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FINDINGS REPORT PILOT-SCALE SOIL VAPOR EXTRACTION STUDY SITE 57 NSWC INDIAN HEAD MD
5/1/1997

Findings Report
Pilot-Scale Soil Vapor Extraction Study
Site 57 - Former Drum Loading Area

for

Naval Surface Warfare Center
Indian Head, Maryland

May 1997

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1.0 INTRODUCTION AND PROJECT BACKGROUND

Installation Restoration (IR) Site 57, also known as the Former Drum Loading Area, includes the asphalt and grassy areas extending approximately 80 feet east, 80 feet west and 230 feet south from the southeast corner of Building 292 (Figure 1-1).

Previous operations conducted within Building 292 included trichloroethene (TCE)-vapor degreasing of metal parts. Between the mid-1960s and 1989 it has been estimated that approximately 1,900 gallons of TCE were used in this vapor degreasing operation. Also, between the mid-1970s and 1989 large dip tanks containing TCE were used for general parts cleaning. The spent TCE from these operations was transferred via a pipe through the building wall, to an outlet located on the exterior of the southeastern wall of Building 292 where the solvent was discharged into metal storage drums. The drums were temporarily stockpiled in the grassy area located 40 feet southeast of Building 292.

1.1 Previous Investigations

A Site Management Plan (B&R Environmental, 1995a) prepared for the Indian Head Division Naval Surface Warfare center (IDH-NSWC), Indian Head, indicated that no investigations for contamination had been conducted at Site 57 prior to 1994. In July 1994 the Navy collected 2 rounds of water samples from Site 57. During the second sampling round, concentrations of TCE were detected in water samples collected from manhole MH-1 (62 μg/L) and also from outfall IW-80 (47 μg/L) which is located downstream, approximately 1,000 feet southeast of Building 292.

A Field Sampling Plan (B&R Environmental, 1995b) and Data Report (B&R Environmental, 1996a) prepared for Site 57 confirmed these findings. According to these reports, TCE was detected in shallow (2 ft to 4 ft) soil and deep (10 ft to 12 ft) soil samples at concentrations of 840,000 μg/kg and 150 μg/kg, respectively. A groundwater sample collected from this area contained TCE at a concentration of 370,000 μg/L.

The Engineering Evaluation and Cost Analysis (EE/CA) subsequently prepared for Site 57 (B&R Environmental, 1996b) advanced and evaluated three alternative methods to reduce concentrations of TCE contained in the unsaturated soil layer of Site 57 soil (Section 4.0 and 5.0, EE/CA). Based on the results of the comparative analysis of remediation alternatives presented in the EE/CA, and the Office of Solid Waste and Emergency Response (OSWER) recommendations on presumptive remedies for VOCs

in soil, Soil Vapor Extraction (SVE) was selected as the preferred method to reduce TCE concentrations in the unsaturated soil layer.

1.2 Pilot-Scale SVE Investigation

This pilot-scale SVE investigation (B&R Environmental, 1996c) was conducted at Site 57 to evaluate the effectiveness and implementability of SVE for reducing TCE concentrations in the unsaturated soil. The evaluation would be based on an assessment of field operating data with regard to the following performance issues:

- Could TCE-contaminated air contained in the unsaturated soils could be collected through a vertical well screen installed in the vadose zone?

- Could an air circulation pattern be established in the vadose zone, by this induced vacuum, that would promote additional volatilization of TCE currently sorbed to the unsaturated soil?

- Measured from the air extraction well, what is the horizontal limit of vacuum within the vadose zone, for four different vacuum levels? And does this limit increase with increasing vacuum levels?

2.0 SYSTEM CONSTRUCTION

The equipment used to conduct this pilot-scale SVE investigation included the following items:

One, 2-inch diameter, Schedule 40 PVC air extraction well installed to a depth of 10 feet below the ground surface (bgs). The 4-foot-long air extraction well screen was located between 6 feet bgs and 10 feet bgs.

- Twelve, 3/4-inch-diameter, steel, drive point monitoring probes.

- A trailer-mounted air extraction system that included a power generator, vacuum blower, air flow control valving and activated-carbon air treatment unit.

- A mobile gas chromatograph for on-site analysis of air samples. The mobile unit was contained in a specially constructed utility van.

The air-extraction well cross-section is illustrated in Figure 2-1. A schematic diagram of the air extraction system layout is illustrated in Figure 2-2. A plan view of the entire SVE pilot-test layout on Site 57 is illustrated on Figure 2-3.

2.1 Air Extraction Well

The 2-inch-diameter, Schedule 40 PVC air extraction well used for this investigation was installed to a depth of 10 feet below the ground surface (bgs). The 0.02-inch slotted screening of the well was located between 6 feet bgs and 10 feet bgs. The extraction well boring log is included as Attachment 1. A split-spoon sampler was used to collect 2 soil samples from the well boring. Samples were collected from depth intervals of 7-feet to 8-feet and also 9-feet to 10-feet. The samples were sent to Ackenheil Engineers, Inc., Pittsburgh, PA, for analysis of grain-size and moisture content. The analytical results are included as Attachment 2.

2.2 Drive Point Monitoring Probes

Two, 3/4-inch-diameter, galvanized-steel drive point monitoring probes were hydraulically installed at each of the 6 monitoring locations indicated on Figure 2-3. As indicated in the figure, each of the probe pairs (A through F) were installed at approximately 5-foot intervals along two radii extending from the air extraction well. One radius extended southward from the air extraction well; the second radius extended eastward from the air extraction well. The increasing horizontal distance of each probe pairing from the extraction well was used to determine the horizontal limit of vacuum influence induced in the vadose by each of the four vacuum settings.

Probe pair F was installed at approximately the same radial distance of 5 feet from the air extraction well as probe pair A. However, the 5-foot horizontal interval to probe pair F was positioned approximately 90-degrees relative to the 5-foot interval to probe pair A. This 90-degree offset between probe pairings A and F was used to evaluate homogeneity of subsurface air flow characteristics at equal horizontal distances from the air extraction source.

A pair of probes was installed at each monitoring location (A through F) to assess vertical differences in air flow characteristics induced across the pilot-test area. At each of the six monitoring locations, the open bottom of the shallow probe was located at a vertical depth of 4 feet bgs. The open bottom of the deep probe was located at a vertical depth of 8 feet bgs.

2.3 Trailer-Mounted Air Extraction System

Air flows were induced in the subsurface soils by using a 1-horsepower, regenerative, vacuum blower, mounted on a small, flat-bed trailer to produce a vacuum within the air extraction well. The air extraction unit was constructed and operated by TPH Technology, Annapolis, MD. Air drawn from the unsaturated soil surrounding the air extraction well screen passed through the blower, and then through an air purification unit prior to discharge to the atmosphere. The blower was connected to the 2-inch -diameter air extraction well using a 2-inch-diameter section of flexible tubing.

The magnitude of the vacuum applied to the extraction well was controlled by means of an air bleed port located in the air line between the extraction well and the vacuum blower.

The air purification unit consisted of one 150-pound canister of granular activated carbon.

A hand-held vacuum gauge was used to measure the vacuums induced in the subsurface soil at each of the 12 drive point monitoring probes and also at the main header attached to the air extraction well. The corresponding air flow rates through the air extraction well and the air purification unit were measured using a hand-held flow meter. Measured vacuums and air flow rates for the 4 distinct settings used in the pilot-scale test are summarized in Table 2-1.

2.4 Air Sample Collection and Analysis

2.4.1 Air Sample Equipment

The concentrations of TCE and other contaminants contained in the extracted air stream were identified through on-site air sample analysis using a Hewlett Packard 5890 Series II gas chromatograph (GC) with electron capture detector and computing integrator. The compounds in the samples were separated in the GC using a packed analytical column (1% SP1000 stationary phase bonded to 60/80 mesh Carbopack B support) in a temperature-controlled oven. Nitrogen was used as the carrier gas. The instrument calibrations were performed at the start of each day and then checked periodically throughout the day to monitor the response factors and retention times. All air sample and analysis equipment was supplied and operated by Tracer Research Corporation, Monmouth Junction, NJ.

Glass syringes were used to collect up to 10 milliliters of air at each of the monitoring locations. A clean syringe was used for each sample. Prior to reuse, each syringe was purged with nitrogen gas, washed and baked.

2.4.2 Air Sample Analysis

As indicated in Figure 2-2, air samples were collected at two locations in the air extraction system:

- At a port located in the air transfer piping between the air extraction blower and the air treatment system.
- At a port located in the air discharge piping extending from the air treatment system.

Analytical results for air samples collected from the port located between the blower and the air treatment unit indicated total concentrations of volatile organic compounds (VOCs), including TCE, contained in all air being drawn from the vadose zone soils. Analytical results for air samples collected from the port located in the air discharge piping indicated total concentrations of VOCs remaining in the extracted air stream after vapor-phase cleaning by the activated carbon air treatment unit.

Air samples were also collected from surface ports located on each of the 12 drive point monitoring probes installed in the study area. All air samples were collected from sections of rubber tubing sealed over the above-ground, open top of each of the 12 drive point monitoring probes. Analytical results for air samples collected from each probe indicated concentrations of VOCs, including TCE, volatilized in the vadose zone in the immediate area around that particular probe bottom.

Analytical results for the air samples collected during the pilot study are summarized in Table 2-2.

The following labeling system was used to identify the order and location of each air sample:

AA	-	AN	-	N
(Sample Type)		(Horizontal/Vertical Sample Location)		(Sample Event)

where A = Alphabetical symbol
N = Numerical Symbol

<u>Sample Type</u>

SG - Soil Gas sample
Carbon - Air sample collected from the effluent line of the carbon treatment system

Horizontal/Vertical Sample Location

M	-	Main air transfer pipe between the vacuum blower and the air treatment system.
A through F	-	Drive point monitoring probe horizontal location label
4 or 8	-	Drive point monitoring probe vertical location label (4 feet or 8 feet below the ground surface)

Sample Event

1 through 3	-	First sample through third sample collected from a particular location

Examples:

Carbon - 1	First air sample collected from the effluent line from the activated carbon airtreatment system
SG-A8-2	Soil gas collected from drive point A, 8-foot deep probe opening, second sample at this location

3.0 SYSTEM OPERATION

This pilot-scale SVE system was installed and operated over 2 days. Four different vacuums were produced within the air extraction well by the vacuum system. These vacuums and the corresponding air flow rates were monitored at several locations within the pilot-scale system (Table 2-1). Air samples were collected at several locations in the pilot-scale system and analyzed on site for concentrations of 1,1 DCE, 1,2 DCE, TCE and TCA (Table 2-2).

3.1 Groundwater

The depth to groundwater reported for this area during the earlier field sampling event (B&R Environmental, 1996a) was 11 feet below ground surface (bgs) to 14 feet bgs. For this reason, the well screen for the air extraction well was located between 6 feet bgs and 10 feet bgs, in the subsurface soil layer believed to be unsaturated. However, saturated soils were encountered between 8 feet bgs and 10 feet bgs (see boring log, Attachment 1) during drilling and installation of the air extraction well. Consequently, as a result of the higher than expected water table, approximately 2 feet of the 4-foot well screen was located in the saturated soil layer. Groundwater that collected in the well and was removed using a disposable bailer was rapidly replaced by additional infiltration.

The groundwater within the well was minimized during the pilot-scale test by using an air driven pump to continuously remove the water and transfer it to a 55-gallon storage drum. Vacuum was maintained within

the well by sealing the area between the water extraction hose and the top of the PVC well casing. Approximately 30 gallons of water was removed from the well during the 2-day test. For the first 2.5 to 3 hours of testing, the pump removed groundwater from the well in sporadic bursts of approximately 8 ounces to 15 ounces every 20 seconds to 30 seconds. During the final hours of SVE testing, this rate declined to 4 ounces to 8 ounces every 40 seconds to 50 seconds. At the end of the pilot-scale test, the pump hose was withdrawn from the well, and the groundwater elevation returned to its original level within 10 minutes.

3.2 Air Flow Monitoring

3.2.1 Induced Vacuum

As indicated in Table 2-1, four different vacuums: 15 inches of water, 30 inches of water, 45 inches of water and 60 inches of water were produced within the air extraction well during the 2 days of testing. At all four vacuum settings, the vacuum induced within the unsaturated soil was detected only at drive point probe A4 which was located 4.25 feet horizontally from the air extraction well and approximately 2 feet above the top of the air extraction well screen (4 feet bgs). No detectable vacuum was measured at probe F4 which was located at relatively the same horizontal (6.5 feet) and vertical (2 feet above) distances from the air extraction well screen, but at a 90-degree offset to the extraction well-probe A4 axis (Figure 2-3). Vacuums were not detected in any of the other probes at any of the four vacuum settings. The horizontal limit of the vacuum detected within the unsaturated soil did not increase as greater vacuums were applied to the air extraction well.

The lack of vacuum transfer through the subsurface soil at all four vacuum settings may have been caused by the presence of a moist clay lens between 6 feet bgs and 8 feet bgs or the saturated conditions of the subsurface soil surrounding the air extraction well screen between 8 feet bgs and 10 feet bgs (See boring log, Attachment 1).

The moist clay lens located between 6 feet bgs and 8 feet bgs would inhibit air flow through its tight, fine grained soil matrix. As indicated in the boring log, the top 2 feet of the air extraction well screen was located in this clay lens. The geotechnical analysis performed on the soil sample collected between 7 feet bgs and 8 feet bgs (Attachment 2) reported a sandy silt comprised of approximately 55-percent silt and clay with a moisture content of approximately 23-percent. It is because of this moist clay lens that no vacuum was detected at the base of probe F4 which was located 6.5 feet horizontally and 2 feet above the top of the air extraction well screen. The low vacuums detected at probe A4 (approximately 2-percent of the well vacuums) may also be attributed to this moist clay lens. Typically, vacuums of greater magnitude

would be expected to be detected at this distance from the extraction well screen (Mohr et al, 1995 and Johnson et al, 1994). The cause of pressures recorded at probe A4 at a well vacuum of 15-inches H2O is not certain, but may be attributed to monitoring error.

Also, as noted earlier in this report, saturated soil conditions were encountered between depths of 8 feet bgs and 10 feet bgs. Although continuous pumping removed water from the air extraction well and exposed a greater portion of the 4-foot well screen, the saturated pore spaces within the surrounding soils continued to inhibit air flow through the saturated layer of soil. The geotechnical analysis of the soil sample collected between 9 feet bgs and 10 feet bgs (well-graded gravel with sand) would suggest that some subsurface vacuum should be detected at probes installed in this soil layer. However, no vacuums were detected at the two closest probes A8 (5.6 feet horizontally and equal vertical depth from the air extraction well screen) or F8 (6.0 feet horizontally and equal vertical depth) for any of the four tested vacuum settings. This is because the soil at this depth was saturated.

As an additional test of subsurface conditions prior to the end of pilot testing, the bottoms of drive point monitoring probes A8 and F8 were raised from 8 feet bgs to 6 feet bgs after 45 minutes of operating the SVE system at vacuum of 60 in H20. Once again, with the bottom of these two probes at the new, shallower soil depth, no vacuums were detected at A8 (now A6) and F8 (now F6). Apparently, the bottom of the probes were now located in the moist clay layer.

As the above discussion indicates, increases in the applied vacuum at the extraction well did not produce corresponding increases in the horizontal limit of the vacuum detected in the drive point monitoring probes. The absence of detected vacuums at probes A8, F4, F8 and at any of the more distant probes (B4 through E8) at applied vacuums of 45-inches H20 and 60-inches H20 would be expected to be caused by the moist clay layer and/or the water table level.

3.2.2 Air Flow

The vacuum blower used for this pilot test was single-speed. The measured air flow rate from the blower exhaust and the carbon air treatment unit was 65 cubic feet per minute. The volumetric air flow rates within the air extraction well for each of the 3 vacuums tested during the second day are summarized below:

Extraction Well Vacuum (inches H20)	Volumetric Air Flow Rate at the Extraction Well (cfm)
30	7.0
45	9.3
60	11.7

A bleed valve from the atmosphere was located in the suction line between the extraction well and the blower intake. The valve was partially opened to provide make up air into the blower suction line thus reducing the magnitude of the suction applied to the extraction well. These air flows were measured in the suction line, at a point between the extraction well and the bleed valve

3.3 Air Sampling

3.3.1 Drive Point Monitoring Probes

Air samples were collected from two locations along the pilot-scale blower system (Figure 2-2) and also at each of the drive point monitoring probes (Figure 2-3). Analytical results for these samples are summarized in Table 2-2. No analytical results are reported for the Day 1 test at 15-inches H2O because the gas chromatograph was being calibrated. As the analytical results summarized in Table 2-2 indicate, concentrations of 1,1-DCE, 1,2-DCE, TCE and TCA were detected in several drive point monitoring probes. Given that vacuum was detected only in probe A4 during pilot-scale testing, the analytical results reported in Table 2-2 for all other probe locations can be interpreted as indicators of ambient subsurface conditions.

Only the concentrations of TCE were consistently detected in the drive probe air samples at concentrations greater than 10 μg/L. An examination of TCE concentrations detected in air samples SG-A4 (drive probe A4) over time indicate a decreasing trend. This reduction in TCE concentration from 32 μg/L at the start of testing at 30-inches H20, vacuum to Non-Detect concentration at the close of testing at 60-inches H2O, vacuum was expected since this was the only probe in which a vacuum was detected.

At all other sampled drive point locations, the detected TCE concentrations remained relatively constant over 2 rounds of air samples. For this reason and because of time constraints, only 2 rounds of air samples were collected from those locations where analytical results were on the same order of magnitude. A comparison of TCE concentrations detected in these drive probe air samples with analytical for soil-gas samples collected from the same general locations during the September 1995 event (B&R Environmental, 1996a, pp 3-2, 3-3) indicate differences of 1, 2 or 3 orders of magnitude. For example, TCE concentrations for drive probe air samples SG-D4-1 and SG-D4-2, Non-Detect and 0.05 μg/L, respectively were significantly different from soil-gas sample SG-02 (3200 μg/L) that was collected from approximately the same horizontal and vertical location in the soil. And while TCE concentrations for soil

samples collected during the earlier investigation were consistently higher for shallow (2 feet to 4 feet) as compared to deep (10 feet to 12 feet) samples, a comparison of TCE concentrations for drive probe air samples collected at 4 feet to drive probe air samples collected at 8 feet does not consistently follow this same trend.

The differences in detected TCE concentrations and concentration trends for the 2 investigations may be attributed to a differences in field sampling techniques. During the SVE study, air samples were collected by syringe from the above ground, sealed sections of rubber tubing attached to each of the 12 drive point monitoring probes. In the earlier study, soil-gas samples were also collected by syringe from the above ground, section of rubber tubing attached to each drive point. However, in the earlier study, the subcontractor used a small peristaltic pump to create a vacuum within the section of rubber tubing prior to collecting the sample. The subcontractor did not use such a pump during the SVE test. And as indicated in Table 2-1, no vacuums were detected in all but 1 of the drive point probes.

3.3.2 Main Header To Air Extraction Well

Soil-gas samples were also collected from the main vacuum header connecting the blower to the air extraction well. The well screen for the SVE air extraction well was installed at approximately the same location where soil-gas, soil and groundwater samples for SG-07 were collected during the earlier investigation (B&R Environmental, 1996a, pp 3-2, 3-7 and 3-9). This was the location of the highest detected TCE concentrations for soil-gas (9600 μg/L) soil (840,000 μg/kg, shallow and 150 μg/kg, deep) and groundwater (370,000 μg/L) for the earlier study. It was expected that, because of the vacuums produced in the SVE well, the reported analytical results for air samples collected from the main header would initially indicate concentrations of DCE, TCE and TCA similar to those reported in the earlier site investigation.

The low concentrations of DCE, TCE and TCA detected in SG-M1 may be attributed to field sampling technique. The soil gas sample was collected by the subcontractor from a port on the header line where the tip of the syringe did not fully extend into the contaminated air stream. Consequently, the first air sample may have been diluted with cleaner atmospheric air. This sampling error was corrected during collection of SG-M2 and SG-M3, as the air samples were collected from a port located along the air transfer pipe, before the air bleed valve.

Comparison of the analytical results for the 2 remaining air samples collected during this investigation (SG-M2 and SG-M3) with those reported for SG-07 indicate that the highest TCE concentration of

370 μg/L detected during the SVE test (SG-M2) was also approximately 1.4 order of magnitude less than the 9,600 μg/L TCE concentration detected in the soil-gas sample collected from SG-07 during the earlier investigation. This analytical result was also approximately 3 orders of magnitude less than the results for the earlier soil and groundwater samples. The tight, moist soils in the clay layer and the saturated conditions of the soils underlying this clay layer inhibited air flow. This inhibited air flow inhibited volatilization of contaminants sorbed to the subsurface soils. Groundwater filled the voids in the soil at the 8-foot bgs to 10-foot bgs interval. Thus any contamination at that depth did not contribute to the soil/gas contaminant concentrations detected during the pilot study.

3.3.3 Air Treatment Unit

Over the period of SVE testing, two soil gas samples were collected along the effluent line leading from the granular activated carbon air treatment unit (Carbon-1 and Carbon-2). The analytical results for these two soil-gas samples indicate that carbon breakthrough and excessive atmospheric discharges of DCE, TCE or TCA during the SVE field tests had not occurred.

4.0 CONCLUSIONS

Based on the vacuum and air flow monitoring results, and analytical results for air samples collected from various locations in the pilot-scale SVE system, the following conclusions can be made:

- TCE-contaminated air contained in the unsaturated soils was collected through the vertical well screen of the air extraction well. However, a moist clay lens located between 6 feet bgs and 8 feet bgs and an unexpectedly high water table located between 8 feet bgs and the base of the well screen inhibited air flow through the subsurface soils and consequently inhibited collection of volatilized contaminants.

- Because of the moist clay layer and the unexpectedly high water table, only a minimal air circulation pattern could be established in the subsurface soils that would promote additional volatilization of TCE currently sorbed to the contaminated soils. Contaminated soils contained in the moist clay layer and the saturated soil underlying the clay layer received minimal air treatment.

- Vacuum increases in the air extraction well from 15-inches H2O to 60-inches of H2O did not produce proportional increases in the horizontal or vertical extensions into the subsurface soil of the applied vacuum. This inhibited horizontal and vertical extension of the well vacuum into the subsurface soil may be attributed to the moist clay layer and the unexpectedly high water table.

- The subsurface conditions at Site 57, as experienced during this pilot study, are not well suited to the application of the Soil Vapor Extraction technology.

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TABLE 2-1

DRIVE POINT VACUUM MONITORING DATA AT DRIVE POINT SAMPLE LOCATION A4 April 1, 1997 and April 2, 1997 NSWC, INDIAN HEAD, MD

Time	Vacuum at Well	Air Flow at Well	Drive Point Vacuum**	Time	Vacuum at Well	Air Flow at Well	Drive Point Vacuum
(min)	(in. H2O)	(cfm)	(in. H2O)	(min)	(in. H2O)	(cfm)	(in. H2O)
0.4	15	NR	0.25	0.5	45	9.3	0.60
3.8	15	NR	0.30	1.0	45	9.3	0.65
9.3	15	NR	0.20	2.7	45	9.3	0.70
12.4	15	NR	0.05	3.2	45	9.3	0.80
13.3	15	NR	-0.15	4.1	45	9.3	0.85
13.8	15	NR	-0.20	12.3	45	9.3	0.80
16.0	15	NR	-0.50	14.2	45	9.3	0.70
16.4	15	NR	-0.60	15.6	45	9.3	0.65
16.7	15	NR	-0.70	16.0	45	9.3	0.60
17.5	15	NR	-0.75	18.5	45	9.3	0.60
18.1	15	NR	-0.80	21.4	45	9.3	0.90
18.8	15	NR	-0.70	23.0	45	9.3	0.95
20.8	15	NR	-0.70	24.3	45	9.3	0.95
35.8	15	NR	-0.05	25.8	45	9.3	1.00
44.5	15	NR	-0.30	26.1	45	9.3	0.95
46.8	15	NR	-0.40	28.9	45	9.3	1.00
49.0	15	NR	-0.40	41.5	45	9.3	1.05
51.5	15	NR	-0.60	50.4	45	9.3	1.05
55.0	15	NR	-0.45	61.6	45	9.3	1.05
63.8	15	NR	-0.50				
77.0	15	NR	-0.20				
0.3	30	7	0.30	0.2	60	11.7	1.00
0.7	30	7	0.35	0.4	60	11.7	1.20
3.0	30	7	0.40	4.7	60	11.7	1.20
5.1	30	7	0.40	6.4	60	11.7	1.15
6.9	30	7	0.35	11.4	60	11.7	1.15
8.3	30	7	0.40	17.3	60	11.7	0.95
11.6	30	7	0.45	18.2	60	11.7	0.85
15.7	30	7	0.45	20.6	60	11.7	0.80
17.1	30	7	0.45	32.1	60	11.7	0.75
19.7	30	7	0.50	37.6	60	11.7	0.70
24.0	30	7	0.50	43.9	60	11.7	0.70
28.5	30	7	0.55	49.2	60	11.7	0.65
41.4	30	7	0.55	61.1	60	11.7	0.60
48.3	30	7	0.55	63.2	60	11.7	0.55
63.7	30	7	0.50	70.7	60	11.7	0.50
77.0	30	7	0.50	77.5	60	11.7	0.45
84.7	30	7	0.50	89.1	60	11.7	0.40
98.4	30	7	0.50	96.2	60	11.7	0.35
				98.2	60	11.7	0.30

* - An induced vacuum was detected only in drive point A4 throughout all test events.
** - Negative values indicate induced pressure at the drive point location.
NR - Value not recorded.

TABLE 2-2

DRIVE POINT SAMPLE ANALYTICAL RESULTS
April 2, 1997
NSWC, INDIAN HEAD, MD

SAMPLE IDENTIFICATION	1,1 DCE ug/L	1,2 DCE ug/L	TCA ug/L	TCE ug/L
7:00 AM - 30 in H_2O Vacume				
Baseline*			0.005	
SG-M-1				
SG-A4-1			0.1	1
SG-A8-1		8	0.4	32
SG-B4-1		4	0.9	22
SG-B8-1				
SG-C4-1		4	4	92
SG-C8-1		2	0.3	8
SG-D4-1				
SG-D8-1		2	0.6	28
SG-E4-1	NS	NS	NS	NS
SG-E8-1	NS	NS	NS	NS
SG-F4-1			1	23
SG-F8-1			0.4	290
12:00 PM - 30 in H_2O Vacume				
Baseline*			0.009	
SG-M-2	2	50	2	370
Carbon-1				
SG-A4-2				0.06
SG-A8-2			0.2	50
SG-B4-2			0.9	37
SG-B8-2				
SG-C4-2			4	110
SG-C8-2		5	0.2	11
SG-D4-2				0.05
SG-D8-2			0.3	21
SG-E4-2	NS	NS	NS	NS
SG-E8-2	NS	NS	NS	NS
SG-F4-2	0.2		2	36
SG-F8-2				220
4:00 PM - 60 in H_2O Vacume**				
Baseline*			0.006	
SG-M-3			3	340
Carbon-2				
SG-A4-3			0.01	

Blank - Concentration below detection limits.
NS - Location not sampled.
* - Ambient air sample.
** - Remaining locations not sampled due to relative simalarity of first two rounds of analytical results.

BORING LOG

PROJECT NAME: INDIAN HEAD CTO 209
PROJECT NUMBER:
DRILLING COMPANY: Hardin - Huber
DRILLING RIG:
BORING NUMBER: SB-01
DATE: 3/31/97
GEOLOGIST: C Farkos
DRILLER:

Sample No. and Type or RQD	Depth (Ft.) or Run No.	Blows / 6" or RQD (%)	Sample Recovery / Sample Length	Lithology Change (Depth/Ft.) or Screened Interval	MATERIAL DESCRIPTION: Soil Density/ Consistency or Rock Hardness	Color	Material Classification	USCS*	Remarks	PID/FID Reading (ppm): Sample	Sampler BZ	Borehole**	Driller BZ**
		5/1			hard	TAN	med-coarse grain w						
	2.0	5/1	4/24		hard	TAN	pebbles sand,						
		3/4			hard	TAN							
	4.0	4/4	8/24		hard	TAN							
		1/2			loose	TAN	med, grain w pebbles						
	6.0	3/4	6/24		/	TAN							
		2/2			soft	GREY	fine grain clay		moist				
SO-01	8.0	4/3	14/24		soft	BLACK	fine grain clay		moist				
		5/8		▼	loose	DBRN	med grain, w pebbles		wet				
SO-02	10.0	8/10	10/24		loose	DBRN			wet				

* When rock coring, enter rock brokeness.

** Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated response read.

Remarks: 2-in split spoon (continuous)

Drilling Area Background (ppm):

Converted to Well: Yes X No ____ Well I.D. #: ____

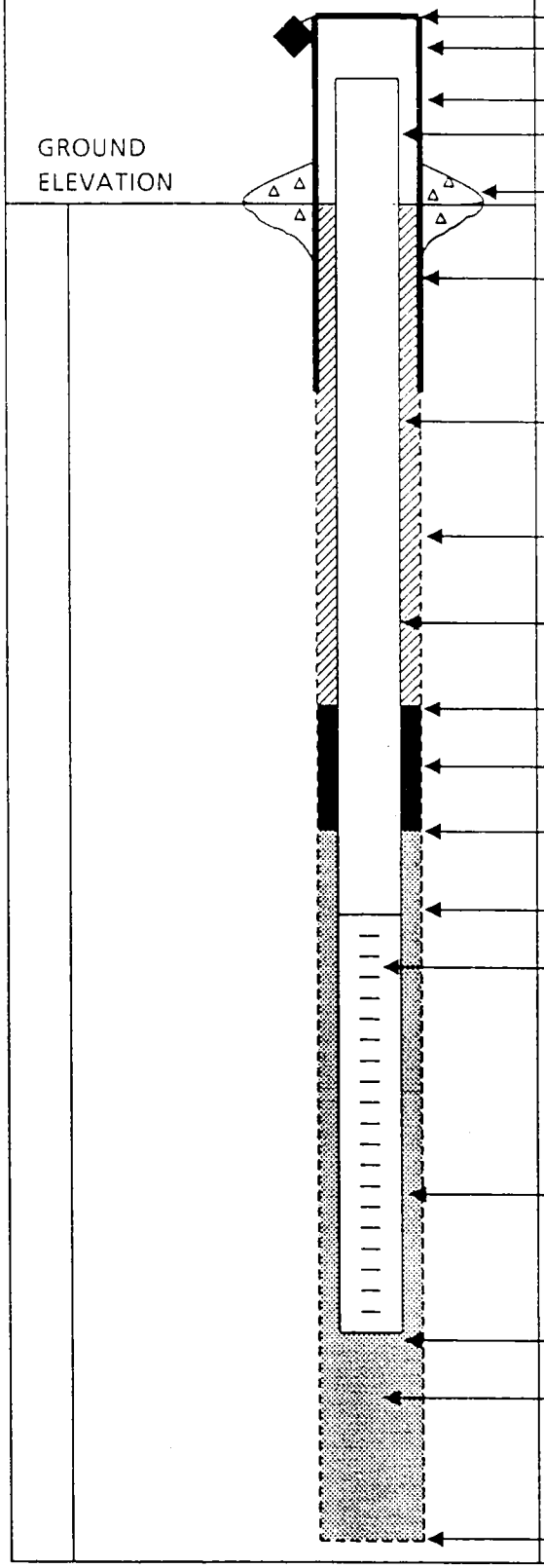
BORING NO.: SB-01

OVERBURDEN
MONITORING WELL SHEET

PROJECT Indian Head
PROJECT NO. CTO 209
ELEVATION
FIELD GEOLOGIST C. Farnos

LOCATION Bldg 292
BORING SB-01
DATE 3/31/97

DRILLER Hardin - Huber
DRILLING METHOD
DEVELOPMENT METHOD



ELEVATION OF TOP OF SURFACE CASING :
ELEVATION OF TOP OF RISER PIPE:
STICK - UP TOP OF SURFACE CASING:
STICK - UP RISER PIPE : 2.5 ft
TYPE OF SURFACE SEAL:
I.D. OF SURFACE CASING:
TYPE OF SURFACE CASING:
RISER PIPE I.D. Sch - 40 PVC
TYPE OF RISER PIPE: 2.0 - inch
BOREHOLE DIAMETER:
TYPE OF BACKFILL:
ELEVATION / DEPTH TOP OF SEAL: 3.0 / ft
TYPE OF SEAL: Bentonite chunks
DEPTH TOP OF SAND PACK: 5.0 ft
ELEVATION / DEPTH TOP OF SCREEN: 6.0 / ft
TYPE OF SCREEN: 0.02 - inch
SLOT SIZE x LENGTH: slotted
I.D. OF SCREEN:
TYPE OF SAND PACK:
ELEVATION / DEPTH BOTTOM OF SCREEN: 10.0 / ft
ELEVATION / DEPTH BOTTOM OF SAND PACK: 10.0 / ft
TYPE OF BACKFILL BELOW OBSERVATION WELL:
ELEVATION / DEPTH OF HOLE: 10.0 / ft

ACKENHEIL
ENGINEERS, INC.
Civil • Environmental • Materials Testing

April 3, 1997

Brown & Root Environmental, Inc.
Foster Plaza 7
661 Anderson Drive
Pittsburgh, Pennsylvania 15220-2745

Attention: Mr. George Latulippe
Project Manager

Subject: Laboratory Test Results
NSWC, Indian Head, Maryland Project
Ackenheil Project No. 97720
Brown & Root CTO No. 0209

Dear Mr. Latulippe:

Please find attached the Geotechnical Test Results for the NSWC project located in Indian Head, Maryland.

If you have any questions, please call me at (412) 531-7111.

Sincerely,

ACKENHEIL ENGINEERS, INC.

James Falcione

James C. Falcione
Laboratory Manager

JCF:tlb

Enclosures

1000 Banksville Road • Pittsburgh, PA 15216 • 412-531-7111 • FAX 412-531-4334

CHAIN (USTODY RECORD

MD.
Bldg. 292

PROJECT NO.: CTO 209

SITE NAME: Building 292

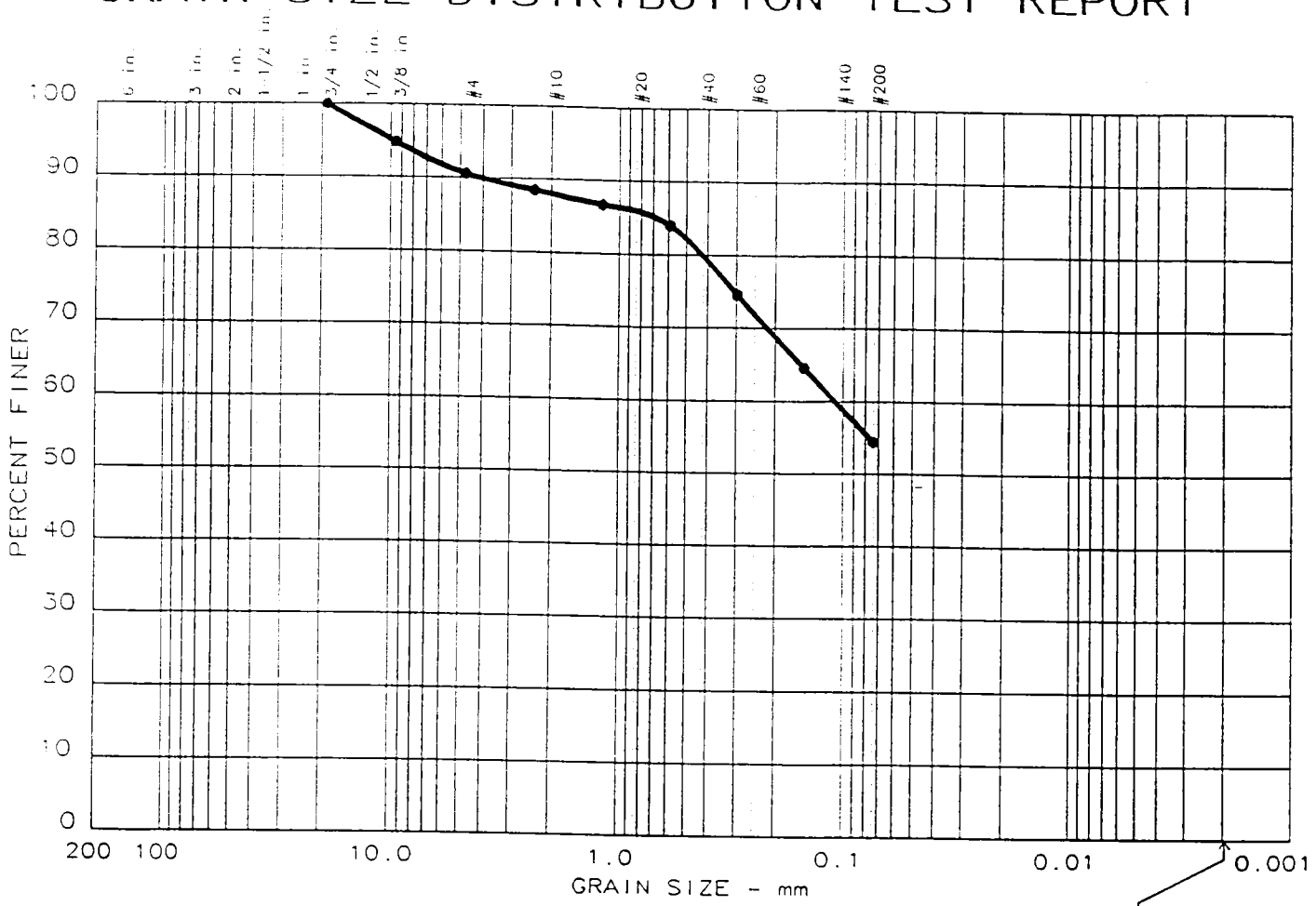
SAMPLERS (SIGNATURE): C.A. Faukos

STATION NO.	DATE	TIME	COMP	GRAB	STATION LOCATION	NO. OF CONTAINERS	Grain Size ASTM-D422 Sieve Only						REMARKS
SO-01-0708	3/31/97	1445		X	Pilot-scale Air extraction well	1	X						7 - 8 ft
SO-02 ~~[illegible]~~ 0910	3/31/97	1450		X	" " " "	1	X						9 - 10 ft

RELINQUISHED BY (SIGNATURE):	DATE / TIME:	RECEIVED BY (SIGNATURE):	RELINQUISHED BY (SIGNATURE):	DATE / TIME:	RECEIVED BY (SIGNATURE):
C.A. Faukos	3/31/97 1900	to Fed Exp			
RELINQUISHED BY (SIGNATURE):	DATE / TIME:	RECEIVED BY (SIGNATURE):	RELINQUISHED BY (SIGNATURE):	DATE / TIME:	RECEIVED BY (SIGNATURE):
	4/1/97 2:30	for [signature]			
RELINQUISHED BY (SIGNATURE):	DATE / TIME:	RECEIVED FOR LABORATORY BY (SIGNATURE):	DATE / TIME:	REMARKS:	

Order No. 70440 (0693)

GRAIN SIZE DISTRIBUTION TEST REPORT



	Test	%+75mm	% GRAVEL	% SAND	% SILT	% CLAY
●	1	0.0	9.4	36.1	54.5	

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●	NA	NA	0.67	0.11						

MATERIAL DESCRIPTION	USCS	AASHTO
● SANDY SILT	ML	A-4(0.0)

Project No.: 97720

Project: NSWC, INDIAN HEAD, MD (CTO 209)

● Location: BUILDING 292, STATION NO. SO-01-0708

Date: 4-3-97

Remarks:

PILOT-SCALE AIR EXTRACTION WELL.

DEPTH: 7.0 TO 8.0 FT.

MOISTURE CONTENT: 22.4%

GRAIN SIZE DISTRIBUTION TEST REPORT

ACKENHEIL ENGINEERS, INC.

Figure No. _____

GRAIN SIZE DISTRIBUTION TEST DATA

Test No.: 1

Date: 4-3-97
Project No.: 97720
Project: NSWC, INDIAN HEAD, MD (CTO 209)

Sample Data

Location of Sample: BUILDING 292, STATION NO. SO-01-0708
Sample Description: SANDY SILT
USCS Class: ML
AASHTO Class: A-4(0.0)

Liquid limit: NA
Plasticity index: NA

Notes

Remarks: PILOT-SCALE AIR EXTRACTION WELL.
DEPTH: 7.0 TO 8.0 FT. MOISTURE CONTENT: 22.4%
Fig. No.:

Mechanical Analysis Data

	Initial	After wash
Dry sample and tare=	290.67	167.56
Tare =	85.30	73.52
Dry sample weight =	205.37	94.04

Minus #200 from wash= 54.2 %
Tare for cumulative weight retained= 73.52

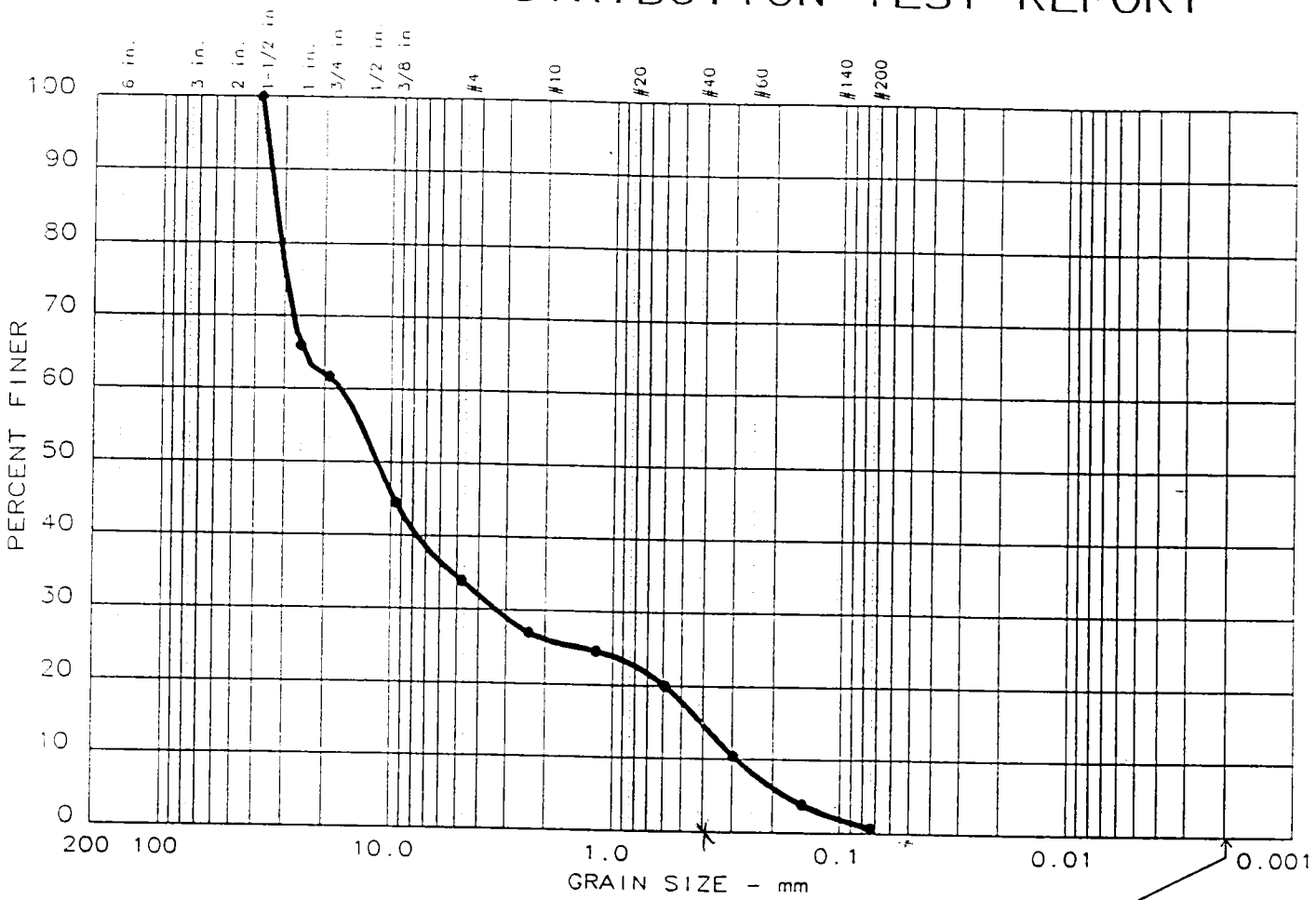
Sieve	Cumul. Wt. retained	Percent finer
0.75 inches	73.52	100.0
0.375 inches	84.16	94.8
# 4	92.87	90.6
# 8	97.14	88.5
# 16	100.83	86.7
# 30	106.42	84.0
# 50	125.81	74.5
# 100	146.33	64.5
# 200	167.08	54.4

Fractional Components

% + 75mm. = 0.0 % GRAVEL = 9.4 % SAND = 36.1
% FINES = 54.5

D85= 0.67 D60= 0.108

GRAIN SIZE DISTRIBUTION TEST REPORT



	Test	%+75mm	% GRAVEL	% SAND	% SILT	% CLAY
•	2	0.0	66.1	33.2	0.7	

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
•	NA	NA	32.92	16.69	11.55	3.330	0.4097	0.2867	2.32	58.2

MATERIAL DESCRIPTION	USCS	AASHTO
• WELL-GRADED GRAVEL WITH SAND	GW	A-1-a

Project No.: 97720

Project: NSWC, INDIAN HEAD, MD (CTO 209)

• Location: BUILDING 292, STATION NO. SO-02-0910

Date: 4-3-97

Remarks:

PILOT-SCALE AIR EXTRACTION WELL.

DEPTH: 9.0 TO 10.0 FT.

MOISTURE CONTENT: 7.5%

GRAIN SIZE DISTRIBUTION TEST REPORT

ACKENHEIL ENGINEERS, INC.

Figure No. _____

GRAIN SIZE DISTRIBUTION TEST DATA

Test No.: 2

Date: 4-3-97
Project No.: 97720
Project: NSWC, INDIAN HEAD, MD (CTO 209)

Sample Data

Location of Sample: BUILDING 292, STATION NO. SO-02-0910
Sample Description: WELL-GRADED GRAVEL WITH SAND
USCS Class: GW
AASHTO Class: A-1-a
Liquid limit: NA
Plasticity index: NA

Notes

Remarks: PILOT-SCALE AIR EXTRACTION WELL.
DEPTH: 9.0 TO 10.0 FT. MOISTURE CONTENT: 7.5%
Fig. No.:

Mechanical Analysis Data

	Initial	After wash
Dry sample and tare=	441.20	375.55
Tare =	120.00	56.00
Dry sample weight =	321.20	319.55

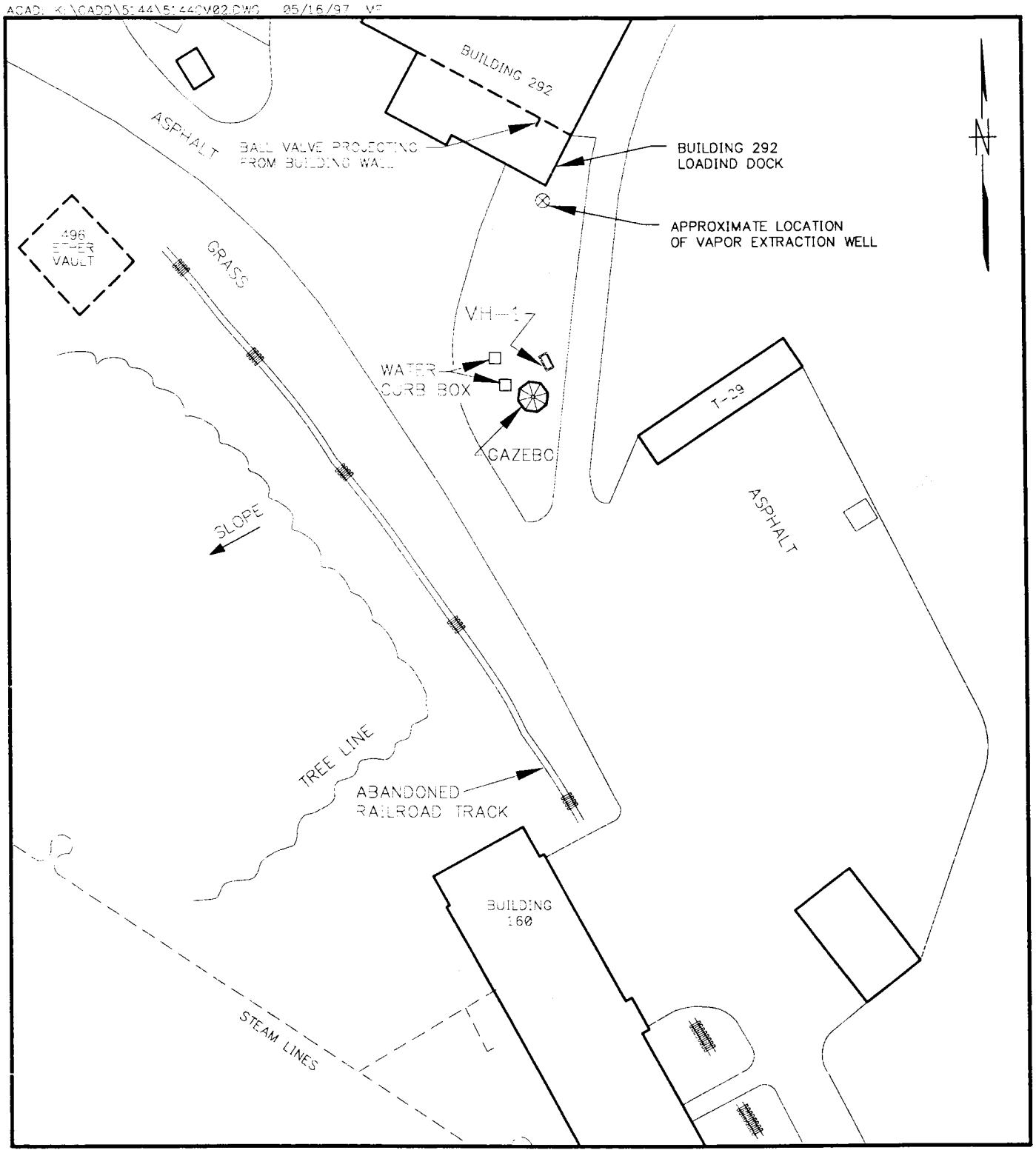
Minus #200 from wash= 0.5 %
Tare for cumulative weight retained= 56

Sieve	Cumul. Wt. retained	Percent finer
1.5 inches	56.00	100.0
1 inches	165.38	65.9
0.75 inches	179.03	61.7
0.375 inches	234.30	44.5
# 4	268.19	33.9
# 8	290.48	27.0
# 16	298.23	24.6
# 30	313.07	20.0
# 50	343.89	10.4
# 100	364.72	3.9
# 200	374.88	0.7

Fractional Components

% + 75mm. = 0.0 % GRAVEL = 66.1 % SAND = 33.2
% FINES = 0.7

D85= 32.92 D60= 16.692 D50= 11.548
D30= 3.3304 D15= 0.40973 D10= 0.28675
Cc = 2.3174 Cu = 58.2103



SOIL VAPOR EXTRACTION TEST AREA
SITE 57, FORMER DRUM LOADING AREA
NAVAL SURFACE WARFARE CENTER,
INDIAN HEAD, MARYLAND

FIGURE 1-1

Brown & Root Environmental

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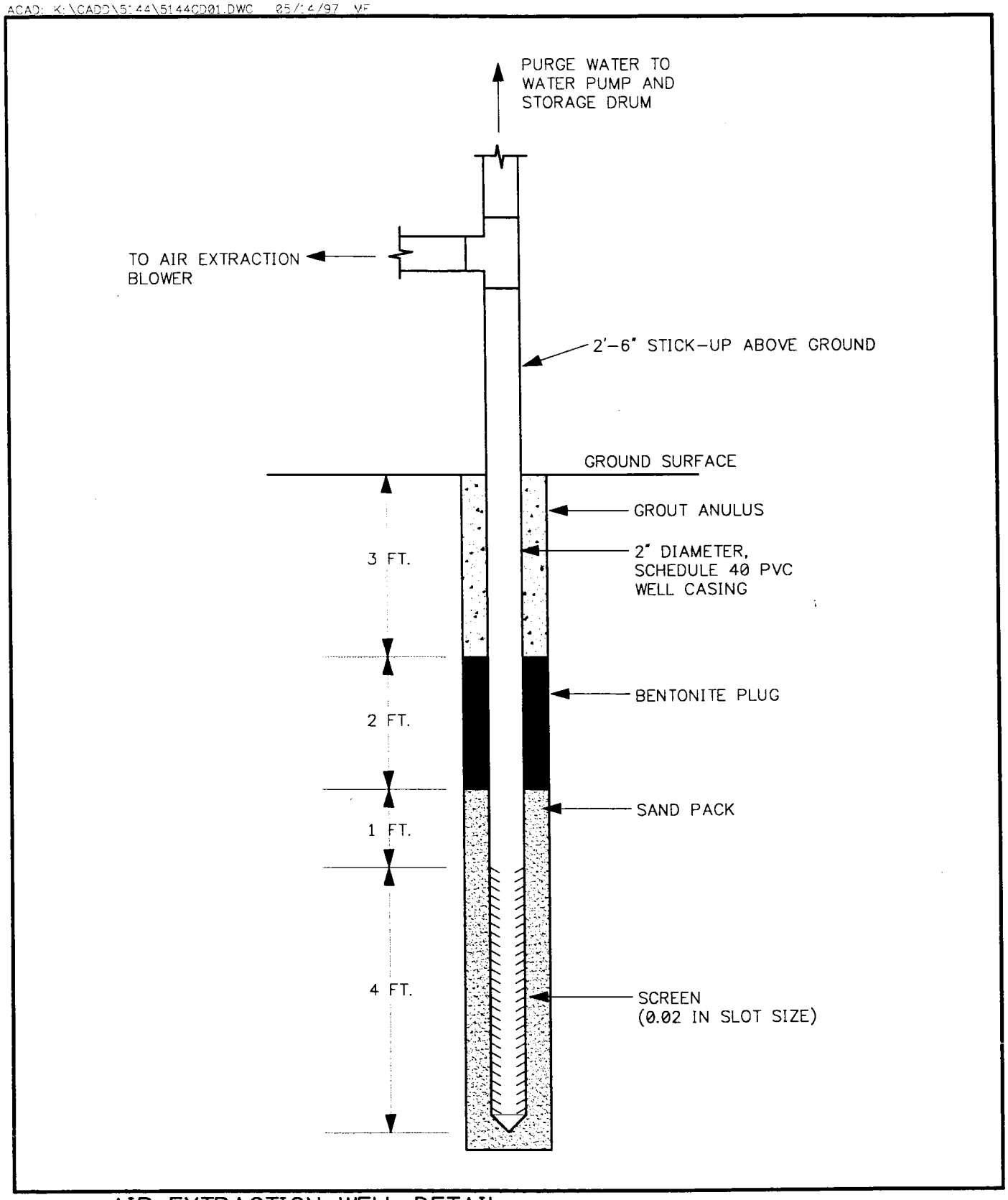

AIR EXTRACTION WELL DETAIL
SITE 57 – FORMER DRUM LOADING AREA
NAVAL SURFACE WARFARE CENTER
INDIAN HEAD, MARYLAND
NOT TO SCALE

FIGURE 2-1

Brown & Root Environmental

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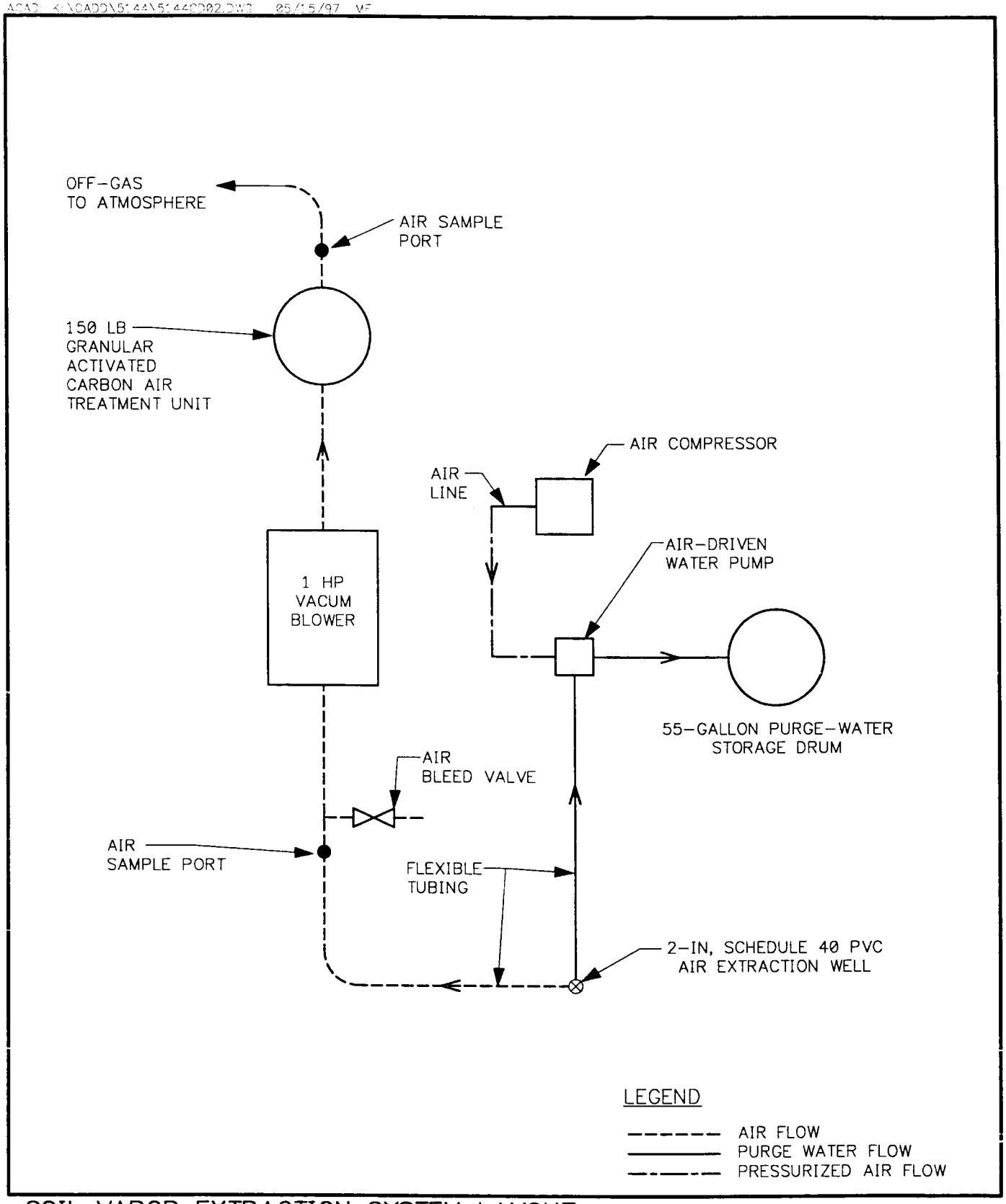
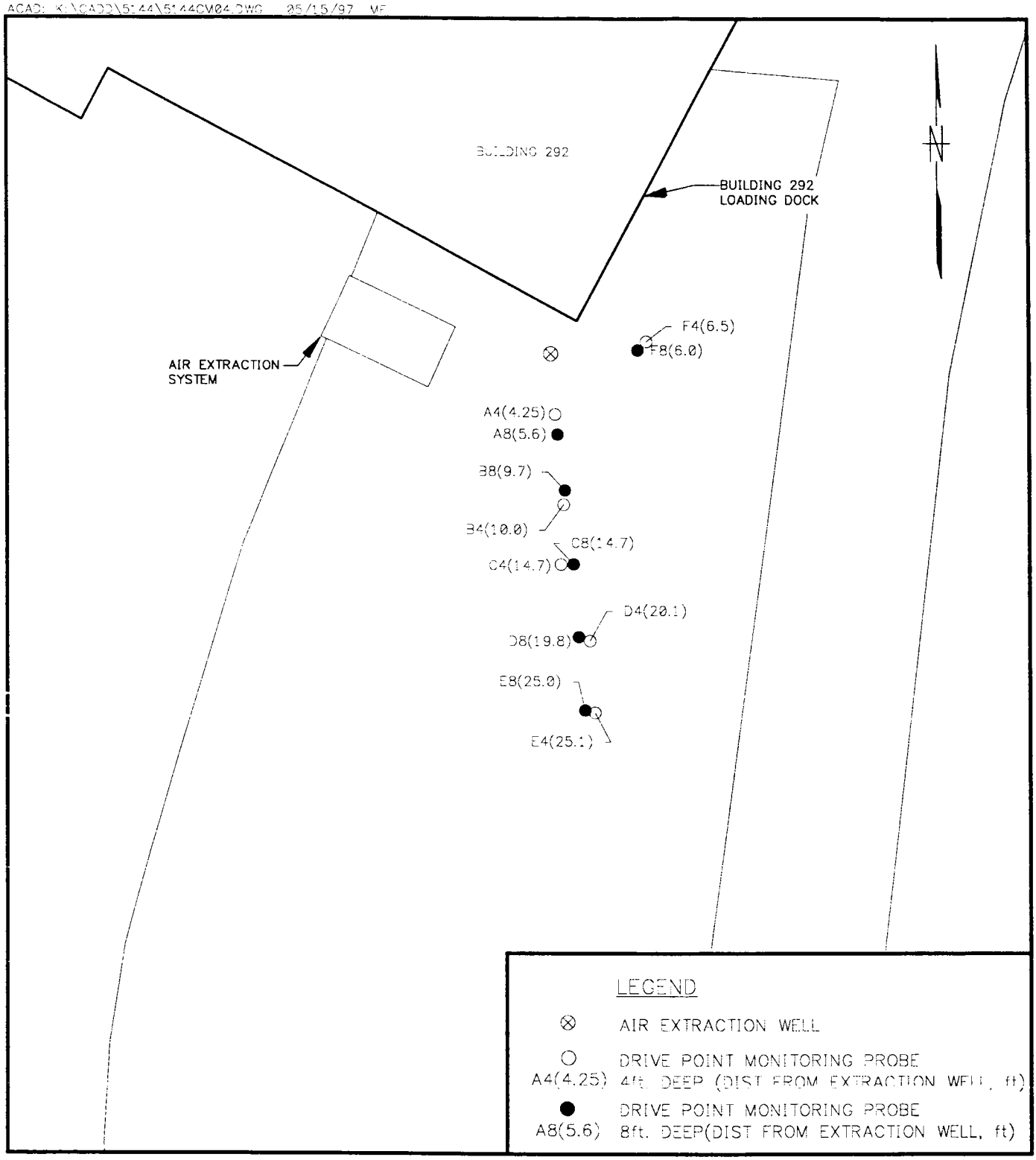


SOIL VAPOR EXTRACTION SYSTEM LAYOUT
SITE 57 - FORMER DRUM LOADING AREA
NAVAL SURFACE WARFARE CENTER
INDIAN HEAD, MARYLAND
NOT TO SCALE

FIGURE 2-2

Brown & Root Environmental

ACAD: K:\CADD\5144\5144CM04.DWG 05/15/97 MF



SOIL VAPOR EXTRACTION PILOT-TEST LAYOUT
SITE 57 – FORMER DRUM LOADING AREA
NAVAL SURFACE WARFARE CENTER,
INDIAN HEAD, MARYLAND

FIGURE 2-3

Brown & Root Environmental