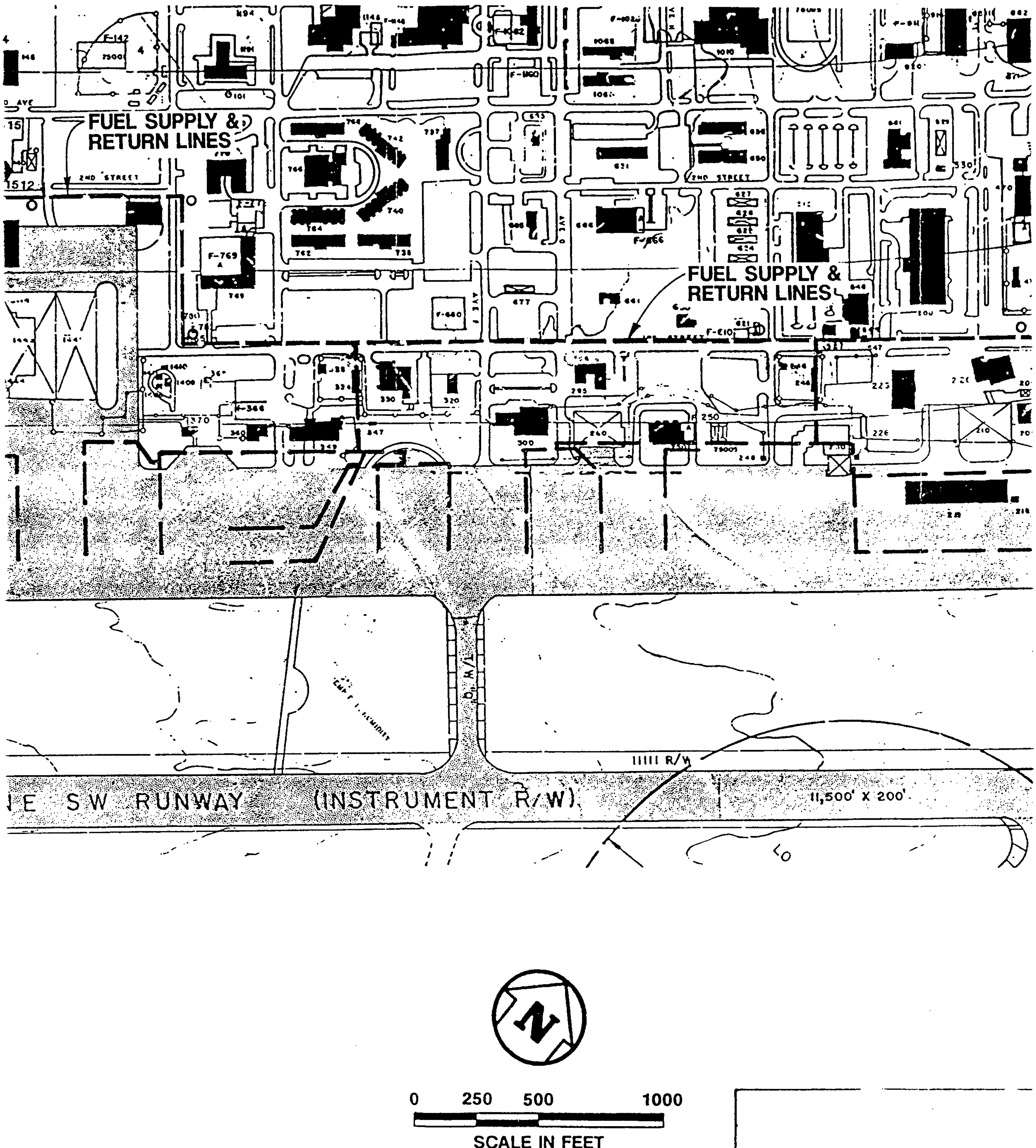
FIG. 1-1



LEGEND

FUEL LINE

141918



FUEL SUPPLY & RETURN LINES
2ND STREET
F-769 A
FUEL SUPPLY & RETURN LINES
2ND STREET
E SW RUNWAY (INSTRUMENT R/W)
11,500' X 200'
N
0 250 500 1000
SCALE IN FEET

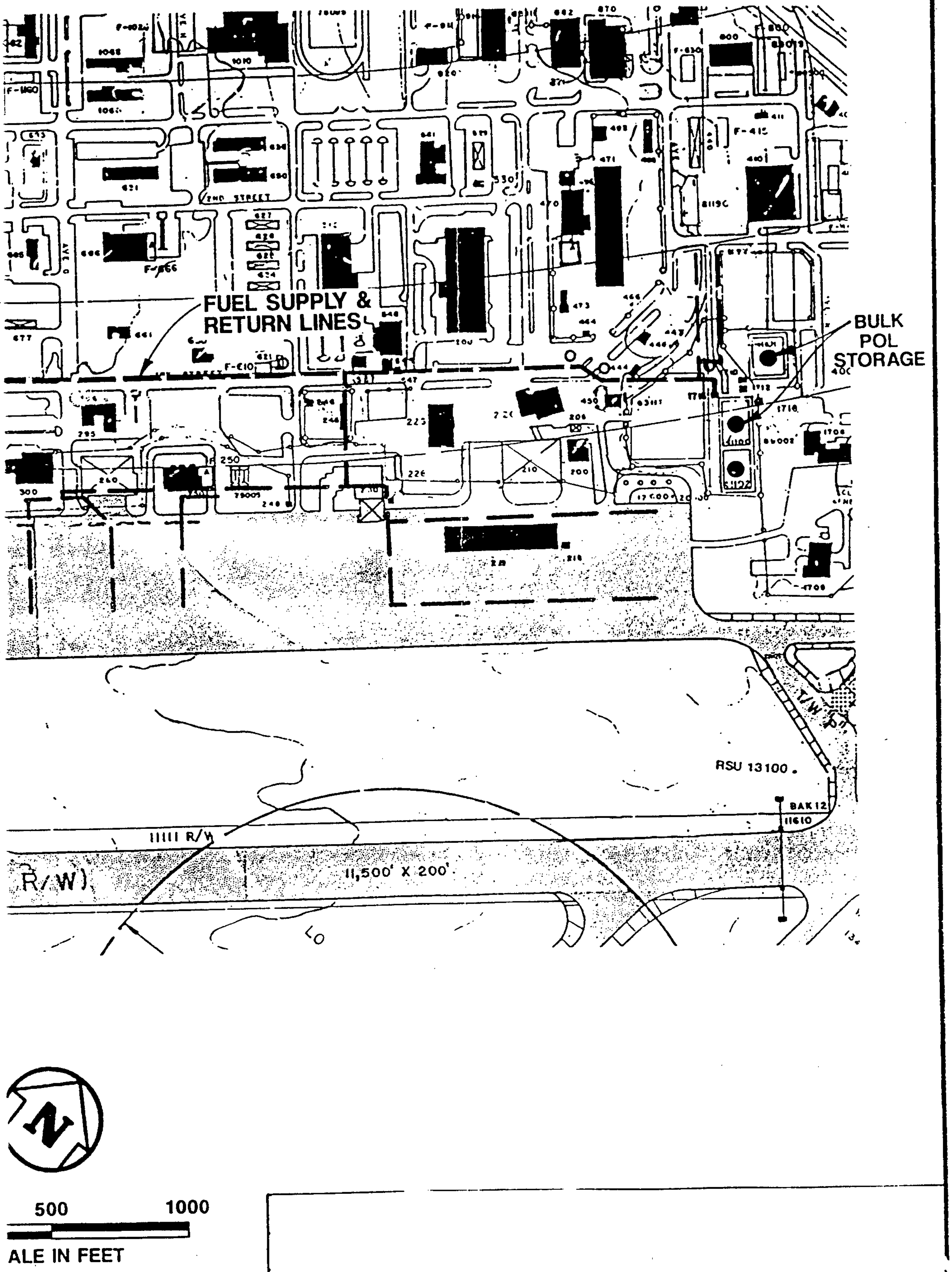

FUEL SUPPLY &
RETURN LINES
BULK
POL
STORAGE
2ND STREET
RSU 13100
BAK 12
11610
1111 R/W
R/W)
11,500' X 200'
T/W
500
1000
ALE IN FEET

FIG. 3-10.2

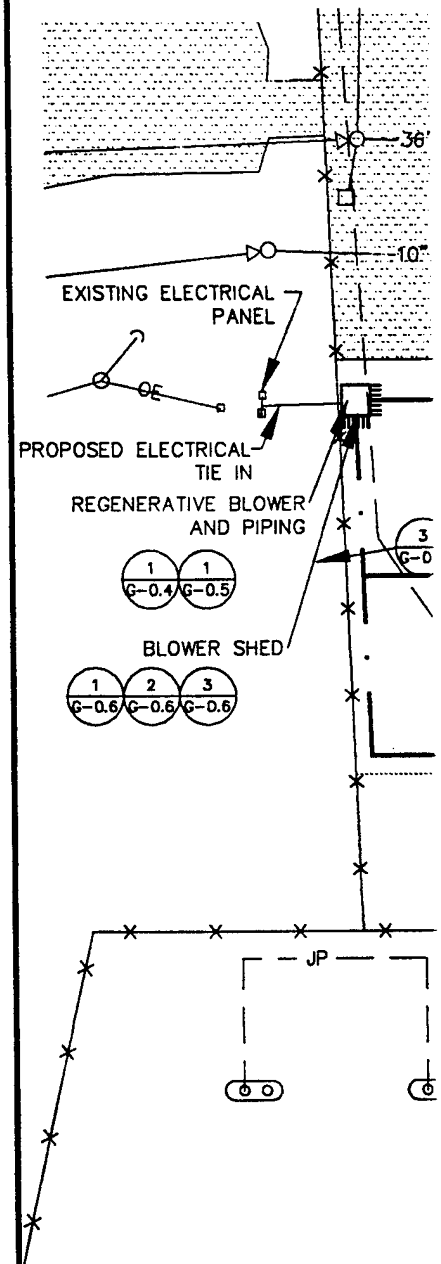
CONSTRUCTION DRAWINGS FOR

EXPANDED BIOVENTING SYSTEM POL YARD MALMSTROM AIR FORCE BASE

PREPARED FOR

AFCEE

AUGUST 1996



DRAWING INDEX

DRAWING NO	
G-0.1	TITLE SHEET AND SITE LAYOUT
G-0.2	LEGEND AND STANDARD TRENCH DETAILS
G-0.3	VENT WELL AND MONITORING POINT STANDARD DETAILS
G-0.4	BLOWER P & ID
G-0.5	BLOWER PIPING LAYOUT DETAIL
G-0.6	BLOWER SHED FIELD INSTALLATION DETAIL AND BLOWER SHED CONSTRUCTION DETAILS

1

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TEM

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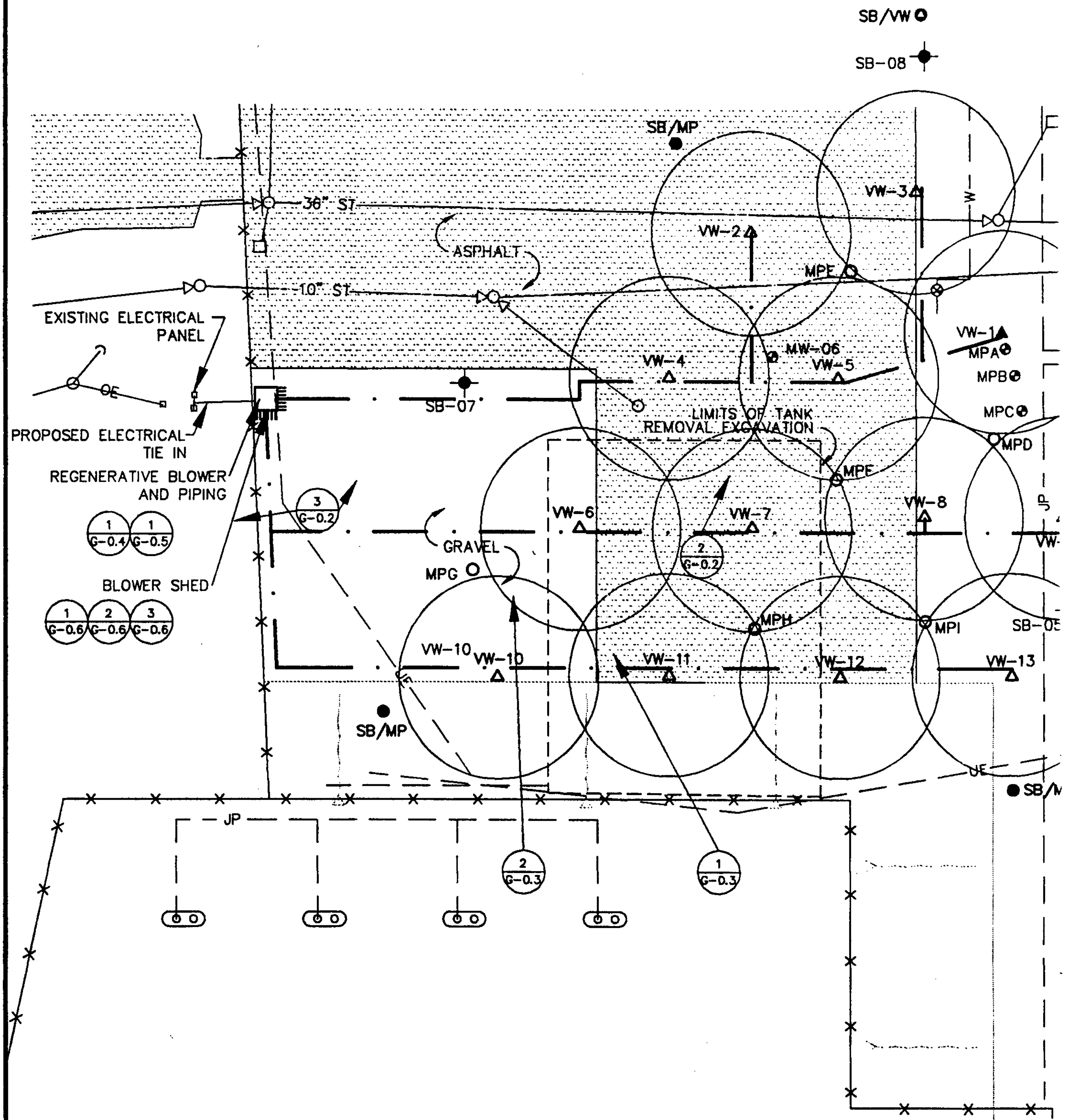

SITE LAYOUT

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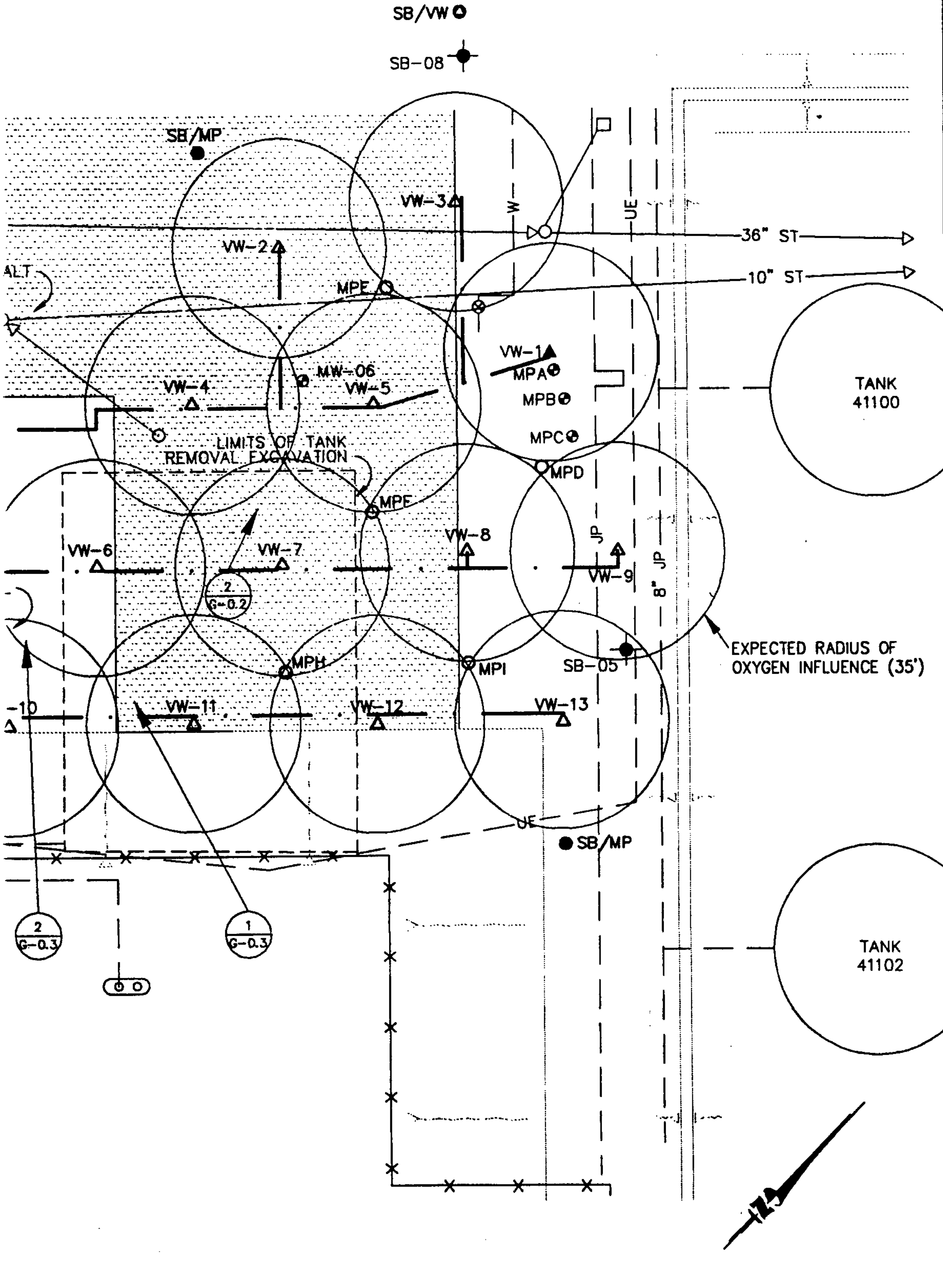

SITE LAYOUT

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Drawn JH			
Checked			
Reviewed			
Approved			
Reg No	A	8/12/96	65% DESIGN
Date	Rev	Date	Description

By

PARSONS ENGINEERING SCIENCE, INC.
Denver, Colorado (303) 831-8100

AIR FORCE CENTER FOR ENVIRONMENTAL EXCELLENCE (AFCEE)

EXPANDED BIOVENTING SYSTEM
POL YARD
MALMSTROM AIR FORCE BASE

TITLE SHEET AND SITE LAYOUT

DRAWING NO **G-0.1** REV **A**

ABBREVIATIONS

AIJ	AIR INJECTION
APPROX	APPROXIMATE
ASTM	AMERICAN SOCIETY OF TESTING AND MATERIALS
&	AND
@	AT
CBM	CENTER BACK MOUNT
CLR	CLEAR
DIA	DIAMETER
EB	EXPLORATORY BORING
ECC	ECCENTRIC
EW	EACH WAY
FOT	FLAT ON TOP
FPT	FEMALE PIPE THREAD
FT	FOOT
GALV	GALVANIZED STEEL
HDPE	HIGH DENSITY POLYETHYLENE
ie	FOR EXAMPLE
JP	JET PROPULSION FUEL
LM	LOWER MOUNT
MAX	MAXIMUM
MIN	MINIMUM
MP	MONITORING POINT
MPT	MALE PIPE THREAD
NO, #	NUMBER
NPT	NATIONAL PIPE THREAD
NTS	NOT TO SCALE
OC	ON CENTER
OD	OUTSIDE DIAMETER
OE	OVERHEAD ELECTRIC
POL	PETROLEUM, OIL & LUBRICANT
PVC	POLYVINYL CHLORIDE
PW	PROPOSED WELL
RED	REDUCER
REF	REFERENCE
SCH	SCHEDULE
S	SOCKET
SPVC	SLOTTED POLYVINYL CHLORIDE
ST	STORM SEWER
ST STL	STAINLESS STEEL
TYP	TYPICAL
UE	UNDERGROUND ELECTRIC
UST	UNDERGROUND STORAGE TANK
VW	VENT WELL
W	WATER
W/	WITH
WN	WELD NECK
WWF	WELDED WIRE FABRIC

SYMBOLS

MW-12	EXISTING GROUNDWATER MONITORING WELL
MPA	EXISTING BIOVENTING MONITORING POINT
VW1	EXISTING VENT WELL
SB-07	PREVIOUS SOIL BORING
MPF	PROPOSED BIOVENTING MONITORING POINT
VW3	PROPOSED VENT WELL
SB/VW	PROPOSED SOIL BORING/ POTENTIAL VENT WELL
SB/MP	PROPOSED SOIL BORING/ POTENTIAL MONITORING POINT
— · —	PROPOSED HEADER PIPE TO VENT WELL
	SLOPE

SECTION DESIGNATION

SECTION NAME

A
X

SECTION CUT

SCALE: NTS

DRAWING OF ORIGIN

SCALE

DETAIL NO

DETAIL NAME

1
X

DETAIL DESCRIPTION

SCALE: NTS

DRAWING OF ORIGIN

SCALE

MATERIAL LEGEND

ASPHALT

BENTONITE

BENTONITE/CEMENT GROUT

BENTONITE PELLETS

BUILDING (EXISTING)

COMPACTED BACKFILL

COMPACTED BASE STONE

CONCRETE

PEA GRAVEL

SAND

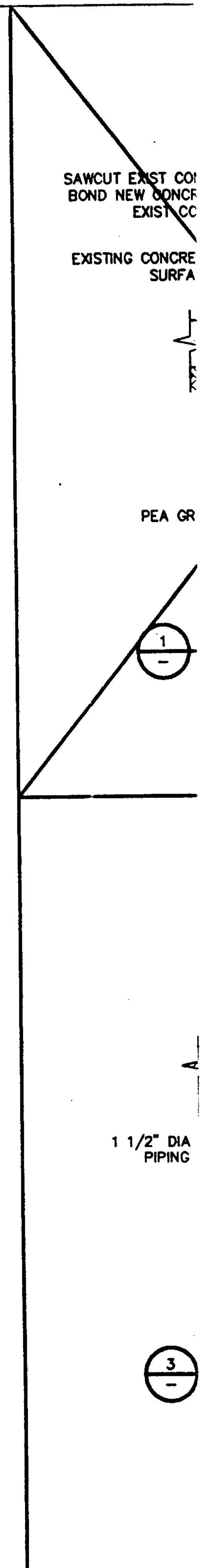
UNDISTURBED SOIL

PIPE MATERIAL

CS	CARBON STEEL
GALV	GALVANIZED STEEL
PVC	POLYVINYL CHLORIDE
SPVC	SCREENED POLYVINYL CHLORIDE

PIPE SERVICE

AIJ	AIR INJECTION
BIV	BIOVENTING
DR	DRAIN



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NAME

N CUT

NAME

DESCRIPTION

EGEND

ASPHALT

BENTONITE

BENTONITE/CEMENT GROUT

BENTONITE PELLETS

BUILDING (EXISTING)

COMPACTED BACKFILL

COMPACTED BASE STONE

CONCRETE

PEA GRAVEL

SAND

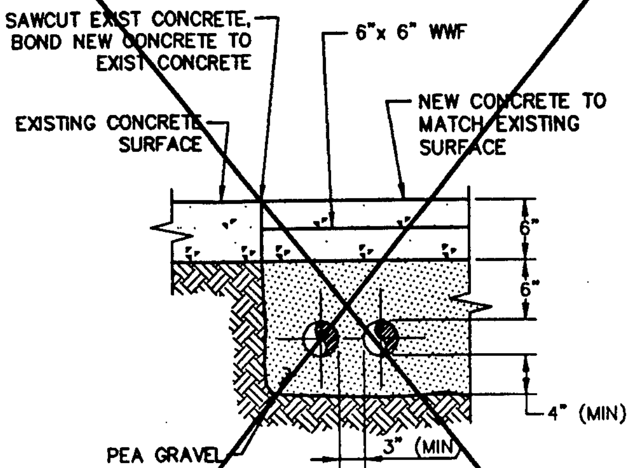
UNDISTURBED SOIL

RIAL

L
STEEL
HLORIDE
LYVINYL CHLORIDE

ICE

N



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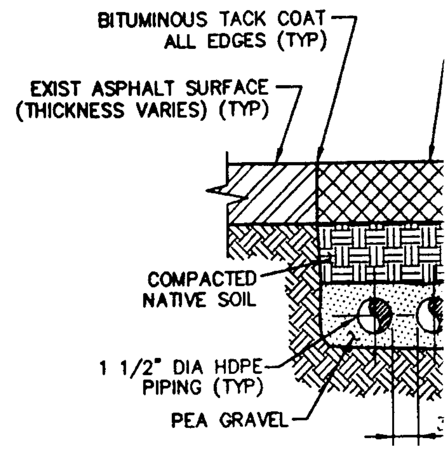

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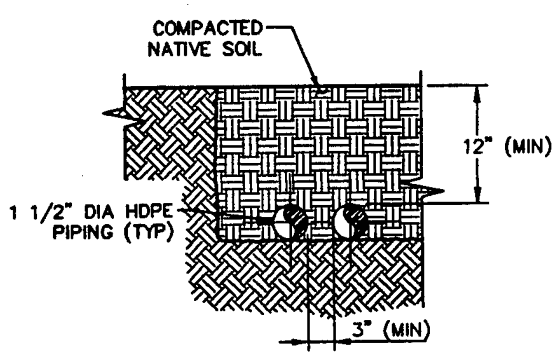
SCAL



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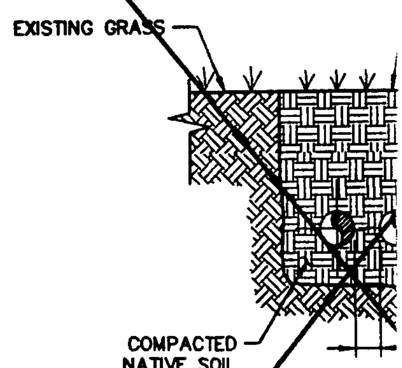
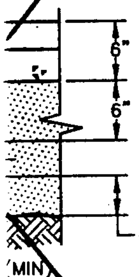


4 — GRASS C REPLACEM

SCA

WWF

NEW CONCRETE TO MATCH EXISTING SURFACE



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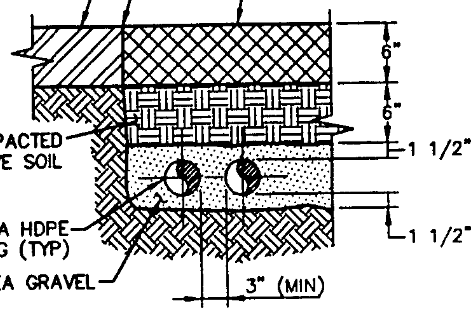

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2 / –

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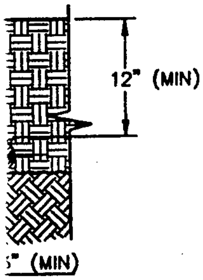

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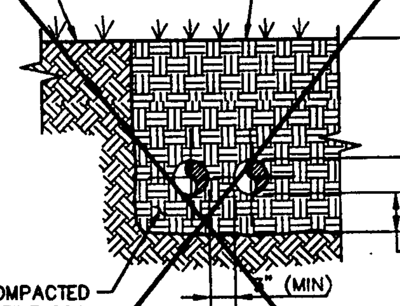

GRASS COVER REPLACEMENT DETAIL

4 / –

SCALE: NTS

(3)

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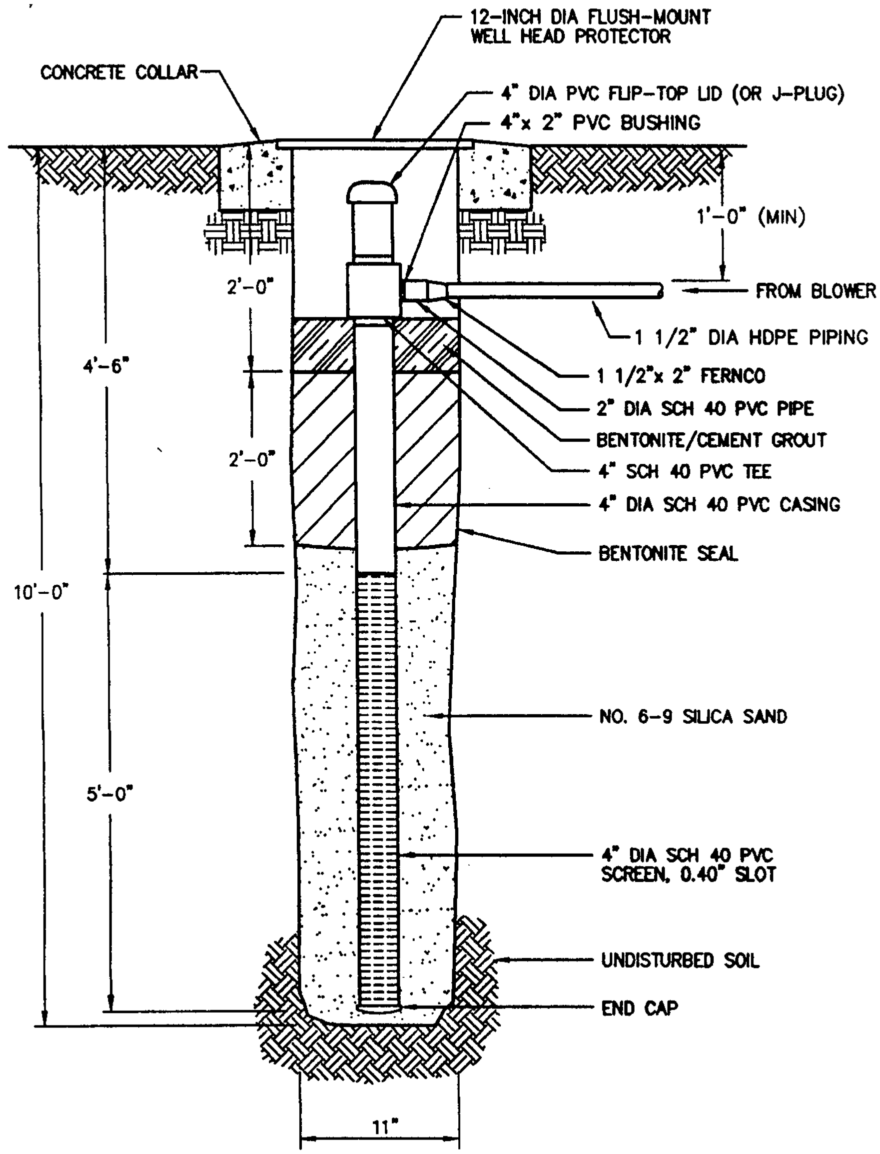
POL YARD
MALMSTROM AIR FORCE BASE

LEGEND AND STANDARD TRENCH DETAILS

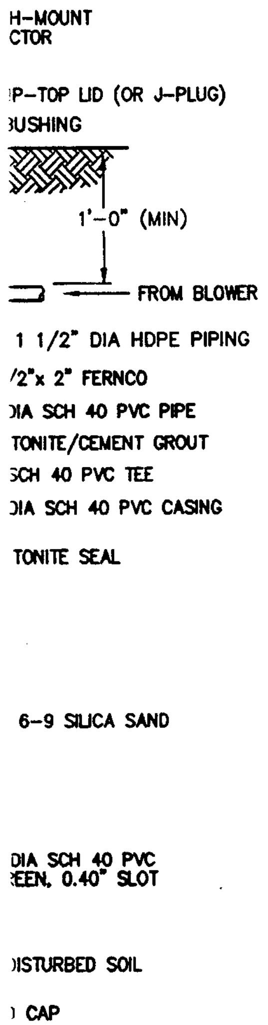
DRAWING NO G-0.2 REV A

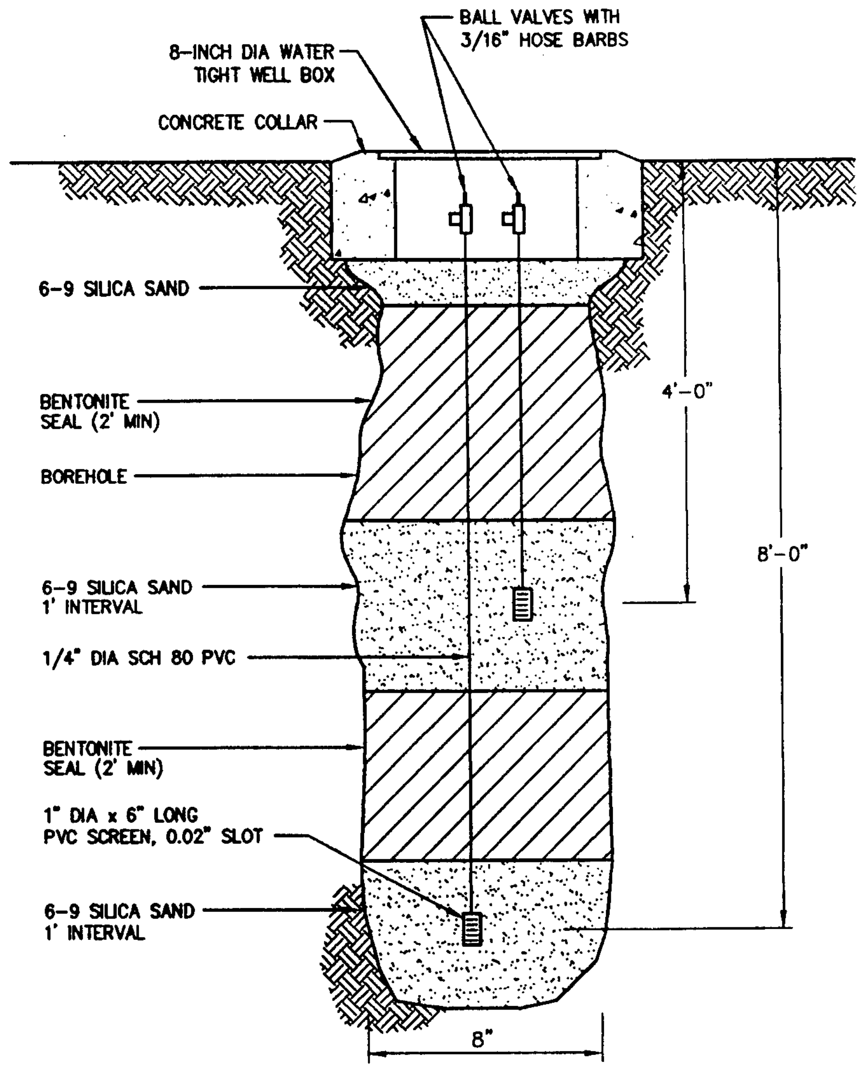


1 VENT WELL (VW) DETAIL

SCALE: NTS

①





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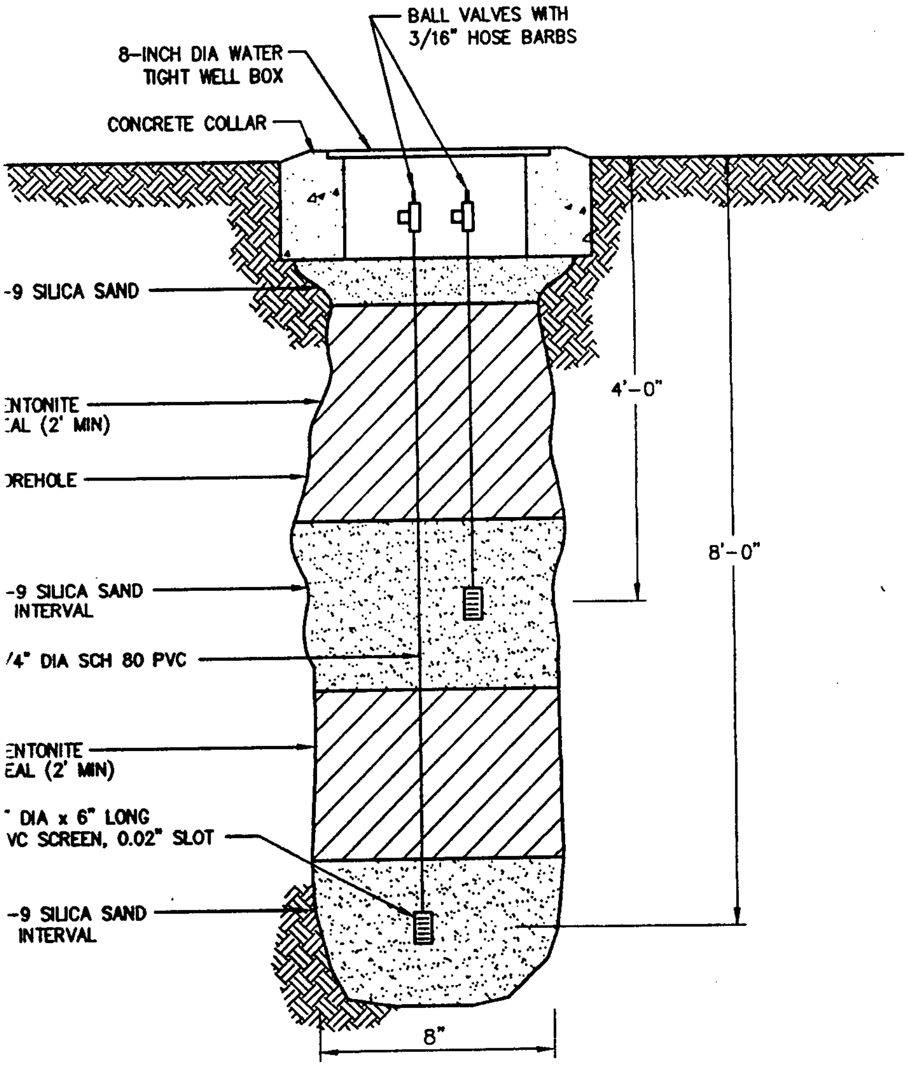

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MONITORING POINT (MP) DETAIL

SCALE: NTS

(3)

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A	8/12/96	65% DESIGN	

Job No. 726876.28242
Designed RAF
Drawn JH
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Reviewed
Approved
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Date

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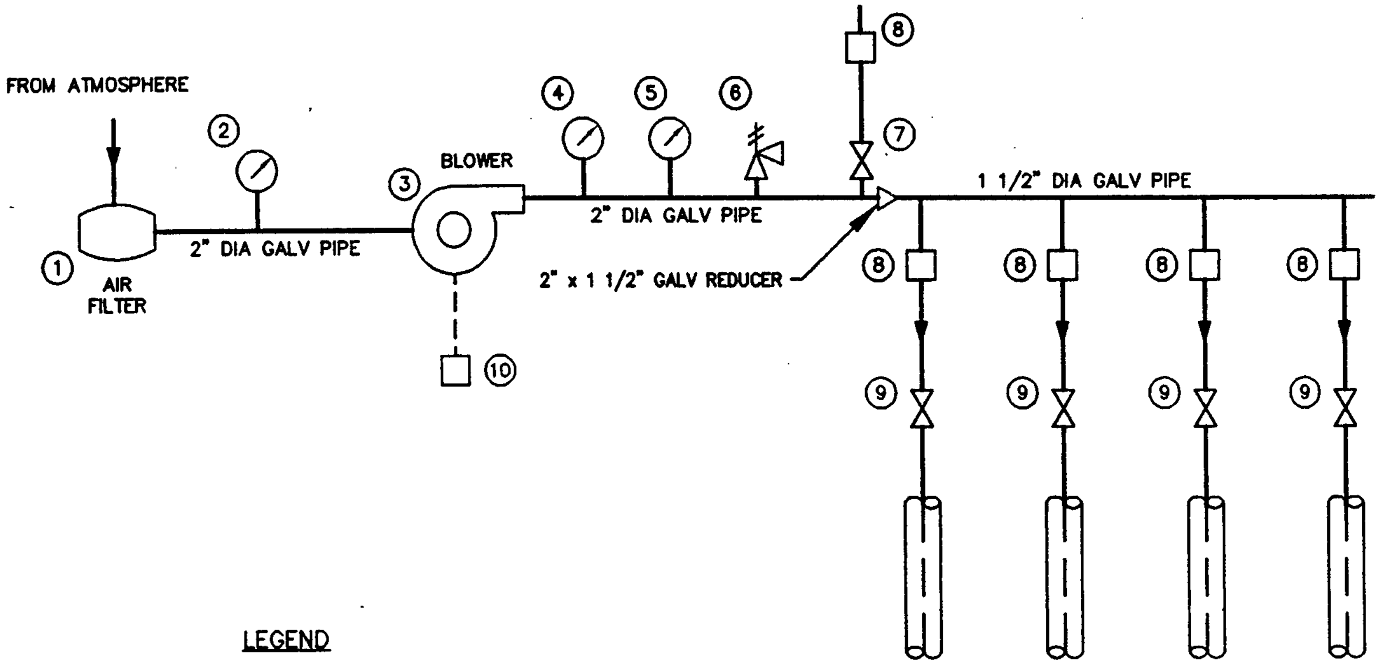
POL SITE
MALMSTROM AIR FORCE BASE

VENT WELL AND MONITORING POINT STANDARD DETAILS

DRAWING NO G-0.3
REV A



LEGEND

1. INLET AIR FILTER – SOLBERG F-30P-150, REPLACEMENT ELEMENT 30P
2. VACUUM GAUGE –GAST® AJ497, 2 1/2" DIA, 0–60" H_2O, 1/4" NPT, LM
3. BLOWER – GAST® 6.0HP R6P355R-50, 215 CFM AT 50" H_2O PRESSURE
4. TEMPERATURE GAUGE – ASHCROFT, 0–250°F, 1/2" NPT, CBM (Part No. 2A606 FROM GRAINGER)
5. PRESSURE GAUGE – WIKA 611.10, 2 1/2" DIA., 0–100" H_2O, 1/4" NPT, LM (Part No. 9851810)
6. AUTOMATIC PRESSURE RELIEF VALVE – GAST® AG258, SET TO RELEASE AT 60" H_2O PRESSURE
7. MANUAL PRESSURE RELIEF (BLEED) VALVE – 2" GATE
8. FLOW MEASURING PORT FITTED WITH PLUG (1/4" x 1/8" NPT BRASS REDUCING BUSHING, 1/8" NPT BRASS PLUG)
9. FLOW CONTROL VALVE – 1 1/2" GATE
10. DISCONNECT SWITCH

1 / – BLOWER PIPING AND

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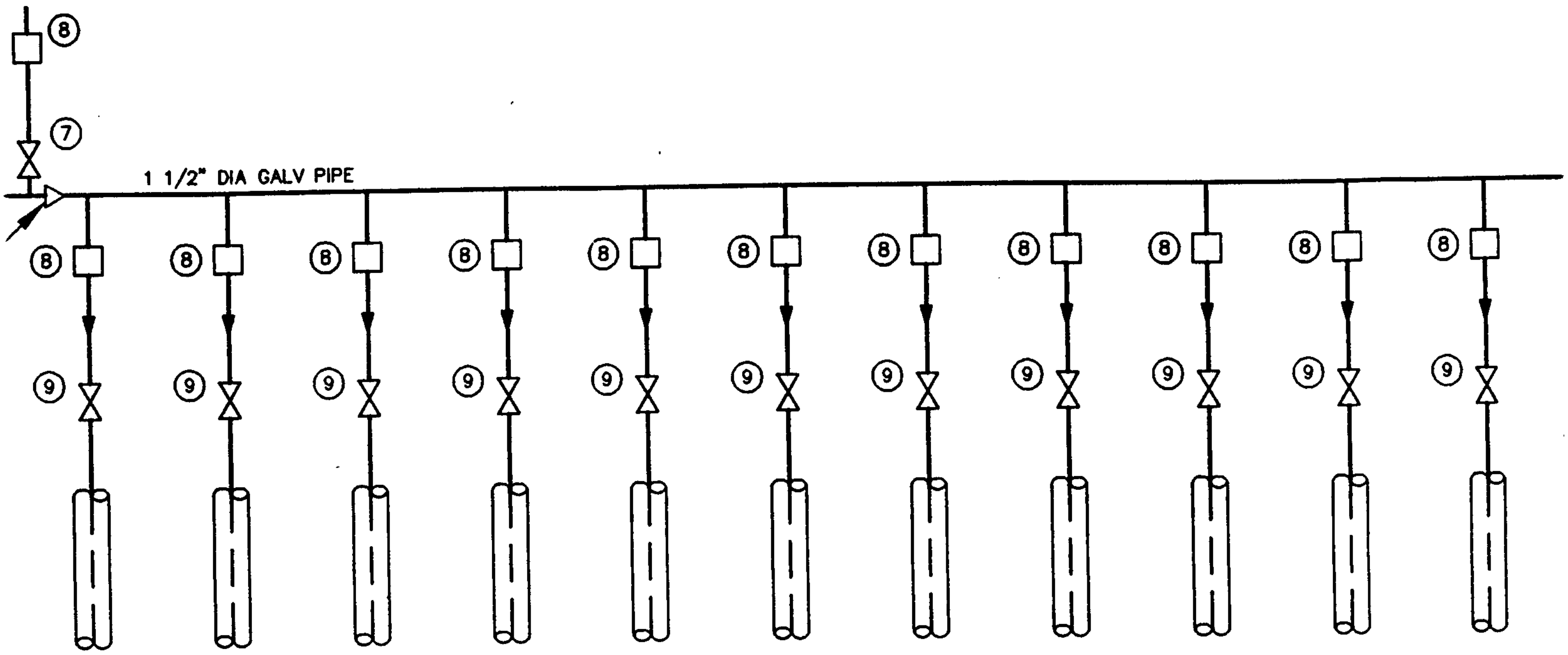
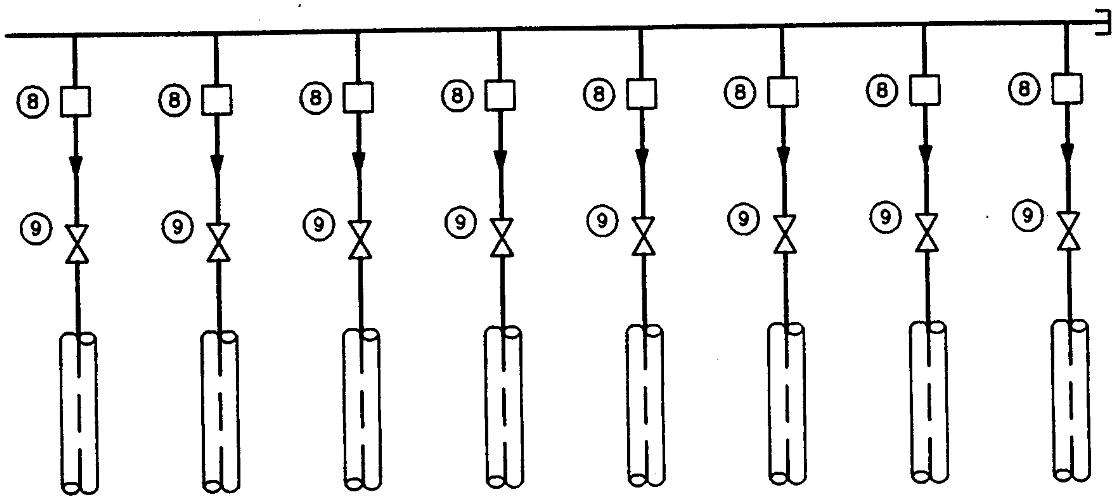


* H_2O PRESSURE

BUSHING, 1/8" NPT BRASS PLUG)

1 BLOWER PIPING AND INSTRUMENTATION DIAGRAM

SCALE: NTS



NTATION DIAGRAM

AIR FORCE CENTER FOR
ENVIRONMENTAL EXCELLENCE
(AFCEE)

EXPANDED BIOVENTING SYSTEM
POL YARD
MALMSTROM AIR FORCE BASE

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BLOWER P & ID

Job No. 726876.38130	
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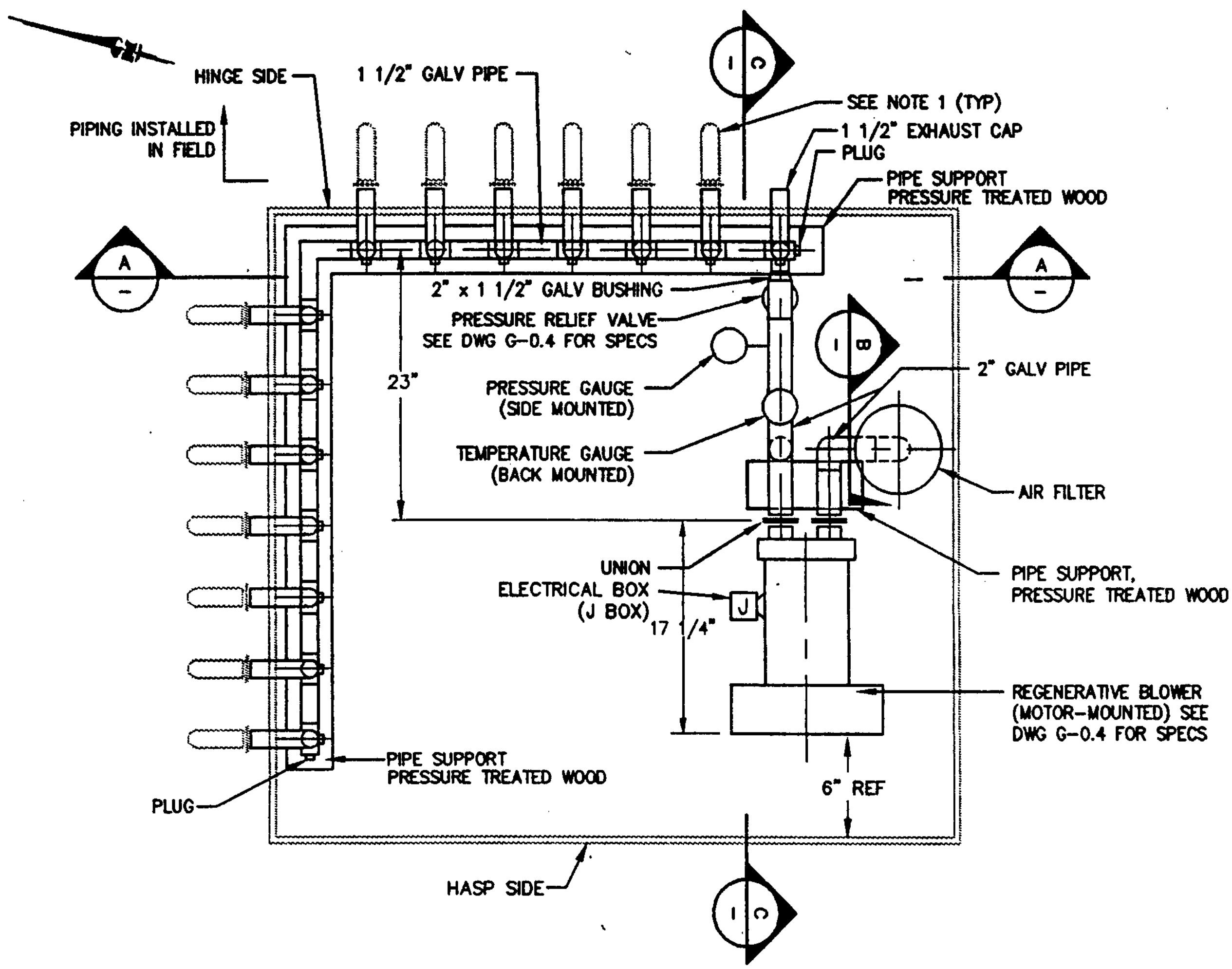
DRAWING NO G-0.4

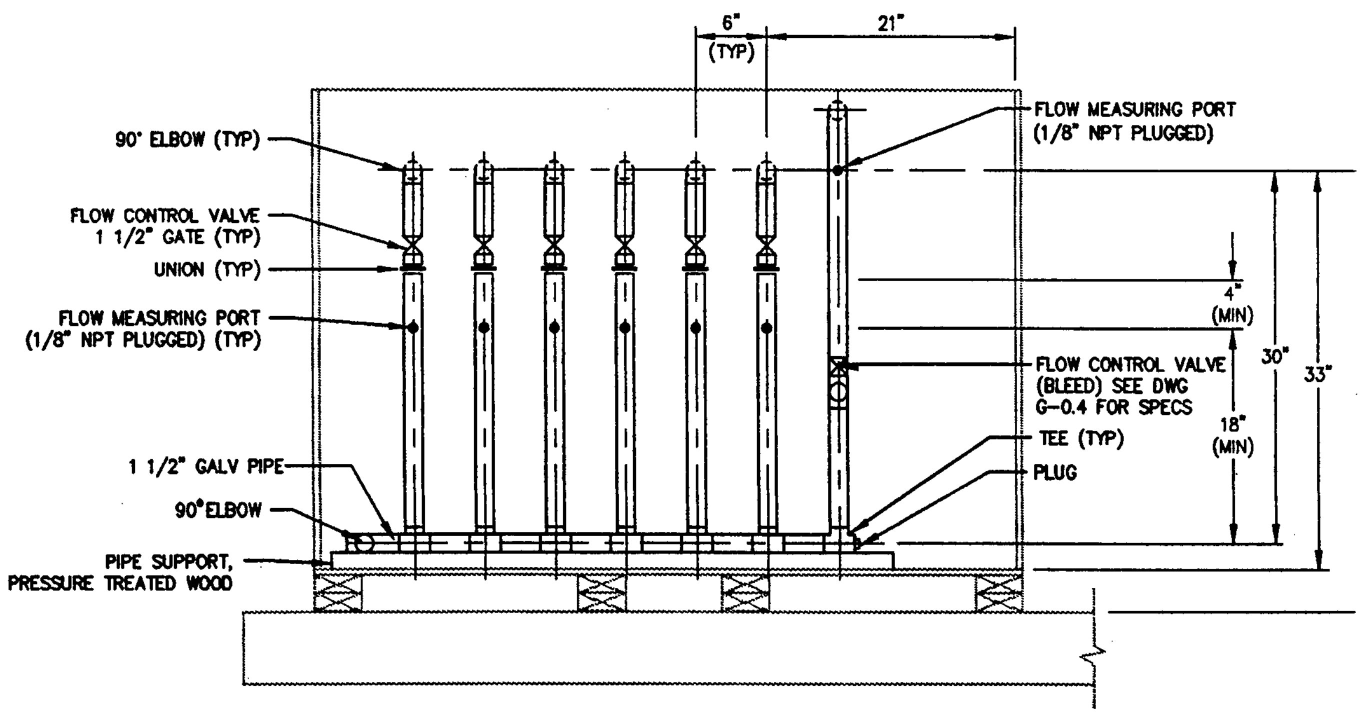
REV A

3



BLOWER PIPING LAYOUT PLAN DETAIL (TYPICAL OF TWO)

3/4" = 1'-0"



MANIFOLD DETAIL SECTION

3/4" = 1'-0"

1

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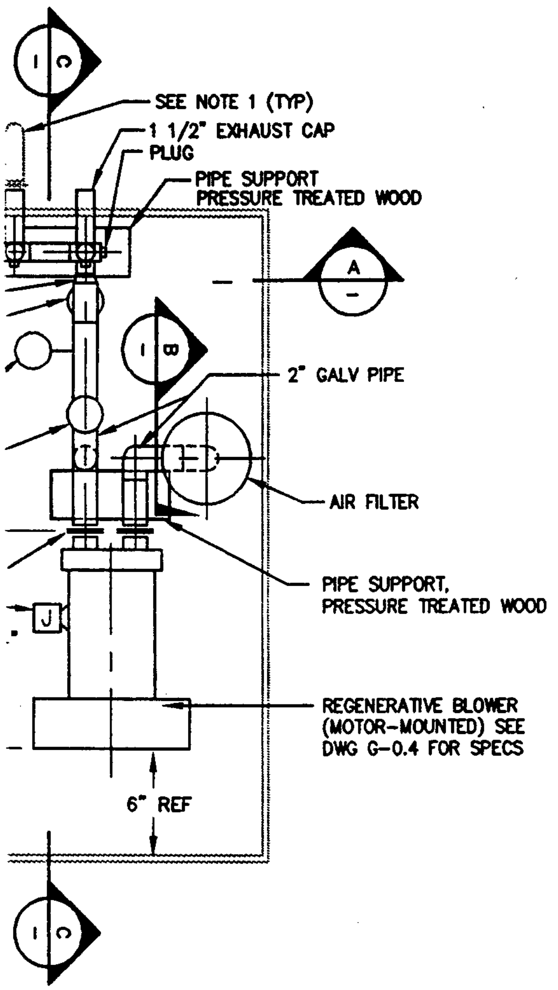
NOTES:

1. SHOP CORE HOLES TO PIPING DIMENSIONS
2. ALL PIPING 1 1/2" DIA. GALVANIZED STEEL, UNLESS OTHERWISE NOTED
3. SEE DRAWING G-0.6 FOR BLOWER BUILDING DETAILS
4. PROVIDE 24" MIN CLEARANCE BETWEEN BLOWER SHEDS



DETAIL (TYPICAL OF TWO)

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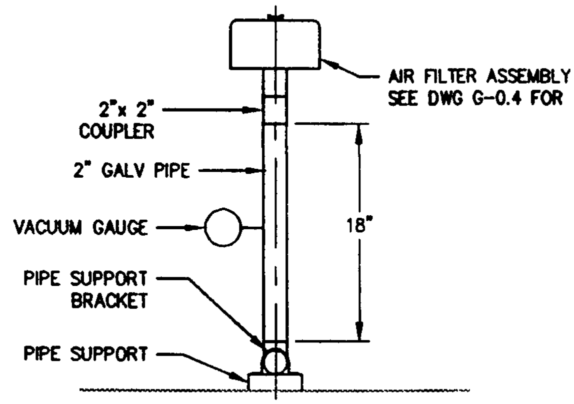
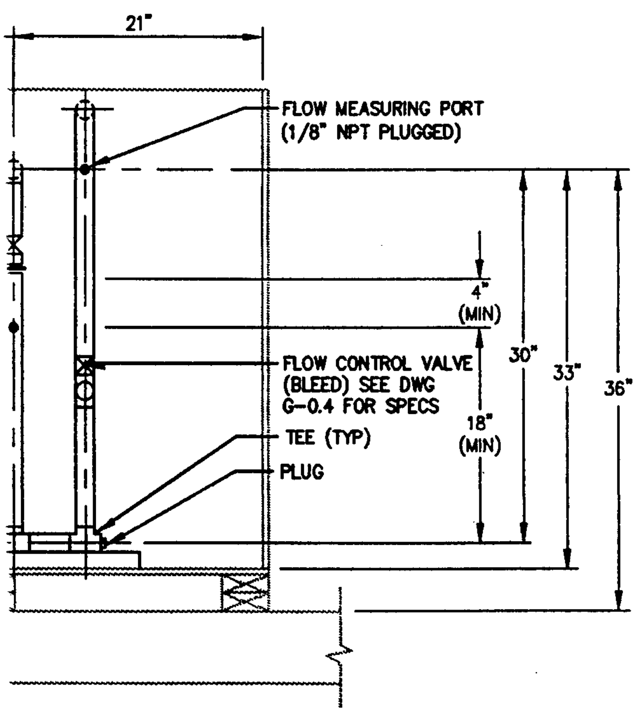
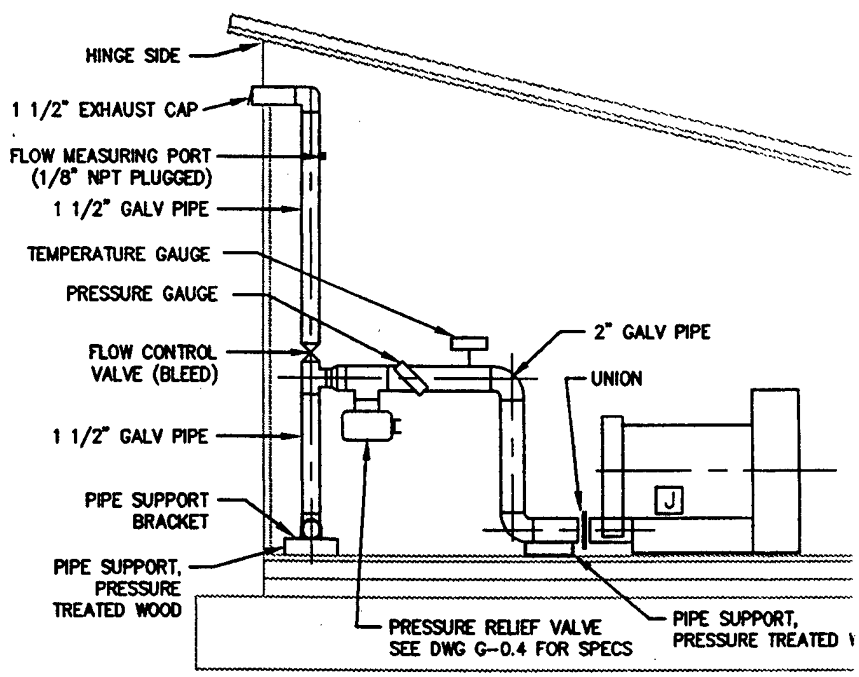


B BLOWER INLET PIPING SECTIC

3/4" = 1'-0"



. SECTION



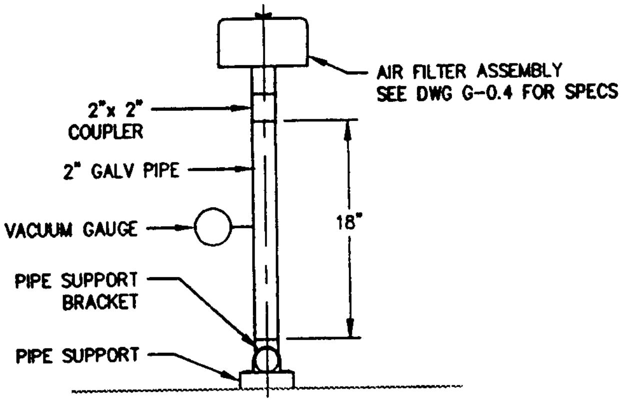
C BLOWER OUTLET PIPING SEC

3/4" = 1'-0"

2

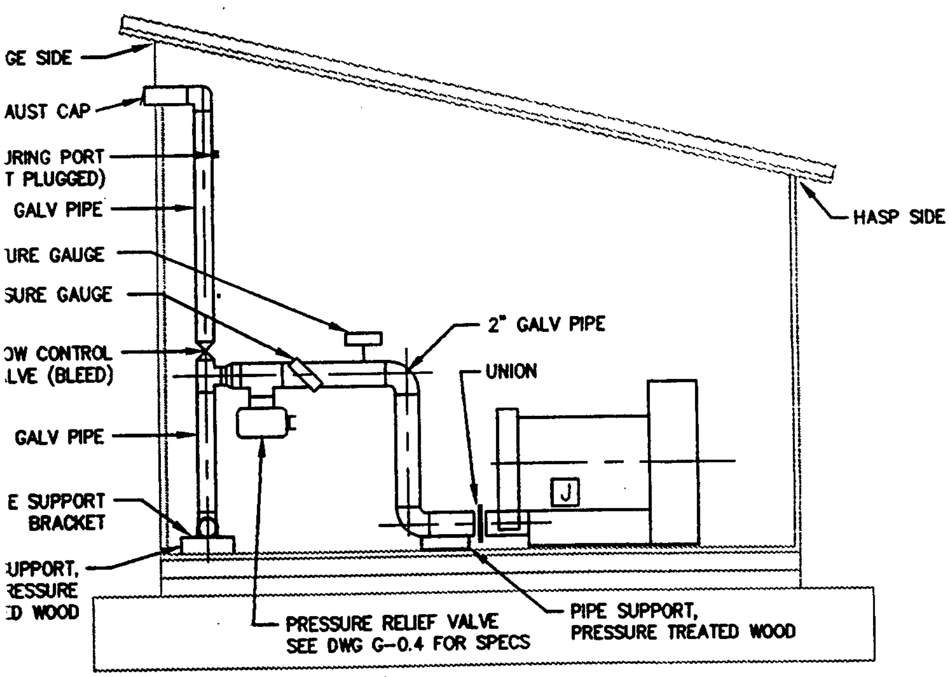
NOTES:

1. SHOP CORE HOLES TO PIPING DIMENSIONS
2. ALL PIPING 1 1/2" DIA. GALVANIZED STEEL, UNLESS OTHERWISE NOTED
3. SEE DRAWING G-0.6 FOR BLOWER BUILDING DETAILS
4. PROVIDE 24" MIN CLEARANCE BETWEEN BLOWER SHEDS



B / – BLOWER INLET PIPING SECTION

3/4" = 1'-0"



C / – BLOWER OUTLET PIPING SECTION

3/4" = 1'-0"

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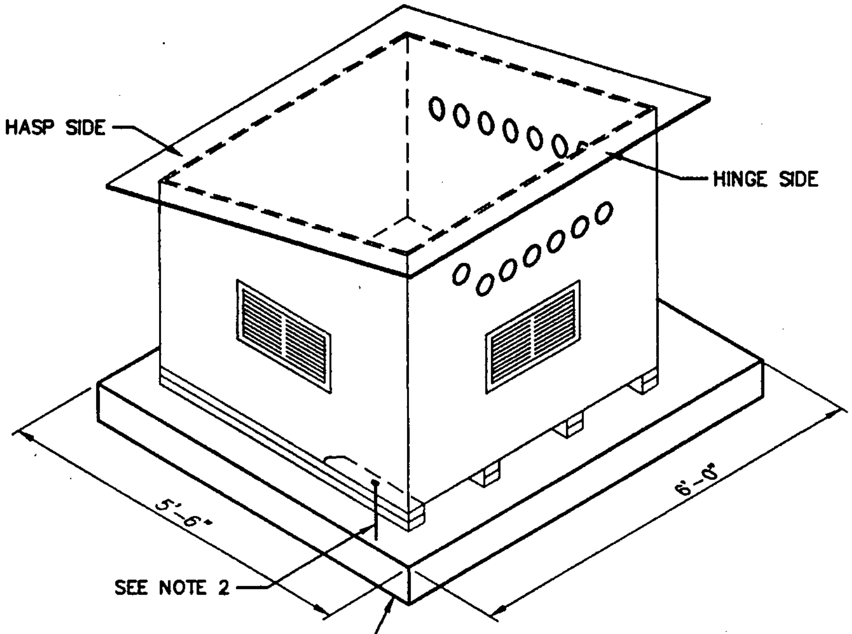
MALMSTROM AIR FORCE BASE

BLOWER PIPING LAYOUT DETAIL

DRAWING NO G-0.5 REV A



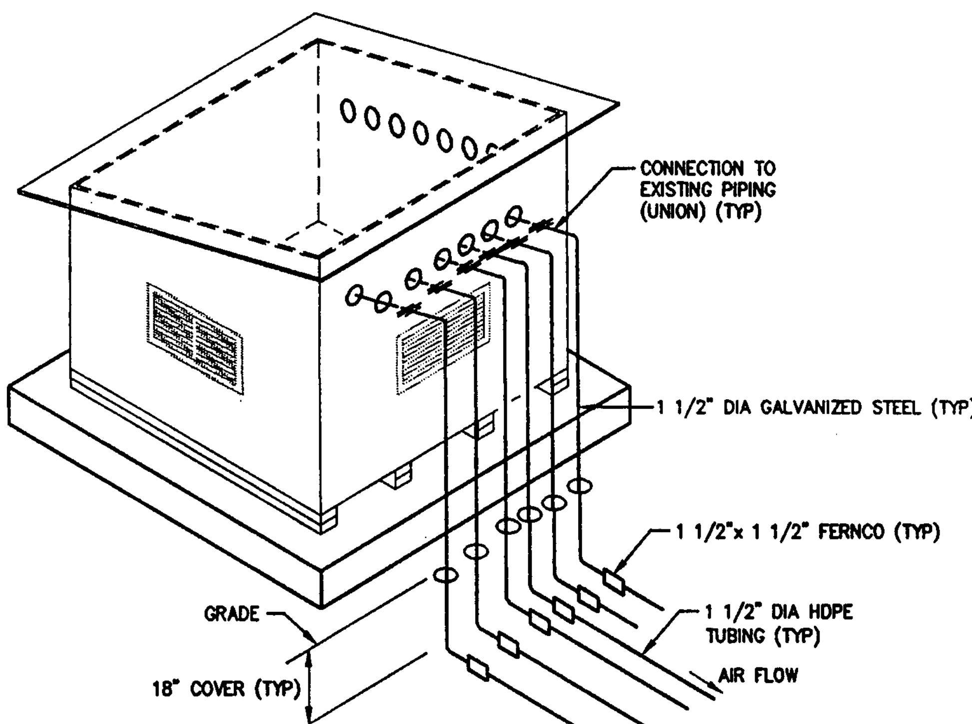
NOTES:

1. FIELD INSTALL BUILDING CENTRAL ON CONCRETE SLAB WITH ORIENTATION AS SHOWN
2. FIELD SECURE BLOWER SHED TO CONCRETE SLAB AT LOCATIONS BY THRU BOLTING. USE 3/8"x 6" LONG ST STL WEDGE ANCHOR BOLTS

CONCRETE SLAB;
6" THICK – 2500 PSI W/6"x 6" WWF
POURED ON COMPACTED OR UNDISTURBED
BASE – 1"x 45 CHAMFER TOP EDGE CONT.

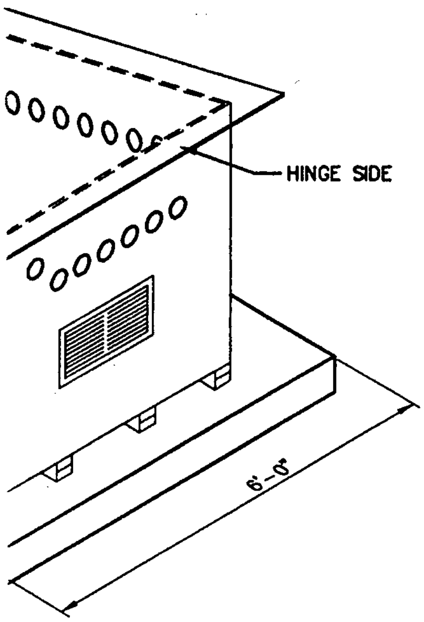
1 BLOWER SHED FIELD INSTALLATION DETAIL

NOT TO SCALE



2 TYPICAL MANIFOLD DISCHARGE PIPING LAYOUT

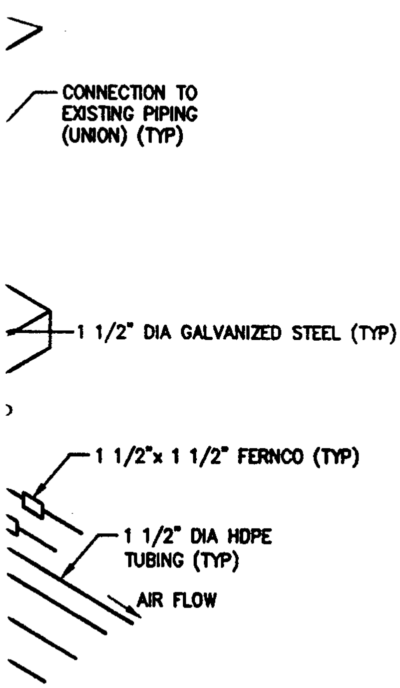
NOT TO SCALE



ͻETE SLAB;
ͻK – 2500 PSI W/6"x 6" WWF
ͻ ON COMPACTED OR UNDISTURBED
– 1"x 45 CHAMFER TOP EDGE CONT.

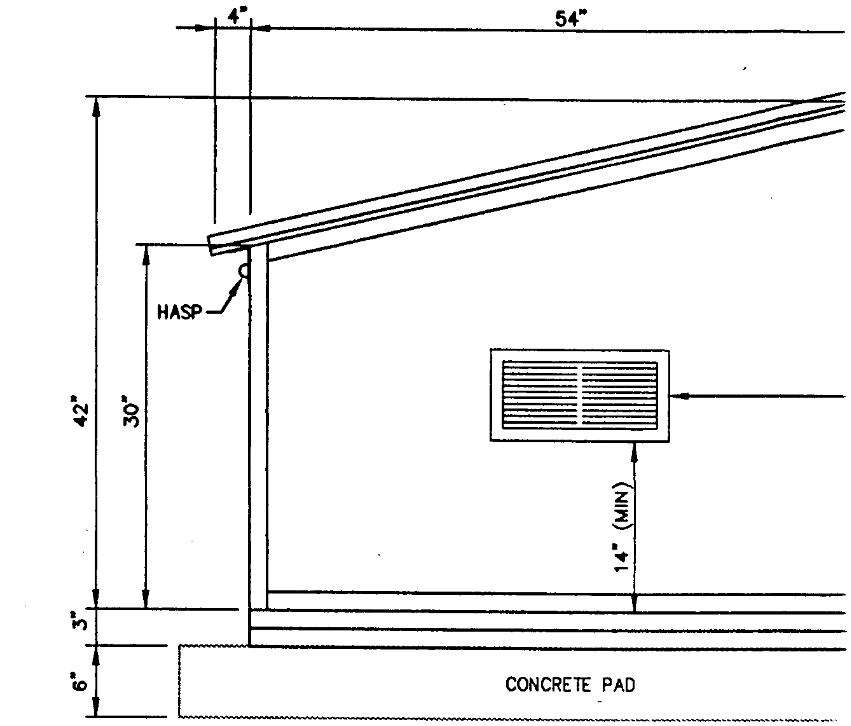
INSTALLATION DETAIL

ͻCALE

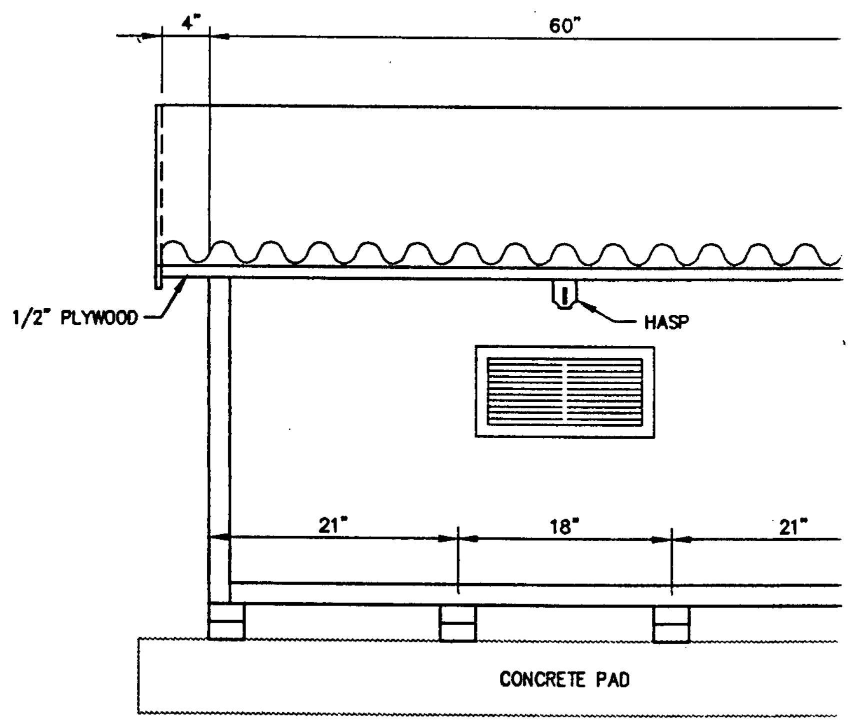


ͻHARGE PIPING LAYOUT

ͻCALE



SIDE ELEVATION



FRONT ELEVATION

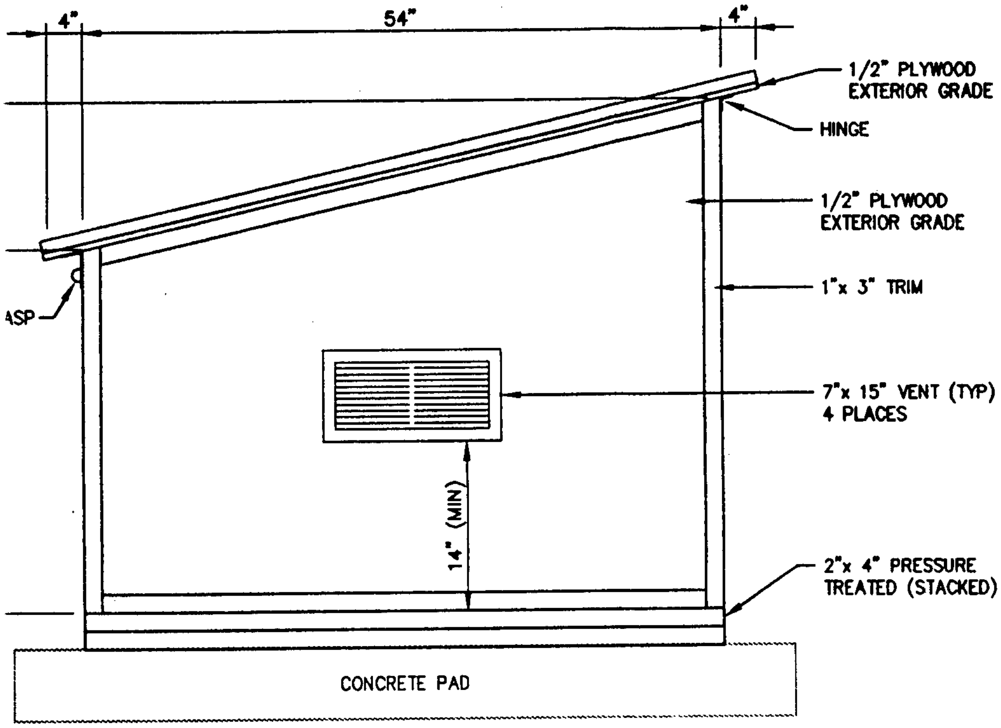
NOTES:

1. 2"x 2" FRAME CONSTRUCTION
2. FLOOR CONSTRUCTED OF 3/4" EXTERIOR GRADE PLYWOOD
3. ROOF CONSTRUCTED OF 1/2" EXTERIOR GRADE PLYWOOD COVERED WIT PVC VINYL CORRUGATED ROOFING

3 / –

BLOWER SHED CONSTRUCTION DI

3/4" = 1'-0"



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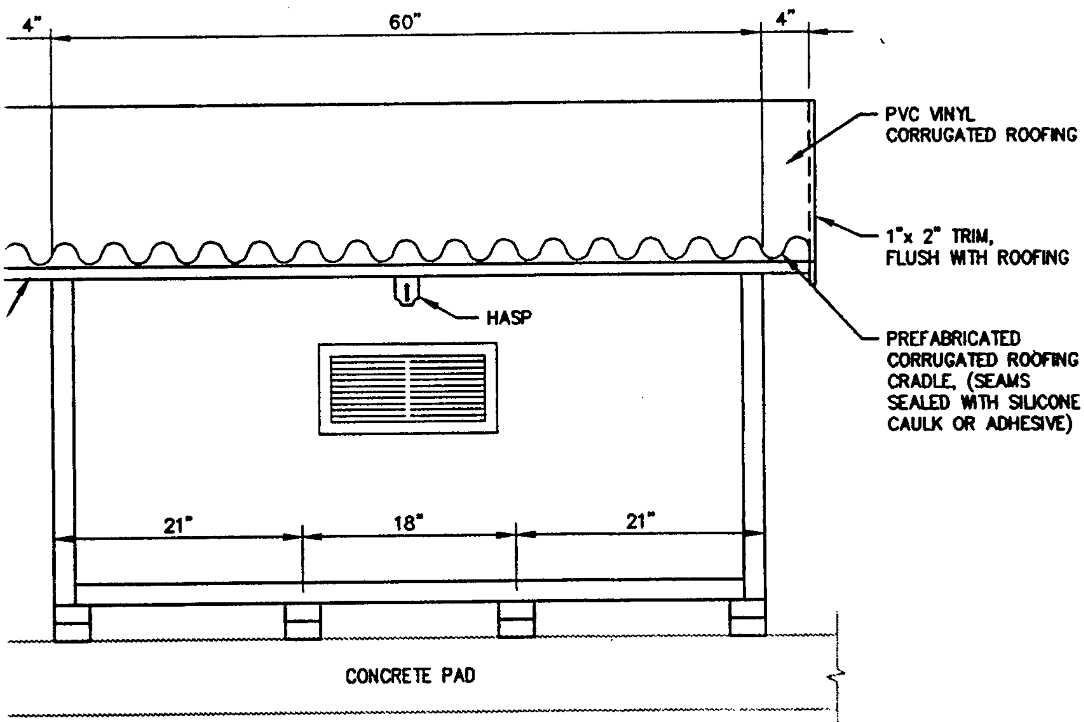

FRONT ELEVATION

NOTES:

1. 2"x 2" FRAME CONSTRUCTION
2. FLOOR CONSTRUCTED OF 3/4" EXTERIOR GRADE PLYWOOD
3. ROOF CONSTRUCTED OF 1/2" EXTERIOR GRADE PLYWOOD COVERED WITH PVC VINYL CORRUGATED ROOFING

BLOWER SHED CONSTRUCTION DETAIL

3/4" = 1'-0"

3

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BLOWER SHED FIELD INSTALLATION DETAIL AND BLOWER SHED CONSTRUCTION DETAILS

DRAWING NO G-0.6
REV A

APPENDIX B

FIELD SAMPLING PLAN

DRAFT

FIELD SAMPLING PLAN
FOR
PS-4, BULK POL STORAGE AREA
MALMSTROM AFB, MONTANA

Prepared for:

Air Force Center for Environmental Excellence
Brooks AFB, Texas
and

341 CES/CEVR
MALMSTROM AFB, MONTANA

September 1996

Parsons Engineering Science, Inc.
1700 Broadway, Suite 900
Denver, Colorado 80290

022/726876/603.WW6

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LIST OF FIGURES

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APPENDIX B

FIELD SAMPLING PLAN

B.1 FIELD ACTIVITIES

This site-specific field sampling plan (FSP) provides guidance for the field procedures to be followed while conducting the full-scale bioventing system installation at PS-4, Bulk Petroleum, Oil, and Lubricants (POL) Storage Area (POL yard), at Malmstrom Air Force Base (AFB) (the Base), Montana. Field activities will include soil borehole drilling and sampling, vent well and monitoring point construction, field screening of soil, and soil gas sampling. The activities which are to take place at the site are discussed in more detail in the remedial action plan (RAP).

B.1.1 Site Reconnaissance, Preparation, and Restoration Procedures

Prior to initiation of ground-intrusive activities, the proposed drilling location will be surveyed for the presence of underground utilities. A site map showing the proposed drilling locations is presented in the RAP.

A temporary decontamination pad for the decontamination of drilling equipment will be constructed within the POL yard, or in a location as directed by Malmstrom AFB personnel. The bermed pad will be constructed to contain decontamination water. The pad will be triple-lined with plastic sheeting to prevent leakage. Collected water will be pumped from the pad into U.S. Department of Transportation (DOT) approved 55-gallon drums.

Safety equipment such as fire extinguishers, protective clothing, first-aid kits, and respirators will be stored in the field trailer, which will be located within the POL yard.

An effort will be made to minimize disturbance at the site. Following completion of drilling activities at each borehole, soil cuttings will be collected and placed in a roll-off container at the site. Following drilling activities, the roll-off container will be emptied at the Base landfarm and the contents will be spread on the ground surface in an 8-inch-thick layer. All trash generated from field activities will be removed from the site.

B.1.2 Drilling and Soil Sampling

Drilling in unconsolidated soils will be accomplished using the hollow-stem auger method with 11-inch-outside-diameter (OD) augers. Borings will be drilled and continuously sampled from ground surface to approximately 10 feet below ground surface (bgs). Boreholes will be logged by a Parsons Engineering Science, Inc. (Parsons ES) engineer.

Continuous soil samples will be obtained using a CME® split-barrel continuous sampling device. Relatively undisturbed soil samples, suitable for chemical analysis, will be collected continuously over the proposed full depth of the soil borehole. Soil samples will be collected in a 2.5-inch-inside-diameter (ID) split-barrel sampler that will be lowered through the hollow stem of the augers and driven approximately 1.5 foot, into undisturbed soil, ahead of the augers.

The split-sampler will be fitted with three precleaned, 2.5-inch-OD by 6-inch-long, thin-walled, brass sleeves. Before samples are collected, sample sleeves will be cleaned using the same procedure used for the sampler. After collection of a sample, the sampler will be retrieved, split apart, and the sleeves will be removed. The ends of the lowest sleeve that contains the sample for chemical analysis will be covered with Teflon® sheets and plastic end caps.

The upper sample sleeves will be used for logging purposes, and will be screened in the field for organic vapors using a photoionization detector (PID). Representative portions of the soil samples will be collected for headspace analysis. These samples will be quickly transferred to containers, which will be sealed and held for 15 minutes at an ambient temperature of 18 degrees Celsius (°C) or greater. Semiquantitative measurements will be made by puncturing the container seal with the PID probe and reading the concentration of the headspace gases. The PID relates the concentration of total volatile organic compounds (VOCs) in the sample to an isobutylene calibration standard. It is anticipated that headspace measurements will be performed on all samples collected during the drilling operations. The PID will also be used to monitor the workers' breathing zone. The data obtained from the logging and screening will be recorded on the borehole logs.

The sleeves for chemical analysis will be labeled with the site name and borehole number, sample depth, date of collection, project name, and other pertinent data. These sleeves will be placed immediately in an insulated shipping container with ice, and will be maintained in a chilled condition of about 4 °C until they are delivered to the analytical laboratory. Table B.1 details the types of sample containers, sample volumes, methods of preservation, and holding times for each sample matrix by analytical method. Chain-of-custody records will be prepared in the field and will accompany the samples to the analytical laboratory.

The Parsons ES site manager will be responsible for observing all drilling activities, maintaining a detailed descriptive log of subsurface materials recovered, photographing representative samples, and properly labeling and storing samples. An example of the proposed geologic boring log form is presented in Figure B.1. The descriptive log will contain:

- Sample interval (top and bottom depth).

- Sample recovery.

- Presence or absence of contamination.

TABLE B.1
SAMPLE CONTAINERS, SAMPLE VOLUMES, SAMPLE PRESERVATION METHODS, AND HOLDING TIMES FOR SOIL SAMPLES [a/]
AFCEE EXTENDED BIOVENTING

Analytical Parameter	Analytical Method[a/]	Sample Containers: Quantity	Sample Containers: Type and Volume	Preservation Method	Holding Time
Total Petroleum Hydrocarbons (TPH)	SW8015A Mod [b/]	1	4 oz glass wide mouth with Teflon®-lined cap, stainless steel tube, polybutylate tube, or brass liner [c/]	Maintain at 4°C	14 days to analysis
Aromatic Volatile Compounds	SW8020A	1	4 oz glass jar with Teflon®-lined cap or brass liner	Maintain at 4°C minimize headspace	14 days to analysis

a/ All handling procedures are in accordance with U.S. Environmental Protection Agency, 1993 and 1995.
b/ The TPH method includes gasoline, diesel, and jet fuel. Method modifications are state-specific.
c/ Brass liners are not to be supplied by laboratory. They will be supplied by CONTRACTOR or another SUBCONTRACTOR such as the drilling firm.

022/726876/604.WW6

FIGURE B.1

Sheet 1 of 1

GEOLOGIC BORING LOG

JOB NUMBER.:	726876.38130	CLIENT:	AFCEE/Malmstrom AFB	DATE:	
BORING NUMBER:		BORING DIA.:		ELEVATION:	
RIG TYPE:		CONTRACTOR:		DATUM:	
TEMPERATURE (°F):		WEATHER:		GEOLOGIST:	
		DRLG MED:	HSA		
COMMENTS:					

Depth (ft.)	Pro-file	USCS	Geologic Description	Split Spoon Interval	Laboratory Sample Identification	Sample Type	PID ppmv	Remarks
								PID = Sample/Bkgrnd
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								
15								
16								
17								
18								
19								
20								

PID - Photoionization Detector
BH - Borehole
BZ - Breathing Zone
SAA - Same As Above
Bkgrnd - Background
HSA - Hollow Stem Auger

ft - Feet
bgs - Below Ground Surface
na - Not Analyzed
ppmv - Parts per Million, Volume per Volume
HS - Sample Headspace
SS - Split Spoon Sample

BS - Brass Sleeve Sample
G - Grab Sample
sm = some
sl = slight
v = very
brn = brown

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- Soil or rock description, including relative density, color, major textural constituents, minor constituents, relative moisture content, grain size, structure or stratification, and any other significant observations.

- Lithologic contacts. The depth of lithologic contacts and/or significant textural changes will be measured and recorded to the nearest 0.1 foot.

B.1.3 Installation of Vent Wells and Vapor Monitoring Points

The vent wells (VWs) and vapor monitoring points (MPs) will be installed as shown on Figure G-0.3 of the RAP.

B.1.4 Decontamination Procedures and Investigation-Derived Waste Handling

Prior to arriving at the site, the drill rig, augers, drilling rods, bits, casing, samplers, tools, and other downhole equipment will be decontaminated using a high-pressure, steam/hot water wash with Alconox® or equivalent laboratory-grade detergent. If necessary, the equipment will be scrubbed until all visible material such as dirt, grime, grease, oil, loose paint, and rust flakes have been removed. The inside surfaces of casings, drill rods, and auger flights will also be washed as described above. The equipment will then be rinsed with copious amounts of cold potable water.

During drilling operations, the drill rig, augers, and any downhole drilling and/or sampling equipment will be decontaminated at the decontamination pad. Water from the decontamination operations will be transferred to 55-gallon drums, then taken to the Base landfarm and sprayed onto the landfarm soils. Precautions will be taken to minimize any impact to the area surrounding the decontamination pad that might result from the decontamination operations.

All soil sampling tools will be decontaminated prior to use and between each use as described below:

- Scrub the equipment with a solution of hot potable water and Alconox® or equivalent laboratory-grade detergent. Rinse equipment with copious quantities of cold potable water.

- Rinse equipment with pesticide-grade methanol.

- Air dry equipment on a clean surface such as Teflon®, stainless steel, or aluminum. If the sampling device will not be used immediately after being decontaminated, wrap it in aluminum foil, shiny side out.

- Conduct all decontamination activities so that all water and methanol will be collected, containerized, and deposited into the decontamination pad collection tanks.

Contaminated soil cuttings generated during drilling will be placed in a roll-off container within the POL yard. The roll-off container will be covered with a tarp when not in use. Upon completion of the drilling activities, contaminated soils will be transported to the Base landfarm.

B.1.5 Borehole Abandonment

It is not anticipated that any of the boreholes will need to be abandoned. Should abandonment be required, the borehole will be abandoned by backfilling with bentonite chips or a Portland® cement/sodium bentonite grout mixture to within approximately 3 feet of ground surface. If Portland® cement/sodium bentonite grout is used, the bentonite content of the grout will not exceed 8 percent by dry weight. If standing water is present in the boring, the grout mixture will be placed using a tremie pipe placed below the static water level near the bottom of the boring. The grout mixture will be pumped through the tremie pipe until undiluted grout is present in the boring near ground surface.

Twenty-four hours after abandonment, the field engineer or his designate will check the abandoned site for grout settlement. As necessary, he will specify additional grout, or backfill the hole to ground surface with clean native soil or asphalt.

B.2 SOIL AND SOIL GAS ANALYTICAL SAMPLES

Soil and soil gas samples will be collected during installation of the full-scale bioventing system to provide baseline data against which the progress of full-scale remediation can be evaluated.

B.2.1 Soil Analytical Samples

Proposed sample analytical methods and detection limits are presented in Table B.2. All samples will be analyzed by the Inchcap Laboratory in Richardson, Texas, an AFCEE-approved laboratory. Ten soil samples from the POL yard will be analyzed by approved methods (U.S. Environmental Protection Agency, 1995). Method SW8015A Modified for TVPH as gasoline (GRO), SW8015 Modified for TEPH as diesel (DRO), and SW8020A for benzene, toluene, ethylbenzene, and xylenes (BTEX) will be used. GRO results will be reported for carbon chain C6 through C10, and DRO results will be reported for carbon chain C10 through C28. The results will be reported in a letter report.

B.2.2 Soil Gas Sampling and Analytical Procedures

The purposes of soil gas sampling and analysis are to:

- Determine the initial levels of BTEX and total volatile hydrocarbons (TVH) in the soil gas;
- Predict potential air emissions;
- Determine the reduction in BTEX and TVH during system operation; and
- Detect migration of these vapors from the source area.

Eight soil gas samples will be collected from the site during full-scale system installation. Prior to soil gas sampling for laboratory analysis, field instruments will be used to establish baseline oxygen, carbon dioxide, and TVH levels. The 8 VWs and

TABLE B.2
PROPOSED SOIL SAMPLE ANALYTICAL METHODS
AND PROJECT DETECTION LIMITS
AFCEE EXTENDED BIOVENTING

Analytical Method	PQL (mg/kg)[a/]
EPA SW8015A Modified for Gasoline (GRO) [b/] (California Department of Health Services Method)	1.0
EPA SW8015 Modified for Diesel (DRO) [c/] (California Department of Health Services Method)	10.0
EPA SW8020A	
Benzene	0.001
Toluene	0.002
Ethylbenzene	0.002
Xylenes	0.002

a/ PQL = practical quantitation limit; mg/kg = milligrams per kilogram.

b/ This corresponds to a n-alkane range from the peak start of C6 to the peak start of C10.

c/ This corresponds to a n-alkane range from the beginning of C10 to the beginning of C28.

the MP intervals exhibiting the highest TVH concentrations will be sampled for laboratory analysis of TVH and BTEX.

Prior to collecting soil gas samples, the VWs and MPs must be purged with a 1-cubic-foot-per-minute (CFM) pump. Approximately three times the VW or MP volume will be purged. To determine adequate purging time, soil gas concentrations will be monitored until the concentrations stabilize or until the oxygen concentration reaches a minimum level. The carbon dioxide/oxygen (CO_2/O_2) analyzer will be connected to the outlet of the sampling pump with a "tee" connection, as shown in Figure 5.1 of the protocol document. Soil gas samples should be taken immediately upon completion of purging.

A sample will be collected in a 1-liter evacuated stainless steel (SUMMA®) canister provided by the analytical laboratory. Because the canisters are evacuated, the sample is collected almost instantaneously when they are opened. In silt and clay soils, the soil gas sample will first be collected in a new 2-liter Tedlar® bag using a vacuum chamber (egg) connected to the vapor well. The Tedlar® bag will then be connected to the evacuated cylinder using a 6-inch-long section of clean Tygon® tubing. The gas will be transferred from the Tedlar® bag by first opening the Tedlar® bag valve and then opening the valve on the evacuated cylinder. The sample will transfer rapidly. Once the transfer is complete, the valve on the cylinder will be immediately closed and sealed with a piece of tape to prevent reopening.

Soil gas samples and chain-of-custody forms will be placed in a box and packed with foam pellets to prevent excessive movement during shipment. Samples will not be sent on ice as this will cause condensation of hydrocarbons and degrade sample integrity.

B.3 FIELD MEASUREMENTS

Typical field parameters that may be measured and the equipment that will be used for the measurements are described in Table B.3. Details of the equipment calibration, maintenance, and decontamination are also described in Table B.3.

B.4 FIELD QUALITY ASSURANCE/QUALITY CONTROL (QA/QC) PROGRAM

Field measurement parameters, control checks, control limits, and corrective actions are identified in Table B.4.

B.5 FIELD SYSTEMS OPERATION AND MONITORING

B.5.1 Pressure/Vacuum Monitoring

Dwyer Instruments Magnehelic® gauges with a range of 0 to 200 inches of water-column will be used to measure pressure/vacuum at the MPs. The pressure/vacuum measurements will be taken by manually connecting the Magnehelic® gauge to each MP. The gauges will be read to 0.1 of the smallest standard unit.

TABLE B.3
FIELD MEASUREMENTS
AFCEE EXTENDED BIOVENTING

Parameter	Equipment	Calibration	Source of Calibration Standards	Equipment Maintenance	Equipment Decontamination
Pressure/ vacuum	Dwyer Instruments Magnehelic® gauge	Calibrated by manufacturer	Not applicable	Replace in case of malfunction	Not Applicable.
Temperature	Mercury thermometer	Calibrated by manufacturer	Not applicable	Replace in case of malfunction	Rinse thermometer with distilled water after each use and blot or shake to remove excess water.
Soil temperature	Type J thermocouple	Check with ambient temperature and ice	Mercury thermometer	Follow manufacturer's procedures	Rinse probe with distilled water. Remove excess water.
Carbon dioxide and oxygen	GasTech® analyzer	Two-point calibration	Commercially available gas mixes	Follow manufacturer's procedures	Rinse probe with distilled water. Remove excess water.
Total volatile hydrocarbons	GasTech® analyzer	Two-point calibration	Commercially available gas mixes	Follow manufacturer's procedures	Rinse probe with distilled water. Remove excess water.

TABLE B.4
CONTROL PARAMETERS, CONTROL LIMITS, AND CORRECTIVE ACTIONS
AFCEE EXTENDED BIOVENTING

Measurement Parameter	Control Checks	Control Limits	Corrective Action[a/]
Pressure/ vacuum	Check measurement	± 1 inch water	Replace gauge.
Temperature	Check measurement	± 1 °C	Replace thermometer or correct temperature readings.
Soil temperature	Check measurement	± 1 °C	Replace thermocouple or return reader to manufacturer.
Carbon dioxide/oxygen	Calibrate standards.	±5% of value	Recalibrate. Check battery. Clean filter.
Total volatile hydrocarbons	Calibrate daily and check battery	± 100 ppm [b/]	Recalibrate. Check battery. Clean filter.

a/ Required if control limits not achieved.
b/ ppm = Parts per million.

An air permeability test will not be conducted at the POL yard. However, pressure/vacuum measurements will taken to assess pressure influence at varying locations.

B.5.2 Temperature Monitoring

Ambient temperature will be measured using a mercury thermometer during the use of direct-reading instruments to account for data variability associated with temperature. Soil temperature will be measured using the type J thermocouples that are placed at MPC.

B.5.3 Oxygen and Carbon Dioxide Monitoring

Both oxygen and carbon dioxide will be monitored with a GasTech® Model 3252OX gas analyzer. This instrument includes an infrared detector for carbon dioxide and an electrochemical cell for oxygen analysis, and is capable of measuring both compounds to an accuracy of 0.1 percent. The instrument requires daily calibration with a 5 percent carbon dioxide gas mixed in laboratory-grade nitrogen. The same calibration gas can also be used to provide a zero for oxygen.

B.5.4 Total Volatile Hydrocarbons

Hydrocarbon concentrations in extracted soil gas will be measure using a GasTech® Trace-Techtor Hydrocarbon Analyzer, model 72-8418E-O2.

B.6 REFERENCES CITED

U.S. Environmental Protection Agency (USEPA). 1993. Methods for the Chemical Analysis of Water and Waste. Washington, D.C.

U.S. Environmental Protection Agency (USEPA). 1995. Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, SW-846, 3rd Edition, Update IIB. Washington, D.C.

APPENDIX C

SITE-SPECIFIC HEALTH AND SAFETY ADDENDUM

ADDENDUM TO

THE PROGRAM HEALTH AND SAFETY PLAN FOR EXTENDED BIOVENTING AT PS-4, BULK POL STORAGE AREA

AND

THE HEALTH AND SAFETY PLAN FOR RISK-BASED REMEDIATION DEMONSTRATIONS AT PUMPHOUSE NUMBER 2

AT

MALMSTROM AIR FORCE BASE MONTANA

September 1996

Prepared by:

Parsons Engineering Science, Inc.
1700 Broadway, Suite 900
Denver, Colorado 80290

REVIEWED AND APPROVED BY:

	Name	Date
Project Manager	[signature]	9/11/96
Program Health & Safety Manager	Timothy J Mustard	9/11/96

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1.0 INTRODUCTION

This addendum modifies the existing program health and safety plan entitled *Program Health and Safety Plan for Extended Bioventing* (Parsons Engineering Science, Inc., 1995) for completing remediation monitoring and for designing and implementing full-scale bioventing systems at numerous United States Air Force (USAF) installations.

Under contract number F41624-92-D-8036, Delivery Order (DO) 17, Air Force Center for Environmental Excellence (AFCEE), Technology Transfer Division (ERT), Brooks Air Force Base (AFB), Parsons Engineering Science, Inc. (Parsons ES) was retained to transition new and existing bioventing pilot-scale systems toward either site closures or toward expansion into full-scale systems. Project options under DO 17 include one additional year of testing for existing bioventing systems; closure soil sampling; completion of initial bioventing tests at new sites; and design and installation of multiple-vent well, full-scale systems.

This addendum also modifies the existing program health and safety plan entitled *Health and Safety Plan for Risk-Based Remediation Demonstrations* (Engineering-Science, Inc., 1994) for site investigations at fuel-contaminated sites at various USAF installations. Under contract F41624-93-C-8044, AFCEE, ERT, Brooks AFB, Parsons ES was retained to assist the USAF in developing and implementing a practical, risk-based approach to fuel-spill remediation.

This addendum to the program health and safety plans was prepared to address the upcoming tasks at Malmstrom Air Force Base (AFB), Montana. Included or referenced in this addendum are the scope of services, site-specific description and history, project team organization, hazard evaluation of known or suspected chemicals, evaluation of physical hazards, emergency response procedures and information, personal protective equipment, decontamination procedures, site control measures, and health and safety procedures required for the proposed work. All other applicable portions of the program health and safety plans remain in effect.

Site-specific health and safety briefings will be conducted daily prior to the commencement of field activities to communicate the site-specific hazards, activities, and procedures to all field personnel. Documentation of training and briefings, including agenda and signatures of attending personnel, will be maintained onsite.

2.0 SCOPE OF SERVICES

The scope of services to be completed by Parsons ES under the extended bioventing contract will involve the installation of a full-scale bioventing system for *in situ* treatment of fuel-contaminated soils at PS-4, the Bulk Petroleum, Oils, and Lubricant Bulk Storage Area (POL Area). The extended bioventing system will include the existing air injection vent well (VW), and will involve the construction of twelve additional VWs, six new vapor monitoring points (MPs), soil and soil gas characterization, *in situ* respiration tests, and the installation of a new blower system for air injection. Well and monitoring point construction will be accomplished with an auger-equipped drilling rig.

The work to be performed by Parsons ES under the risk-based remediation contract will involve the installation of eight monitoring wells (six, using a drilling rig and two using a hand auger); soil and groundwater sampling; and soil excavation with the use of a backhoe. The excavated soil will be removed from the site by a subcontractor and placed in an area to be designated by Parsons ES.

3.0 SITE DESCRIPTION AND HISTORY

The site description and history for the bioventing tasks are outlined in the work plan entitled *Remedial Action Plan for Expanded Bioventing System at PS-4, Bulk POL Storage Area, Malmstrom Air Force Base, Montana* (Parsons ES, 1996).

PS-4 is the POL Yard located near the northeast corner of the Base. It once consisted of twelve underground storage tanks (USTs) used for bulk fuel storage. Three aboveground storage tanks (ASTs), also used for bulk fuel storage, are presently located at the site.

The site description and history for the tasks at Pumphouse #2 are outlined in the work plan located in Section 9 of the *Engineering Evaluation/Cost Analysis for the Risk-Based Remediation of Pumphouse #2* (Parsons ES, 1995).

Pumphouse #2 is the former fuel storage pumping facility located just off the flightline in the northern portion of the Base. It once consisted of a pumphouse, an electrical control building, and seven USTs. All of the tanks and structures have been removed.

4.0 PROJECT TEAM ORGANIZATION

The project team assigned to the extended bioventing activities at Malmstrom AFB are identified below.

Mr. John Ratz	Project Manager
Mr. Dave Teets	Site Manager
Mr. Ray Brammer	Site Health and Safety Officer
Ms. Barb Slayman	Alternate Site Health and Safety Officer
Mr. Dan Duff	Site Contact
Capt. Ed Marchand	AFCEE/ERT Contact

5.0 HAZARD EVALUATION

5.1 Chemical Hazards

Potential chemical hazards are addressed in the program health and safety plan. Site-specific hazards are identified below.

The primary contaminants at PS-4 are JP-4, diesel fuel, and the associated petroleum hydrocarbon constituents benzene, toluene, ethylbenzene, and xylenes (BTEX). These contaminants, with the exception of diesel fuel, are also of concern at Pumphouse #2.

Health hazard qualities for these compounds are presented in Table 5.1 of this addendum. If additional compounds are discovered during the course of field activities, this health and safety plan addendum shall be amended and pertinent information about the compounds will be communicated to all field personnel.

Protection standards for chemical hazards are located in Section 7 of the program health and safety plans. Additional requirements are provided below.

To avoid employee contamination and exposures above the permissible exposure limits (PELs), personnel involved in the trenching operations under the risk-based contract will not enter the trench unless the trench is less than 4 feet in depth and only if it is absolutely necessary for excavation by hand under the existing piping. If such an entrance is absolutely necessary, vapor concentrations will be closely monitored and ventilation may be necessary to ensure that vapor concentrations are below appropriate levels, as discussed in Section 7.1 of this addendum.

As a general precaution, the breathing zone will be closely monitored for all personnel in the vicinity of the trench, and the area around the backhoe will be monitored for flammable atmospheres.

5.2 Physical Hazards

Potential physical hazards at this site include risks associated with auger drilling, hand augering, and trenching activities; electrical equipment; heavy equipment; motor vehicles; overhead and underground utilities; slip, trip, and fall hazards; noise; and heat stress.

Safe work practices related to the site physical hazards are contained in Sections 5 and 9 of each program health and safety plan and also in Section 6 of the risk-based remediation plan. Additional requirements are provided below.

5.2.1 Motor Vehicles and Heavy Equipment

In addition to the information provided in Section 5.2.1 of the extended bioventing program health and safety plan and Section 6.5.1 of the risk-based remediation health and safety plan, the following precautions will also be taken.

- All personnel working at and around the drill rig must be informed of the locations of the kill switches, in the event of an emergency.

- The kill switches must be tested daily prior to the start of field activities. A log of the testing must be maintained onsite.

TABLE 5.1 HEALTH HAZARD QUALITIES OF HAZARDOUS SUBSTANCES OF CONCERN

Compound	PEL [a/] (ppm)	TLV [b/] (ppm)	IDLH [c/] (ppm)	Odor Threshold[d/] (ppm)	Ionization Potential[e] (eV)	Physical Description/Health Effects/Symptoms
Benzene	1 (29 CFR 1910.1028) [f/]	10	500	4.7	9.24	Colorless to light-yellow liquid (solid<42°F) with an aromatic odor. Eye, nose, skin, and respiratory system irritant. Causes giddiness, headaches, nausea, staggered gait, fatigue, anorexia, exhaustion, dermatitis, bone marrow depression, and leukemia. Mutagen, experimental teratogen, and carcinogen.
Diesel Fuel	400[g/]	400[g/]	1,100[g/]	0.08	NA[h/]	Colorless to brown, slightly viscous liquid with a gasoline- or kerosene-like odor. Irritates eyes, nose, and throat. Causes dizziness, drowsiness, headaches, nausea, chemical pneumonia, and dry, cracked skin.
Ethylbenzene	100	100	800	0.25-200	8.76	Colorless liquid with an aromatic odor. Irritates eyes, skin, and mucous membranes. Causes dermatitis, headaches, narcosis, and coma. Mutagen and experimental teratogen.
Jet Fuel	400 [g/]	400 [g/]	1,000 [g/]	0.08-1	NA	Colorless to light-brown liquid with a fuel-like odor. Long-term effects include liver, kidney, and CNS damage. JP-4 is a questionable carcinogen.
Toluene	100	50 (skin)[i/]	500	0.2-40 [j/]	8.82	Colorless liquid with sweet, pungent, benzene-like odor. Irritates eyes and nose. Causes fatigue, weakness, dizziness, headaches, hallucinations or distorted perceptions, confusion, euphoria, dilated pupils, nervousness, tearing, muscle fatigue, insomnia, skin tingling, dermatitis, bone marrow changes, and liver and kidney damage. Mutagen and experimental teratogen.
Xylene (o-, m-, and p-isomers)	100	100	900	0.05-200 [j/]	8.56 8.44 (p)	Colorless liquid with aromatic odor. P-isomer is a solid <56°F. Irritates eyes, skin, nose, and throat. Causes dizziness, drowsiness, staggered gait, incoordination, irritability, excitement, corneal irregularities, conjunctivitis, dermatitis, anorexia, nausea, vomiting, abdominal pain, and olfactory and pulmonary changes. Also targets blood, liver, and kidneys. Mutagen and experimental teratogen.

Revised
01/18/96

TABLE 5.1 HEALTH HAZARD QUALITIES OF HAZARDOUS SUBSTANCES OF CONCERN

a/ PEL = Permissible Exposure Limit. OSHA-enforced average air concentration to which a worker may be exposed for an 8-hour workday without harm. Expressed as parts per million (ppm) unless noted otherwise. PELs are published in the *NIOSH Pocket* California) may have more restrictive PELs. Check state regulations.

b/ TLV = Threshold Limit Value - Time-Weighted Average. Average air concentration (same definition as PEL, above) recommended by the American Conference of Governmental Industrial Hygienists (ACGIH), *1994-1995 Threshold Limit Values for Chemical Substances and Physical Agents and Biological Exposure Indices*.

c/ IDLH = Immediately Dangerous to Life or Health. Air concentration at which an unprotected worker can escape without debilitating injury or health effects. Expressed as ppm unless noted otherwise. IDLH values are published in the *NIOSH Pocket Guide to Chemical Hazards*, 1994.

d/ When a range is given, use the highest concentration.

e/ Ionization Potential, measured in electron volts (eV), used to determine if field air monitoring equipment can detect substance. Values are published in the *NIOSH Pocket Guide to Chemical Hazards*, June 1994.

f/ Refer to expanded rules for this compound.

g/ Based on exposure limits for petroleum distillates (petroleum naphtha).

h/ NA = Not available.

i/ (skin) = Refers to the potential contribution to the overall exposure by the cutaneous route.

j/ Olfactory fatigue has been reported for the compound and odor may not serve as an adequate warning property.

- The limits of the swing radius of the backhoe must be marked on the ground with cones or boundary tape. Personnel will not enter this bounded area until the backhoe has been shut down, and the operator signals that it is acceptable to enter.

- When working near the backhoe, field personnel will maintain sight contact with the operator.

5.2.2 Excavation Activities

As previously stated in Section 5.2.4 of the extended bioventing program health and safety plan and Section 6.5.4 of the risk-based health and safety plan, the location of underground utilities must be delineated in the area before intrusive activities can occur. A water line is known to exist in the vicinity of the trenching activities under the risk-based contract. The exact location of this line must be determined before trenching activities can begin.

5.2.3 Electrical Line Clearance

In addition to the information presented in the electrical hazards section (Section 5.2.5) of the extended bioventing program health and safety plan, and as stated in Section 6.5.7 of the risk-based remediation health and safety plan, extra precautions must be taken when drilling or using a backhoe in the vicinity of overhead power lines. The minimum clearance is 10 feet between heavy equipment and an overhead electrical line rated 50 kilovolts (kV) or less. For lines rated over 50 kV, the minimum clearance is 10 feet plus 0.4 inches for each kV over 50 kV.

An overhead power line occurs adjacent to the location of the trenching activities under the risk-based contract.

6.0 Emergency Response Plan

6.1 Emergency Recognition and Prevention

In amendment of the information presented in Section 6.2 of the bioventing program health and safety plan, emergency conditions are considered to exist if:

- Concentrations of combustible vapors reach or exceed 10 percent of the lower explosive limit (LEL).

6.2 Emergency Information

Listed below are the names and telephone numbers for medical and emergency services in the event of any situation or unplanned occurrence requiring assistance. For emergency situations, telephone or radio contact should be made with the site point of contact or site emergency personnel who will then contact the appropriate response team.

A list of emergency contacts must be posted at the site.

Contingency Contacts	Telephone Number
Fire Department	911
Security Police	911
Site Contact: Dan Duff	(406) 731-6369
AFCEE-ERT Contact: Capt. Ed Marchand	(210) 536-4364
Medical Emergency	
Ambulance	911
Hospital Name	Deaconess Hospital
Hospital Address	1101 26th Street South, Great Falls, MT
Hospital Telephone Number	(406) 761-1200
Route to Hospital	Proceed to west gate and follow the road to the 57th Street Bypass (Bypass 87). Turn left onto the bypass and follow to Route 200. Turn right onto Route 200 and continue to 26th Street South. Turn left onto 26th Street South and proceed to the hospital.

Parsons ES Contacts	Telephone Number
John Ratz Parsons ES Project Manager	(303) 831-8100 (W) (303) 733-5582 (H)
Timothy Mustard, C.I.H. Program Health and Safety Manager (Denver)	(303) 831-8100 (W) (303) 450-9778 (H)
Ed Grunwald, C.I.H. Corporate Health and Safety Manager (Atlanta)	(404) 235-2300 (W) (404) 299-9970 (H)
Judy Blakemore Asst. Program Health and Safety Manager (Denver)	(303) 831-8100 (W) (303) 831-4028 (H)

7.0 LEVELS OF PROTECTION AND PERSONAL PROTECTIVE EQUIPMENT REQUIRED FOR SITE ACTIVITIES

7.1 Personal Protective Equipment

Both the extended bioventing and risk-based contracts will use Figure 7.1, the fuels flow chart for selection of respiratory protection presented or described in the program health and safety plans for the individual projects and attached to this addendum. While respirators are not expected to be used during the bioventing tasks, vapor concentrations during the risk-based activities may necessitate the use of respirators.

Air-purifying respirators will be used when fuel vapor concentrations in the worker breathing zone are between 25 and 50 meter units (mu) and as long as benzene concentrations in the worker breathing zone are less than 1 ppm. No respirator is necessary if fuel vapor concentrations in the worker breathing zone are less than 25 mu and benzene concentrations in the worker breathing zone are less than 1 ppm, unless otherwise directed by the site health and safety oficer. Benzene concentrations will be measured with colorimetric tubes. Fuel vapor concentrations greater than 50 mu in the worker breathing zone will require the suspension of activities in the trench until the area is ventilated and the vapor concentrations in the worker breathing zone are reduced to under 50 mu, or until Level B, self-contained breathing apparatus and trained personnel are supplied. Field activities cannot be performed in Level B without the approval of the USAF and the Parsons ES corporate health and safety manager, Ed Grunwald.

All breathing zone readings and instrument calibrations must be documented in a field notebook or on a personal air monitoring data form. The time that personnel spend wearing respirators must also be documented in a field notebook, and respirator logs must be completed. Field personnel will be fit-tested prior to the commencement of field activities.

In accordance with Occupational Safety and Health Administration (OSHA) requirements, personal exposure monitoring will be performed during the risk-based remediation activities, due to the potential for exposure. During trenching activities, benzene vapor monitoring badges will be worn, preferably for an 8-hour period, by the backhoe operator and the person performing breathing zone monitoring. A blank badge must also be submitted for laboratory analysis, along with the badges worn by personnel.

In amendment of the information presented in Section 7.1 of the both program health and safety plans, SilverShield® or 4H outer gloves will be worn when handling contaminated equipment or samples.

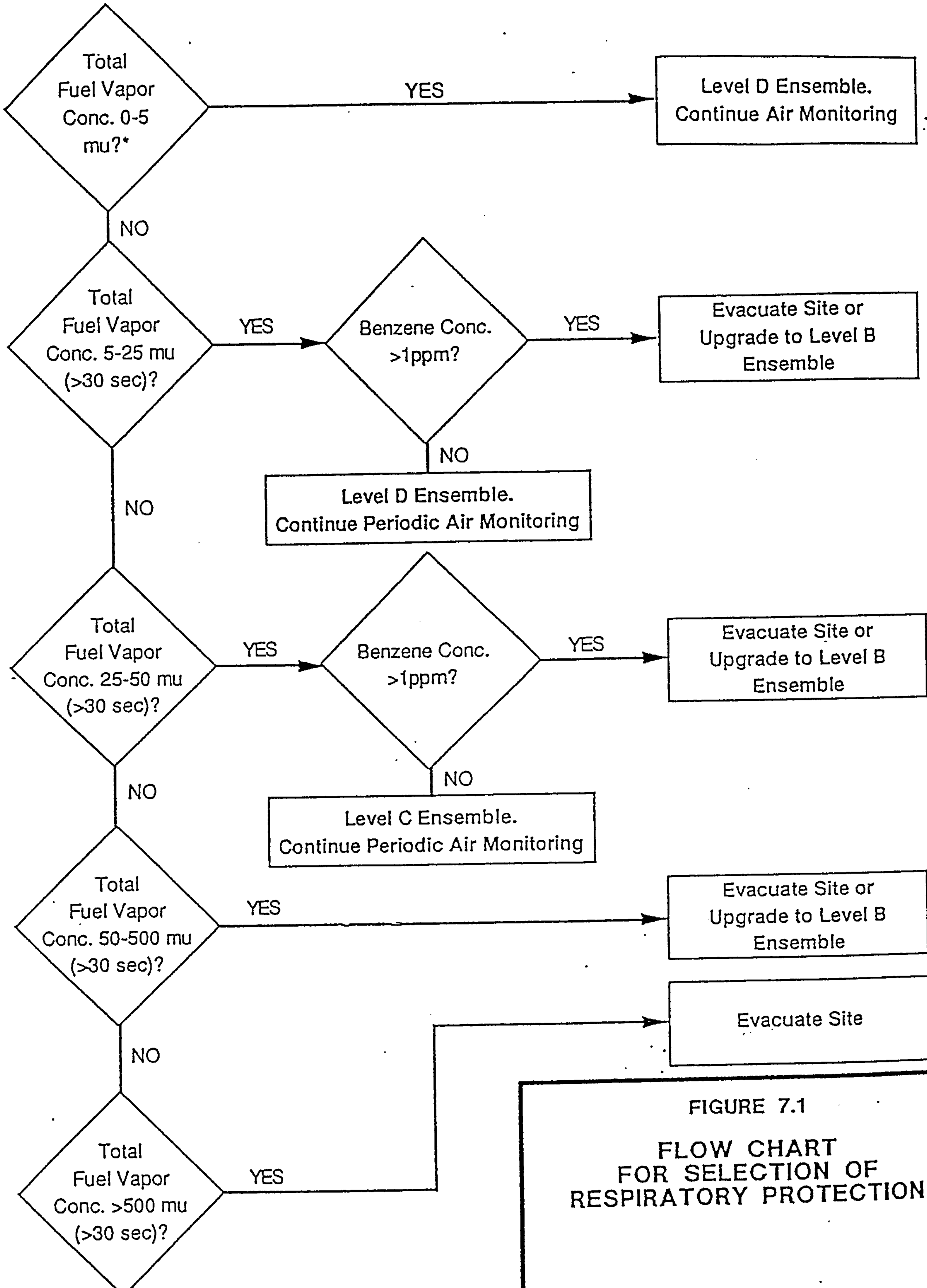

FIGURE 7.1

FLOW CHART
FOR SELECTION OF
RESPIRATORY PROTECTION

PARSONS
ENGINEERING SCIENCE, INC.
Denver, Colorado

* mu = Meter Units

8.0 DECONTAMINATION PROCEDURES

8.1 Personnel Decontamination Procedures

The size and location of the decontamination station will be determined in the field prior to the commencement of field activities, and will be based on the level of personal protective equipment used and the site conditions, including topography, wind direction, and traffic patterns.

9.0 SITE CONTROL

During intrusive activities, field personnel will remain in locations upwind from potential contamination. Wind direction indicators (e.g., tape, pin flags, etc.) will be used in the appropriate places and will be visible at all times.