

**Preliminary Analysis
Of Soil Contamination Data**

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1. Introduction

The purpose of this section is to further our understanding of site contamination by plotting and analyzing soil data and descriptions. The goals are to get a better idea of contaminant location, how reliably we can predict exposures that may lead to risk, and what additional data will be most helpful.

The Data Package (1996) includes both qualitative and quantitative information. Qualitative information includes soil boring logs and cross sections (Data Package Appendices A, B and L) that are helpful in understanding the distribution of contaminants. The RI Summary Report uses such qualitative information and rough ranges of concentrations to provide insights and estimated boundaries and contours of product locations.

In this appendix we focus on the quantitative contamination data, that is the roughly 5,000 data values collected at about 165 locations and depths. The plots and analyses in this appendix are intended to provide a variety of windows into the data to help detect and understand patterns and trends. Specifically, we:

1. Evaluate sampling, duplicate results, and mixes of PAH compounds.
2. Plot concentrations in 3-d scatter plots, histograms, and other plots to help see the spatial distribution of samples with elevated concentrations.
3. Consider statistical evidence for and against breaking the site into areas based on surface location and on depth. Depths considered are “surface” (0-0.2 feet), “shallow” (0.2-15 feet), and “deep” (>15 feet).
4. Consider how concentrations are related to soil odor, sheen, and the presence of product.
5. Provide examples of how concentration probability distributions can be constructed from site data for risk analyses.
6. Summarize findings.

We consider the contaminants:

Carcinogenic PAHs (CPAHs)
Total PAHs (TPAHs)
Benzene
Arsenic

0.2 and 3 feet

Generally broken down into the following 3 depths:

- Surface (up to 0.2 feet deep; potential source of dust, exposure during surface activities)
- Shallow (between 0.2 and 15 feet; likely to include soil encountered during future trenching and sub-surface work at site)
- Deep (greater than 15 feet; important to understanding site and to groundwater, but not as direct exposure pathway)

CPAHs and benzene are expected to be leading sources of risk among chemicals identified at the site. Total PAHs were considered due to correlation with CPAHs. PAHs are of interest since they are present site wide. Benzene is evaluated since it is the most toxic and prevalent of the BTEX (benzene, toluene, ethylbenzene and xylene) compounds at the site.

Helpful comments to drafts of this memorandum were provided by David Ruppert, Professor of Statistical Science, Cornell University; Rob Ede, Hahn and Associates; and Steve Sonnen, Montgomery and Watson.

2. Sampling And Data

2.1. Data

The data for this analysis were taken from the Data Package (Hahn, 1996), from samples taken at monitoring well 13 (MW-13), and from the four geotechnical borings taken near the river in the area of B-8 (GT-1, GT-2, GT-3, GT-4). The preceding represents all available soil quality data for the site (see Data Summary document to which this is attached).

2.2. Sampling Strategy

Surface sampling was done essentially at random to roughly cover the site. Thus evaluation of surface samples as random samples is valid for the purposes of statistical analysis.

Sub-surface sampling locations, however, were selected to (1) investigate areas in which historic operations were thought to create contamination potential, and (2) to roughly cover the site. The first of these goals creates a non-random sampling strategy, due to targeting of expected sources. The second introduces a random-grid element into the locations across the site. The laboratory analyses run on samples were generally not selected based on sample appearance, so this did not introduce bias.

Another source of bias in sub-surface samples is that samples were taken in part based on soil appearance and apparent contamination. Typically, samples were taken above, in, and below what appeared to be contaminated soils. At monitoring wells, samples were primarily guided by identifying the lower limits of contamination. See the Final Work Plan, August 4, 1995, for a further description of sampling activities. Such potentially biased data is useful for characterizing contamination, but must be used with caution for statistical analysis (e.g., see Section 1.3, EPA, 1996).

To investigate this bias we consider the relationship between soil appearance and contaminant concentrations later in this document. We find that sub-surface PAH concentrations are modestly biased upward by use of visual inspection, but benzene concentrations are probably not significantly biased.

2.3. Duplicates

Figure 1 shows the ratios of concentrations found in duplicates. If samples were uniform and tests were perfect, all values would be 1.0. In fact, for those duplicates in which significant concentrations of contaminants were found the two duplicates have rather different results, with most varying by about 50%, and sample B-01 varying by a factor of 4. Since the PAHs in these samples were fairly low (about 10 ppm) the differences are large percentages but low quantities. Ranges in precision for PAH analyses in a range from 30-150% of true values, depending on the constituent, are considered acceptable by lab QA/QC standards. Lab QA/QC tests indicated that they were operating within these standards. Therefore it is likely that the differences represent normal test imprecision for all samples except for B-01. For B-01 heterogeneous contamination on the scale of a few inches (the space between samples taken in two 4-9 oz. sample jars) is the likely explanation. However, in analyzing results the significant potential imprecision of testing should be kept in mind.

3. Visual Examination Of Data And Evaluation Of Differences By Area

In the following paragraphs we present several ways to plot and view data.

3.1. PAH Compound Mix

3.1.1. *Relation between CPAHs and TPAHs.*

Figure 2 shows TPAHs versus CPAHs by depth on a log-log scale. A linear relation with zero intercept indicates that the relationship between TPAHs and CPAHs is proportional. The two chemical groups are strikingly well correlated for surface soils. Explanations include that surface PAHs are from a single source or that weathering has left them uniform in nature (more discussion below). The two groups of chemicals are roughly correlated for deeper soils, suggesting variety in the nature of sub-surface PAH contamination. This may be associated with diverse sources, differential weathering and/or differing rates of migration. In a number of samples TPAHs were detected at low concentrations while CPAHs were not detected (values of -3 in the figures represent no detects).

3.1.2. *PAH Fingerprints.*

Beyond the above breakdown into total and carcinogenic, the relative concentrations of the sixteen different PAH compounds analyzed can be considered a “fingerprint” for a PAH mix.

Figure 3 displays the PAH fingerprint of all surface soil samples by constituent. Each sample is shown as one of the thin bars above each constituent. In this figure the right-most thin bar above each constituent is a sample we believe is Koppers pencil pitch dust (see discussion in Data Summary). The fact that for surface soils the thin bars tend to be similar (e.g. most are high for Pyrene and low for Naphthalene) indicates similar PAH fingerprints among surface samples. Further, it appears that PAHs in surface samples are generally quite similar to dust collected at Koppers.

Figures 4 and 5 show similar comparisons for shallow and deep soils, respectively. PAHs in shallow and deep soils are more diverse. They are generally dissimilar to surface PAHs and somewhat similar to each other. Part of this the distinction between surface and deeper samples is due to weathering, for example with naphthalene volatilizing near the surface. Similarity of surface samples may also reflect a common source. The differences between surface and deeper PAHs should be addressed in assessing the potency of CPAHs.

3.2. 3-D Concentration Scatter Plots of Concentrations

Figures 6-13 show 3-dimensional scatter plots of the contaminants:

- TPAHs
- CPAHs
- Benzene

In each plot the site is shown from a south-southwest vantage point, with approximate site borders and river locations shown. The north and east coordinates are in feet, and are those used in records of borings and wells at the site. These plots are primarily intended to clarify the extent to which elevated concentrations occur in various areas and at various depths. Sample locations are provided for points with highest concentrations¹.

TPAHs and CPAHs are distributed very similarly, with elevated concentrations of each occurring at the same points. Elevated surface concentrations of CPAHs are about 10% of the concentrations elevated shallow and deep soil concentrations. Elevated concentrations of PAHs occur within each of these

¹ Note that while concentrations of contaminants in deep soil have been carried throughout this analysis, they are not directly important in the evaluation of human health risks due to the lack of a viable route of exposure (DEQ letter to S. Hart, August 23, 1996).

depth intervals towards the eastern corner of the site (former tar pond area, near Wacker and the river), an area with residual tar product in the soil. A few other samples showing elevated concentrations are scattered across the site, with high variability by both depth and location.

Benzene concentrations in shallow soil are elevated primarily in the central part of the site near the southwest boundary, near the former light oil plant. In deep soil the elevated concentrations are about 50% as high and are farther down-gradient of the light oil plant, with another spike at MW-6. Elevated benzene concentrations do not perfectly coincide with observed product, with the highest concentration occurring in a sample at B18 that had no obvious product.

3.3. Site Breakdown and Histograms

The site could be divided in a number of ways for the purpose of statistical analysis. One reason for breaking the site down is variability of human activity, and thus exposure parameters, by area (e.g. the 3-area breakdown below). Another reason is variability in the nature and extent of contamination (e.g. 2 and 4-area breakdowns below). We consider the site as a whole and using 3 breakdowns as shown in Figures 14 and 14a and described below.

The 2-Area breakdown was used to investigate the apparently higher concentrations occurring in the eastern corner of the site (see scatter plots, above), with the eastern corner being nearly identical to the Former Tar Pond area of the 4-area breakdown.

The 3-Area breakdown follows approximate boundaries of current usage, with the NWN area including all but the northeastern area (PNO) and the southwestern corner (Koppers). This breakdown is likely to be useful to the extent that exposure parameters vary by current lease areas.

The 4-Area breakdown was suggested by DEQ in the memo of June 27, 1997 “Data Summary and Exposure Pathway Analysis-Technical Memorandum, Former GASCO Site.” The proposed breakdown included a small fifth area in the northeast corner of the site near the abandoned office building called “Office Area.” No data have been taken in that area, as broken out, so it is not included in the analysis. The memo showed the LNG containment basin as an excluded area. The assignment of sampling locations to areas for each breakdown is shown in Table 1 below.

Table 1. Assignment of Sampling Locations to Areas

Area Breakdowns	Borings and Wells by Area			
2-Area	<i>East Corner</i> Borings: 9, 29-35 Wells: 3-5, 8	<i>Main Area</i> All other samples		
3-Area	<i>NWN</i> Borings: 2, 5, 9, 11-17, 26, 29-35 Wells: 3-5, 8-11	<i>Koppers</i> Borings: 18-25, 27, 28 Wells: 12	<i>PNO</i> Borings: 1, 3, 4, 6-8,10 Wells: 1, 2, 6, 13 Geotech: 1-4	
4-Area	<i>Tar Pond Area</i> Borings: 9, 26, 28-35 Wells: 3-5, 8,11	<i>Retorts/Koppers</i> Borings: 11, 13-25, 27 Wells: 6, 9,10,12	<i>PNO</i> Borings: 7, 8, 10 Wells: 13 Geotech: 1-4	<i>Oxide Area</i> Borings: 1-6 Wells: 1-2

Figures 15-22 are histograms of the frequency with which concentrations of TPAHs, CPAHs, and benzene were found by area and depth, on a log scale. The left-hand columns, at 10^{-3} , indicate non-detects. With the high variability found, mean values primarily reflect the several highest concentrations found. Because of the log scale even fairly subtle differences in the appearance of histograms, particularly in the right-hand most columns, reflect significant differences in the highest and mean concentrations. In cases where a single sample of elevated concentration has a dramatic impact on the mean, the mean is also shown without that sample included in the data set.

In studying these histograms some patterns appear:

- The 4-Area breakdown provides the best resolution of concentrations, most clearly showing lower PAH concentrations in the PNO area and higher concentrations in the eastern corner (near the river and Wacker).
- The 3- and 4-Area sets of histograms both show lower surface concentrations in the northern part of the site (PNO and Oxide areas) relative to other areas.
- Shallow soil has fewer non-detects and higher concentrations than deep soil.
- All 3 sets of histograms show great variability in PAH concentrations in shallow and deep soils (7 orders of magnitude), and somewhat less variability in surface soils (3 orders of magnitude). This reinforces other observations suggesting that surface PAHs differ in distribution and nature from sub-surface PAHs.

Figure 23 shows arsenic concentrations found in the PNO and Oxide areas of the 4-Area break down. Samples have not been taken in other areas. Concentrations are consistently higher in the Oxide area, with no arsenic concentrations in the PNO area exceeding 3 ppm and no arsenic concentrations in the Oxide area below 3 ppm.

4. Statistical Analysis of Concentration Differences by Area and Depth

We can use statistical tools to further evaluate the significance of differences by depth and by the areas defined above. As noted below, however, these statistical results are best used with caution and as supplemental to visual examination of the data, due to method and data limitations.

The Mann-Whitney U test (also known as Wilcoxon Rank Sum test, e.g. EPA, 1996 section 3.3.3) was used to test for significant differences between groups when concentration data were grouped by depth and area. The Mann-Whitney test considers the hypothesis that two populations (e.g., concentrations in two areas or depths) are shifted relative to each other. When assumptions and limitations are not violated, this is the most powerful non-parametric test for this purpose². For information on this test

² This test does not assume any distribution shape (i.e., is “nonparametric”), but does assume that the distributions to be compared have the same shape and dispersion. The histograms suggest that this assumption is met to varying degrees across comparisons. Extreme values have limited impact with a ranking statistic. The benefit is that the statistic will not be greatly affected by one or two extreme values, but the caution is that where very high values are considered representative, their importance may be underestimated. Substantial numbers of identical data values in the two sample sets being compared (e.g. non-detects with same assumed values) can lead to underestimates of the confidence that the sets are different – i.e. differences in populations will tend to be greater than indicated by p-values. Our data (like most real data) violates these assumptions to some degree, so results should be viewed as suggestive, not as “proofs.”

Devore 1995, or other statistics texts. The calculations were done in the software Statistica (1998 release 5.1 M, StatSoft Inc.).

The reported p-value is the probability of error in rejecting the null hypothesis that the two samples are from the same population. That is, the test is looking for evidence that the samples are from different populations. The p-value is the probability of error in the statement “the two populations from which samples are drawn are different.” Exact two-tailed p-values are used here, since we do not know a-priori which area or depth would have higher concentrations, should they be different. A value of 0.05 indicates a one-in-twenty (5%) chance of such an error, and this is often considered a marginally significant result. P-values closer to .01 are fairly strong statements regarding likely differences.

Applied to arsenic in the PNO versus Oxide areas, the concentrations are significantly different with a p-value of <0.001 when subjected to the Mann-Whitney U Test. The remainder of statistical analyses will be devoted primarily to PAHs.

Mean values for PAHs and benzene (and mean values calculated without extreme values³) and number of samples for each area and depth are provided in Table 2.

Detailed results of the Mann-Whitney test for the significance of differences by area and depth are attached in Appendix 1. The following is a summary of the results.

- 2-Area breakdown: PAHs are significantly higher in the eastern corner of the site than the remainder of the site (“Main Area”) for shallow and deep soils.
- 3-Area breakdown
 - PNO appears to have lower concentrations than the other two areas. The elevated PNO samples at B6 (shallow) and MW6 (deep) are exceptions to this trend.
 - Mean concentrations at NWN are substantially higher than at Koppers, but the difference is not statistically significant. This lack of significance most likely reflects the limited impact of extreme values on the test..

³ Extreme values were arbitrarily selected by inspecting data for single samples that accounted for over about ½ of the mean. These extreme values were associated with samples from B6, B13, and B18 in shallow soil; and B6, B27, and MW6 in deep soils.

Table 2. Mean Concentrations[†] and Number of Data Points for Each Area Breakdown and Depth.

Area Division	Depth	Area	CPAHs		TPAHs		Benzene	
			Mean (ppm)	N	Mean (ppm)	N	Mean (ppm)	N
1-Area	All Depths	All Areas	285	136	2290	136	21.1	58
	Surface	All Areas	104	23	197	23	0.15	5
	Shallow	All Areas	531	36	3469	36	29.5	21
	Deep	All Areas	223	77	2364	77	18.8	32
2-Area	Surface	Main Area	57	13	129	13	0.15	3
		East Corner	166	10	286	10	0.15	2
	Shallow	Main Area	325	30	1604 (624 w/o B13)	30 (29)	30.9	18
		East Corner	1560	6	12793	6	21.7	3
	Deep	Main Area	52 (24 w/o MW6)	50 (49)	815	50	16.7	26
		East Corner	541	27	5232	27	28.2	6
3-Area	Surface	PNO	10	4	21	4	0.15	1
		NWN	123	15	212	15	0.15	2
		KOP	125	4	318	4	0.15	2
	Shallow	PNO	311 (35 w/o B6)	16 (15)	889 (108 w/o B6)	16 (15)	0.03	10
		NWN	1115	12	8945	12	15.6	6
		KOP	91	8	415	8	105.3	5
	Deep	PNO	65 (1.9 w/o MW6)	22 (21)	941 (4.3 w/o MW6)	22 (21)	4.6	15
		NWN	391	40	3982	40	42.2	9
		KOP	9	15	137 (54 w/o B27)	15 (14)	19.2	8
4-Area	Surface	Oxide	10	4	21	4	0.15	1
		PNO		0		0		0
		Former Tar Pond	132	14	228	14	0.15	3
		Koppers	102	5	251	5	0.15	1
	Shallow	Oxide	956 (73 w/o B6)	5 (4)	2765 (268 w/o B6)	5 (4)	0.15	1
		PNO	21	10	39	10	0.01	9
		Former Tar Pond	1361	7	11053	7	17.7	4
		Koppers	327 (47 w/o B13)	14 (13)	2378 (279 w/o B13)	14 (13)	78.5 (27 w/o B18)	7 (6)
	Deep	Oxide	8.4 (0.4 w/o B6)	5 (4)	19 (2.0 w/o B6)	5 (4)		0
		PNO	0	15	0	15	0.12	13
		Former Tar Pond	484	32	4901	32	41.3	8
		Koppers	67 (11 w/o MW6)	25 (24)	1005 (180 w/o MW6)	25 (24)	24.6	11

[†]For values in which a single data point has a dramatic impact on the calculated mean, the mean value calculated without that data point has also been calculated and is shown in parenthesis. This is intended to show the impact of extreme values on the mean.

- 4-Area breakdown
 - All depths: PNO has significantly lower concentrations than other areas in nearly all comparisons.
 - Surface PAHs: The Former Tar Pond and Koppers areas have similar concentrations and both have higher surface PAH concentrations than the Oxide area.
 - Shallow PAHs: The Former Tar Pond area has significantly higher concentrations than all other areas except the Oxide area. If sample B6 is removed from the Oxide area (B6 accounts for about 90% of PAHs found in Oxide area samples) then the Oxide area too has concentrations significantly less than the Pond area ($p < 0.05$ for both TPAHs and CPAHs).
 - Deep PAHs: While the Former Tar Pond shows elevated levels in histograms and means, the difference is not statistically significant in deep soil. As mentioned above, the test may under-estimate significance when extreme values and duplicates are present.

The overall picture from statistical tests is that the PNO area has lower concentrations of PAHs than other areas of the site, and the Former Tar Pond area has higher concentrations of PAHs. The 4-area breakdown shows greatest resolution.

Variations in distribution shapes, substantial numbers of identical values in different groups (non-detects), and extreme values limit test power and reliability. Generally we suggest that test results be considered only supplemental to visual analysis of the data presented in plots and tables.

5. Another Way to View Relation Between Proximity and Concentration – Variograms

Figures 24-27 show scatter plots relating the straight-line distances (x,y,z) between samples and the differences in contaminant concentrations found in those two samples. Thus every possible pair of points is shown as a point with the corresponding difference in concentrations and distance between those points. Such plots, called “variograms” in geo-statistics, are used to examine spatial relations between concentrations. Variograms are shown for the full site (up to 1,600 feet between samples, on x-axis) and for samples within 300 feet. If concentrations change in a continuous fashion across the site then concentration differences will increase with distance between the samples.

For PAHs below the surface the variograms show differences in concentration even for points that are very close together (points spread along or close to the y-axis). This is evidence for what is referred to as “pure nugget” or small clumps with different concentrations than surroundings. For deep PAHs and benzene there no visible “ranges” (a distance over which there seems to be a relation between concentration and distance). This indicates a lack of smooth concentration gradients in deep soil. PAHs in surface and shallow soils show less variation in concentrations for points within about 100 feet, which is consistent with a tendency for concentrations to vary more smoothly.

The nuggets and limited distance/concentrations ranges are consistent with the observed presence of distinct zones and “fingers” of oil tar and tar product (especially the tar) having been incorporated within fill at the site. PAH concentrations beyond the limit of tar or oil product tend to display a sharp decline in contamination. Given the placement of product at numerous portions of the site as fill the presence of gradually declining concentrations from a “source” is not anticipated, but rather the highly heterogeneous patterns displayed by the variograms would be expected.

6. Relationships Between Shallow Soil Description And Concentrations

Soil odor, sheen, and the presence of product were recorded in boring logs while collecting samples. These descriptions were used in the body of the Summary Report to develop an idea of product location and contour plots showing product location. In this section we look at how soil descriptions are related to concentrations for shallow soils. As described later, we can use these relationships to estimate the degree of bias in the sub-surface sampling.

6.1. Are Contaminant Concentrations Related to Soil Descriptions?

Table 3 below shows, for shallow soils, the number of data points and mean contaminant concentrations when samples are grouped by clean/sheen/odor and by the presence of observed product. There appear to be substantial differences in mean concentrations depending on whether there is sheen, odor, or product. We examine these apparent relationships in more detail below for PAHs and benzene.

Table 3. Shallow Soil Mean Concentrations and Number of Samples by Soil Description and Observed Product

Soil Description Observed Product	Carcinogenic PAHs		Total PAHs		Benzene	
	Means (ppm)	N	Means (ppm)	N	Means (ppm)	N
Clean	13	16	10	16	0.01	8
None	13	16	10	16	0.01	8
Lampblack		0		0		0
Tar		0		0		0
Oil		0		0		0
Odor	861	4	7331	4	0.15	2
None	79	1	163	1	0.15	1
Lampblack	1121	3	9720	3	0.15	1
Tar		0		0		0
Oil		0		0		0
Sheen & Odor	966	16	5962	16	56	11
None	2.2	4	271	4	120	3
Lampblack	638	2	4028	2	18	1
Tar	1961	5	10951	5	24	2
Oil	873	5	6301	5	39	5
All Groups	531	36	3469	36	30	21

6.1.1. PAHs

Soil with no odor, sheen, or product (i.e., looks clean) tends to have low PAH concentrations; soil with odor or sheen but no product tends to have intermediate concentrations, and soil with visible product tends to have the highest concentrations. However, there is significant variation within each category. Details follow.

Figures 28 and 29 show histograms of the occurrence of PAHs in soil for each combination of soil description, with number of points (N) and mean values shown (Note that the figures show data compiled for all depths, not just shallow depths as in the table above). Samples with no visible product and no odor or sheen have low concentrations and 42% (73 of 174) are non-detects. Soil with visible product usually has a sheen (48 of 54 samples, or 89%) and otherwise has an odor, and these points have elevated concentrations. There is no clear difference between samples with odor versus sheen. The samples with sheen or odor but no product have low to intermediate concentrations.

Based on the above analysis, three soil categories present themselves for evaluation:

- Soil with no odor sheen nor product;
- Soil with odor or sheen but without product
- Soil with product

The data sets associated with each of these categories can be compared to each of the other categories to determine if a statistically significant difference exists between the data categories. Tables 4 and 5 display the statistical difference between data sets associated with the soil categories listed above. The low p-values produced via the Mann-Whitney u-test for the comparison of these data sets indicates that each of the soil categories presented above displays a statistically significant difference from the others for CPAHs and TPAHs. To further illustrate this point, box plots of concentrations in each of the 3 categories used in the above tables, for shallow soil, are shown in Figures 30 and 31 (note the log scale).

Table 4. TPAH Concentrations by Soil Description

Soil Category 1	Soil Category 2	P-value of difference (Mann-Whitney u-test)
No Odor, Sheen, nor Product (N=87, mean =57 ppm TPAH)	Product	<0.001
Odor or Sheen without Product (N=22, mean=369 ppm TPAH)	No Odor, Sheen, or Product	0.001
Product (N=27, mean=11,050 ppm TPAH)	Odor or Sheen without product	<0.001

Table 5. CPAH Concentrations by Soil Description

Soil Category 1	Soil Category 2	P-value of difference (Mann-Whitney u-test)
No Odor, Sheen, or Product (N=87, mean =31 ppm CPAH)	Product	<0.001
Odor or Sheen without visible product (N=22, mean=88 ppm CPAH)	No Odor, Sheen, or Product	0.05
Product (N=27, mean=1263 ppm CPAH)	Odor or Sheen without product	<0.001

We cannot generally relate the nature of the product (oil versus tar versus lampblack) to concentrations, given the amount and variability of the data. We did find, however, that PAH concentrations in oily soil are higher in the tar pond area than in the Koppers area, suggesting variation in types and sources of oil⁴.

6.1.2. *Benzene*

The relation between soil description categories and concentration is less clear for benzene, with the presence of sheen or oil being the best indicators of benzene. Figure 35 shows the occurrence of benzene concentrations in soil for each combination of soil category. Soil with no visible product and no odor or sheen has lower concentrations. Soil with visible product nearly always has a sheen (16 of 18 samples, or 89%). The two points with product and no sheen have low benzene, and the 7 points with no product but sheen include the point with the highest concentration (B18, 12 ft deep) and 2 other points with significant concentrations. This suggests sheen is a better indicator of benzene concentration than the presence of product.

Figure 36 shows box plots of the log of benzene concentrations with samples either sorted by presence of product or odor and sheen. If we do not exclude the high sample at B18 then there is no difference in mean concentrations based on the presence of lampblack or tar, but samples with oil have elevated concentrations. Using the appearance of odor and sheen seems to give a bit more consistent, although still rough, predictor of benzene concentration.

Based on these graphs of the data, the following two alternative sets of soil categories suggest themselves:

- Clean soil
- Soil with an odor
- Soil with a sheen

and

⁴ While oil was found in soil samples in both the Koppers and tar pond areas, PAH concentrations are higher in the pond area. Thus we investigated whether oily samples in the various areas are comparable. Table 6 below summarizes the concentrations of PAHs in oily soil samples in the Pond and Koppers areas, with the significance of the difference shown in the bottom row. This data is also shown in a box-whisker plot in Figure 32-34.

Table 6. Shallow soil (0.2-15 feet) with Visible Oil, Concentrations of PAHs and Benzene.

	CPAHs		TPAHs		Benzene	
	Mean (ppm)	N	Mean (ppm)	N	Mean (ppm)	N
Former Tar Pond	1997	6	23087	6	79	4
Koppers	727	8	6881	8	52	7
P-value significance of difference (Mann-Whitney)	0.23		0.34		0.53	

The difference is not statistically significant, but concentrations of PAHs in oily soils appear to be higher in the pond area than in the Koppers area. This difference could be due to a differing source for the oil in the former tar pond area than that identified in the Koppers area, with the oils in the former tar pond area perhaps more closely related to, or derived from, the tars, while no tars were present in the Koppers area.

- No product
- Lampblack
- Tar
- Oil

Table 7 shows the statistical significance of differences in soil categories the first set of categories (i.e., clean, odor and sheen).

Table 7. Benzene Concentrations by Soil Description

Soil Category 1	Soil Category 2	P-value of difference (Mann-Whitney u-test)
Clean (N=20, mean=0.85 ppm benzene)	Sheen	<0.001
Odor (N=4, mean=12.5 ppm benzene)	Clean	0.13
Sheen (N=25, mean=47.8 ppm benzene)	Odor	0.50

Table 7 indicates that soil categorized as clean differs in a statistically significant manner from soil categorized as having a sheen. The other category combinations do not show a strong statistical difference, but there are only 4 samples with just odor.

Table 8 shows the statistical significance of differences in soil categories the second set of categories (i.e., no product, lampblack, oil and tar).

Table 8. Benzene Concentrations by Soil Description

Soil Category 1	Soil Category 2	P-value of difference (Mann-Whitney u-test)
No Product (N=40, mean=11.6 ppm benzene)	Lampblack	0.07
No Product	Oil	<0.001
No Product	Tar	.11
Lampblack (N=3, mean =10 ppm benzene)	Tar	.8
Oil (N=11, mean=62 ppm benzene)	Lampblack	.37
Tar (N=4, mean=12 ppm benzene)	Oil	.28

Table 8 indicates that soil categorized as having no product differs in a statistically significant manner from soil categorized as having oil present. The other category combinations do not show a strong statistical difference, although there are only 3 samples with lampblack and 4 with tar.

In summary, the relationship between soil description categories and concentration for benzene is weaker than the relationship for PAHs. The presence of sheen or oil being the best indicators for the presence of benzene.

6.2. Estimating Average Concentrations Using Soil Descriptions

We found above that, particularly for PAHs, contaminant concentrations vary significantly with soil description. This confirms the common-sense expectation that the visible presence of contamination is related to the concentrations of contaminants.

It also confirms that sampling preferentially according to soil appearance is likely to result in a biased data set, i.e., the average concentration of such samples is unlikely to be the same as the average of randomly collected samples. This is important in that it could suggest that analyzed samples may be an imperfect indication of what a worker in a trench at a random location would encounter.

However, we can develop an estimated distribution of shallow soil concentrations based on soil categories. We can do this by first associating a distribution of concentrations with each soil category⁵. We can then examine each boring log to determine what fraction of shallow depth soil falls in each category (i.e., soil with no odor sheen nor product; soil with odor or sheen without product; soil with product for PAHs). This information can be determined from the cross-section figures of the Data Package Hahn, 1996, appendix L. Based on this information, we can estimate the distribution of concentrations that would be found if random samples had been collected.

We ran a simulation of 10,000 draws that estimated sample concentrations based on (a) likelihood of encountering each soil category, (b) concentration distribution for the soil category encountered, and (c) uncertainty in the measurement of concentration⁶. This produced distributions for concentrations intended to be representative for the site.

These distributions are shown together with the distributions for sample data in Figure 37. The simulated distributions based on the amount of soil of various descriptions are very similar in shape to those of the samples. However, the distributions based on soil description show about 30% fewer of the highest values of PAHs⁷. The reason for this difference is a bias towards sampling soil with visible product. As shown in Figure 38, about 30% of all soil encountered in boring was product contaminated, but about 40% of samples were taken from such soil. This is consistent with the sampling strategy, which was in part to characterize the worst contamination.

A comparison of average concentrations in shallow soil is shown in Table 9. A site-wide average is of limited use, given site area differences highlighted in other sections. However, averages do provide an idea of the difference in total contamination based sampling that was done versus results which might have been generated by random sampling in shallow soil. It appears that PAH contamination is overestimated by about 25% relative to random samples, while benzene is not overestimated. This is consistent with the results of the previous section – recall that the presence of benzene could not be well predicted on the basis of visual examination. Hence, if sampling preferentially based on soil appearance, benzene data would tend to be relatively unbiased. PAH concentrations, however, would

⁵ There a number of alternatives for developing distributions, as discussed later in the report. One approach would be to find the best-fitting parametric distribution. The fit for any distribution will be coarse, given histograms of concentrations. A second approach is to use the existing data as the distribution (“empirical distribution”). The testing error offers some smoothing of this distribution (see footnote below and later in text). As a comparison, a set of parametric distributions were fit (maximum likelihood) and the simulation was run with both these and empirical distributions. The results were nearly identical, with results using the empirical distributions shown.

⁶ We multiplied each concentration by a value selected from a normal distribution with mean 1 and standard deviation 0.25 to simulate the random error of sample analysis.

⁷ The average values for values shown as “More” on histograms are virtually identical for simulation and samples.

have a greater tendency to be biased toward high-end concentrations due to the stronger correlation between appearance and concentration.

Table 9. Shallow Soil Average Contaminant Concentrations, Site-wide in Shallow Soil

Contaminant	Average of Sample Concentrations (ppm)	Estimated Average Concentrations for Random Samples, Based on Amount of Soil with Sheen, Odor, Product (ppm)	Percent by Which Sample Average Exceeds Est. Random Samples
CPAHs	531	425	25%
TPAHs	3469	2804	24%
Benzene	29.5	29.7	-1%

To summarize, a comparison of sample concentrations with expected concentrations that would occur with random sampling suggests that sample concentrations are very similar to those that would be collected randomly, but likely overestimates the occurrence of the highest PAH concentrations.

7. Developing Distributions for Contaminant Concentrations

One purpose for concentration data is in assessing possible health risks. A probabilistic risk assessment requires probability distributions for chemical concentrations, so an important criterion for data is whether it is sufficient to construct or select distributions that adequately describe concentrations. The process of constructing distributions will generally help reveal whether data is adequate or inadequate for this purpose.

Unfortunately, there is no single right way to build a probability distribution based on empirical data. Depending on the amount of data, nature of the data, judgement, and available tools, methods include:

- Using data itself as the distribution (simple empirical distribution)
- Selecting the best-fitting parametric distribution
- Creating smoothed distribution from the data (smoothed empirical distribution)
- Selecting a distribution to maximize uncertainty consistent with data (maximum entropy)
- Using Bayesian updating to develop posterior distributions from priors (e.g. Roeder and Wasserman, 1997)
- Bootstrapping a smoothed distribution
- Manually creating a piece-wise combination of simple distributions

NWN and DEQ will need to work together to select and apply approaches that are mutually satisfactory. In this section we first examine existing data for obvious gaps and then provide examples of how distributions may be constructed using GASCO data⁸.

⁸ For useful general background information see ODEQ 1998 and it's appendix, EPA 1997.

7.1. Locations and Depths for Risk Assessment

Exposure scenarios and parameters dictate the appropriate area and depth breakdowns for purposes of risk assessment. In terms of area, there are three populations that are active on the lease areas: NWN, Koppers, and PNO. In terms of depth, we are concerned about exposure to surface soils, directly and via dust inhalation, and trenching and other activities that may bring people into contact with sub-surface soil up to 15 feet in depth. CPAHs and benzene appear to pose potential risks. Therefore we ultimately will need 9 soil concentration distributions: CPAH distributions for each of the below six location/depth combinations and benzene for each location at the shallow depth:

1. NWN Surface
2. NWN Shallow
3. PNO Surface
4. PNO Shallow
5. Koppers Surface
6. Koppers Shallow

7.2. Screen for Data Adequacy: Sample Number and Locations

During construction of the distributions we expect to learn about the adequacy of data. However, we can conduct a screening of it's adequacy by first simply considering how many samples are available in each location/depth combination, and how well they are distributed.

Regarding the number of data points, there is no hard and fast number that is either too few or plenty (although we will develop a better idea when constructing distributions). However, our judgement is that a minimum of 4 or 5 samples should be available in each area at each depth.

Regarding location, we do not currently have information indicating that surface or shallow soil exposures will occur more frequently in one area versus another within each of the 3 areas. Thus, as an approximation, we assume that the likelihood of exposures is essentially uniform within each of the 3 areas. This suggests that we would like roughly evenly spaced samples in each area. To the degree that samples are not uniform, we would like to see more samples in areas more likely to be visited.

Reviewing Table 2 we see that we indeed have at least 4 data points for each combination, although only 4 for surface CPAHs at PNO and Koppers. However, the points are not spread evenly. Surface sample locations are shown in Figure 39. This is a "Voronoi Tessellation", which draws lines that are equidistant between points, so the area surrounding each point is closest to that point. This provides an idea of the coarseness and uniformity of sampling locations. The southeastern portion of the site is well sampled, but there are few samples in the PNO and Koppers areas, and few in the area of the LNG yard, where surface activity is common. The 10 x's on the figure indicate proposed approximate sampling locations to provide more uniform and complete coverage.

Figure 40 shows that shallow PAH samples are fairly uniform, except that (a) geotechnical borings near the river are clumped and thus over-represent that area, (b) there are no samples in the office area of NWN, and (c) the south eastern corner is slightly under-represented, and since this corner has highest concentrations, this is not conservative. To address these issues we would recommend (a) leaving out 2 geotechnical boring samples (which have low concentrations) and adding 3 samples at the approximate locations shown with x's in the figure.

Figure 41 shows that shallow benzene samples provide fair coverage, but 8 x's indicate locations for new points that would result in more complete and uniform coverage. The sample in the eastern corner can be collected with installation of a new well planned near MW-5, and 3 of the other points are in

roughly the same locations as those recommended above for shallow PAHs. Thus about 7 shallow samples appear useful for PAHs and benzene, in addition to samples taken during well installation.

We will learn more about possible data gaps while building distributions, but have identified 10 surface and 7 shallow soil samples that appear desirable based on the number and location of existing points.

7.3. Examples of Constructing Distributions

We will illustrate two approaches in surface CPAHs in the NWN area:

1. Fitting of parametric distribution
2. Smoothed empirical distribution

7.3.1. Parametric Fit for Surface CPAHs in the NWN Area.

Figure 42 shows a histogram surface carcinogenic PAH data for the NWN area. We do not know what distribution is appropriate a-prior, but the histogram appears similar to the overlaid lognormal distribution⁹. We will now consider measures of the lognormal fit.

A probability-probability plot for a lognormal fit is shown, suggesting a fairly good fit (points lie close to diagonal line). Table 10 summarizes numerical tests of fit for a lognormal distribution. The Shapiro-Wilks W test of the normality does not reject the hypothesis of normality of the log transformed data¹⁰. The fit measure most sensitive to tails (Anderson-Darling) is also consistent with a good fit. However, the lognormal distribution that is fit, by selecting parameters to maximize the likelihood of observed values, has a mean of 176, versus the actual mean of 123 for data points. As discussed below, this results from fitting a distribution with a tail extending to infinitely high concentrations, and can be addressed by truncating the tail at a point well beyond the highest observed values.

Given the visual comparison (perhaps most important, e.g. EPA 1997) and numerical results, aside from the infinite tail, the lognormal distribution appears to be a fairly good representation for surface CPAHs in the NWN area.

Table 10. Lognormal Fit (mean 176, SD 664) to Surface CPAHs in NWN Area.

Measure of Fit	Fit Parameter Value	Common threshold for "good" fit
Shapiro-Wilks W test of normality (on log-transformed data), p-value	p=0.71 W=.96	p>0.05
Chi-squared	Undefined	p>0.5
Anderson-Darling	0.22	<1.5
Kolmogorov-Smirnov	0.10	<0.03

⁹ This is somewhat appealing in that dilution and degradation processes can be viewed as yielding concentrations that are the product of random numbers, yielding a lognormal distribution. However many data sets from the site do not appear to fit any parametric distribution.

¹⁰ The Shapiro-Wilk test is considered one of the best methods for testing for normality, and is sensitive to departures from normality in the tails of distributions. When the statistic is significant (e.g. p < 0.05) normality can be rejected and when insignificant normality can be accepted.

With a small data set, even if we accept that the distribution is lognormal, there is uncertainty regarding the true mean and standard deviations of the distribution. Thus using the best fitting distribution directly is not sufficiently conservative. We can address this by using a tiered simulation approach in which (a) we estimate distributions for parameters (mean and sd), (b) sample from these parameter distributions to construct a family of distributions, and (c) sample from this family of concentration distributions for estimating risk. This procedure reflects both uncertainty in the population distribution parameters (mean, sd) and variability in what an individual might encounter at the site. We carried this out and the ultimate result is also a lognormal distribution, but with a slightly increased uncertainty relative to the best-fit distribution (sd increased from 664 to 783).

Finally, we note that the tail length and shape for the fit is an artifact of the choice of distributions, and does not reflect information in the data. For example, a tail extending to infinity, as does the lognormal, is not realistic. We also note that the mean of the data is the best unbiased estimate of the population mean, so we would like the fit to have similar mean to the data. Further, we would like the fit distribution to have a SD at least similar to the data. In this case we find that truncating the tail at 3.5 times the highest data value (i.e. at 2,012 ppm, which is at 98.8% for the distribution) yields a distribution with mean 125 and SD 241, which are similar to these parameter values for the data.

7.3.2. *Smoothed Empirical Distribution for CPAHs in Surface NWN Soil.*

Another approach to obtaining a distribution from empirical data is to simply sample from the data itself. While this is simple and seemingly avoids assumptions, it has two primary weaknesses. First, the population distribution (i.e. real distribution) is in fact continuous – we could undoubtedly find some soil sample with virtually any concentration between zero and our highest value. Using our few discrete points in place of a continuous distribution could introduce unrealistic patterns into results.

Second, and more importantly, it makes no provision for the likelihood that there are in fact concentrations that are higher than we found – i.e., that there is a tail beyond our highest value. One way to address this issue is through the use of non-parametric tolerance limits, which estimate the certainty with which our highest value exceeds a given percentage of all values. For example, Montgomery (1996) provides a method for calculating tolerance limits for nonparametric distributions. Using this approach, we find that with 16 samples we can say with 75% certainty that our highest value exceeds 92% of all values. Thus if we place 8% of the probability density beyond our highest value we have a 75% chance that we have over, rather than under, represented the number of samples beyond our highest value. However, there is no magic way to guess where those last 8% should be, so we would need to select some shape for the tail we are adding¹¹.

An alternative approach that uses empirical data, but avoids both of the above problems, is to smooth the data (e.g. Silverman, 1986). This is commonly done by replacing each empirical data point with a probability distribution (“kernel”) scaled down to have the probability of that point (1/n). Since the distributions overlap and extend beyond the highest point, the combined distribution is smoothed and extends beyond the highest point. Various kernel distributions are used, including some with tails extending to infinity (“infinite support”) such as the normal distributions, and others with finite support. The primary impact of kernel choice for our application will be tail shape and length. In this example we will use the normal distribution, keeping in mind that we will want to truncate the tail, as we did above for the lognormal parametric fit.

¹¹ In any case it is difficult to estimate rare events, or the tail of a distribution, without very large data sets. If we select a parametric distribution we sidestep the issue by taking the particular tail of that distribution. But as noted above, these tails are often unrealistic – e.g. extending to infinity – so require truncation or other adjustment.

Having selected a kernel, the challenges become selecting the broadness, or “bandwidth” of the kernel, and then correcting for the known increase in variance resulting from smoothing. A systematic way of selecting bandwidth that has theoretical appeal is called “cross validation.” This is done by calculating the likelihood of each observation, given that kernels of a particular bandwidth replace other observations. Bandwidth is then adjusted to maximize the product of these likelihoods. To correct for variance added to the data by the smoothing the distribution is “shrunk.” Finally, we will truncate the infinite tail for realism and to obtain a mean equal to the data mean¹².

To summarize, empirical smoothing is a method for selecting a nonparametric distribution that maximizes the probability of existing data. Assumptions include (a) the kernel does not introduce uncorrectable bias and provides a reasonable tail shape, (b) bandwidth should be uniform across kernels, and (c) the maximum likelihood selection of bandwidth is appropriate.

In our case we performed the smoothing on the log-transformed data, reflecting our expectation that the general shape will be asymmetric, will not extend below zero, and will have a significant tail. For fitting the surface CPAHs in the NWN area we found that truncating the tail at 2 times the highest value (beyond 96.4%) gives a mean of 124 and SD of 190, which closely match our data.

Figure 43 shows the best fitting smoothed empirical distribution with a solid line and the lognormal parametric fit (previous subsection) with a dotted line. The distributions have very similar shape, but with the smoothed empirical distribution being slightly more uniform versus the parametric fit having slightly more emphasis on the lowest and highest values.

Table 11. Comparison of Distribution Fits to Surface PAHs in NWN Area (approximate values, based on 10,000 trial simulation).

Distribution Parameter	Data	Fit Developed from Lognormal Parametric	Fit of Smoothed, Empirical Distribution
Mean	123	125	124
Standard Deviation (SD)	171	241	190

In this example the reasonable visual fits and close similarity of fits from two different methods gives us some confidence that we have been able to construct reasonable distributions from available data. This may not be the case with other needed distributions for which less data exists. By constructing all of the needed distributions we will discover more about where further data is needed.

¹² Fitting a kernel to data is known to increase the variance by the variance of the kernel (i.e., the bandwidth squared). To correct for this the distance between the mean and the mean of each kernel is shrunk by multiplication by the correction $p = (Vd / (Vd + BW^2))^{0.5}$ to keep the mean and variance of the smoothed distribution equal to those values for the original distribution. We apply this shrinking factor to the log-transformed data, to which we fit our kernels. We still get an uncorrected increase in variance when exponentiating back to our final distribution. This bias, and the infinite tail length, are addressed by truncating the tail.

8. Summary and Conclusions

Conclusions of this preliminary analysis of available soil data include:

- There is substantial small-scale variability superimposed on site-scale trends. The variability is consistent with placement of fill, mixing of soils, and preferential transport of contaminants in rootlets and other channels. This variability is likely to continue to be large for future sampling.
- There appear to be significant differences in concentrations and variability by area and depth. For PAHs site-scale trends include increasing contamination towards the eastern corner of the site and lower and less variable concentrations at the surface. For benzene, concentrations differ by area and appear consistent with a shallow source spreading down gradient and deeper.
- The mix of PAHs differs between surface soil and subsurface soil. For surface soils the PAH mix is fairly constant across the site, while subsurface PAHs show diversity in mix.
- PAH concentrations are related to soil description (odor, sheen, and presence of product). Benzene concentrations tend to be elevated when there is oil or sheen, but the relationship is weaker.
- Surface samples were placed essentially randomly. Sub-surface samples were collected in part based on soil appearance, and are therefore biased. We analyze this bias and estimate that it (1) increases representation of high-concentration PAH samples by about 25%, and (2) has no measurable impact on benzene values.
- 17 new soil data samples are identified that would improve the completeness and uniformity of samples. 10 approximate locations for additional surface samples for PAHs are identified, primarily in the PNO and office areas. 7 approximate locations for shallow soil samples for CPAHs and benzene are identified.
- Constructing concentration probability distributions requires agreement in selection of approach and in implementation. Examples are provided for two methods (fitting parametric distributions and smoothing of empirical) of fitting distributions to concentrations of CPAHs in surface soil on the NWN lease area. Other data needs may become apparent with similar construction of the additional 8 concentration probability distributions that are needed for assessing risk.

Entire site evaluation; needs to be broken down into separate sites.

9. Appendix 1. Detailed Results of Mann-Whitney U Tests for Difference Between Groups

Detailed results are shown for pair-wise comparisons of areas for:

- all depths together
- surface (<0.2 feet deep)
- shallow(0.2-15 feet deep), and
- deep soil (> 15ft)

The areas breakdowns considered are, as defined in text and Table 1:

- 2-Area
- 3-Area
- 4-Area

3-Area Pair-wise Comparison by Area, All Depths:

Chemical	Group 1 N	Group 2 N	p value
	PNO	NWN	
Carc. PAHs	42	67	<.001
Total PAHs	42	67	<.001
Benzene	26	17	<.001

Chemical	N, Group 1	Group 2 N	p value
	PNO	KOP	
Carc. PAHs	42	27	.01
Total PAHs	42	27	<.001
Benzene	26	15	<.001

Chemical	Group 1 N	Group 2 N	p value
	NWN	KOP	
Carc. PAHs	67	27	.29
Total PAHs	67	27	.98
Benzene	17	15	.94

3-Area Pair-wise Comparison by Area, Surface Samples (< 0.2 feet):

Chemical	Group 1 N	Group 2 N	p value
	PNO	NWN	
Carc. PAHs	4	15	.05
Total PAHs	4	15	.05
Benzene	1	2	--

Chemical	Group 1 N	Group 2 N	p value
	PNO	KOP	
Carc. PAHs	4	4	.03
Total PAHs	4	4	.03
Benzene	1	2	--

Chemical	Group 1 N	Group 2 N	p value
	NWN	KOP	
Carc. PAHs	15	4	.47

Total PAHs	15	4	.36
Benzene	2	2	--

3-Area Pair-wise Comparison by Area, Shallow Depth Samples (Between 0.2 and 15 feet):

Chemical	Group 1 N	Group 2 N	p value
	PNO	NWN	
Carc. PAHs	16	12	.007
Total PAHs	16	12	.005
Benzene	10	6	.001

Chemical	Group 1 N	Group 2 N	p value
	PNO	KOP	
Carc. PAHs	16	8	.11
Total PAHs	16	8	.03
Benzene	10	5	<.001

Chemical	Group 1 N	Group 2 N	p value
	NWN	KOP	
Carc. PAHs	12	8	.21
Total PAHs	12	8	.27
Benzene	6	5	.25

3-Area Pair-wise Comparison by Area, Deep Samples (more than 15 feet):

Chemical	Group 1 N	Group 2 N	p value
	PNO	NWN	
Carc. PAHs	22	40	.005
Total PAHs	22	40	<.001
Benzene	15	9	.001

Chemical	Group 1 N	Group 2 N	p value
	PNO	KOP	
Carc. PAHs	22	15	.06
Total PAHs	22	15	.007
Benzene	15	8	.004

Chemical	Group 1 N NWN	Group 2 N KOP	p value
Carc. PAHs	40	15	.43
Total PAHs	40	15	.93
Benzene	9	8	.54

4-Area Pair-wise Comparison by Area, All Depths:

Chemical	Group 1 N Oxide	Group 2 N PNO	p value
Carc. PAHs	14	25	<.001
Total PAHs	14	25	<.001
Benzene	2	22	.04

Chemical	Group 1 N Oxide	Group 2 N Pond	p value
Carc. PAHs	14	53	.55
Total PAHs	14	53	.32
Benzene	2	15	.24

Chemical	Group 1 N Oxide	Group 2 N Koppers	p value
Carc. PAHs	14	44	.39
Total PAHs	14	44	.84
Benzene	2	19	.24

Chemical	Group 1 N PNO	Group 2 N Pond	p value
Carc. PAHs	25	53	<.001
Total PAHs	25	53	<.001
Benzene	22	15	<.001

Chemical	Group 1 N PNO	Group 2 N Koppers	p value
Carc. PAHs	25	44	<.001
Total PAHs	25	44	<.001
Benzene	22	19	<.001

Chemical	Group 1 N Pond	Group 2 N Koppers	p value
Carc. PAHs	53	44	.03
Total PAHs	53	44	.25
Benzene	15	19	.66

4-Area Pair-wise Comparison by Area, Surface (<0.2 feet):

Chemical	Group 1 N Oxide	Group 2 N PNO	p value
Carc. PAHs	4	0	—
Total PAHs	4	0	—
Benzene	0	0	—

Chemical	Group 1 N Oxide	Group 2 N Pond	p value
Carc. PAHs	4	14	.05
Total PAHs	4	14	.05
Benzene	1	3	.66

Chemical	Group 1 N Oxide	Group 2 N Koppers	p value
Carc. PAHs	4	5	.03
Total PAHs	4	5	.03

Chemical	Group 1 N PNO	Group 2 N Pond	p value
Carc. PAHs	0	14	—
Total PAHs	0	14	—
Benzene	0	3	—

Chemical	Group 1 N PNO	Group 2 N Koppers	p value
Carc. PAHs	0	5	—
Total PAHs	0	5	—
Benzene	0	0	—

Chemical	Group 1 N Pond	Group 2 N Koppers	p value
Carc. PAHs	14	5	.89
Total PAHs	14	5	1.0
Benzene	3	1	—

4-Area Pair-wise Comparison by Area, Shallow (0.2 to 15 feet):

Chemical	Group 1 N Oxide	Group 2 N PNO	p value
Carc. PAHs	5	10	.05
Total PAHs	5	10	.10
Benzene	1	9	—

Chemical	Group 1 N Oxide	Group 2 N Pond	p value
Carc. PAHs	5	7	.20
Total PAHs	5	7	.11
Benzene	1	4	—

Chemical	Group 1 N Oxide	Group 2 N Koppers	p value
Carc. PAHs	5	14	.44
Total PAHs	5	14	.82
Benzene	1	7	—

Chemical	Group 1 N PNO	Group 2 N Pond	p value
Carc. PAHs	10	7	<.001
Total PAHs	10	7	<.001
Benzene	9	4	<.001

Chemical	Group 1 N PNO	Group 2 N Koppers	p value
Carc. PAHs	10	14	.03
Total PAHs	10	14	.015
Benzene	9	7	<.001

Chemical	Group 1 N Pond	Group 2 N Koppers	p value
Carc. PAHs	7	14	.003
Total PAHs	7	14	.02
Benzene	4	7	.79

4-Area Pair-wise Comparison by Area, Deep (>15 feet):

Chemical	Group 1 N Oxide	Group 2 N PNO	p value
Carc. PAHs	5	15	.01
Total PAHs	5	15	<.001

Benzene 0 13 --

Chemical	Group 1 N Oxide	Group 2 N Pond	p value
Carc. PAHs	5	32	.91
Total PAHs	5	32	.62
Benzene	0	8	--

Chemical	Group 1 N Oxide	Group 2 N Koppers	p value
Carc. PAHs	5	25	.52
Total PAHs	5	25	1.0
Benzene	0	11	--

Chemical	Group 1 N PNO	Group 2 N Pond	p value
Carc. PAHs	15	32	<.001
Total PAHs	15	32	<.001
Benzene	13	8	<.001

Chemical	Group 1 N PNO	Group 2 N Koppers	p value
Carc. PAHs	15	25	.008
Total PAHs	15	25	<.001
Benzene	13	11	<.001

Chemical	Group 1 N Pond	Group 2 N Koppers	p value
Carc. PAHs	32	25	.26
Total PAHs	32	25	.52
Benzene	8	11	.97

2-Area Pair-wise Comparison by Area, All Depths:

Chemical	Group 1 N Main Area	Group 2 N East Corner	p value
Carc. PAHs	93	43	.003
Total PAHs	93	43	.009
Benzene	47	11	.05

2-Area Pair-wise Comparison by Area, Surface:

Chemical	Group 1 N Main Area	Group 2 N East Corner	p value
Carc. PAHs	13	10	.21
Total PAHs	13	10	.21
Benzene	3	2	--

2-Area Pair-wise Comparison by Area, Shallow:

Chemical	Group 1 N Main Area	Group 2 N East Corner	p value
Carc. PAHs	30	6	<.001
Total PAHs	30	6	<.002
Benzene	18	3	.18

2-Area Pair-wise Comparison by Area, Deep:

Chemical	Group 1 N Main Area	Group 2 N East Corner	p value
Carc. PAHs	50	27	.05
Total PAHs	50	27	.07
Benzene	26	6	.21

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11. Figures

Figure 1.

Comparison of Duplicate Results for Three Compounds

(B-31 & MW-03 samples were all ND or very low)

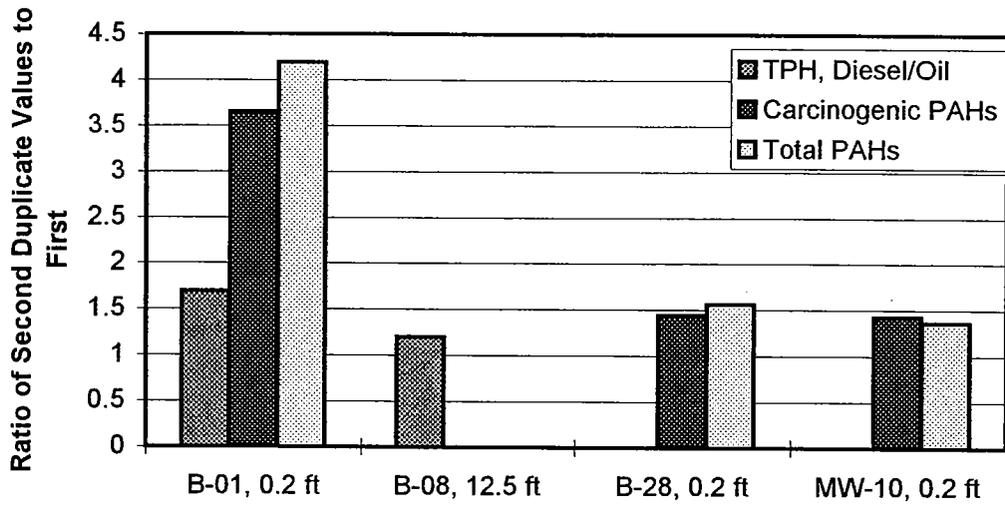


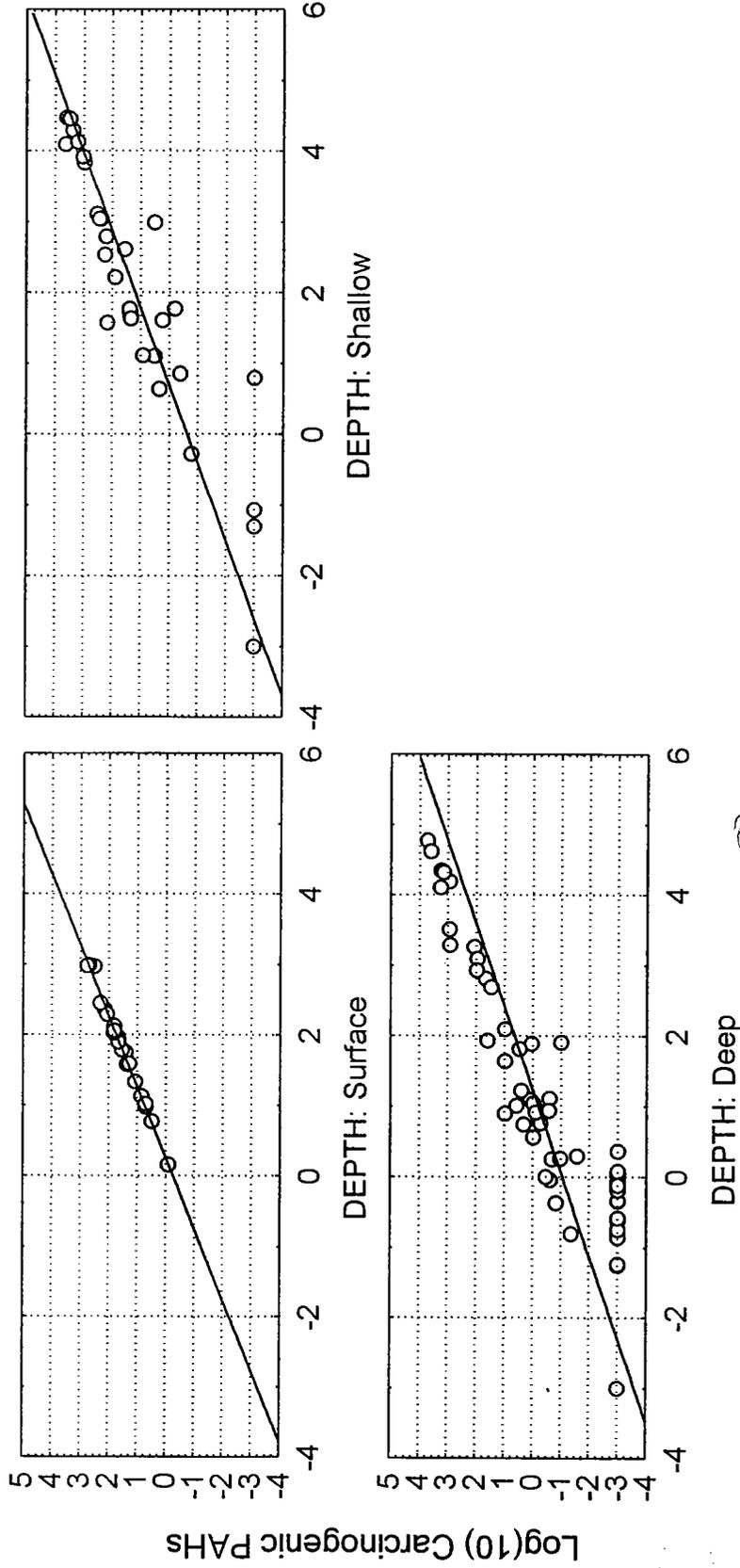
Figure 2.

Total vs. Carcinogenic PAHs by Depth (Log-Log)

DEPTH: Surface $y = -0.252 + 0.994 * x + \text{eps}$

DEPTH: Shallow $y = -0.628 + 0.913 * x + \text{eps}$

DEPTH: Deep $y = -1.047 + 0.849 * x + \text{eps}$



Log(10) Total PAHs
not nat log

Figure 3.
 Comparison of PAH Compound Mix in Surface Soil Samples

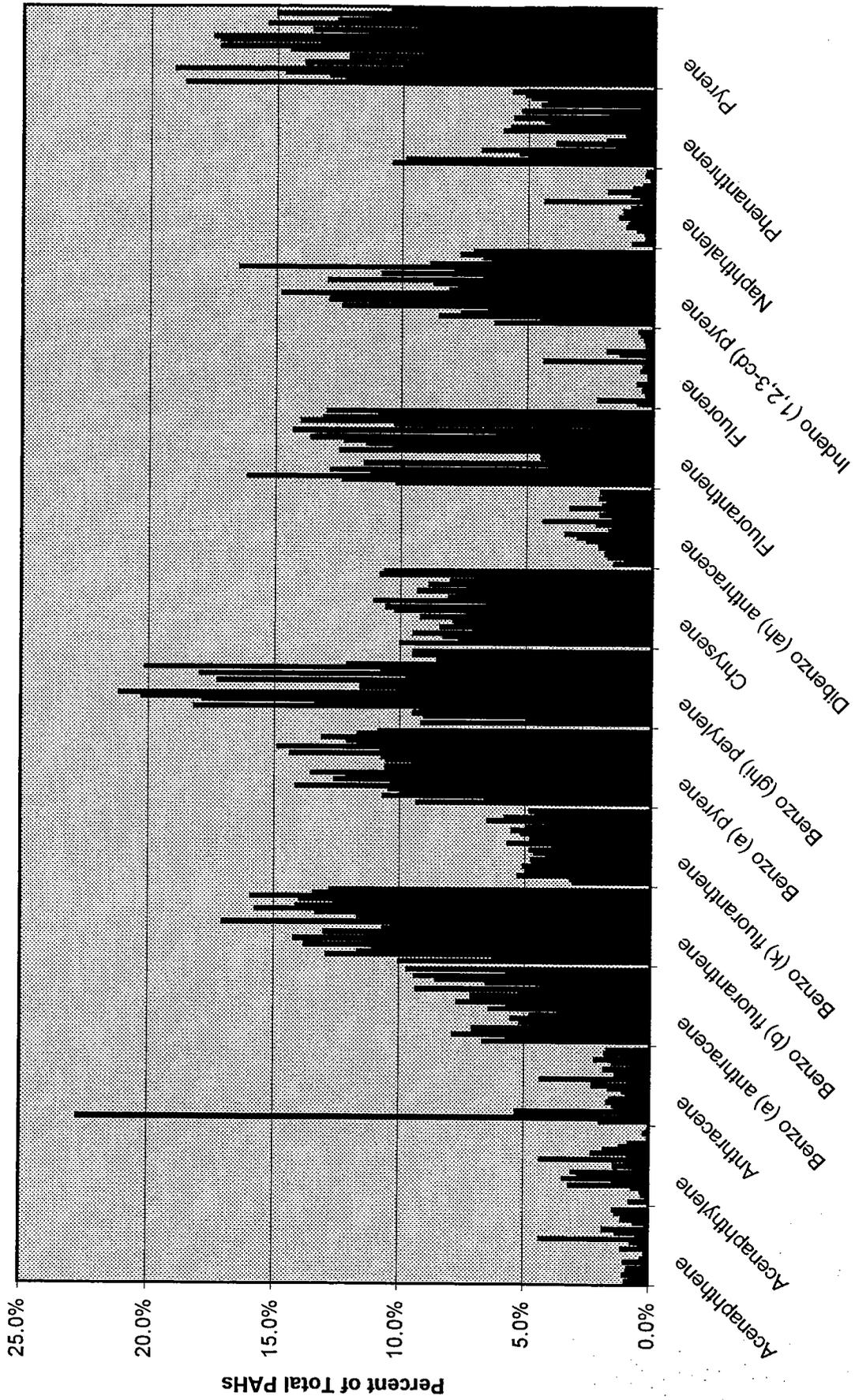


Figure 4.

Comparison of PAH Compound Mix in Shallow Soil Samples

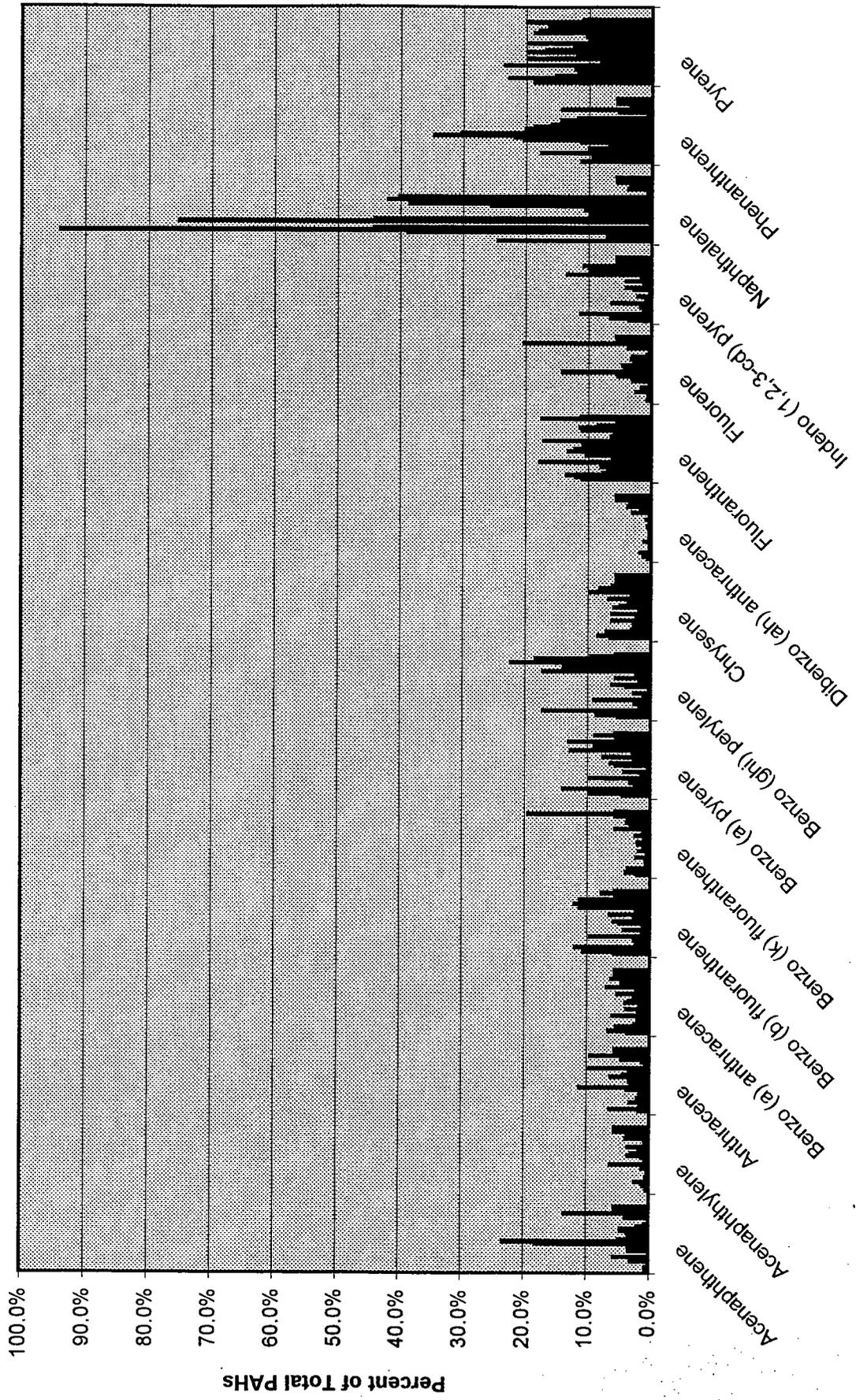


Figure 6.

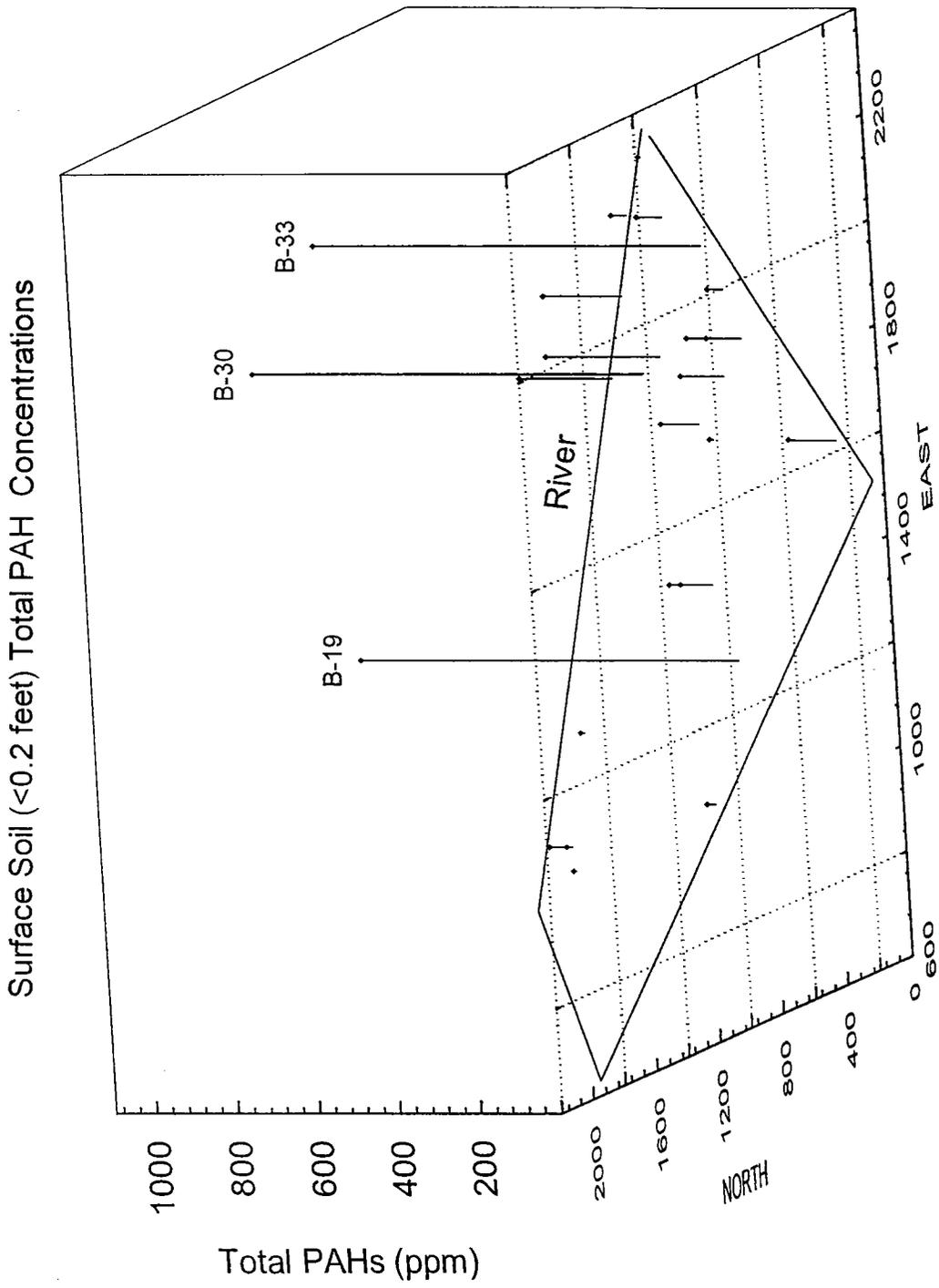


Figure 7.

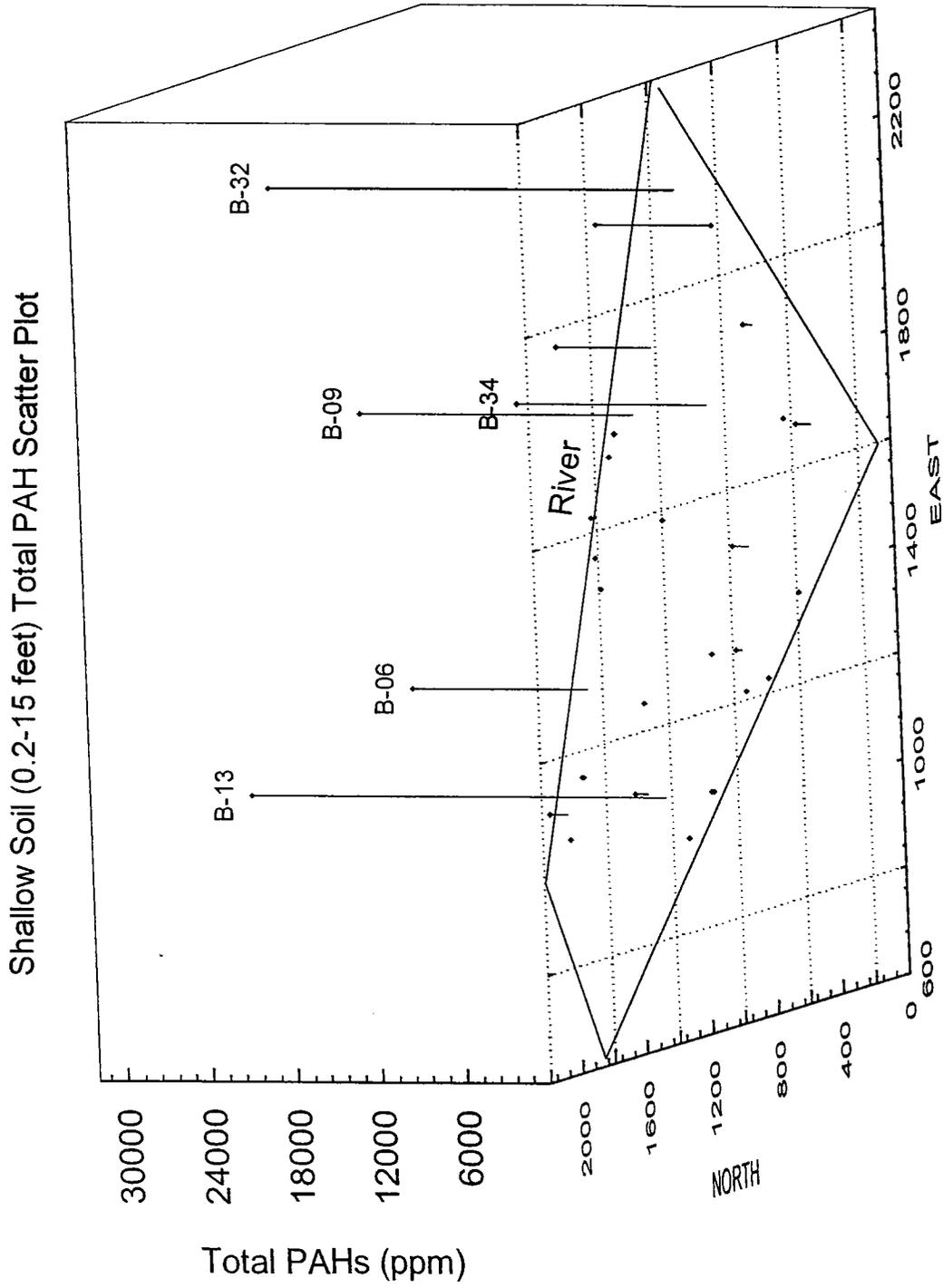


Figure 8.

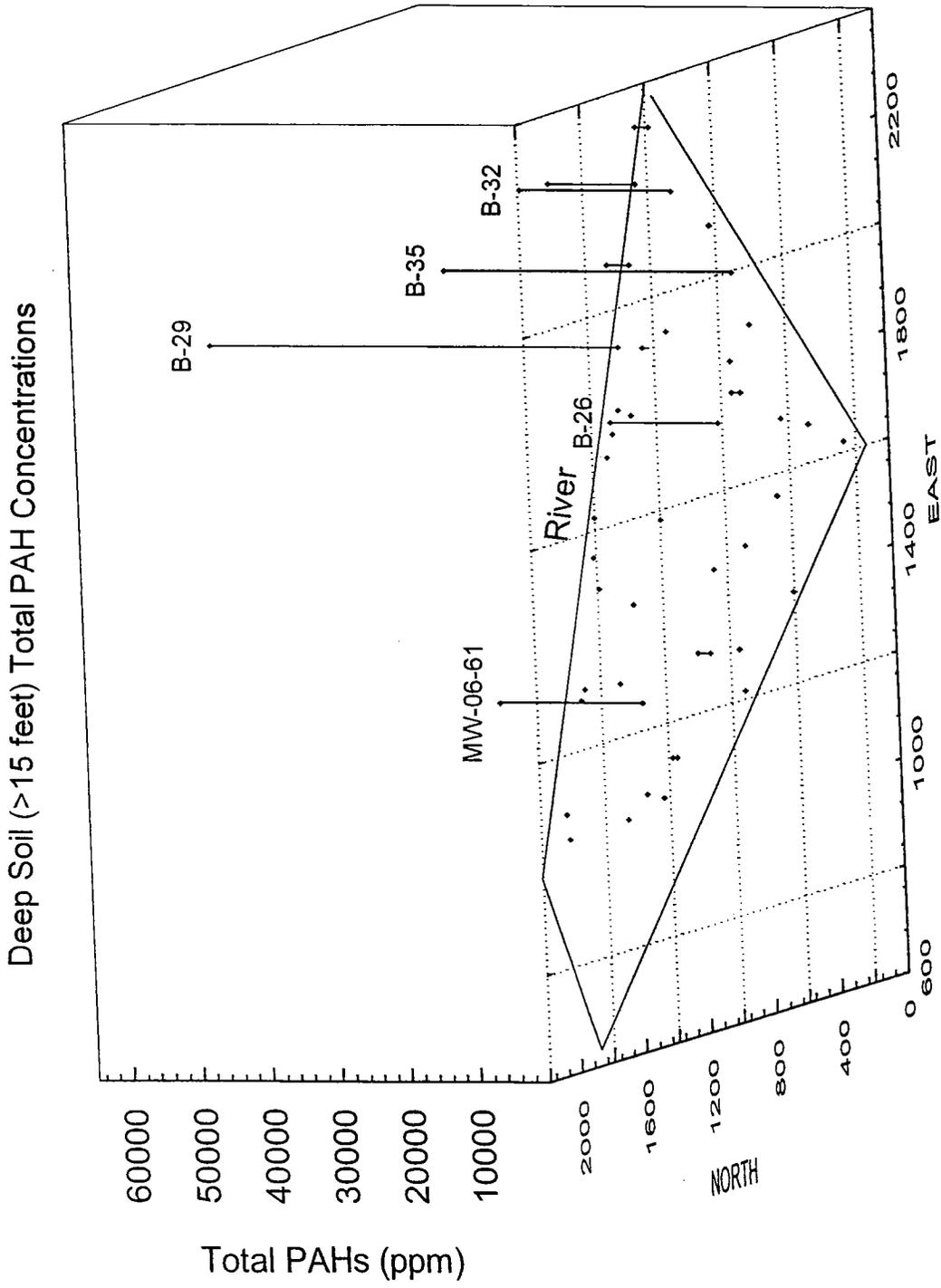


Figure 9.

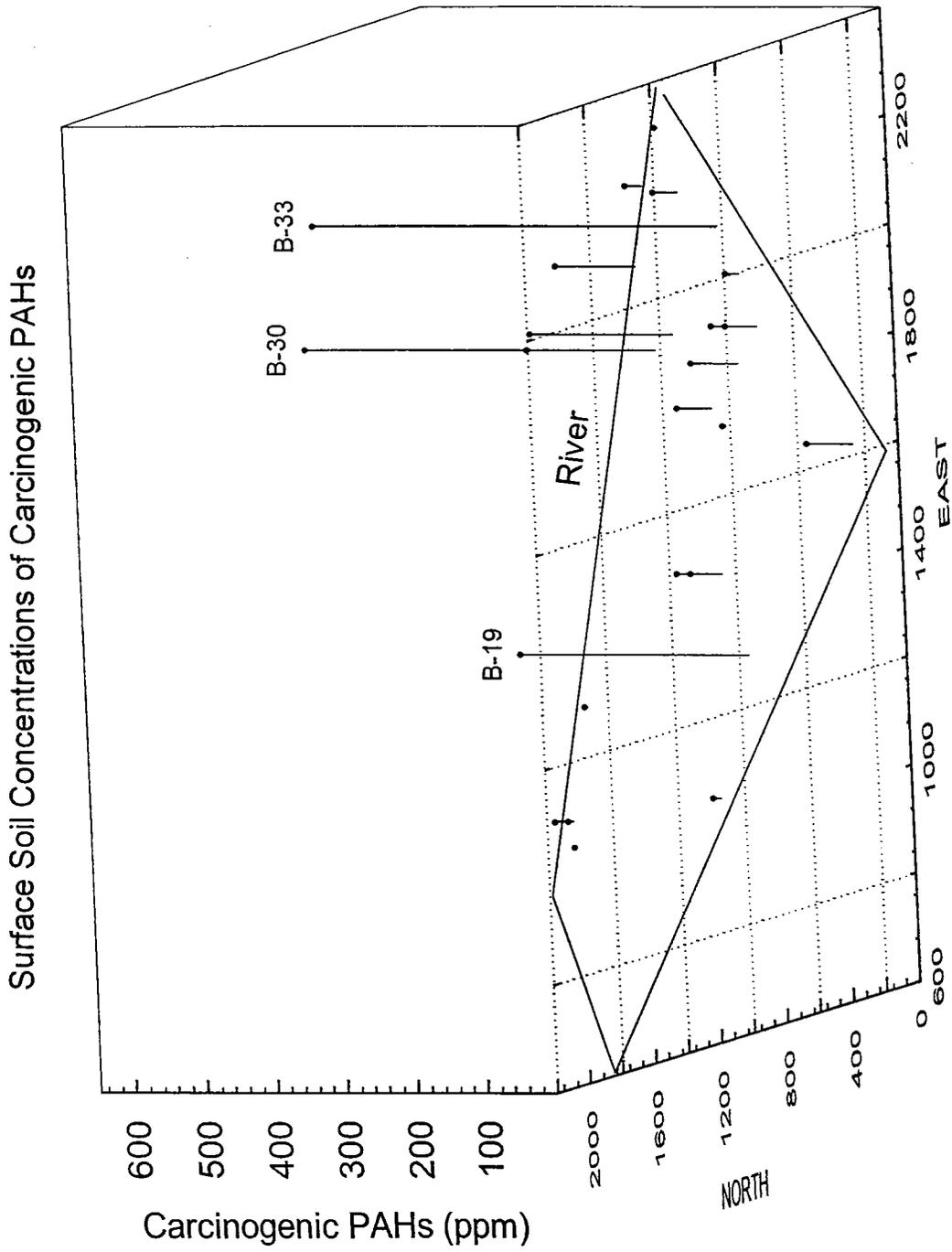


Figure 10.

Shallow Soil (0.2-15 feet) Carcinogenic PAH Concentrations

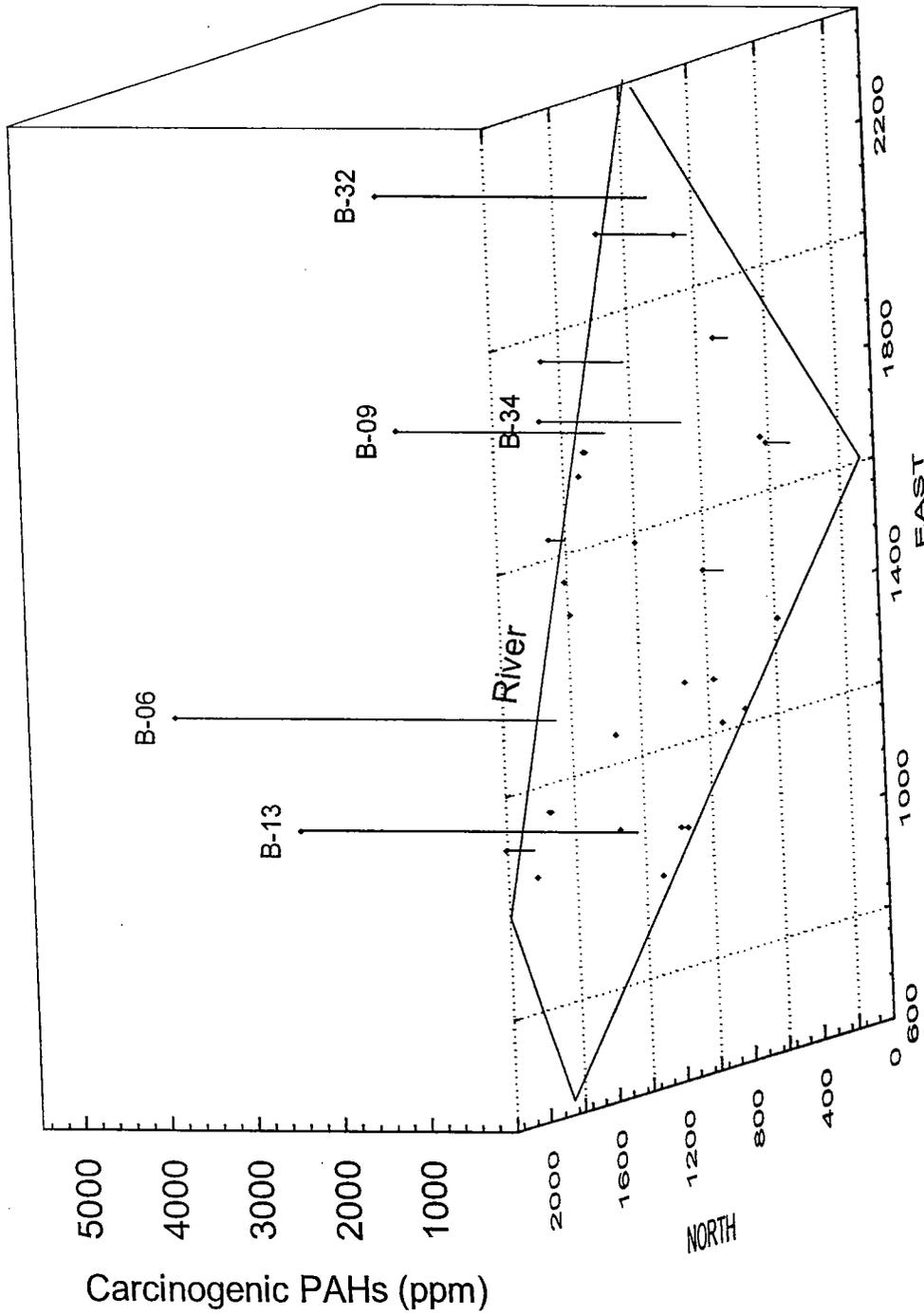


Figure 11.

Deep Soil (>15 feet) Carcinogenic PAH Concentrations

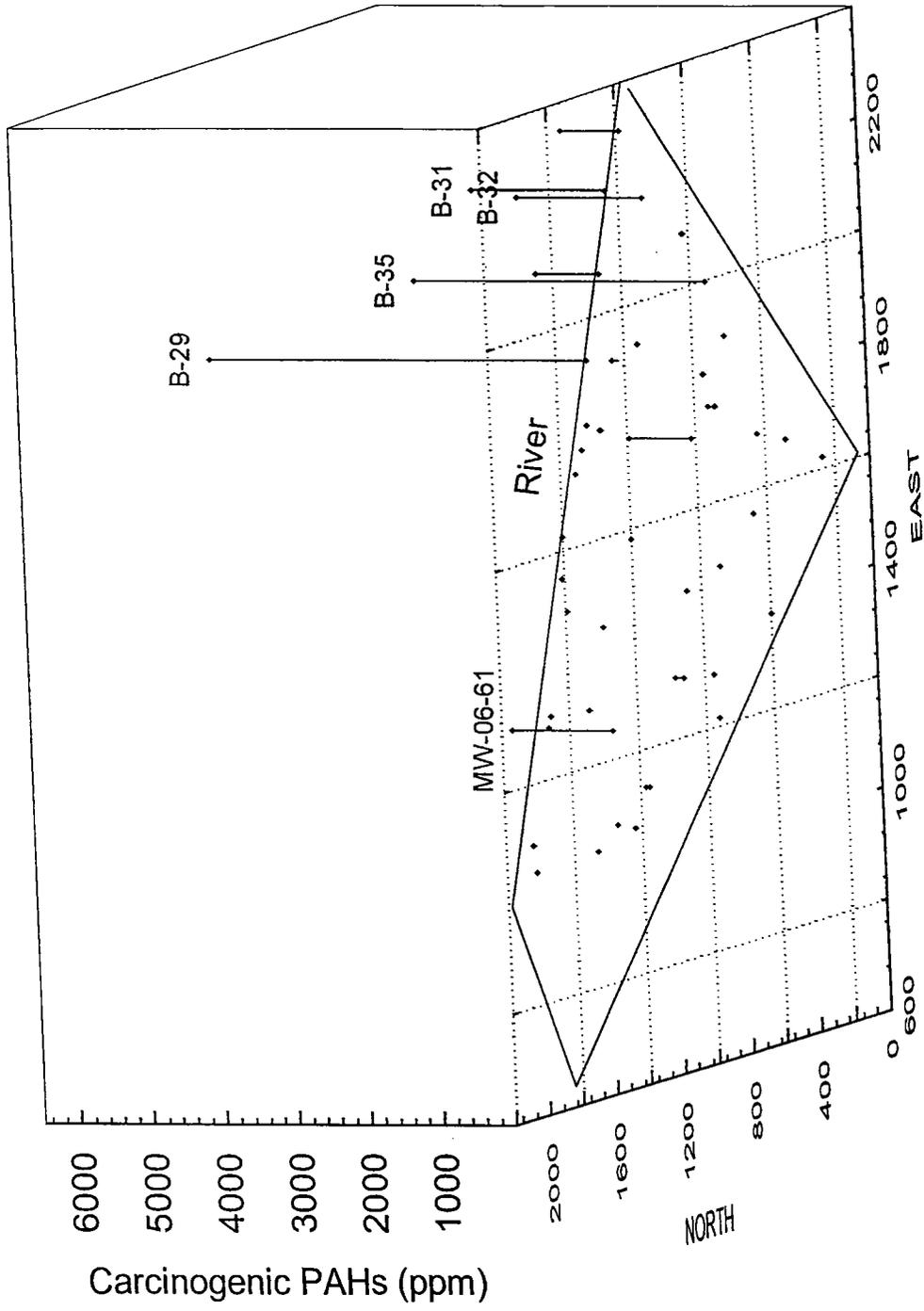


Figure 12.

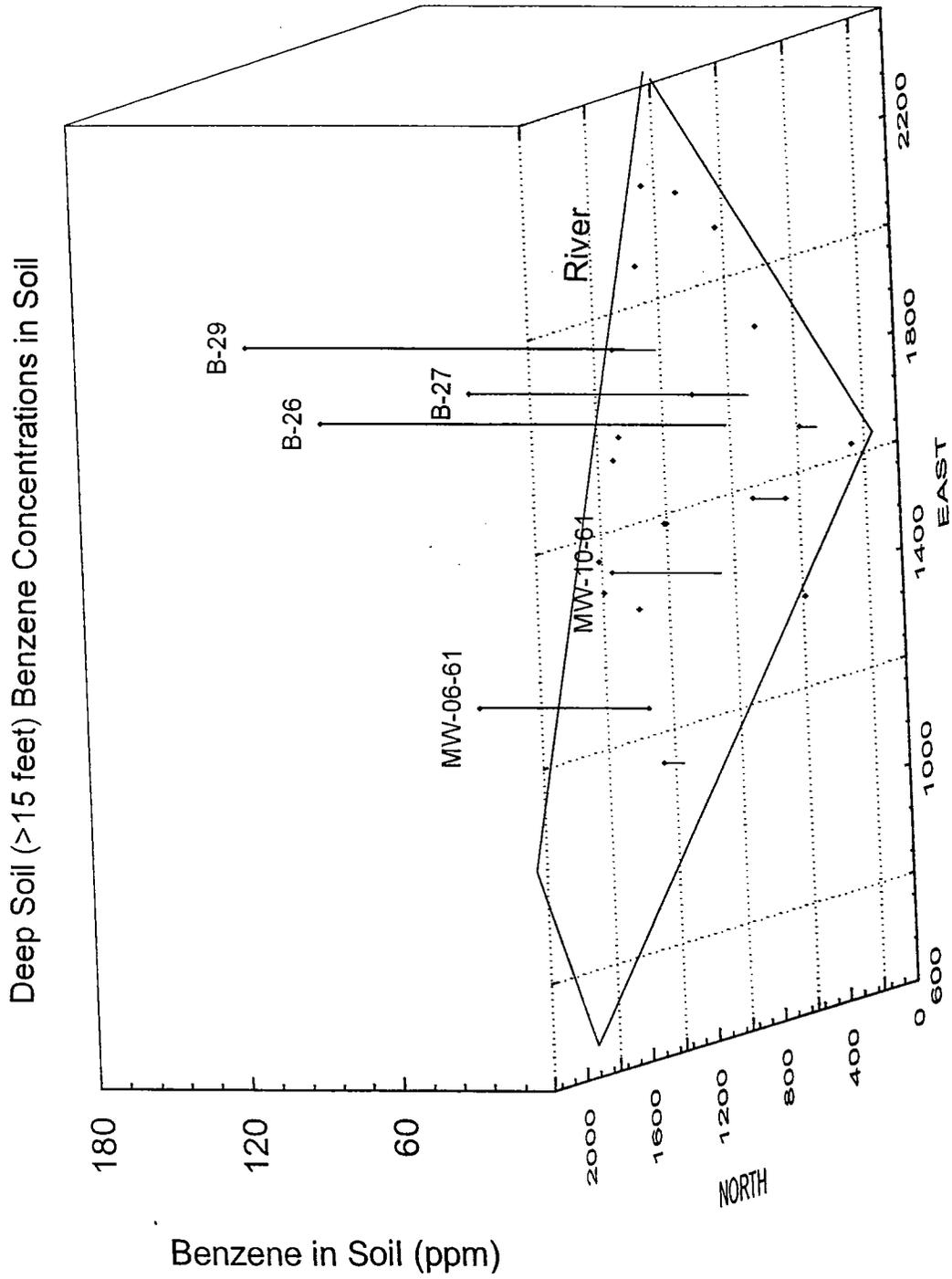


Figure 13.

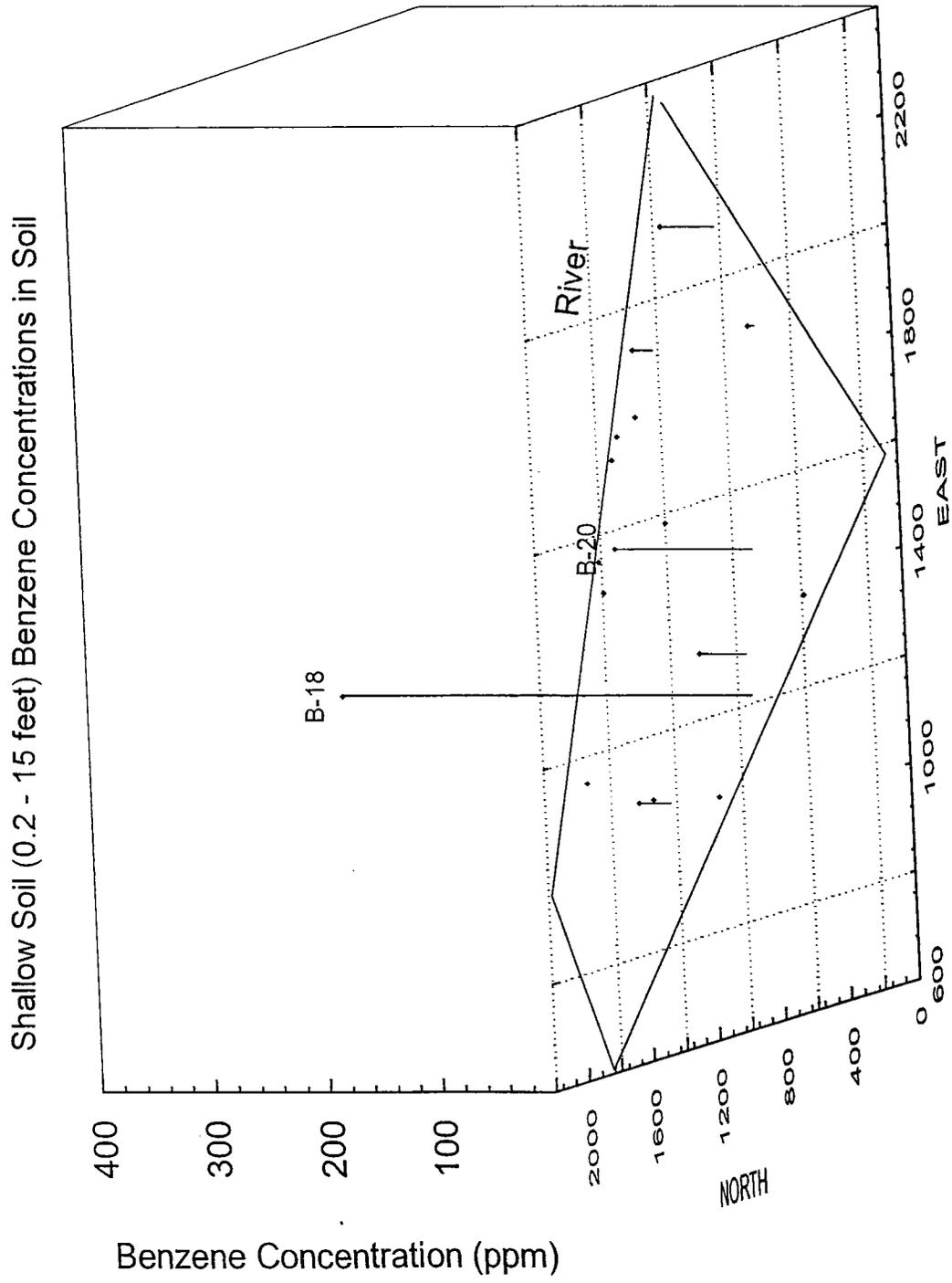
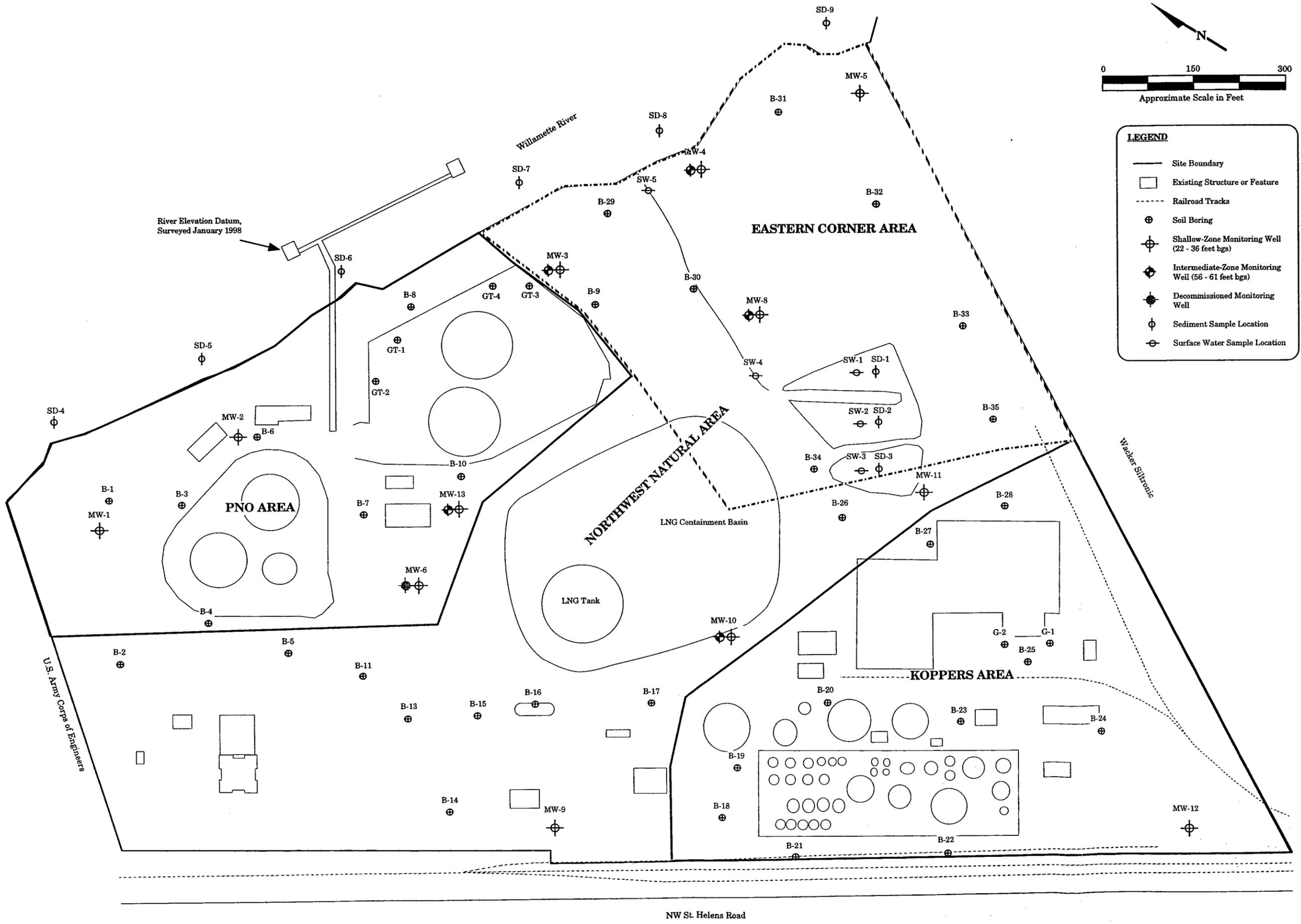


Figure 14



LEGEND

- Site Boundary
- ▭ Existing Structure or Feature
- - - Railroad Tracks
- ⊕ Soil Boring
- ⊕ Shallow-Zone Monitoring Well (22 - 36 feet bgs)
- ⊕ Intermediate-Zone Monitoring Well (56 - 61 feet bgs)
- ⊕ Decommissioned Monitoring Well
- ⊕ Sediment Sample Location
- ⊕ Surface Water Sample Location

Site Area Breakdown Map

Remedial Investigation
 Northwest Natural - Gasco Facility
 7900 NW St. Helens Road
 Portland, Oregon

HAHN & ASSOCIATES, INC.

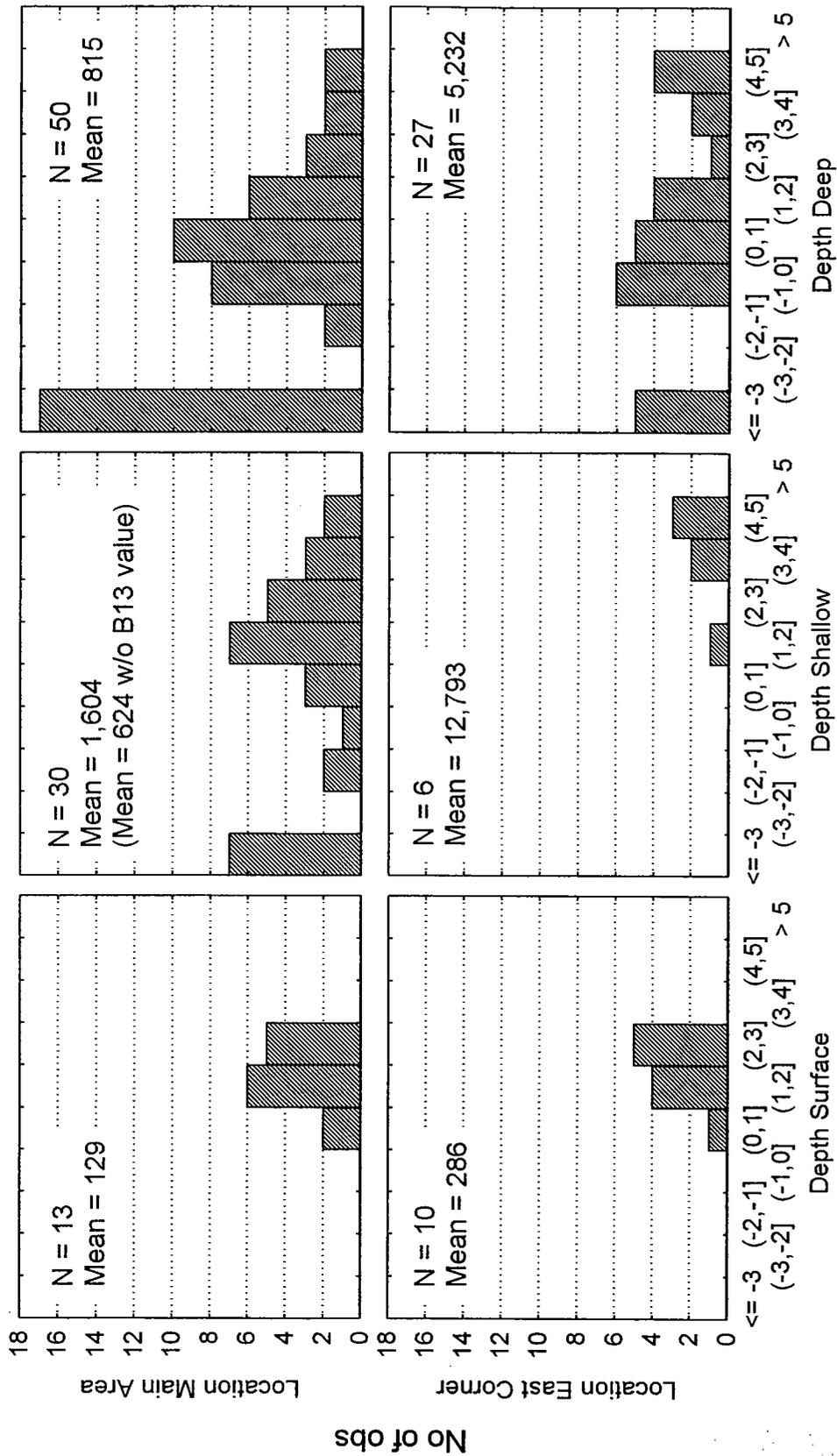
ENVIRONMENTAL MANAGEMENT
 434 NW SIXTH AVENUE, SUITE 203
 PORTLAND, OREGON 97209
 503/796-0717

September 1998

Project #2708

Figure 15.

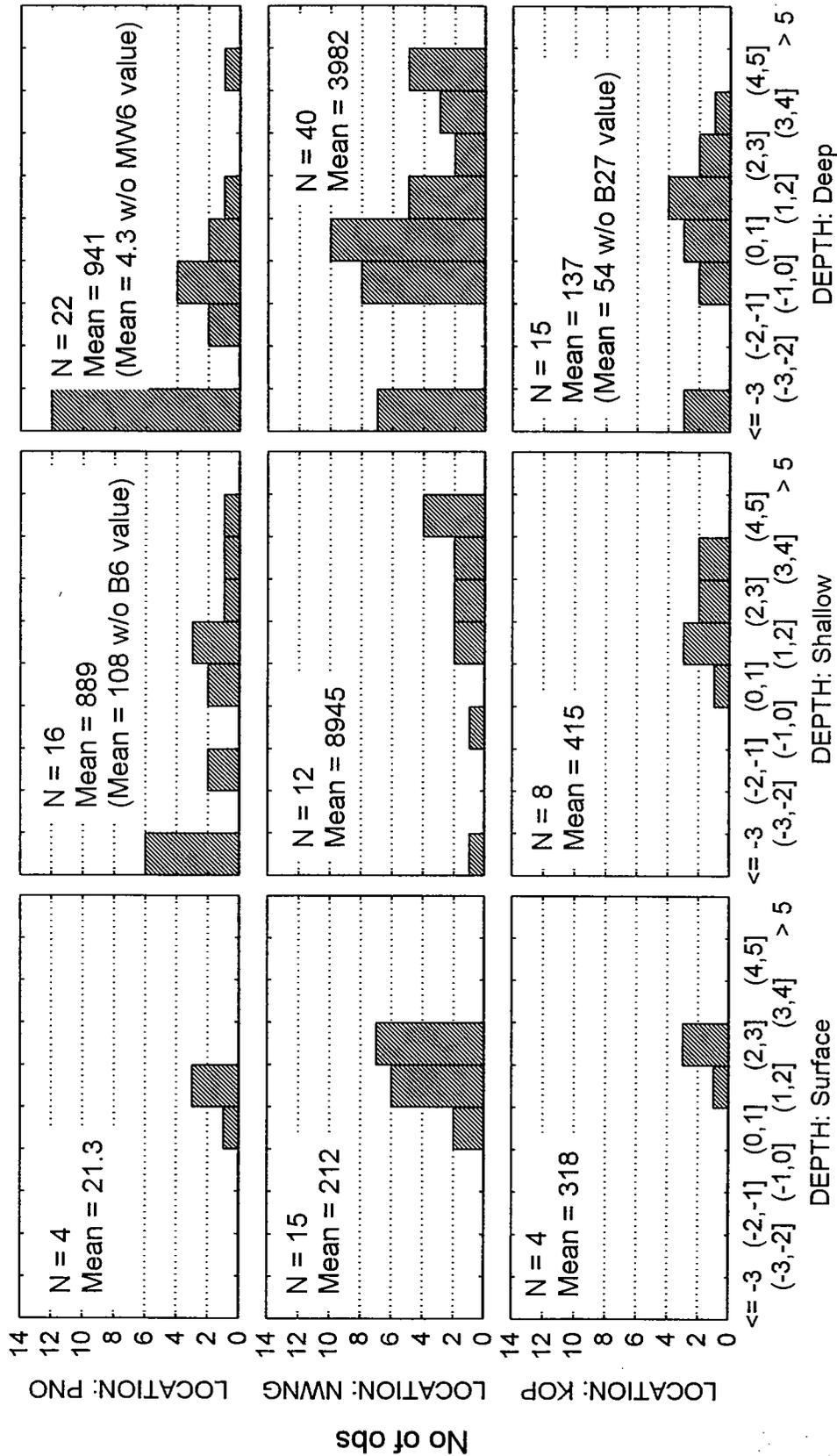
Log Total PAHs in Soil for 2 Areas and 3 Depths



Log (10) Total PAH Concentrations in Soil

Figure 16.

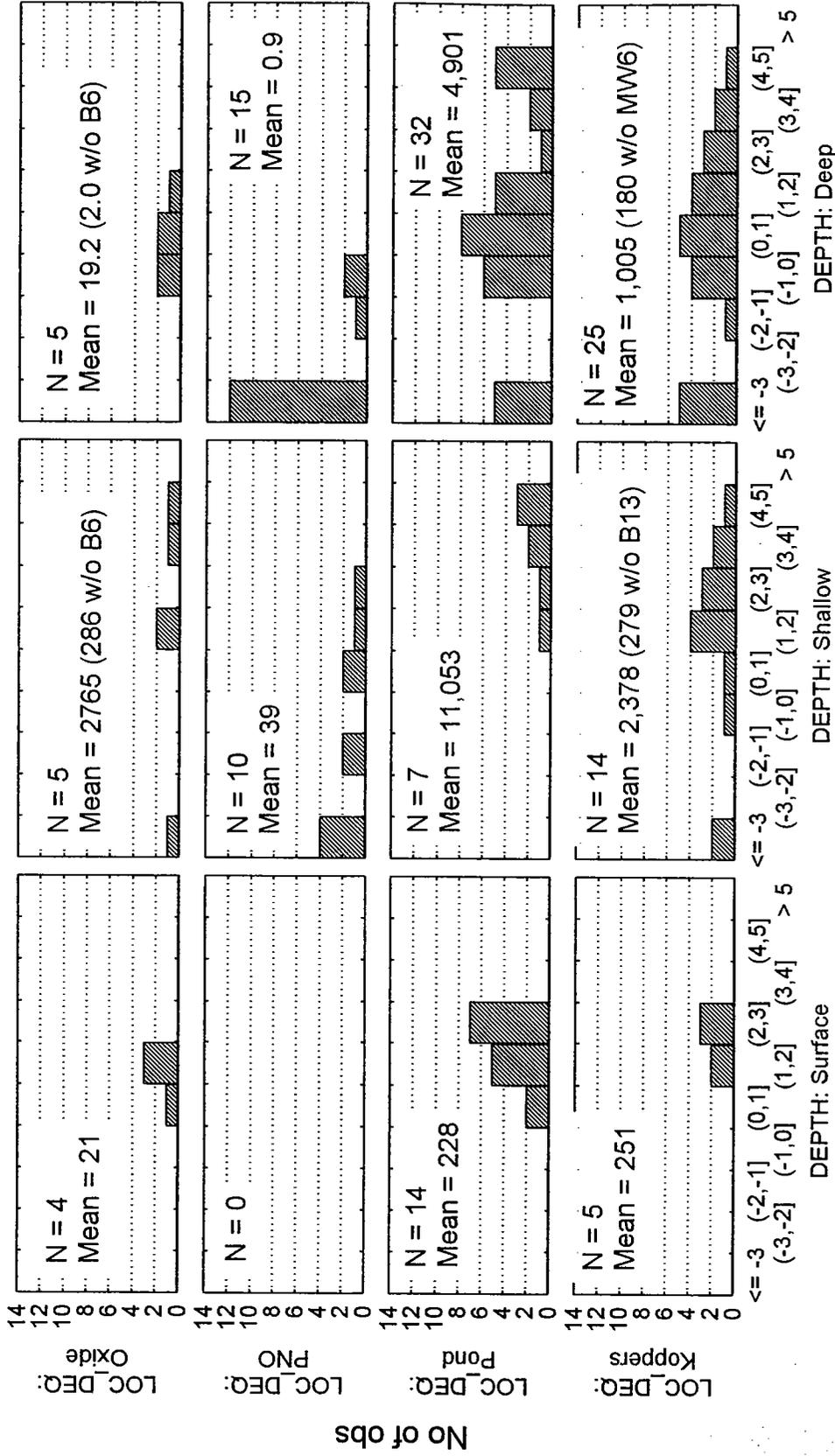
Log Total PAHs in Soil for 3 Locations and 3 Depths



Log (10) Total PAH Concentrations in Soil

Figure 17.

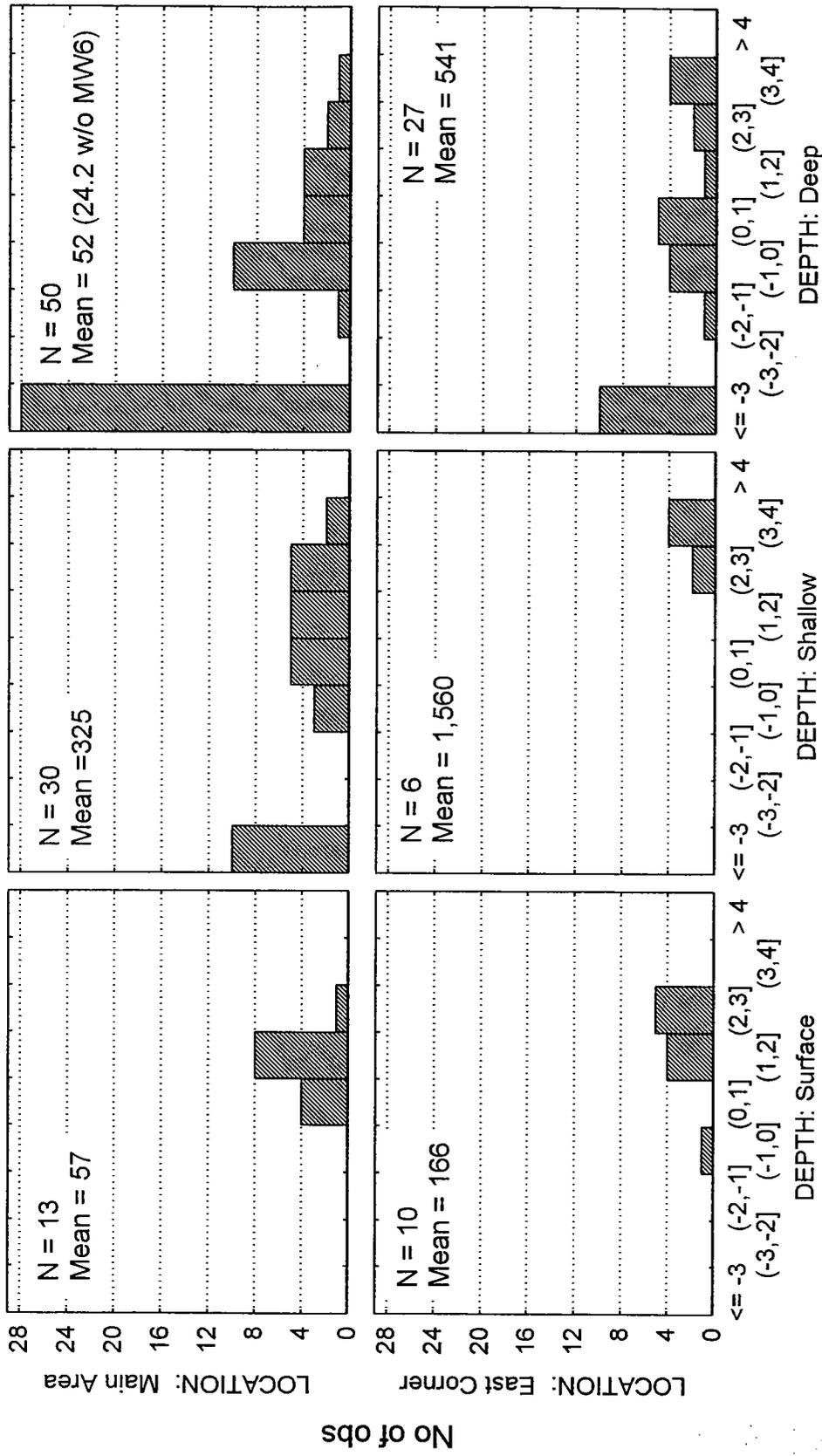
Log Total PAHs for 4 Locations and Depths



Log (10) of Total PAH Concentrations

Figure 18.

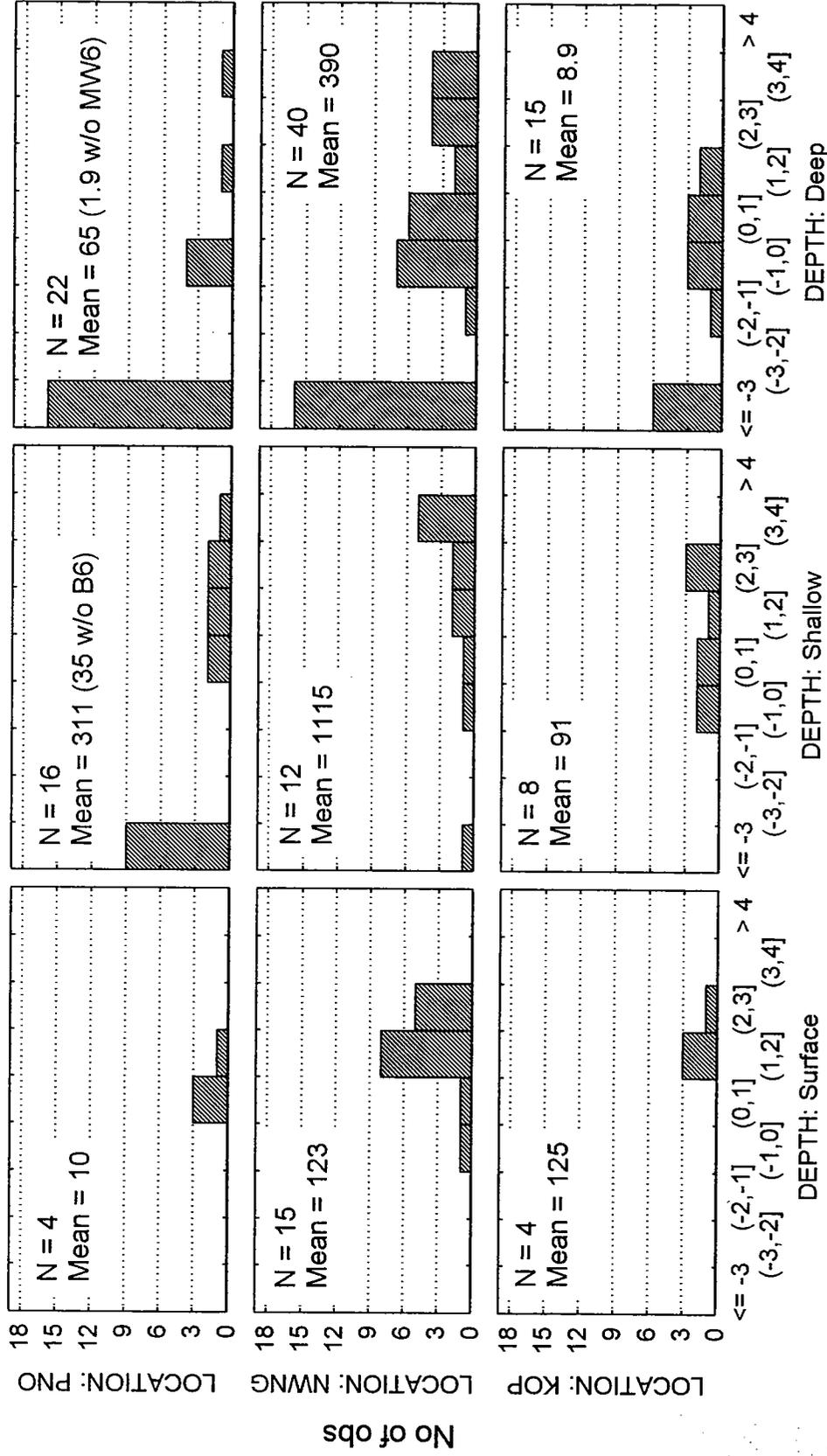
Log Carcinogenic PAHs in Soil for 2 Areas and 3 Depths



Log (10) Carcinogenic PAH Concentrations in Soil

Figure 19.

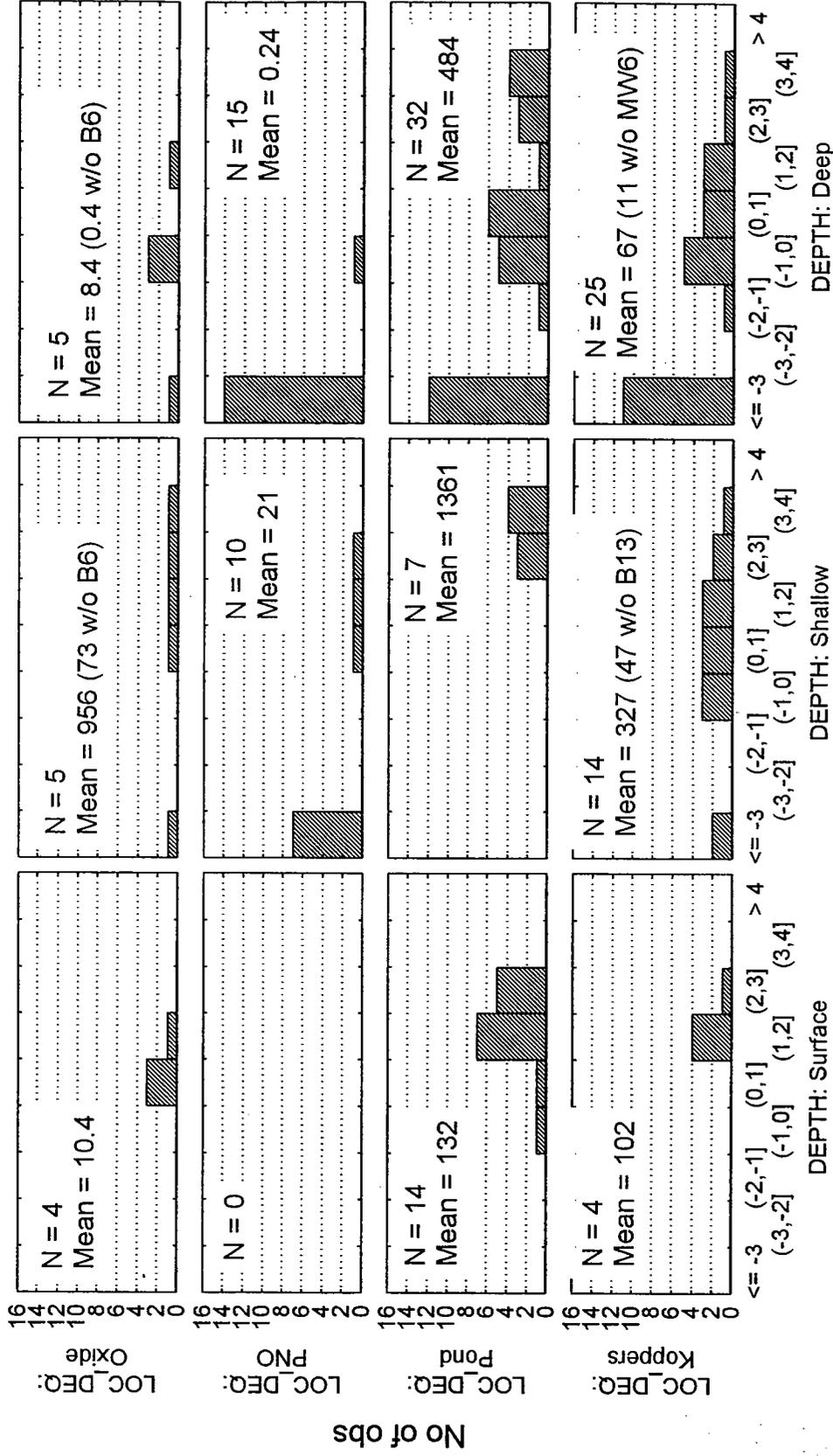
Log Carc PAHs for 3 Locations and for Depths



Log(10) of Carcinogenic PAH Concentrations

Figure 20.

Log Carcinogenic PAHs in Soil for 4 Locations and 3 Depths

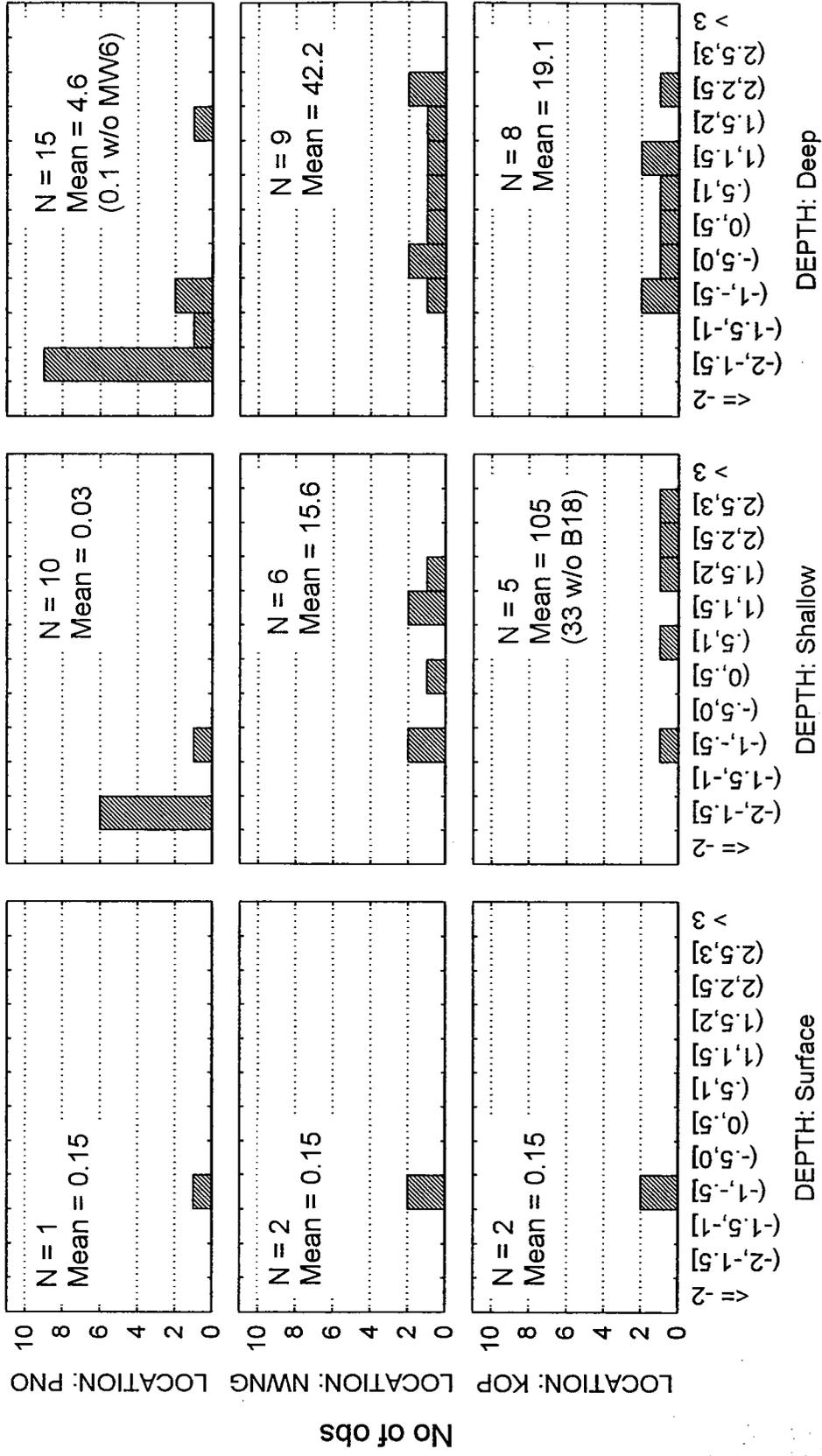


Log (10) Carcinogenic PAH Concentrations in Soil

<= -3 (-2,-1] (0,1] (2,3] > 4
 (-3,-2] (-1,0] (1,2] (3,4]

Figure 21.

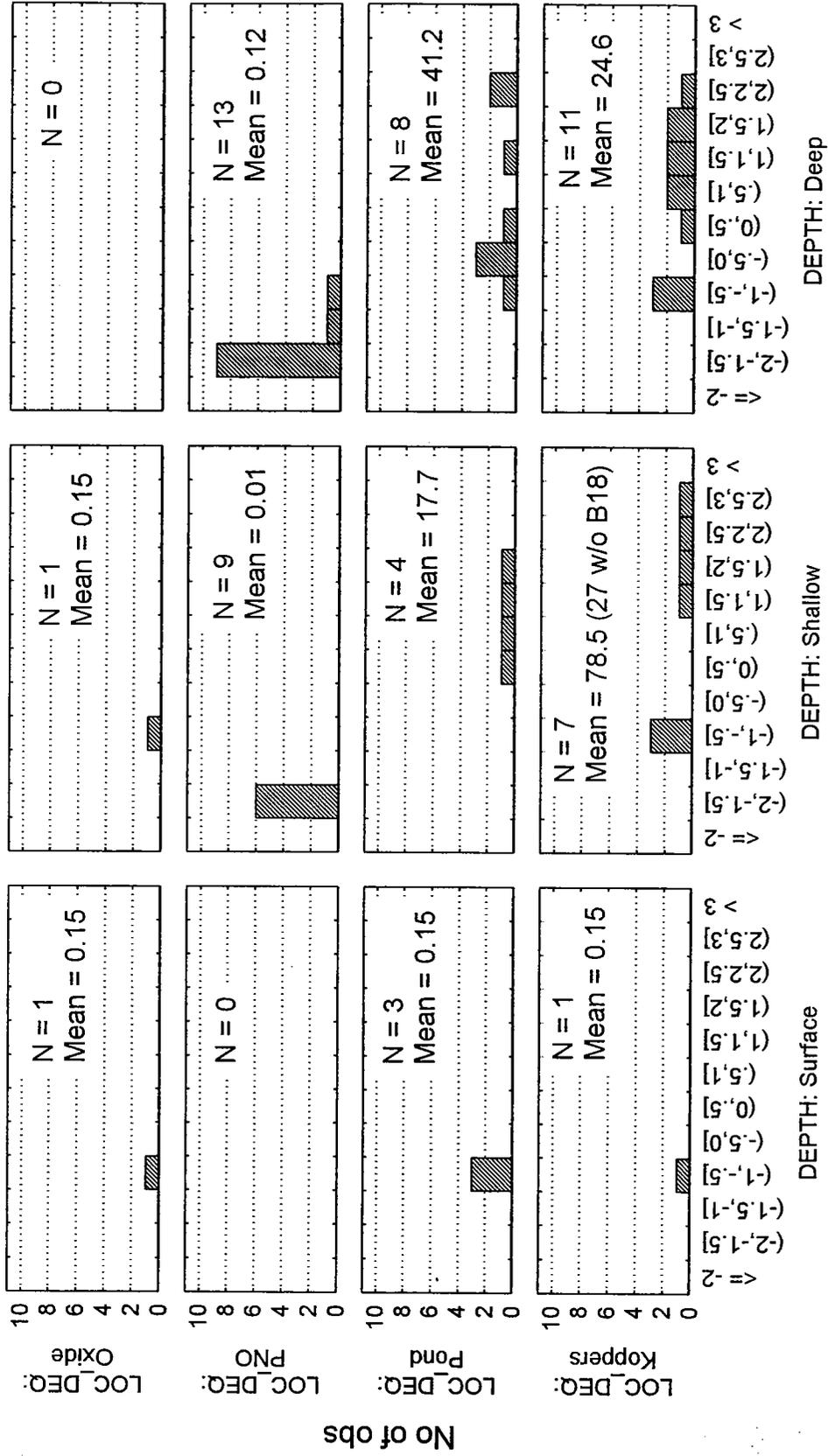
Log Benzene Concentrations in Soil for 3 Locations and 3 Depths



Log(10) Benzene Concentrations in Soil

Figure 22.

Log Benzene for 4 Locations and 3 Depths



Log(10) Benzene Concentrations

Figure 23.

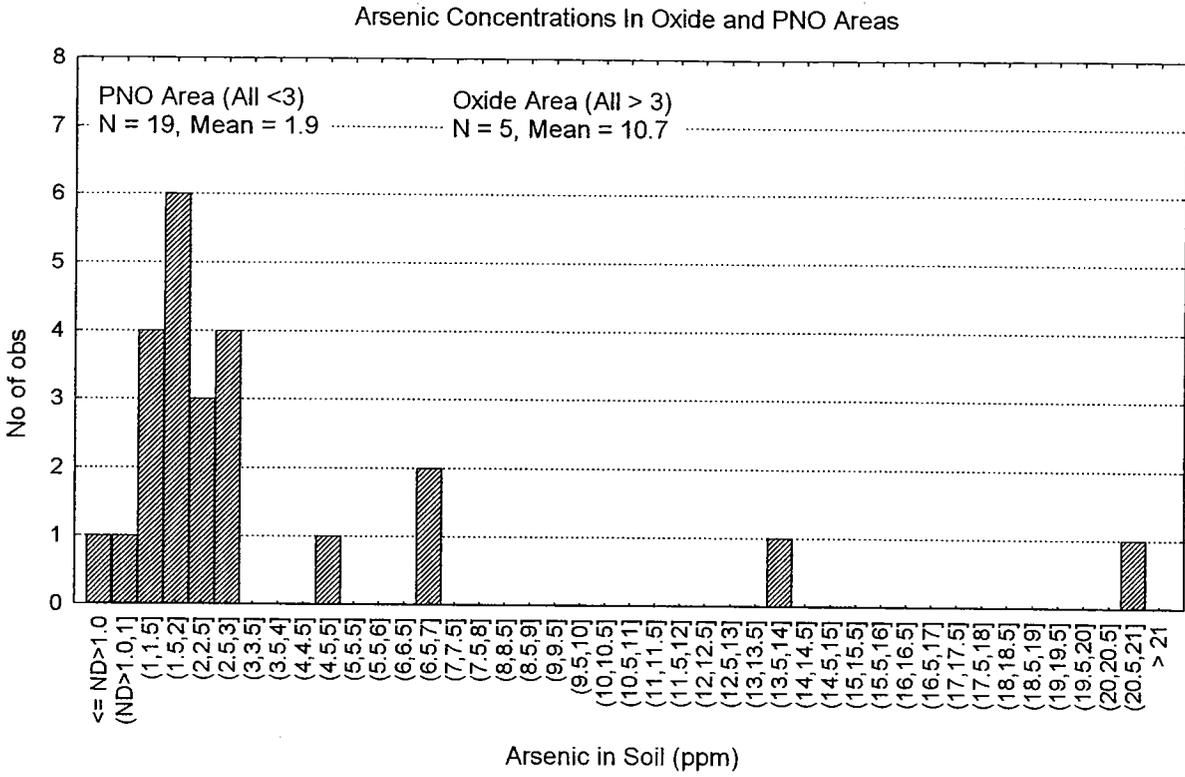


Figure 24.

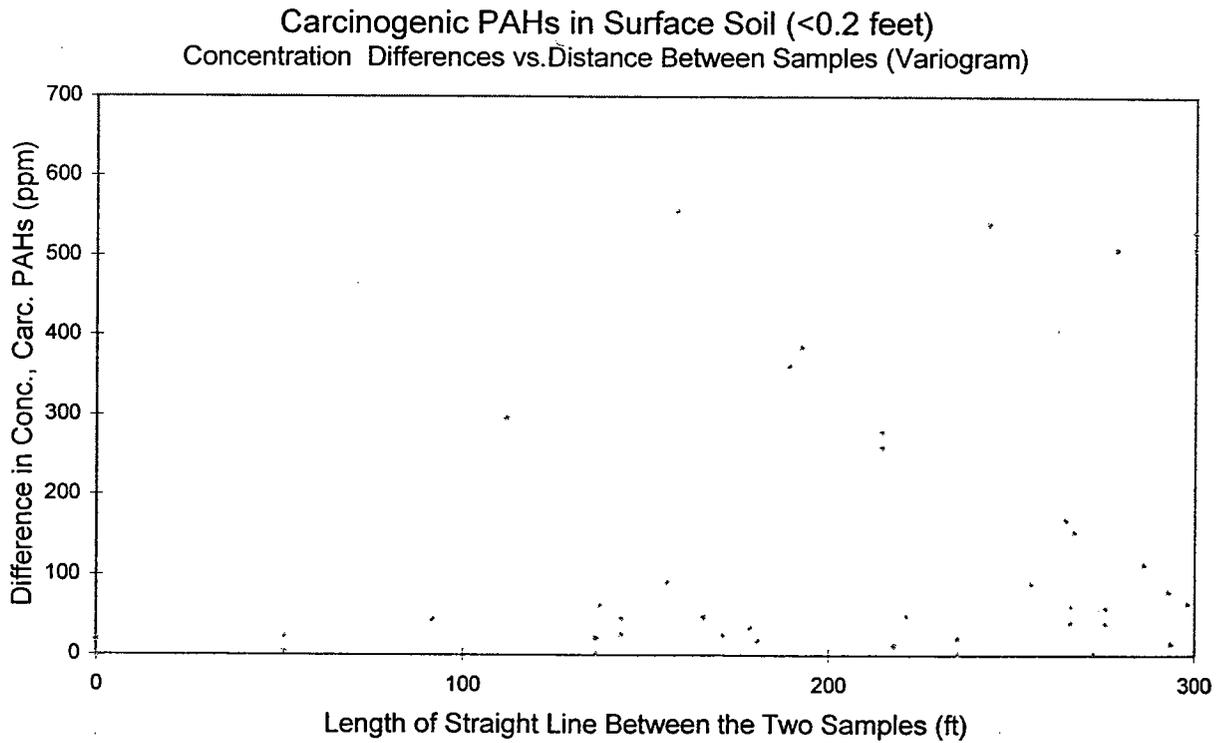
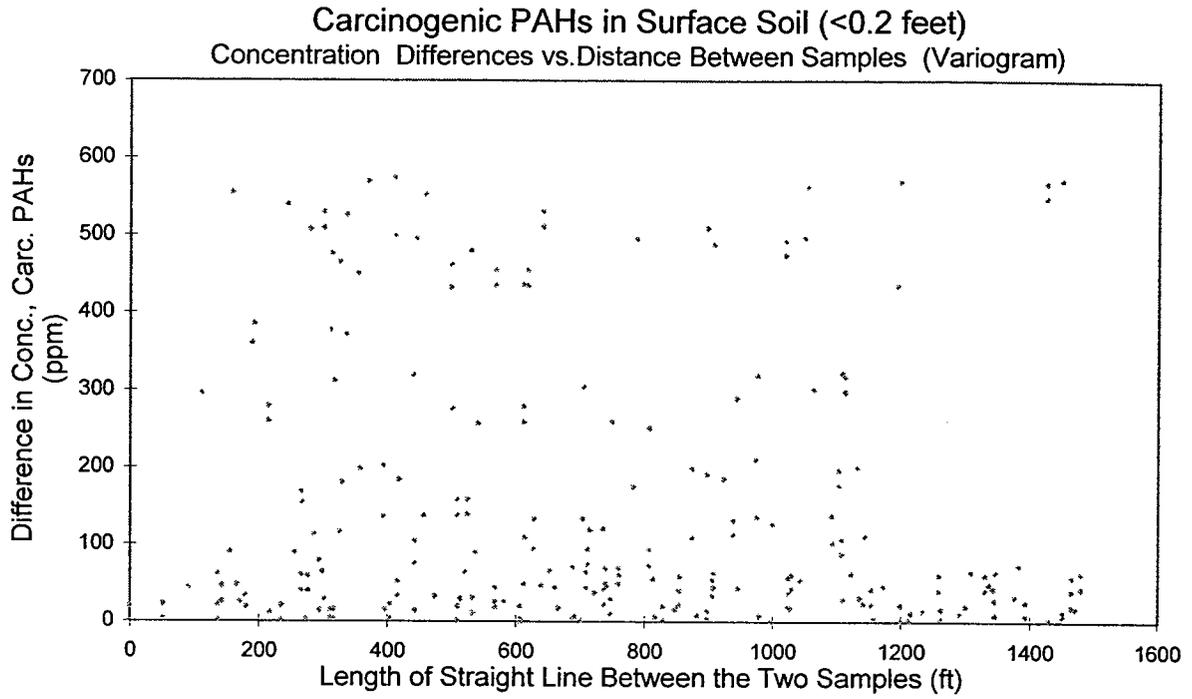
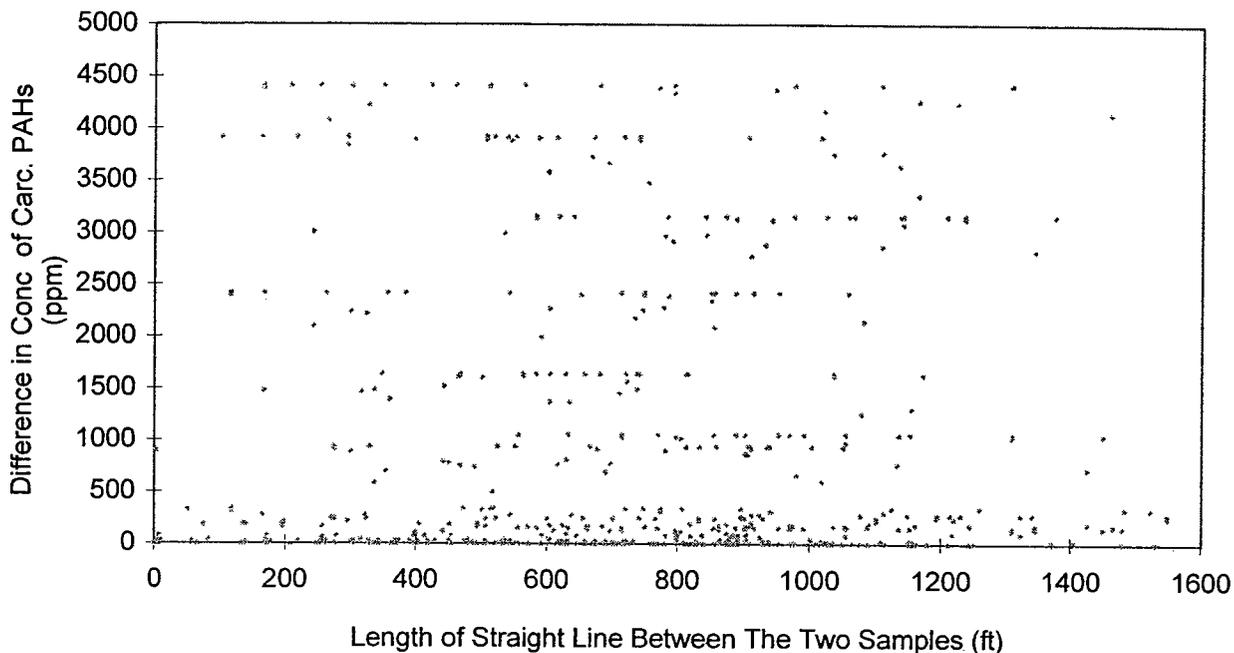


Figure 25.

Carcinogenic PAHs in Shallow Soil (.2' to 15')
Concentration Differences vs. Distance Between Samples (Variogram)



Carcinogenic PAHs in Shallow Soil (.2' to 15' depth)
Concentration Differences vs. Distance Between Samples (Variogram)

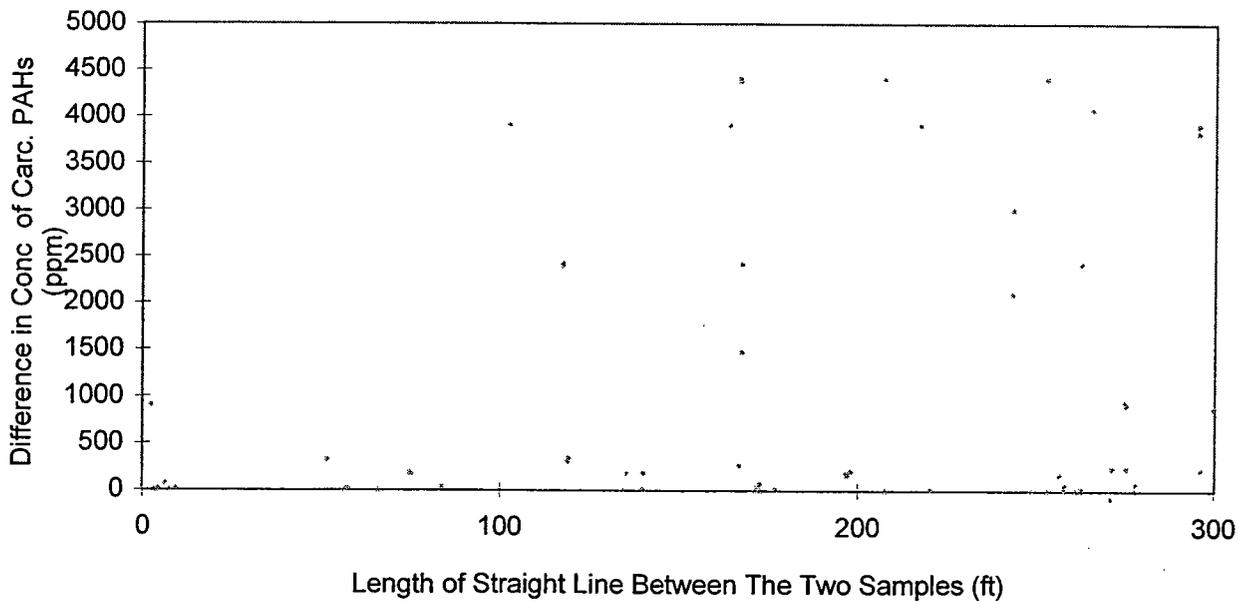
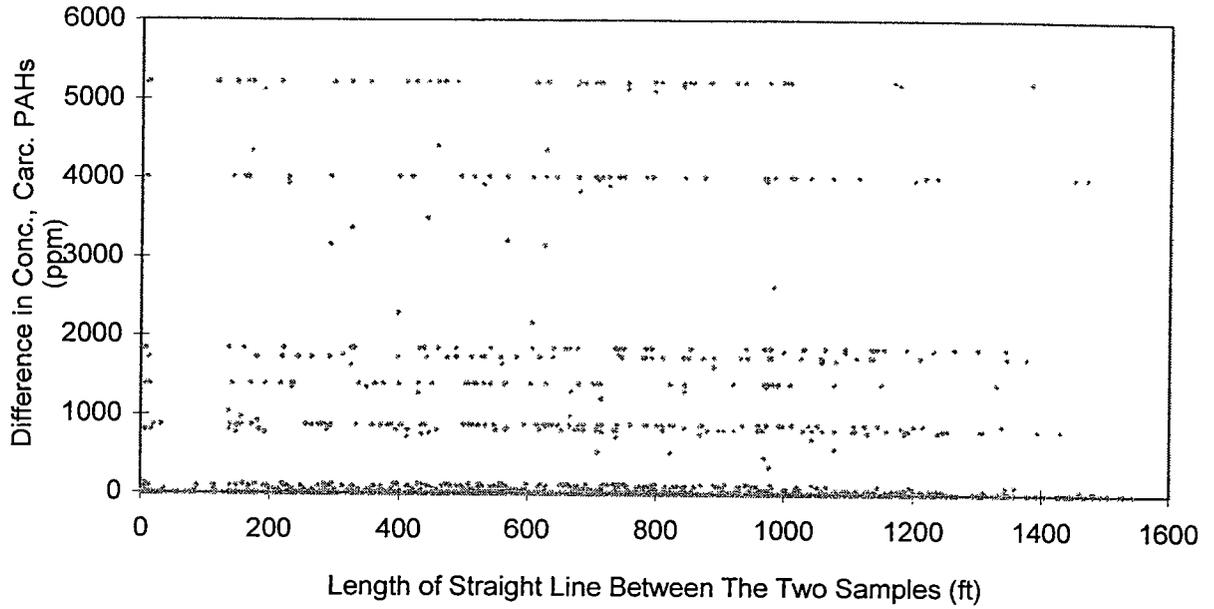


Figure 26.

Carcinogenic PAHs in Deep Soil (>15')
Concentration Differences vs. Distance Between Samples (Variogram)



Carcinogenic PAHs in Deep Soil (>15')
Concentration Differences vs. Distance Between Samples (Variogram)

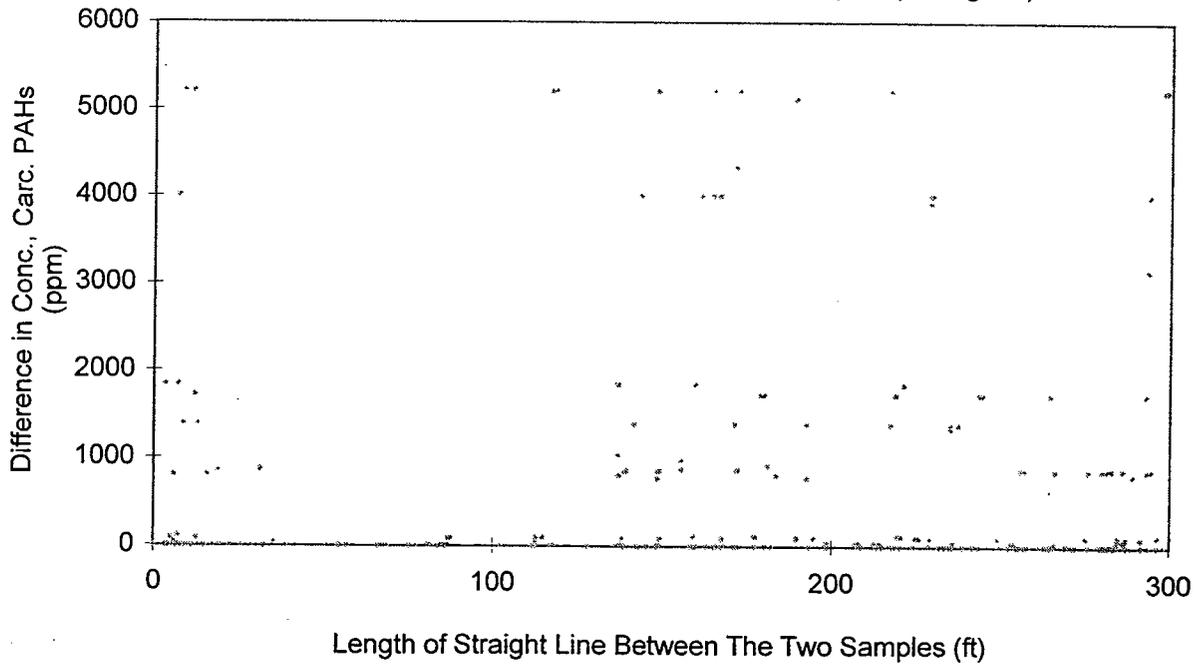
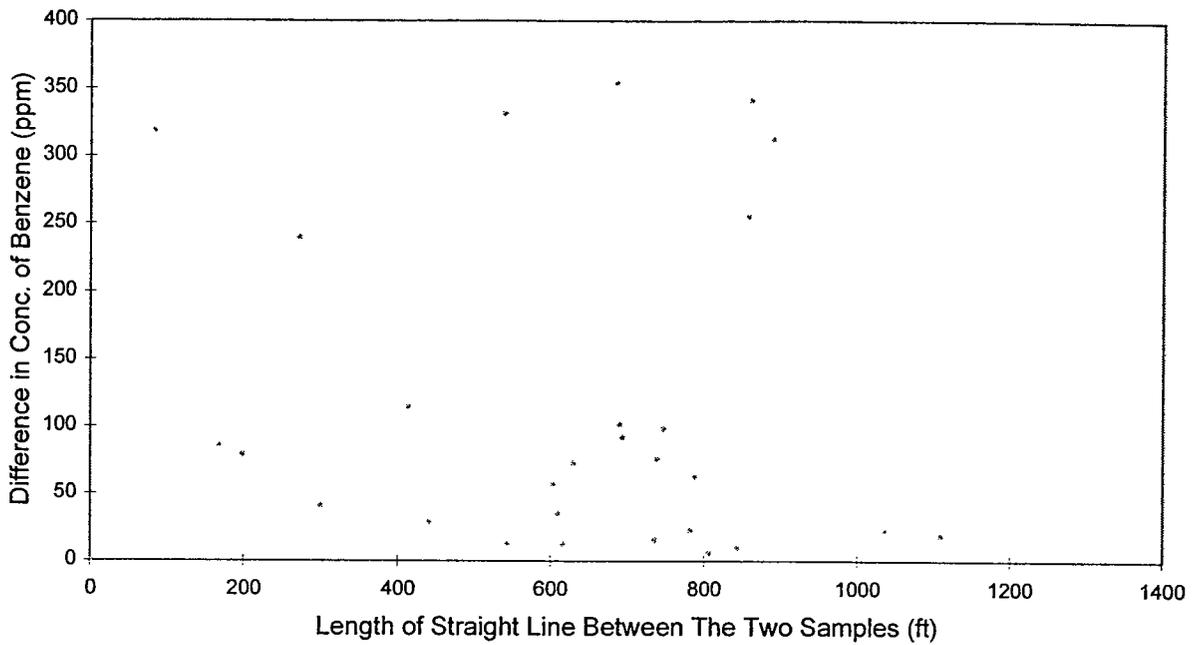


Figure 27.

Benzene in Shallow Soil (>.2', <=15')
Concentration Differences vs.Distance Between Samples (Variogram)



Benzene in Deep Soil (>15' deep)
Concentration Differences vs.Distance Between Samples (Variogram)

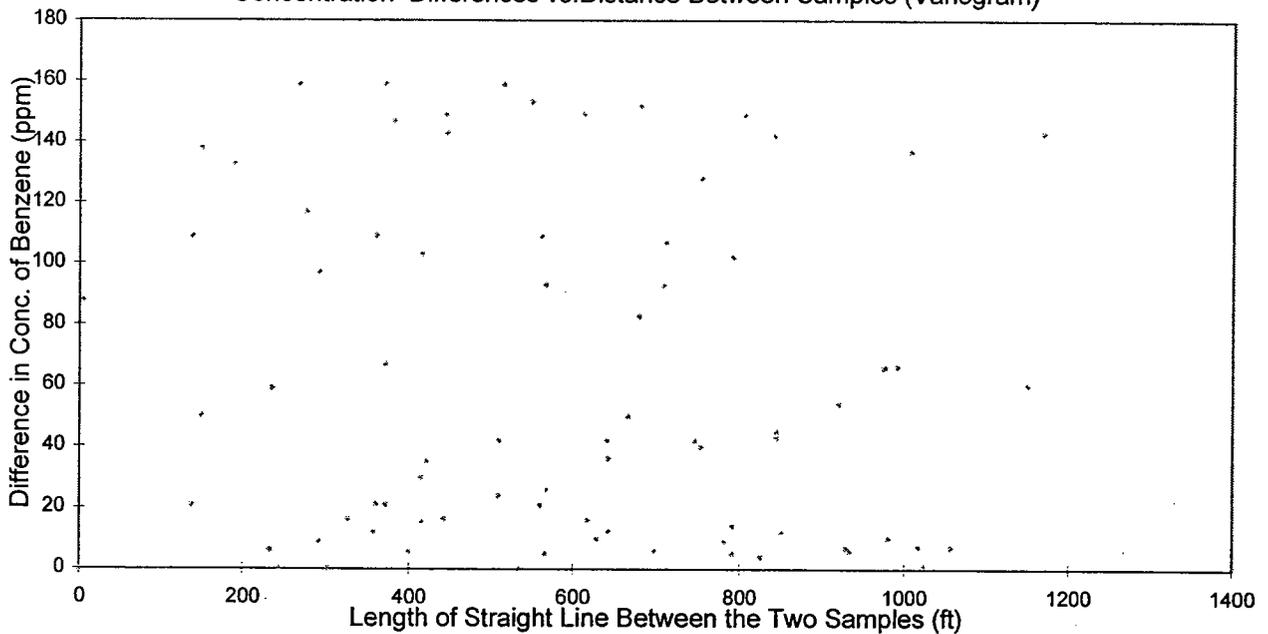


Figure 28.

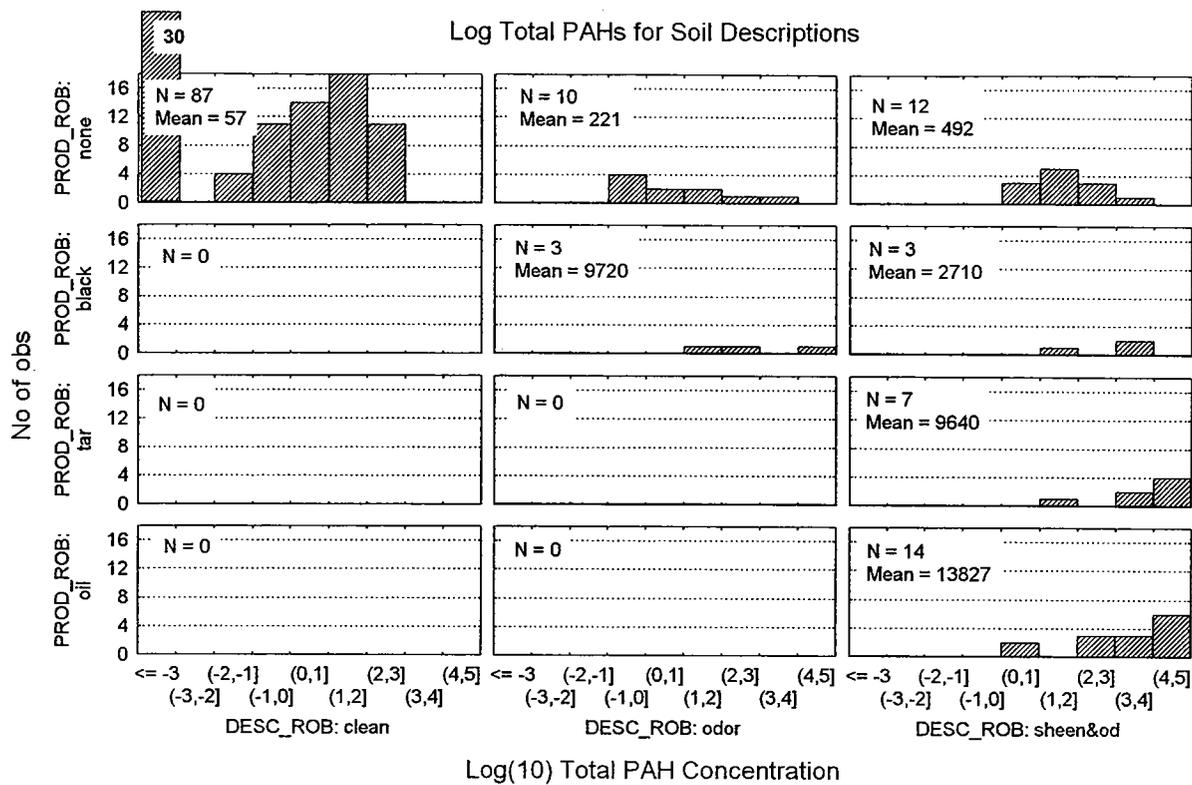


Figure 29.

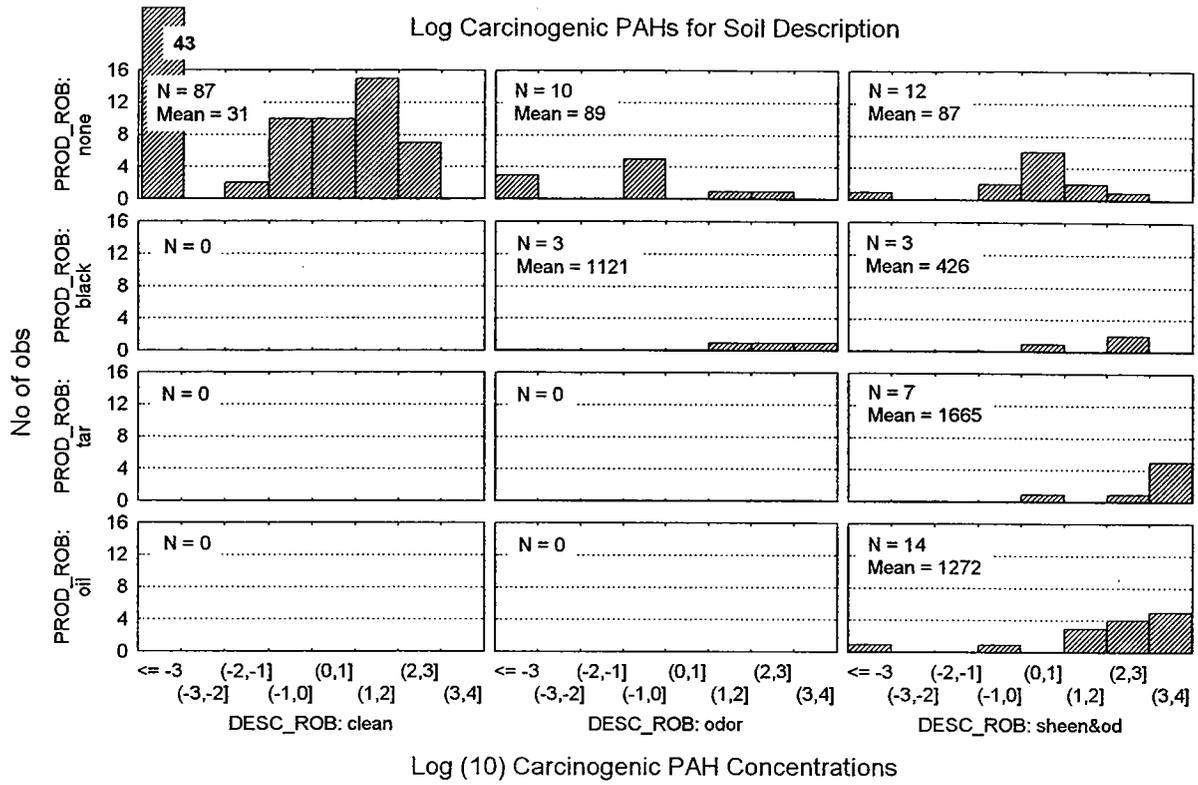


Figure 30.

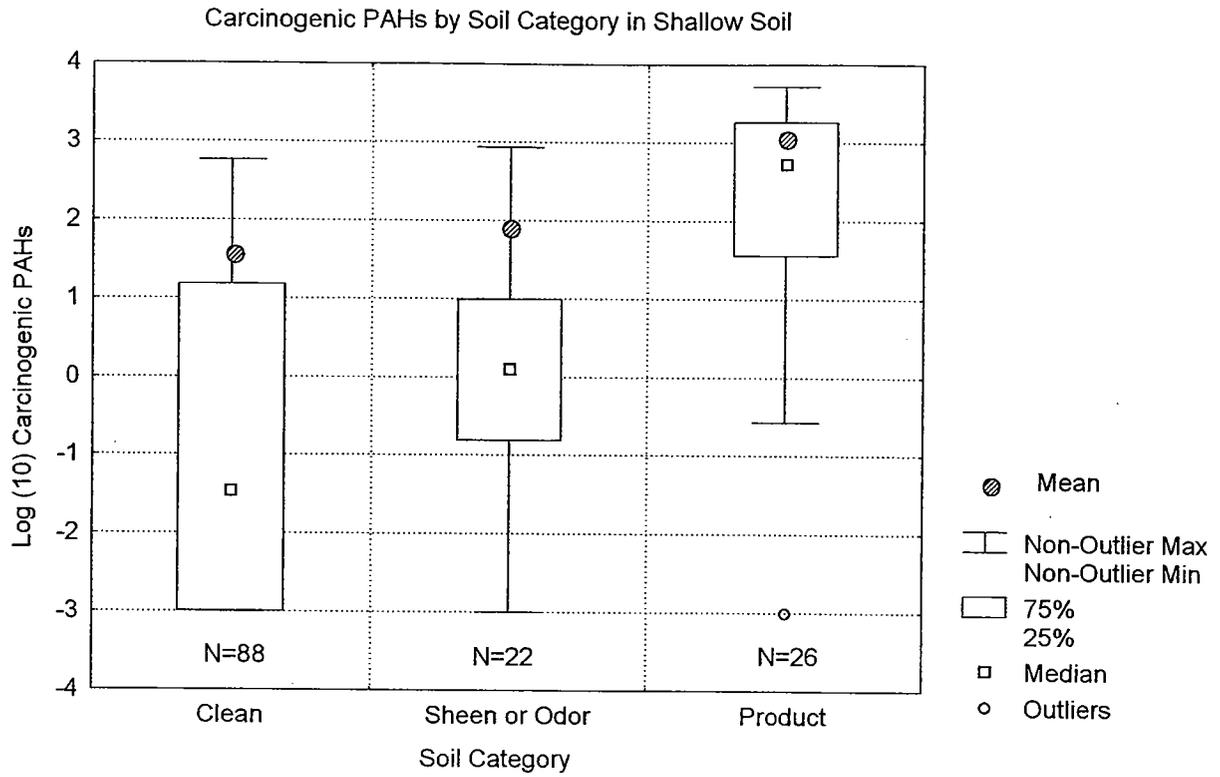


Figure 31.

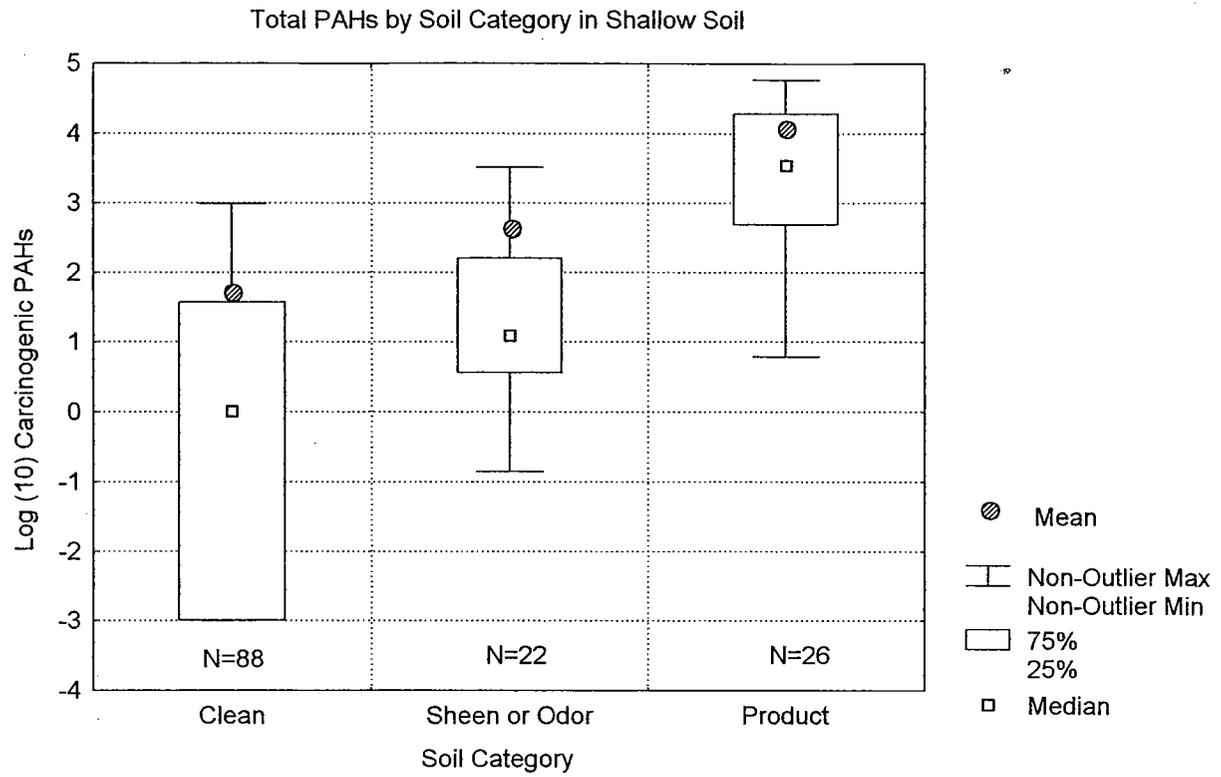


Figure 32.

Shallow Soil with Oil in Pond and Koppers Areas, Total PAHs

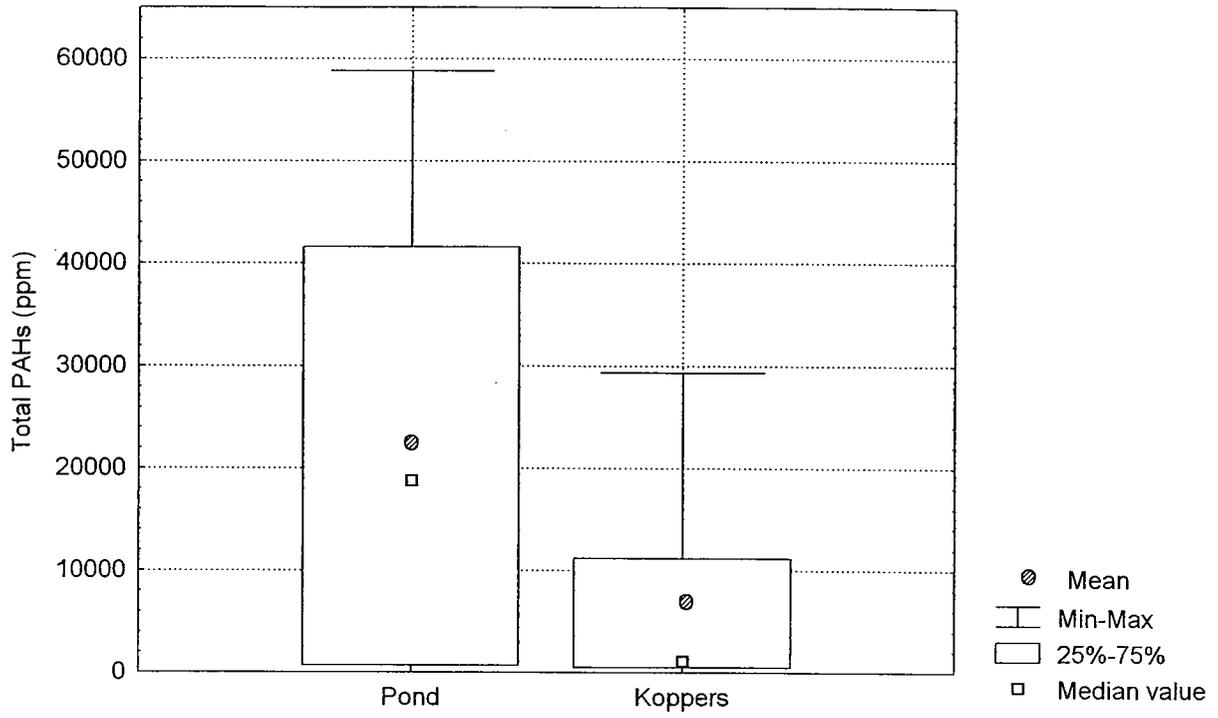


Figure 33.

Shallow Soil with Oil in Pond and Koppers Areas, Carcinogenic PAHs

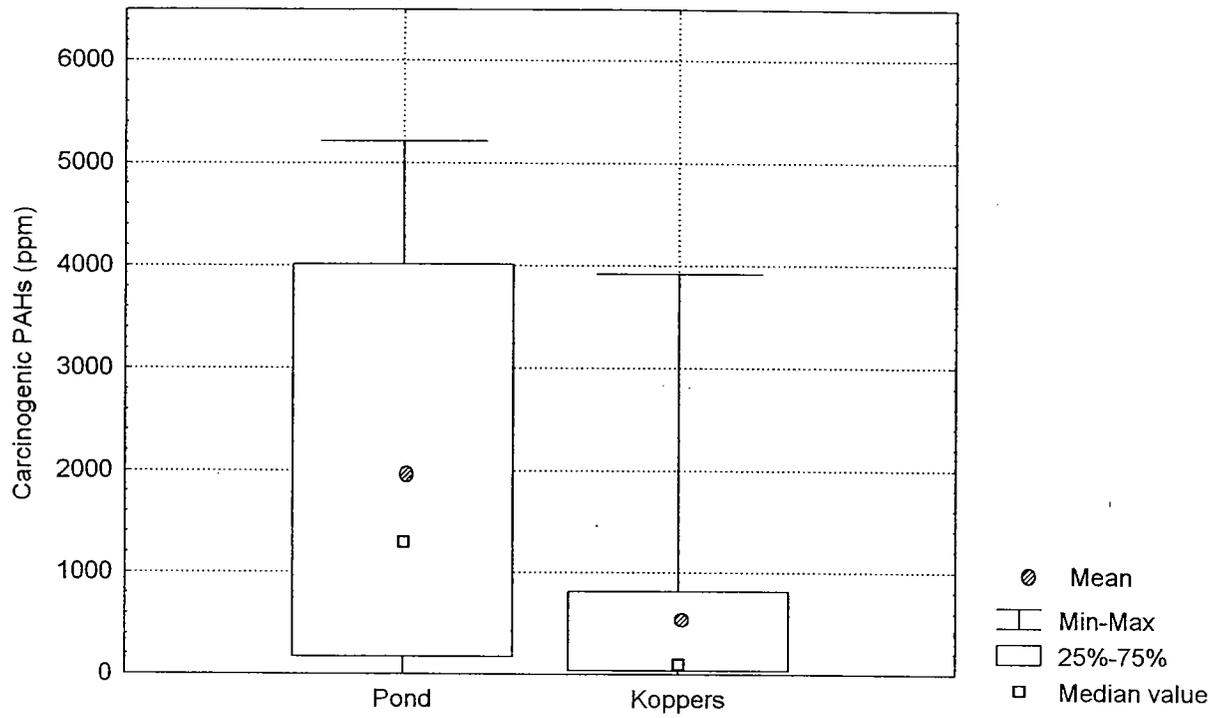


Figure 34.

Shallow Soil with Oil in Pond and Koppers Areas, Benzene

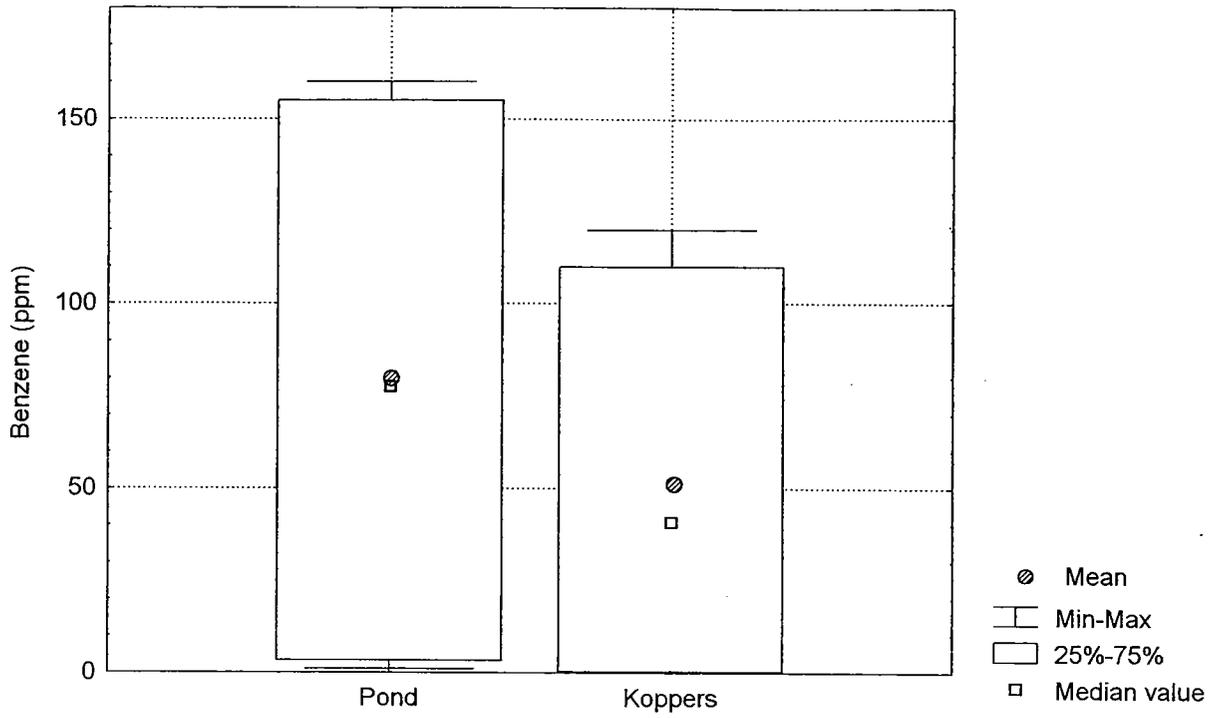


Figure 35.

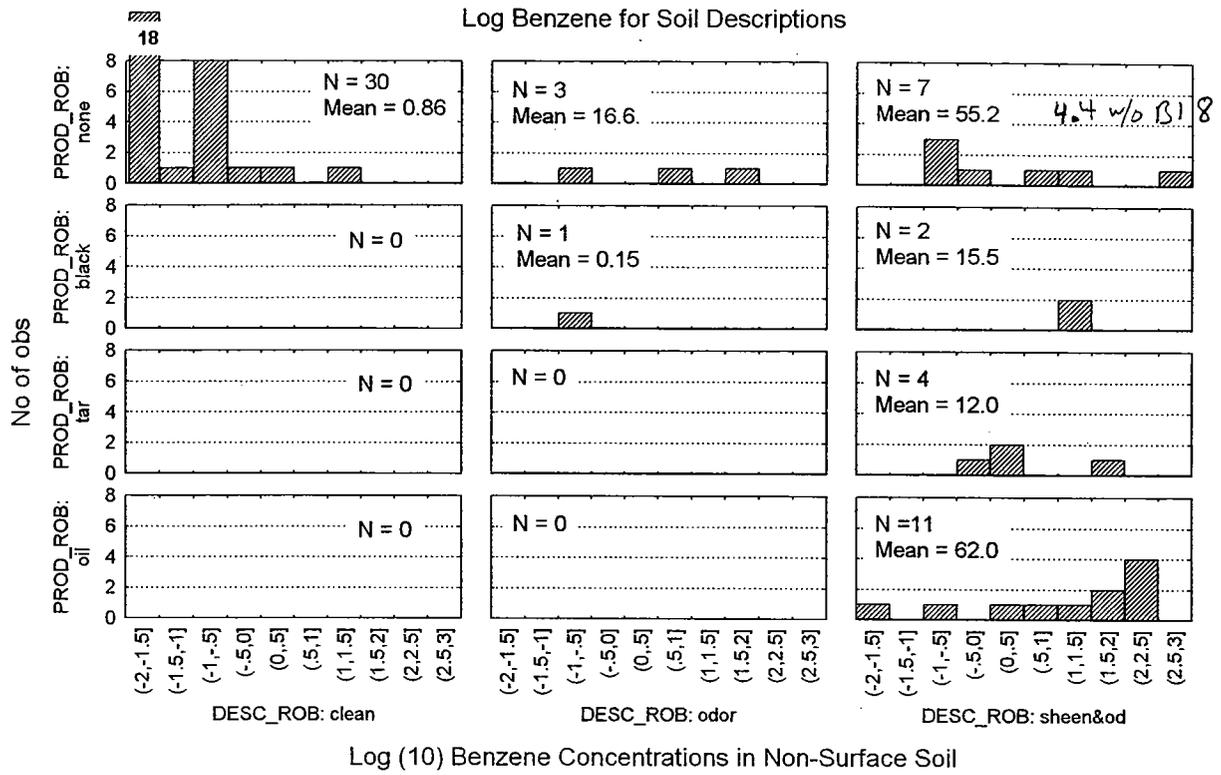


Figure 36.

Benzene Concentrations by Soil Description, Shallow and Deep Soil

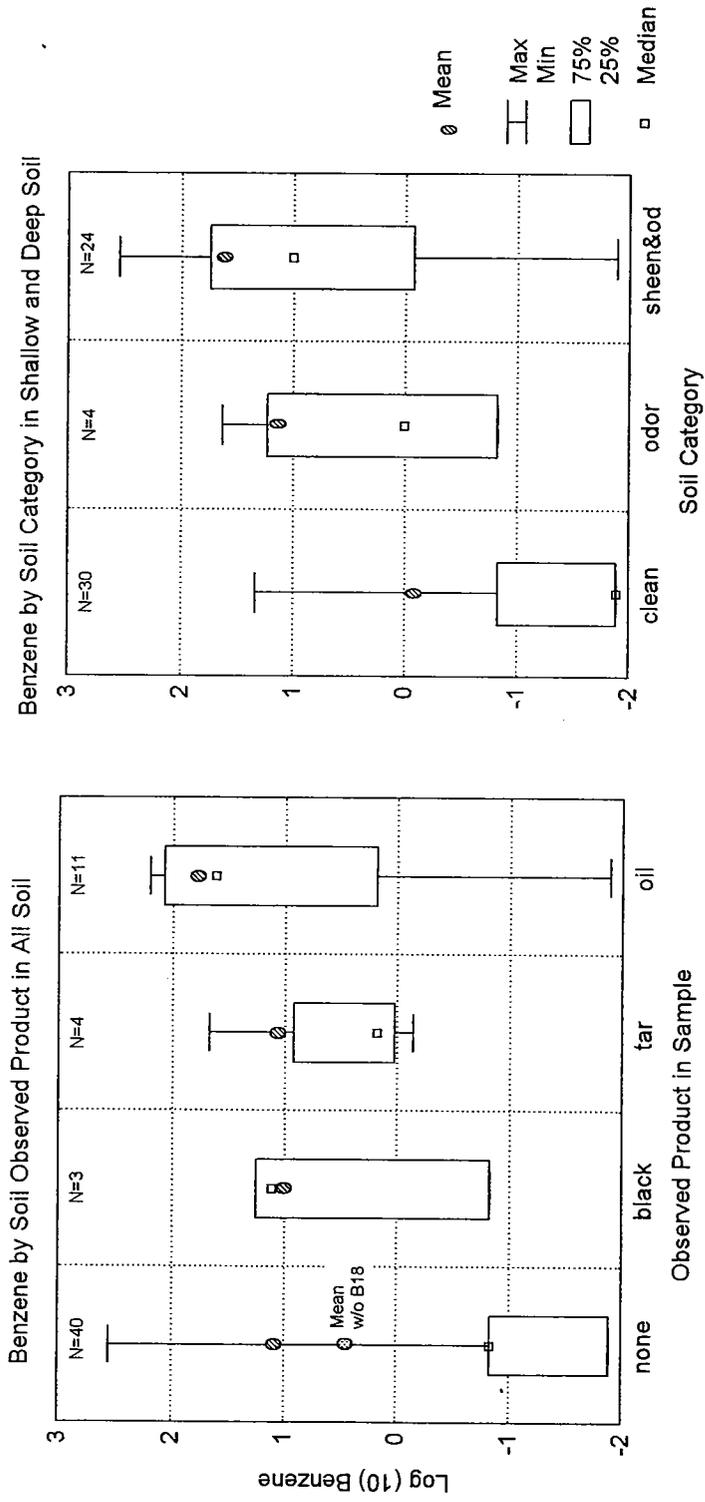


Figure 37.

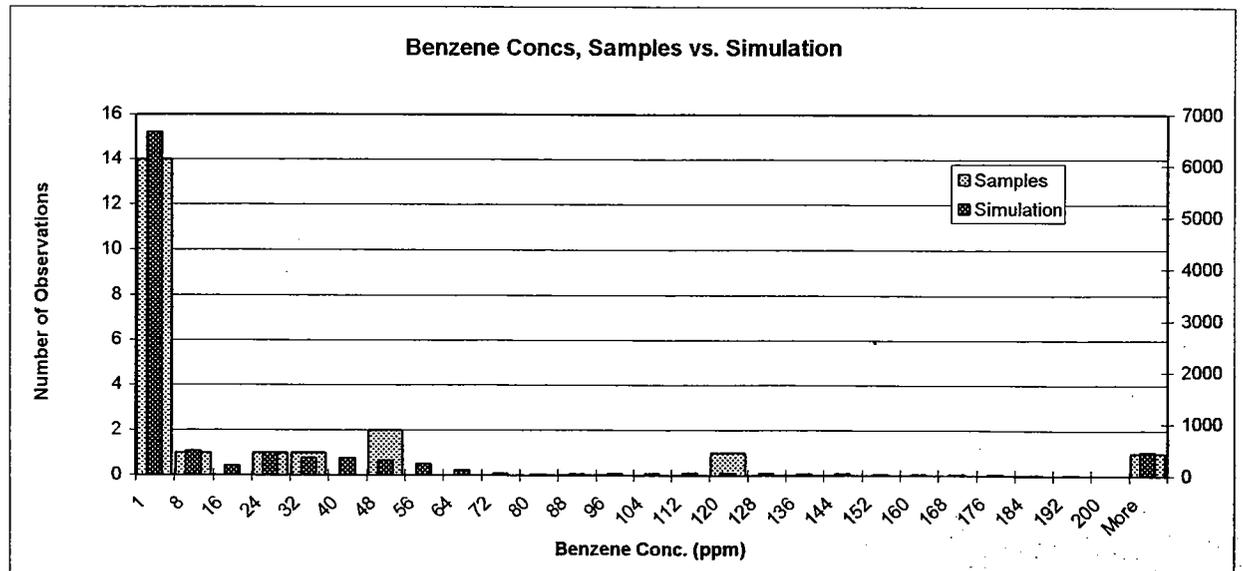
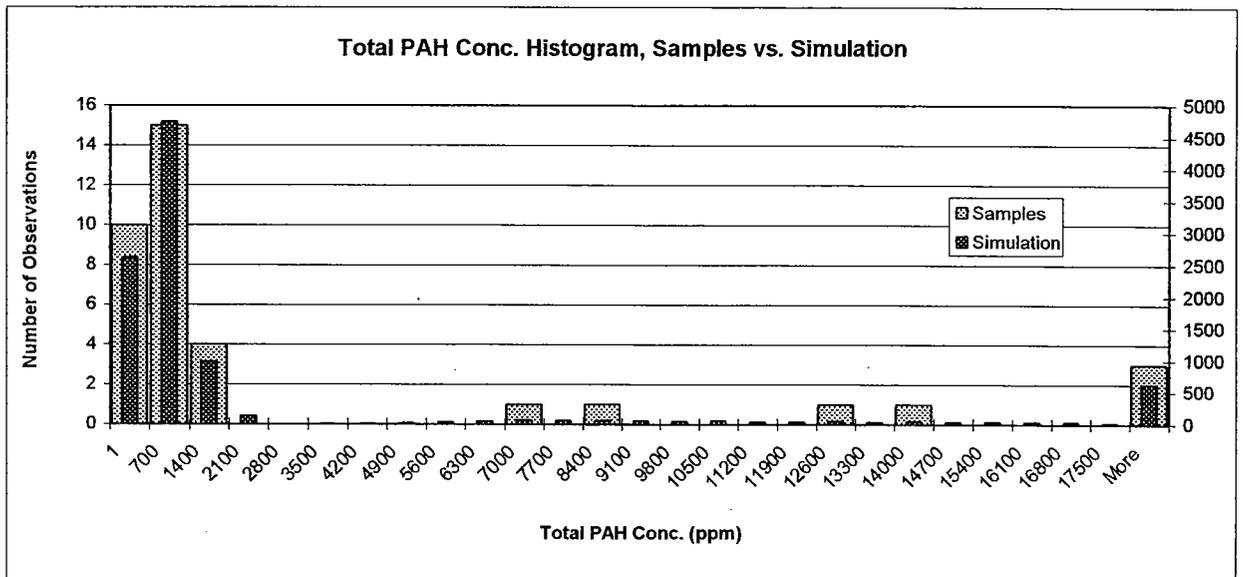
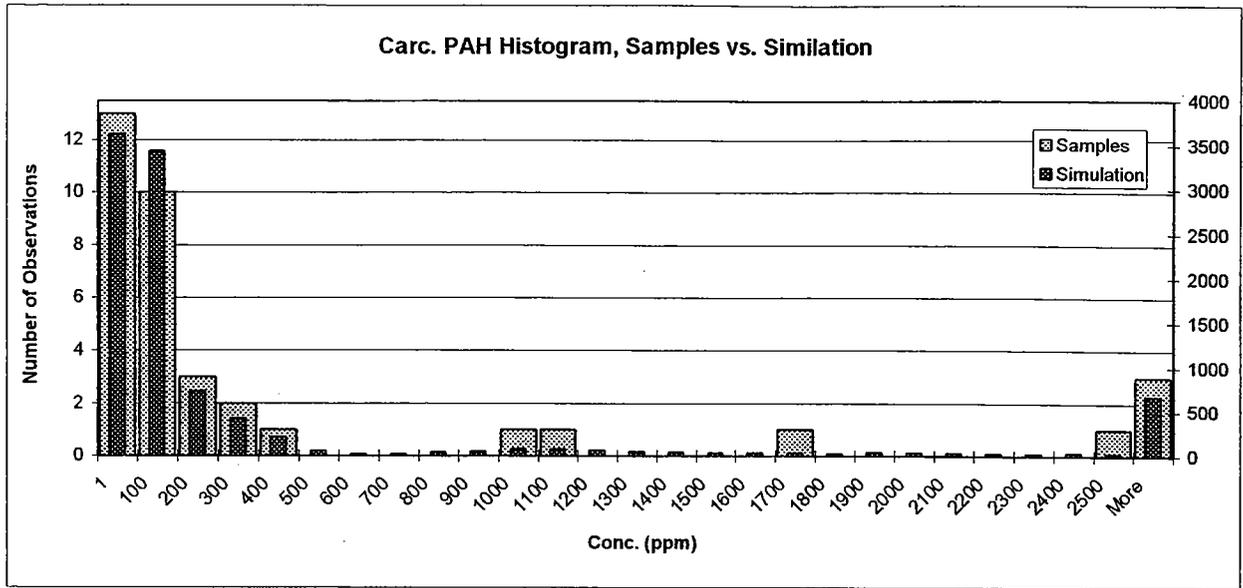


Figure 38.

Frequency of Samples by Soil Description and Total Amount of Soil in Each Description

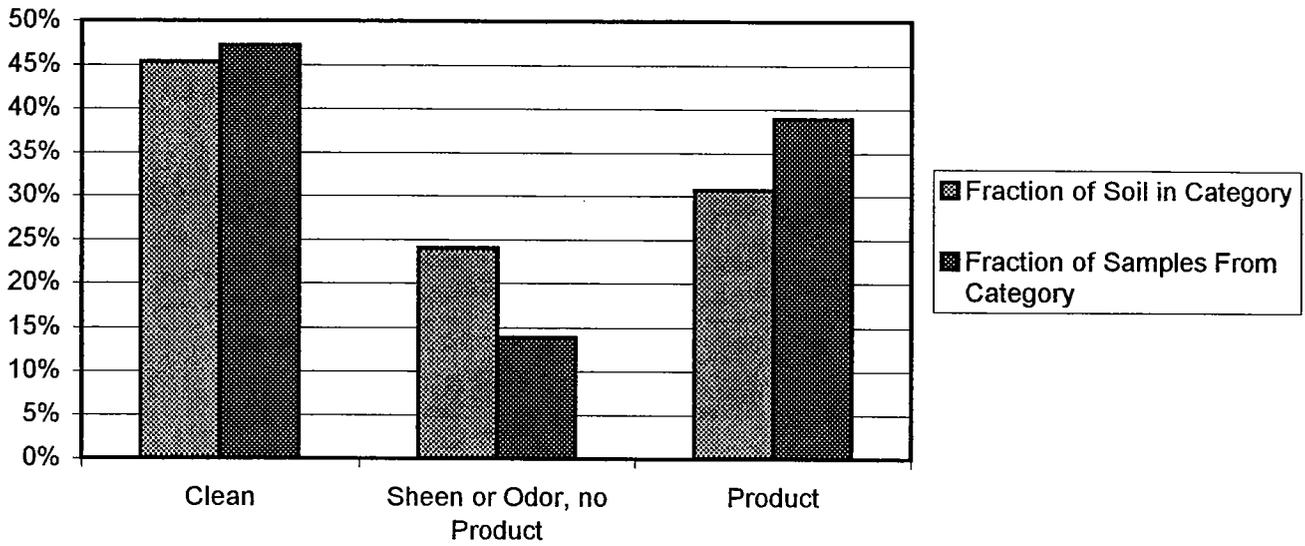


Figure 39.

Locations of Surface Carcinogenic PAH Samples
Voronoi Tessellation Showing Areas Closest to Each Point

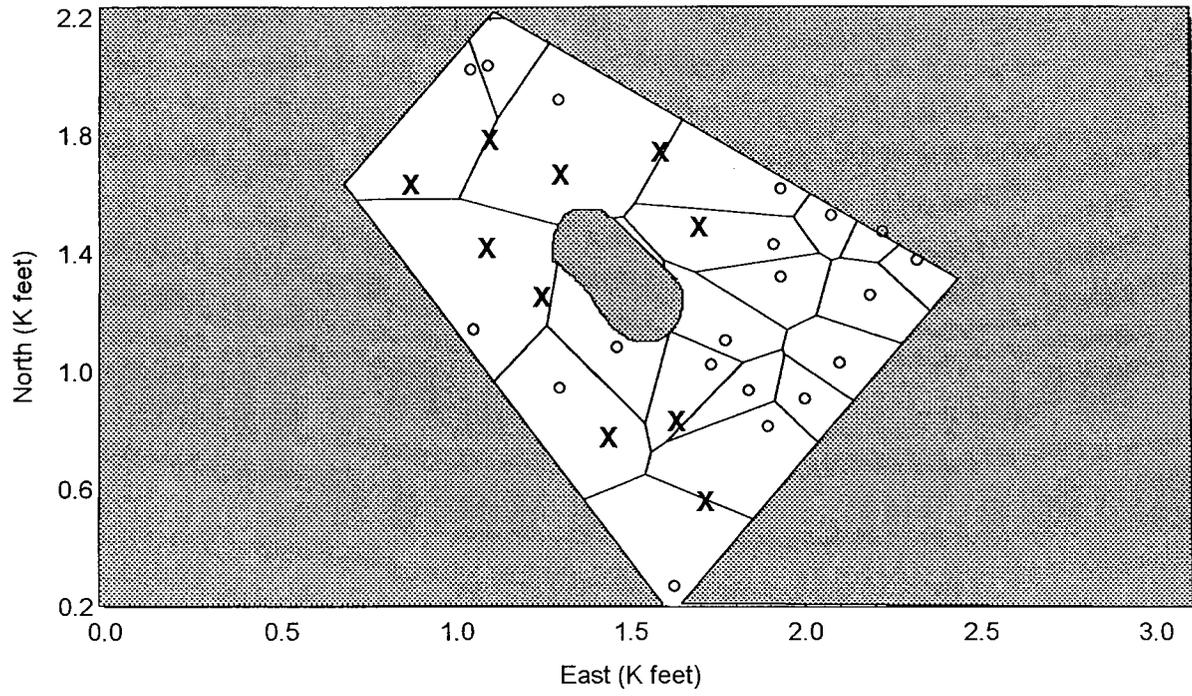


Figure 41.

Locations of Shallow Benzene Samples
Voronoi Tessellation Showing Areas Closest to Each Point

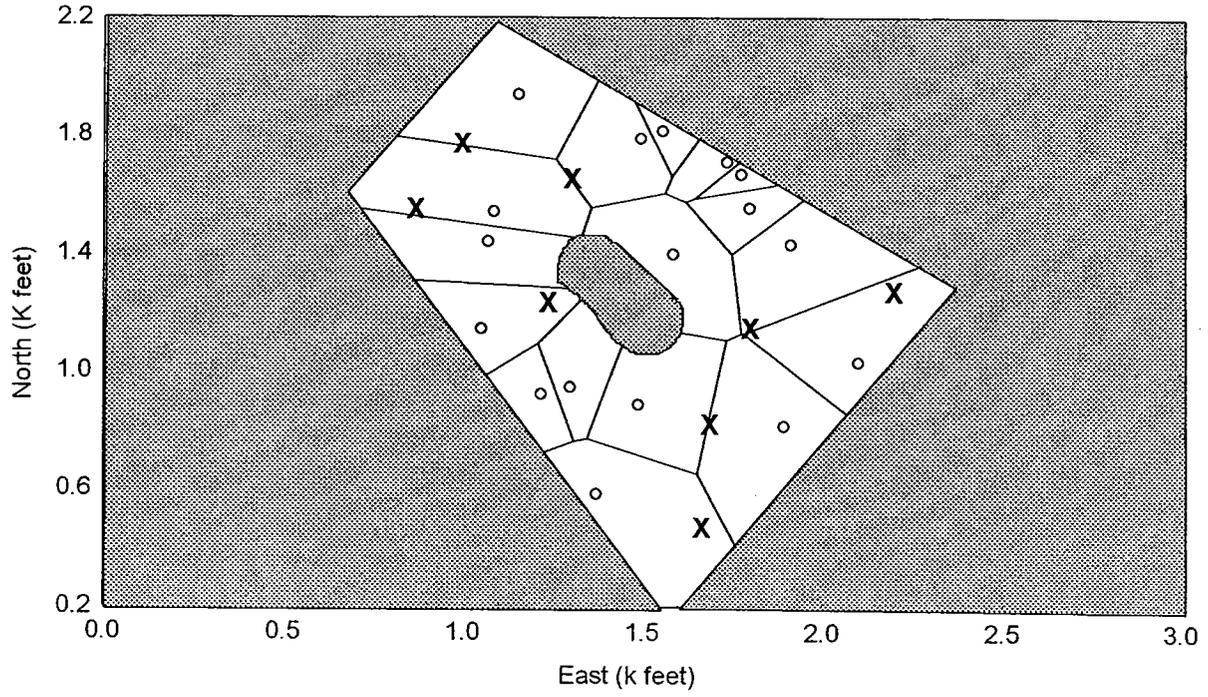


Figure 42.

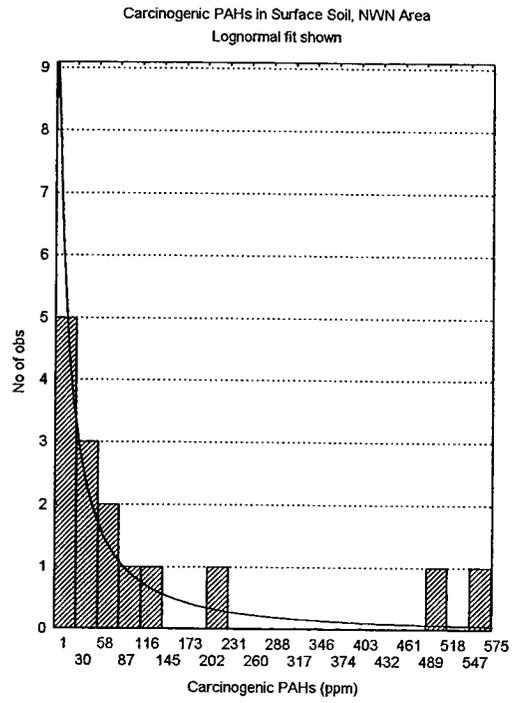
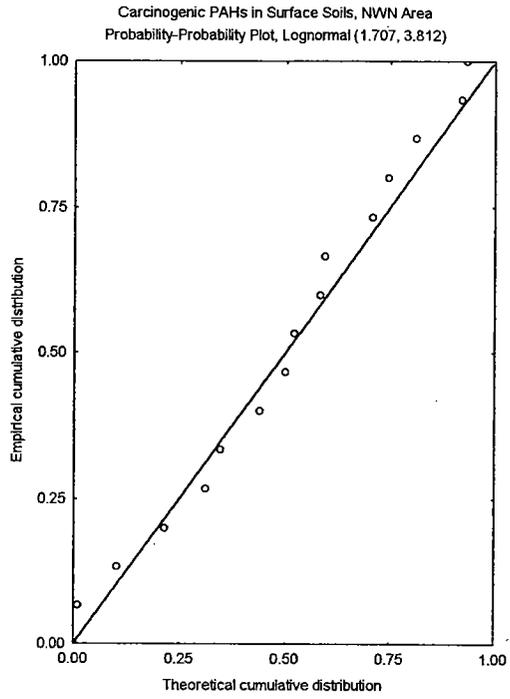
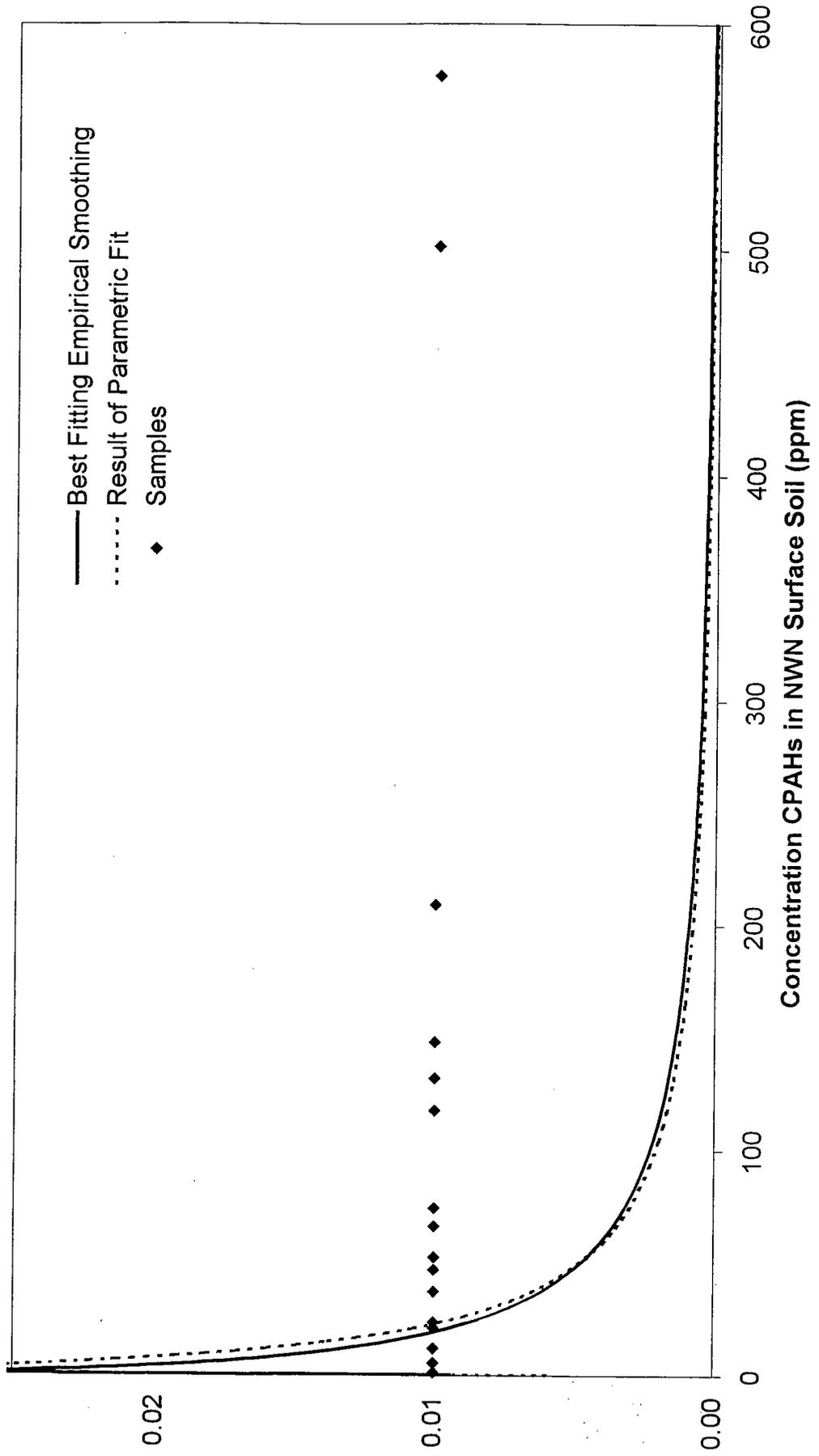


Figure 43.

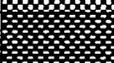
Probability Distribution Fits for Surface CPAHs in NWN Area
Best Fits Using Empirical Smoothing (solid) and Parametric (dotted)



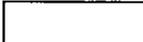
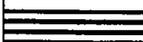
APPENDIX A
Soil Boring Logs

KEY TO BORING LOGS

Soil classification in this report is based upon visual and manual field observations which include moisture, consistency, plasticity and grading estimates and should not be construed to imply field or laboratory testing unless presented herein. Soils are classified in accordance with the Unified Soil Classification System. Stratigraphic boundaries are approximate representations only. No warranty is provided as to the continuity of soil strata between borings.

UNIFIED SOIL CLASSIFICATION SYSTEM (USCS)					
MAJOR DIVISIONS			GROUP SYMBOLS		TYPICAL NAMES
COURSE GRAINED SOILS More Than Half is Larger Than #200 Sieve	GRAVELS More Than Half the Course Fraction is Larger Than No. 4 Sieve Size	Clean Gravels With Little or No Fines	GW		Well Graded Gravels, Gravel-Sand Mixtures
		Gravels With Over 12% Fines	GP		Poorly Graded Gravels, Gravel-Sand Mixtures
		Gravels With Over 12% Fines	GM		Silty Gravels, Poorly Graded Gravel-Sand-Silt Mixtures
		Gravels With Over 12% Fines	GC		Clayey Gravels, Poorly Graded Gravel-Sand-Clay Mixtures
	SANDS More Than Half the Course Fraction is Smaller Than No. 4 Sieve Size	Clean Sands With Little or No Fines	SW		Well Graded Sands, Gravelly Sands
		Sands With Over 12% Fines	SP		Poorly Graded Sands, Gravelly Sands
		Sands With Over 12% Fines	SM		Silty Sands, Poorly Graded Sand-Silt Mixtures
		Sands With Over 12% Fines	SC		Clayey Sands, Poorly Graded Sand-Clay Mixtures
FINE GRAINED SOILS More Than Half is Smaller Than #200 Sieve	SILTS AND CLAYS Liquid Limit Less Than 50%		ML		Inorganic Silts and Very Fine Sands, Rock Flour, Silty or Clayey Fine Sands, or Clayey Silts with Slight Plasticity
	Liquid Limit Less Than 50%		CL		Inorganic Clays of Low to Medium Plasticity, Gravelly Clays, Sandy Clays, Silty Clays, Lean Clays
	Liquid Limit Less Than 50%		OL		Organic Clays and Organic Silty Clays of Low Plasticity
	SILTS AND CLAYS Liquid Limit Greater Than 50%		MH		Inorganic Silts, Micaceous or Diatomaceous Fine Sandy or Silty Soils, Elastic Silts
	Liquid Limit Greater Than 50%		CH		Inorganic Clays of High Plasticity, Fat Clays
	Liquid Limit Greater Than 50%		OH		Organic Clays of Medium to High Plasticity, Organic Silts
HIGHLY ORGANIC SOILS			Pt		Peat and Other Highly Organic Soils

LEGEND FOR BORING LOGS

	Blank Casing
	Slotted Screen
	Cement Grout
	Concrete
	Bentonite
	Sand Pack
	Fill Material

ABBREVIATIONS

NA	Not Applicable
ND	Not Detected Above Detection Limit
NS	Not Sampled
PAH	Polynuclear Aromatic Hydrocarbons
ppm	Parts Per Million
SPT	Standard Penetration Test
	Measured Static Water Level in Well
	Estimated Water Level During Drilling

HAHN & ASSOCIATES, INC.
 434 NW Sixth Avenue
 Portland, Oregon
 (503) 796-0717

SOIL BORING NUMBER B-1

PROJECT:
 Northwest Natural Gas Co.
 Gasco Facility
 Portland, Oregon
PROJECT #: 2708

HAI LOGGER:	Rob Ede	DRILL START	DRILL FINISH
SAMPLING METHOD:	3" OD Split Spoon/4" OD Core Barrel	Time:	Time:
DRILLING METHOD:	4 1/4-inch ID Hollow Stem Auger	13:55	15:35
EQUIPMENT TYPE	B-59 Mobile Drill	Date:	Date:
DRILLER:	Brad James	9/21/95	9/21/95
DRILLING CONTRACTOR:	Geo-Tech Explorations, Inc.		

ABANDONMENT DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHs (ppm)	SPT (blows/6 in) or Core Interval	RECOVERY or INTERVAL	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	BORING DIAMETER: 8-inch		
										CASING DIAMETER: Not Applicable		
										SURFACE ELEVATION: 30.1 feet msl		
										TOP OF CASING ELEVATION: Not Applicable		
										SOIL DESCRIPTION		
3/4" Bentonite Chips	B1-01	13:45	5.6	13					SM	Silty SAND with some Gravel - brown, dry (surface sample)		
	B1-02 Dup	13:50	Dup	56			1					
							2	50/5"	90	GP	Sandy GRAVEL - brown, dry, very dense	
							3					
							4					
	B1-03	14:05	8.2	-	21	100	5			ML	Sandy SILT - brown to yellow, moist, very stiff, slightly plastic, no hydrocarbon odor, no sheen	
							6					
							7	9	100			
	B1-04	14:10		-	6	100	8				Sandy SILT - brown to yellow, moist, stiff, slightly plastic, slight hydrocarbon odor, no sheen	
			4.7		5	60	9					
							10				Concrete encountered at 8.5 to 10 feet bgs.	
							11			SM	Silty SAND with Gravel - wet, medium dense, very strong hydrocarbon odor, sheen, hard black material (lampblack?) from 11 to 11.5 feet bgs	
				44.6		38	50					
						2	100					
	B1-06	14:35		-	6	100	13				Silty GRAVEL - olive gray, wet, dense, strong hydrocarbon odor, no sheen	
				26.5		28	100					
							14			GM		
						16	0					
						22	0					
						25	0					
					4	100						
B1-07	14:50	16.8	-	40	60	18			SP	SAND - black, wet, medium dense, poorly graded, strong hydrocarbon odor, no sheen, appears to be saturated with oily substance		
					4	0						
						19						
					6	100						
B1-08	14:57	22.3	-	6	100	20						

HAHN & ASSOCIATES, INC. 434 NW Sixth Avenue Portland, Oregon (503) 796-0717					SOIL BORING NUMBER B-1					
PROJECT: Northwest Natural Gas Co. Gasco Facility Portland, Oregon					HAI LOGGER: Rob Ede			DRILL START	DRILL FINISH	
PROJECT #: 2708					SAMPLING METHOD: 3" OD Split Spoon/4" OD Core Barrel			Time:	Time:	
					DRILLING METHOD: 4 1/4-inch ID Hollow Stem Auger			13:55	15:35	
					EQUIPMENT TYPE: B-59 Mobile Drill			Date:	Date:	
					DRILLER: Brad James			9/21/95	9/21/95	
					DRILLING CONTRACTOR: Geo-Tech Explorations, Inc.					
ABANDONMENT DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHs (ppm)	SPT (blows/6 in) or Core Interval	RECOVERY or INTERVAL	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	BORING DIAMETER: 8-inch
3/4" Bentonite Chips	B1-09	15:20	24.6	21	6	40	21		SP	CASING DIAMETER: Not Applicable
							22			SURFACE ELEVATION: 30.1 feet msl
							23			TOP OF CASING ELEVATION: Not Applicable
	B1-10	15:30	20.6	-			24		ML	SOIL DESCRIPTION
							25			SAND - black, wet, dense, strong hydrocarbon odor, wood fragments present at sand-silt boundary
							26			Continuous core barrel sampling device used to collect soil samples from 20.5 to 24.5 feet bgs
							27			SILT with some Sand - olive gray, wet, slightly plastic, mild petroleum hydrocarbon odor, no sheen
							28			Installed a 2-inch diameter 0.010-inch slotted stainless steel well screen at 20 to 23 feet bgs. Purged twelve gallons of water using a peristaltic pump prior to groundwater sampling. GROUNDWATER SAMPLE (2708-950921-BW1-01) collected at 17:30 hrs, 9/21/95. Well point was removed prior to abandonment.
							29			Drilled to 25 feet bgs Sampled to 24.5 feet bgs
							30			* Sample Number Prefix is 2708-950921-
							31			
							32			
							33			
							34			
							35			
							36			
							37			
							38			
							39			
							40			

Hahn & Associates, Inc.
 434 NW Sixth Avenue
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 (503) 796-0717

SOIL BORING NUMBER B-2

PROJECT:
 Northwest Natural Gas Co.
 Gasco Facility
 Portland, Oregon
PROJECT #: 2708

HAI LOGGER:	Rob Ede	DRILL	DRILL
SAMPLING METHOD:	4" OD Core Barrel	START	FINISH
DRILLING METHOD:	4 1/4-inch ID Hollow Stem Auger	Time:	Time:
EQUIPMENT TYPE	B-59 Mobile Drill	8:50	10:15
DRILLER:	Brad James	Date:	Date:
DRILLING CONTRACTOR:	Geo-Tech Explorations, Inc.	9/27/95	9/27/95

ABANDONMENT DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHs (ppm)	CORE INTERVAL	SAMPLE RECOVERY	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	BORING DATA	
										BORING DIAMETER:	8-inch
	B2-01	8:50	4.7	-			1		SM	Silty SAND with Gravel - brown, moist, organic matter (surface sample)	
							2				
							3				
	B2-02	9:05	5.5	-			4			Silty SAND with some Gravel - green to gray, moist, no sheen, organic matter (pieces of wood)	
							5				
	B2-03	9:10	3.9	-			6			Silty SAND with some Gravel - green to gray, mottled, slight hydrocarbon odor, slight sheen, tar (pieces of asphalt)	
							7		SM		
							8				
							9				
							10				
							11		GM	Sandy GRAVEL with Silt - moist, no sheen, large pieces of brick, possible pieces of lampblack (hydrophobic material)	
							12				
							13				
	B2-04	9:25	2.5	-			14			SAND - brown, moist, poorly graded, medium grained, moderate hydrocarbon odor, no sheen	
							15		SP		
							16			SAND - black, moist, moderate hydrocarbon odor, no sheen, hydrophobic black powder is present, thin layer of silt at 15.5 feet bgs (15-17 feet bgs)	
	B2-05	9:35	2.2	-			17				
	B2-06	9:38	2.7	-			17				
							18				
							19		SP	SAND - gray to green, moist, no sheen, black powder is no longer present in sample (17-17.5 feet bgs)	
							20				

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PROJECT:
 Northwest Natural Gas Co.
 Gasco Facility
 Portland, Oregon

PROJECT #: 2708

SOIL BORING NUMBER B-2

HAI LOGGER: Rob Ede

SAMPLING METHOD: 4" OD Core Barrel

DRILLING METHOD: 4 1/4-inch ID Hollow Stem Auger

EQUIPMENT TYPE: B-59 Mobile Drill

DRILLER: Brad James

DRILLING CONTRACTOR: Geo-Tech Explorations, Inc.

DRILL START	DRILL FINISH
Time: 8:50	Time: 10:15
Date: 9/27/95	Date: 9/27/95

ABANDONMENT DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHs (ppm)	CORE INTERVAL	SAMPLE RECOVERY	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	BORING DATA	
										BORING DIAMETER:	8-inch
	B2-07	9:42		-			21				
			5.9				22		SP		SAND - gray to green, wet, poorly graded, medium grained, strong hydrocarbon odor, no sheen, (20-22 feet bgs)
							23				
	B2-08	9:50		-			24				SAND - as above, no hydrocarbon odor, no sheen (22-24 feet bgs)
			3.1				25				Heaving sands encountered at 25 feet bgs - re-drill out hole to remove.
							26		SP		
	B2-09	10:10		-			27				SAND - gray to green, wet, poorly graded, medium grained, no hydrocarbon odor, no sheen
			3.2				28				
							29				
							30				Drilled to 27.5 feet bgs Sampled to 27 feet bgs
							31				* Sample Number Prefix is 2708-950927-
							32				
							33				
							34				
							35				
							36				
							37				
							38				
							39				
							40				

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PROJECT:
 Northwest Natural Gas Co.
 Gasco Facility
 Portland, Oregon

PROJECT #: 2708

SOIL BORING NUMBER B-3

HAI LOGGER:	Rob Ede	DRILL START	DRILL FINISH
SAMPLING METHOD:	Split Spoon	Time:	Time:
DRILLING METHOD:	4 1/4-inch ID Hollow Stem Auger	10:30	12:30
EQUIPMENT TYPE	B-59 Mobile Drill	Date:	Date:
DRILLER:	Brad James	9/21/95	9/21/95
DRILLING CONTRACTOR:	Geo-Tech Explorations, Inc.		

ABANDONMENT DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHs (ppm)	SPT (blows/0.5 feet)	RECOVERY (%)	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	BORING DIAMETER: 8-inch	
										CASING DIAMETER: Not Applicable	
										SURFACE ELEVATION: 34.1 feet msl	
										TOP OF CASING ELEVATION: Not Applicable	
										SOIL DESCRIPTION	
3/4" Bentonite Chips	B3-01	10:30	2.4	-			1		GP	Sandy GRAVEL - dry, road fill (surface sample)	
							2		SP		
	B3-02	10:35	7.0	-	10	100	3			SAND with some Gravel - brown, moist, medium dense, poorly graded, fine to medium grained, no hydrocarbon odor, no sheen	
					17	100	4				
					9	100	5				
	B3-03	10:40	7.4	-	10	70	6			SAND with some Gravel - brown, moist, medium dense, poorly graded, slight hydrocarbon odor, no sheen	
					17	0	7		SP		
					10	100					
	B3-04	10:45		-	18	100	8			SAND - brown with gray mottling, moist, medium dense, slight hydrocarbon odor, no sheen	
					18	0	9				
					12	100	10				
	B3-05	11:00	8.3	49	34	60	11			SAND - brown, moist, medium dense, fine grained black sand at lower 4 inches of sample, black material has hydrocarbon odor and is hydrophobic (lampblack)	
							12		SP		
	B3-06	11:10	4.0	-	44	60	13			SAND - brown, moist, dense, large piece of wood stained black stuck in end of spoon - sands directly surrounding wood are coated black, slight hydrocarbon odor, no sheen	
					27	0	14				
					34	0	15				
					13	100	16				
	B3-07	11:20		ND	16	100	17			SAND - brown, dry, medium dense, poorly graded, no hydrocarbon odor, no sheen	
				8.0	13	100	18		SP		
							19				
B3-08	11:30		-	4	100	20			SAND - green to gray, moist to wet, stiff, poorly graded, moderate hydrocarbon odor, no sheen		
			5.3	9	100						
				14	100						

HAHN & ASSOCIATES, INC. 434 NW Sixth Avenue Portland, Oregon (503) 796-0717		SOIL BORING NUMBER B-3								
PROJECT: Northwest Natural Gas Co. Gasco Facility Portland, Oregon		HAI LOGGER: Rob Ede	DRILL START 10:30							
PROJECT #: 2708		SAMPLING METHOD: Split Spoon	DRILL FINISH 12:30							
		DRILLING METHOD: 4 1/4-inch ID Hollow Stem Auger	Date: 9/21/95							
		EQUIPMENT TYPE: B-59 Mobile Drill	Date: 9/21/95							
		DRILLER: Brad James								
		DRILLING CONTRACTOR: Geo-Tech Explorations, Inc.								
ABANDONMENT DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHs (ppm)	SPT (blows/0.5 feet)	RECOVERY (%)	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	BORING DIAMETER: 8-inch
	B3-09	11:40	2.0	-	17	100	21		SP	CASING DIAMETER: Not Applicable
					17	50	22			SURFACE ELEVATION: 34.1 feet msl
					3	100	23			TOP OF CASING ELEVATION: Not Applicable
	B3-10	12:00	22.0	-	12	100	24			SOIL DESCRIPTION
					14	100	25			SAND - green to gray, wet, medium dense, poorly graded, strong hydrocarbon odor, no sheen
					4	100	26			
	B3-11	12:05	29.1	-	6	100	27		ML	SAND - green to gray, wet, medium dense, poorly graded, strong hydrocarbon odor, no sheen, Clayey SILT in bottom 6 inches of core
					10	100	28			Clayey SILT, green to gray, wet, loose, plastic, strong hydrocarbon odor, no sheen
					4	100	29			
	B3-12	12:24	4.5	-	5	100	30		SP	SAND - green to gray, wet, stiff, poorly graded, fine grained, slight hydrocarbon odor, no sheen
					5	100	31			
							32			
							33			
							34			
							35			
							36			
							37			
							38			
							39			
							40			

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PROJECT:
 Northwest Natural Gas Co.
 Gasco Facility
 Portland, Oregon

PROJECT #: 2708

SOIL BORING NUMBER B-4

HAI LOGGER: Rob Ede

SAMPLING METHOD: 4" OD Core Barrel

DRILLING METHOD: 4 1/4-inch ID Hollow Stem Auger

EQUIPMENT TYPE: B-59 Mobile Drill

DRILLER: Brad James

DRILLING CONTRACTOR: Geo-Tech Explorations, Inc.

DRILL	DRILL
START	FINISH
Time: 8:20	Time: 9:40
Date: 9/21/95	Date: 9/21/95

ABANDONMENT DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHs (ppm)	CORE INTERVAL	SAMPLE RECOVERY	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	BORING DIAMETER: 8-inch
										CASING DIAMETER: Not Applicable
										SURFACE ELEVATION: 36.9 feet msl
										TOP OF CASING ELEVATION: Not Applicable
SOIL DESCRIPTION										

3/4" Bentonite Chips	B4-01	8:15	0.3	-			1		GP	Sandy GRAVEL - dry, roadbed material (surface sample)
							2			
							3		SP	
	B4-02	8:30		-			4			SAND with some Gravel - brown, dry, non-plastic, poorly graded, no hydrocarbon odor, no sheen
			8.9				5			
							6			
							7			
	B4-03	8:40		-			8			SAND with some Gravel - as above
			7.1				9		SP	
							10			
							11			
	B4-04	8:55		-			12			SAND with some Gravel - as above, moist
			7.7				13			
							14		SP	
							15			
							16			
	B4-05	9:05		-			17			SAND with some Gravel - as above
			15.0				18			
							19		SP	
							20			

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SOIL BORING NUMBER

B-4

PROJECT:

Northwest Natural Gas Co.

Gasco Facility

Portland, Oregon

PROJECT #: 2708

HAI LOGGER:

Rob Ede

SAMPLING METHOD:

4" OD Core Barrel

DRILLING METHOD:

4 1/4-inch ID Hollow Stem Auger

EQUIPMENT TYPE

B-59 Mobile Drill

DRILLER:

Brad James

DRILLING CONTRACTOR:

Geo-Tech Explorations, Inc.

DRILL

START

Time:

8:20

Date:

9/21/95

DRILL

FINISH

Time:

9:40

Date:

9/21/95

BORING DIAMETER: 8-inch

CASING DIAMETER: Not Applicable

SURFACE ELEVATION: 36.9 feet msl

TOP OF CASING ELEVATION: Not Applicable

SOIL DESCRIPTION

ABANDONMENT DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHs (ppm)	CORE INTERVAL	SAMPLE RECOVERY	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	BORING DATA	
										BORING DIAMETER:	8-inch
3/4" Bentonite Chips	B4-06	9:15		-			21		SP	SAND with some Gravel - as above, moist to wet	
			5.3				22				
							23				
							24		SP		
							25				
							26				
	B4-07	9:25		-			27			SAND with some Gravel - as above, green to gray, wet, (25-27 feet bgs)	
				2.5			28				
	B4-08	9:30		-			29		ML	Clayey SILT - gray, moist, stiff, plastic, no hydrocarbon odor, no sheen (27-30 feet bgs)	
				2.0			30				
						31					
						32					
						33					
						34					
						35					
						36					
						37					
						38					
						39					
						40					

Drilled to 30 feet bgs
Sampled to 29.5 feet bgs

* Sample Number Prefix is 2708-950921-

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PROJECT:
 Northwest Natural Gas Co.
 Gasco Facility
 Portland, Oregon

PROJECT #: 2708

SOIL BORING NUMBER B-5

HAI LOGGER: Rob Ede

SAMPLING METHOD: 4" OD Core Barrel

DRILLING METHOD: 4 1/4-inch ID Hollow Stem Auger

EQUIPMENT TYPE: B-59 Mobile Drill

DRILLER: Brad James

DRILLING CONTRACTOR: Geo-Tech Explorations, Inc.

DRILL START	DRILL FINISH
Time: 13:35	Time: 14:50
Date: 9/28/95	Date: 9/28/95

ABANDONMENT DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHS (ppm)	CORE INTERVAL	SAMPLE RECOVERY	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	SOIL DESCRIPTION
3/4" Bentonite Chips	B5-01	13:30	1.4	-			1			Silty SAND with some Gravel - brown, wet, no hydrocarbon odor, no sheen, (surface)
							2			
								3	SP	
	B5-02	13:40	3.9	-			4			SAND with some Gravel - brown, slightly moist, loose, non-plastic, poorly graded, medium grained, no hydrocarbon odor, no sheen
								5		
								6		
	B5-03	13:50	3.3	-			7			SAND with some Gravel - as above, moist
								8		
								9	SP	
								10		
								11		
								12		
	B5-04	14:00	3.8	-			13			SAND with some Gravel - as above, moist
								14	SP	
								15		
	B5-05	14:08	4.3	3.6			16			SAND with some Gravel - as above, hydrocarbon odor, (15-17 feet bgs)
								17		
	B5-06	14:10	4.9	-			18		ML	SILT - green to gray, moist, hydrocarbon odor, sheen, wood fragments, (17-17.5 feet bgs)
								19	SP	
	B5-07	14:12	3.6	-			19			SAND - green to gray, moist, loose, slight hydrocarbon odor, no sheen, (17.5-19 feet bgs)
							20			

HAHN & ASSOCIATES, INC.

434 NW Sixth Avenue

Portland, Oregon

(503) 796-0717

SOIL BORING NUMBER

B-5

PROJECT:

Northwest Natural Gas Co.

Gasco Facility

Portland, Oregon

PROJECT #: 2708

HAI LOGGER:

Rob Ede

SAMPLING METHOD:

4" OD Core Barrel

DRILLING METHOD:

4 1/4-inch ID Hollow Stem Auger

EQUIPMENT TYPE

B-59 Mobile Drill

DRILLER:

Brad James

DRILLING CONTRACTOR:

Geo-Tech Explorations, Inc.

DRILL

START

Time: 13:35

Date: 9/28/95

DRILL

FINISH

Time: 14:50

Date: 9/28/95

ABANDONMENT DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHS (ppm)	CORE INTERVAL	SAMPLE RECOVERY	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	BORING DIAMETER:	CASING DIAMETER:	SURFACE ELEVATION:	TOP OF CASING ELEVATION:	SOIL DESCRIPTION
							21		SP	8-inch	Not Applicable	36.1 feet msl	Not Applicable	<p>SAND - green to gray, wet, loose, medium grained, no hydrocarbon odor, no sheen</p> <p>Installed a 2-inch diameter 0.010-inch slotted stainless steel well screen at 25 to 28 feet bgs. Purged 5 gallons of water using a peristaltic pump prior to groundwater sampling. GROUNDWATER SAMPLE (2708-950929-BW5-01) collected at 8:00 hrs, 9/28/95. Well point was removed prior to abandonment.</p> <p>SAND - as above, alternating thin sand and silt beds in 4 inch layer above massive silt</p> <p>SILT with some Clay - green to gray, moist, stiff, plastic, no hydrocarbon odor, no sheen</p>
							22							
	B5-08	14:15		-			23							
			3.5				24							
							25							
							26		SP					
							27							
	B5-09	14:35		-			28							
			3.5				29							
	B5-10	14:40		-			30		ML					
			3.1											
							31							
							32							
							33							
							34							
							35							
							36							
							37							
							38							
							39							
							40							

HAHN & ASSOCIATES, INC. 434 NW Sixth Avenue Portland, Oregon (503) 796-0717					SOIL BORING NUMBER B-6					
PROJECT: Northwest Natural Gas Co. Gasco Facility Portland, Oregon					HAI LOGGER: Rob Ede			DRILL START	DRILL FINISH	
PROJECT #: 2708					SAMPLING METHOD: 3"OD Split Spoon/4" OD Core Barrel			Time: 11:15	Time: 12:35	
					DRILLING METHOD: 4 1/4-inch ID Hollow Stem Auger			Date: 9/27/95	Date: 9/27/95	
					EQUIPMENT TYPE: B-59 Mobile Drill					
					DRILLER: Brad James					
					DRILLING CONTRACTOR: Geo-Tech Explorations, Inc.					
ABANDONMENT DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHS (ppm)	SPT (blows/6 in) or Core Interval	Recovery (%) or Sample Interval	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	BORING DIAMETER: 8-inch
Concrete							1		GP	GRAVEL - old pavement at surface
							2		SP	
					15	100	3		SP	SAND - brown, slightly moist, medium dense, poorly graded, fine to medium grained, no hydrocarbon odor, no sheen, (2.5-3 feet bgs)
	B6-01	11:20	4.8	-	30	100	4		GP	Sandy GRAVEL - black, dense, pieces of lampblack (hydrophobic in water), no hydrocarbon odor, no sheen, (3-4 feet bgs)
							5		GP	
					9	10	6		SP	
					4	0	6		SP	
					2	0	7		SP	Sandy GRAVEL - gray, moist, loose, no hydrocarbon odor, no sheen
							8		SP	
	B6-02	11:30	38.5	12,487	12	50	9		SP	SAND with Gravel and Brick - black, moist, medium dense, grains stuck together by tarry substance, strong hydrocarbon odor, strong sheen
					10	0	9		SP	
							10		SP	
					7	10	11		SP	Large Rock in end of sampler - blue matrix, concoidal fracture, specimen retained
					11	0	11		SP	
					13	0	12		SP	
							13		SP	
					5	50	13		SP	
					5	0	14		SP	Weathered Brick in end of tube - moist, stiff, no hydrocarbon odor, no sheen
					5	0	14		SP	
							15		SP	
	B6-03	12:00		87	6	100	16		SP	SAND - brown, slightly moist, loose, fine to medium grained, gravels from 16-16.5 feet bgs, no hydrocarbon odor, no sheen
			8.0				17		SP	
							17		SP	
							18		SP	
	B6-04	12:10		-			19		SP	
			7.2				19		SP	
							20		SP	SAND - as above, no gravel

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SOIL BORING NUMBER B-6

PROJECT:
 Northwest Natural Gas Co.
 Gasco Facility
 Portland, Oregon
PROJECT #: 2708

HAI LOGGER: Rob Ede
SAMPLING METHOD: 3"OD Split Spoon/4" OD Core Barrel
DRILLING METHOD: 4 1/4-inch ID Hollow Stem Auger
EQUIPMENT TYPE: B-59 Mobile Drill
DRILLER: Brad James
DRILLING CONTRACTOR: Geo-Tech Explorations, Inc.

DRILL START	DRILL FINISH
Time: 11:15	Time: 12:35
Date: 9/27/95	Date: 9/27/95

ABANDONMENT DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHS (ppm)	SPT (blows/6 in) or Core Interval	Recovery (%) or Sample Interval	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	BORING DIAMETER: 8-inch
										CASING DIAMETER: Not Applicable
										SURFACE ELEVATION: 34.7 feet msl
										TOP OF CASING ELEVATION: Not Applicable
										SOIL DESCRIPTION

3/4" Bentonite Chips							21		SP	SAND - green to gray, wet, poorly graded, fine to medium graded, no hydrocarbon odor, no sheen Sandy SILT - green to gray, stiff, slightly plastic, slight organic odor (anaerobic degradation), no sheen, sand content decreasing with depth Sandy SILT - green to gray, wet, slightly plastic, no hydrocarbon odor, no sheen
	B6-05	12:20		-			22			
				9.4				23		
	B6-06	12:25		-			24		ML	
				8.3				25		
								26		
	B6-07	12:30		-			27		ML	
				9.2				28		
	B6-08	12:35		-			29			
				9.8				30		
							31		Drilled to 30 feet bgs Sampled to 29.5 feet bgs * Sample Number Prefix is 2708-950927-	
							32			
							33			
							34			
							35			
							36			
							37			
							38			
							39			
							40			

HAHN & ASSOCIATES, INC. 434 NW Sixth Avenue Portland, Oregon (503) 796-0717					SOIL BORING NUMBER B-7					
PROJECT: Northwest Natural Gas Co. Gasco Facility Portland, Oregon PROJECT #: 2708					HAI LOGGER: Rob Ede			DRILL START	DRILL FINISH	
SAMPLING METHOD: 3" OD Split Spoon/4"OD Core Barrel					DRILLING METHOD: 4 1/4-inch ID Hollow Stem Auger			Time: 13:30	Time: 14:30	
EQUIPMENT TYPE B-59 Mobile Drill					DRILLER: Brad James			Date: 9/27/95	Date: 9/27/95	
DRILLING CONTRACTOR: Geo-Tech Explorations, Inc.										
ABANDONMENT DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHS (ppm)	SPT(blow/6 in) or Core Interval	RECOVERY (%) or INTERVAL	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	BORING DIAMETER: 8-inch
CASING DIAMETER: Not Applicable										
SURFACE ELEVATION: 36.1 feet msl										
TOP OF CASING ELEVATION: Not Applicable										
SOIL DESCRIPTION										
Concrete							1		Concrete	
							2		SP	
					4	100	3			
	B7-01	13:35		-	6	100	4			SAND - brown, slightly moist, loose, poorly graded, fine to medium grained, no hydrocarbon odor, no sheen
			3.9		5	100	4			
							5			
	B7-02	13:45		-	5	100	6			SAND - as above
			5.0		5	100	6			
							7			
							8		SP	
	B7-03	13:50					9			SAND - as above, some pebbles, moist, no hydrocarbon odor, slight sheen
			4.6				9			
							10			
							11			
							12			
	B7-04	13:55		-			13			SAND - as above, moist, no hydrocarbon odor, slight sheen
			6.0				13			
							14			
							15			
							16		SP	
							17			
	B7-05	14:02		ND			18			SAND - as above, moist, no hydrocarbon odor, no sheen
			7.7				18			
							19			
							20			

HAHN & ASSOCIATES, INC. 434 NW Sixth Avenue Portland, Oregon (503) 796-0717				SOIL BORING NUMBER B-7										
PROJECT: Northwest Natural Gas Co. Gasco Facility Portland, Oregon				HAI LOGGER: Rob Ede		DRILL START	DRILL FINISH							
PROJECT #: 2708				SAMPLING METHOD: 3" OD Split Spoon/4"OD Core Barrel		Time: 13:30	Time: 14:30							
				DRILLING METHOD: 4 1/4-inch ID Hollow Stem Auger		Date: 9/27/95	Date: 9/27/95							
				EQUIPMENT TYPE: B-59 Mobile Drill										
				DRILLER: Brad James										
				DRILLING CONTRACTOR: Geo-Tech Explorations, Inc.										
ABANDONMENT DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHS (ppm)	SPT(blow/6 in) or Core Interval	RECOVERY (%) or INTERVAL	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	BORING DIAMETER: 8-inch	CASING DIAMETER: Not Applicable	SURFACE ELEVATION: 36.1 feet msl	TOP OF CASING ELEVATION: Not Applicable	
3/4" Bentonite Chips	B7-06	14:10	8.4	-			21	9/27/95	SP	SAND - brown, wet, poorly graded, medium grained, slight hydrocarbon odor, no sheen, (20-21 feet bgs)				
							22							
	B7-07	14:12	6.6	-			23			SAND - green to gray, wet, poorly graded, medium grained, no hydrocarbon odor, no sheen, (21-25 feet bgs)				
							24							
							25							
							26			SP				
							27							
	B7-08	14:20	5.2	-			28			SAND - as above				
							29							
	B7-09	14:30	6.4	-			30			ML	SILT - green to gray, moist, stiff, plastic, no hydrocarbon odor, no sheen, some brown organic matter			
						31								
						32		Drilled to 30 feet bgs Sampled to 29.5 feet bgs						
						33								
						34								
						35								
						36								
						37								
						38								
						39								
						40								

HAHN & ASSOCIATES, INC.
 434 NW Sixth Avenue
 Portland, Oregon
 (503) 796-0717

SOIL BORING NUMBER B-8

PROJECT:
 Northwest Natural Gas Co.
 Gasco Facility
 Portland, Oregon
PROJECT #: 2708

HAI LOGGER:	Rob Ede	DRILL	DRILL
SAMPLING METHOD:	1.5" / 3" OD Split Spoon	START	FINISH
DRILLING METHOD:	4 1/4-inch ID Hollow Stem Auger	Time:	Time:
EQUIPMENT TYPE	B-59 Mobile Drill	9:30	12:10
DRILLER:	Brad James	Date:	Date:
DRILLING CONTRACTOR:	Geo-Tech Explorations, Inc.	9/18/95	9/18/95

ABANDONMENT DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHS (ppm)	SPT (blows/0.5 feet)	RECOVERY (%)	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	BORING DIAMETER: 8-inch	
										CASING DIAMETER: Not Applicable	
										SURFACE ELEVATION: 23.0	
										TOP OF CASING ELEVATION: Not Applicable	
										SOIL DESCRIPTION	
3/4" Bentonite Chips							1				
							2				
						5	100	3	GM	Silty GRAVEL - brown, moist, loose, non-plastic, slightly graded, no hydrocarbon odor or discoloration, spotty sheen	
	B8-01	9:35	9.3	-	6	50	4				
					8	0					
							5				
	B8-02	9:42		-	4	100			GM	Silty GRAVEL - brown, dry, loose, non-plastic, slightly graded, no hydrocarbon odor or discoloration, spotty sheen	
					7	0	6				
					9	0	7				
	B8-03	9:44		-	9	70	8			Silty GRAVEL - as above, wet, medium dense	
					18	0					
					23	0	9				
							10				
	B8-04	9:50		338	17	100			GM	Sandy GRAVEL - brown, moist, medium dense, non-plastic, poorly graded, no hydrocarbon odor, no sheen, large pieces of slag in sampling tube	
				7.5	23	20	11				
					17	0	12				
	B8-05	10:00	8.0	-	11	100	13			SAND - gray, wet, medium dense, non-plastic, poorly graded, fine grained, mild hydrocarbon odor, no sheen	
	B8-06 Dup	10:02			10	20					
					8	0	14			Note: Change to 1.5" Split Spoon sampling device	
							15				
				3	100						
B8-07	10:05		-	4	100	16		SP	SAND - gray, wet, loose, non-plastic, poorly graded, medium grained, mild hydrocarbon odor, no sheen		
			7.3	6	50	17					
				3	100	18			Sandy SILT - gray, wet, soft, slightly plastic, no hydrocarbon odor, no sheen		
B8-08	10:15		0.24	3	100						
			6.5	3	100	19		ML			
						20					

HAHN & ASSOCIATES, INC. 434 NW Sixth Avenue Portland, Oregon (503) 796-0717					SOIL BORING NUMBER B-8				
PROJECT: Northwest Natural Gas Co. Gasco Facility Portland, Oregon					HAI LOGGER: Rob Ede			DRILL START	DRILL FINISH
PROJECT #: 2708					SAMPLING METHOD: 1.5" / 3" OD Split Spoon			Time: 9:30	Time: 12:10
					DRILLING METHOD: 4 1/4-inch ID Hollow Stem Auger			Date: 9/18/95	Date: 9/18/95
					EQUIPMENT TYPE: B-59 Mobile Drill				
					DRILLER: Brad James				
					DRILLING CONTRACTOR: Geo-Tech Explorations, Inc.				
ABANDONMENT DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHS (ppm)	SPT (blows/0.5 feet)	RECOVERY (%)	DEPTH (feet)	GROUNDWATER	STRATA (USCS)
3/4" Bentonite Chips	B8-09	10:20		-	1	100	21		
			6.1		1	100	22		SP
					2	100	23		
	B8-10	11:45	5.1	-	2	100	24		SM
					4	100	25		
					1	100	26		
					2	100	27		
	B8-11	12:00	4.1	-	3	100	28		
							29		
							30		
							31		
						32			
						33			
						34			
						35			
						36			
						37			
						38			
						39			
						40			

BORING DIAMETER: 8-inch
CASING DIAMETER: Not Applicable
SURFACE ELEVATION: 23.0
TOP OF CASING ELEVATION: Not Applicable

SOIL DESCRIPTION

SAND - gray, wet, very loose, non-plastic, poorly graded, moderate petroleum hydrocarbon odor, slight sheen

Silty SAND - dark gray, wet, very loose, non-plastic, poorly graded, fine grained, mild petroleum hydrocarbon odor

Silty SAND - as above

Installed a 2-inch diameter 0.010-inch slotted stainless steel well screen at 20.5 to 23.5 feet bgs. Purged two gallons of water using a peristaltic pump prior to groundwater sampling. GROUNDWATER SAMPLE (2708-950918-BW8-01) collected at 11:30 hrs, 9/18/95. Well point was removed prior to abandonment.

Drilled to 26.5 feet bgs
Sampled to 26.5 feet bgs

* Sample Number Prefix is 2708-950918-

HAHN & ASSOCIATES, INC. 434 NW Sixth Avenue Portland, Oregon (503) 796-0717				SOIL BORING NUMBER B-9										
PROJECT: Northwest Natural Gas Co. Gasco Facility Portland, Oregon PROJECT #: 2708				HAI LOGGER: Rob Ede			DRILL START	DRILL FINISH						
				SAMPLING METHOD: 1.5" OD Split Spoon/4" OD Core Barrel			Time: 14:50	Time: 16:40						
				DRILLING METHOD: 4 1/4-inch ID Hollow Stem Auger			Date: 9/18/95	Date: 9/18/95						
				EQUIPMENT TYPE: B-59 Mobile Drill										
				DRILLER: Brad James										
				DRILLING CONTRACTOR: Geo-Tech Explorations, Inc.										
ABANDONMENT DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHS (ppm)	SPT (blows/6 in) or Core Interval	RECOVERY (%) or INTERVAL	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	BORING DIAMETER:	CASING DIAMETER:	SURFACE ELEVATION:	TOP OF CASING ELEVATION:	SOIL DESCRIPTION
3/4" Bentonite Chips							1			8-inch	Not Applicable	31.6 feet msl	Not Applicable	See boring log B-9A for 0 to 5 foot soil description. SAND with some Gravel - black, dry, medium dense, very strong petroleum hydrocarbon odor, all pores filled with tar-like substance throughout SAND with some Gravel - as above, dense, large piece of gravel in end of sampler SAND with some Gravel - as above, moist, dense Silty SAND with some Gravel - brown, moist, medium dense, poorly graded, strong petroleum hydrocarbon odor, some tar-like blebs Silty SAND with Gravel - brown with black mottles, dry, medium dense, tar-like substance mottled throughout, strong petroleum hydrocarbon odor SAND with some Gravel - black, very dense, possible lampblack
							2		SP					
								3						
								4						
								5						
	B9-01	14:50		-	8	100		6						
			8:10		10	20		7						
					11	0		8						
					18	10		9						
					33	0		10	SP					
					21	0		11						
	B9-02	15:00	897	19,438	18	100		12						
					13	0		13						
					23	0		14						
	B9-03	15:10	278.0	-	16	100		15	SM					
					6	0		16						
					17	0		17						
	B9-04	15:20	118	-	4	100		18						
					7	0		19						
					11	0		20						
B9-05	15:30	211	-	13	100		19	SP						
				50?3"	5		20							
B9-06	15:40	363	-	3	100		20							

PROJECT:	HAI LOGGER: Rob Ede	DRILL	DRILL
Northwest Natural Gas Co.	SAMPLING METHOD: 1.5" OD Split Spoon/4" OD Core Barrel	START	FINISH
Gasco Facility	DRILLING METHOD: 4 1/4-inch ID Hollow Stem Auger	Time:	Time:
Portland, Oregon	EQUIPMENT TYPE: B-59 Mobile Drill	14:50	16:40
PROJECT #: 2708	DRILLER: Brad James	Date:	Date:
	DRILLING CONTRACTOR: Geo-Tech Explorations, Inc.	9/18/95	9/18/95

ABANDONMENT DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHS (ppm)	SPT (blows/6 in) or Core Interval	RECOVERY (%) or INTERVAL	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	SOIL DESCRIPTION
					4	0				BORING DIAMETER: 8-inch
					4	0	21			CASING DIAMETER: Not Applicable
							22			SURFACE ELEVATION: 31.6 feet msl
	B9-07	1	100	-	2	100				TOP OF CASING ELEVATION: Not Applicable
					3	100	23		SP	SOIL DESCRIPTION
					6	100	24			SAND - black, wet, very loose, poorly graded, fine to medium grained, slight petroleum hydrocarbon odor
							25			
							26			
							27			
							28			
	B9-08	16:10	504	-			29		SM	SAND with some Gravel - black, wet, very loose, slightly graded, medium grained, strong petroleum hydrocarbon odor, strong sheen
							30			
							31			
	B9-09	16:20	33.1	43.5			32			Silty SAND - gray to black, wet, mild petroleum hydrocarbon odor, sheen
							33			
							34		SP	
	B9-10	16:21	9.1	0.46			35			Silty SAND - dark gray, wet, poorly sorted, petroleum hydrocarbon odor, slight sheen
							36			
							37			
							38			
							39			
							40			

HAHN & ASSOCIATES, INC. 434 NW Sixth Avenue Portland, Oregon (503) 796-0717					SOIL BORING NUMBER B-9A				
PROJECT: Northwest Natural Gas Co. Gasco Facility Portland, Oregon PROJECT #: 2708					HAI LOGGER: Rob Ede			DRILL START	DRILL FINISH
					SAMPLING METHOD: 4" OD Core Barrel			Time: 14:00	Time: 14:20
					DRILLING METHOD: 4 1/4-inch ID Hollow Stem Auger			Date: 9/18/95	Date: 9/18/95
					EQUIPMENT TYPE: B-59 Mobile Drill				
					DRILLER: Brad James				
					DRILLING CONTRACTOR: Geo-Tech Explorations, Inc.				
ABANDONMENT DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHS (ppm)	CORE INTERVAL	RECOVERY INTERVAL	DEPTH (feet)	GROUNDWATER	STRATA (USCS)
							1		
	B9A-01	14:00		-			2		SP
	B9A-02	14:02	614	-			3		
	B9A-03	14:05	274	-			4		
							5		
							6		
							7		
							8		
							9		
							10		
							11		
							12		
							13		
							14		
							15		
							16		
							17		
							18		
							19		
							20		

BORING DIAMETER: 8-inch
CASING DIAMETER: Not Applicable
SURFACE ELEVATION: 31.6 feet msl
TOP OF CASING ELEVATION: Not Applicable

SOIL DESCRIPTION

Gravelly SAND - black, dry, strong petroleum hydrocarbon odor, saturated with tar-like substance throughout

Note: Stopped drilling at 14:20 due to lack of soil recovery from 5 to 15 feet bgs. Relocate to boring B-9.

Drilled to 15 feet bgs
Sampled to 3 feet bgs
*Sample prefix is 2708-950918-

HAHN & ASSOCIATES, INC.
 434 NW Sixth Avenue
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SOIL BORING NUMBER

B-10

PROJECT:
 Northwest Natural Gas Co.
 Gasco Facility
 Portland, Oregon
PROJECT #: 2708

HAI LOGGER: Rob Ede
SAMPLING METHOD: 4" OD Core Barrel
DRILLING METHOD: 4 1/4-inch ID Hollow Stem Auger
EQUIPMENT TYPE: B-59 Mobile Drill
DRILLER: Brad James
DRILLING CONTRACTOR: Geo-Tech Explorations, Inc.

DRILL START	DRILL FINISH
Time: 11:50	Time: 12:50
Date: 9/25/95	Date: 9/25/95

ABANDONMENT DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHS (ppm)	CORE INTERVAL	SAMPLE RECOVERY	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	BORING DIAMETER: 8-inch
										CASING DIAMETER: Not Applicable
										SURFACE ELEVATION: 35.2 feet msl
										TOP OF CASING ELEVATION: Not Applicable
SOIL DESCRIPTION										

3/4" Bentonite Chips							1			
							2		SP	
						↑	3			
	B10-01	12:10		-		↓	4			SAND - brown, dry, poorly graded, medium grained, no hydrocarbon odor, no sheen
			102.0			↑	5			
						↓	6			
						↑	7			
	B10-02	12:20		-		↓	8		SP	SAND with some Pebbles - brown, moist, poorly graded, medium grained, no hydrocarbon odor, no sheen
			164.0			↑	9			
						↓	10			
						↑	11			
						↓	12			
	B10-03	12:30		-		↑	13		SP	SAND - brown, slightly moist, poorly graded, medium grained, no hydrocarbon odor, no sheen, slight froth via sheen test
			165.0			↓	14			
						↑	15			
						↓	16			
						↑	17			
	B10-04	12:40		ND		↓	18		SP	SAND - brown, moist, poorly graded, medium grained, no hydrocarbon odor, no sheen
			127.0			↑	19			
						↓	20			

Hahn & Associates, Inc.
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SOIL BORING NUMBER B-10

PROJECT:
 Northwest Natural Gas Co.
 Gasco Facility
 Portland, Oregon
PROJECT #: 2708

HAI LOGGER:	Rob Ede	DRILL	DRILL
SAMPLING METHOD:	4" OD Core Barrel	START	FINISH
DRILLING METHOD:	4 1/4-inch ID Hollow Stem Auger	Time:	Time:
EQUIPMENT TYPE	B-59 Mobile Drill	11:50	12:50
DRILLER:	Brad James	Date:	Date:
DRILLING CONTRACTOR:	Geo-Tech Explorations, Inc.	9/25/95	9/25/95

ABANDONMENT DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHS (ppm)	CORE INTERVAL	SAMPLE RECOVERY	DEPTH (feet)	GROUNDWATER	STRATA (USCS)
3/4" Bentonite Chips							21	9/25/95	SP
							22		
	B10-05	12:50		-			23		
				167.0			24		
							25		
							26		
							27		
							28		
							29		
							30		
							31		
							32		
							33		
							34		
							35		
							36		
							37		
						38			
						39			
						40			

BORING DIAMETER:	8-inch
CASING DIAMETER:	Not Applicable
SURFACE ELEVATION:	35.2 feet msl
TOP OF CASING ELEVATION:	Not Applicable

SOIL DESCRIPTION

SAND - green to gray, wet, poorly graded, medium grained, no hydrocarbon odor, no sheen

Drilled to 25 feet bgs
 Sampled to 24 feet bgs

* Sample Number Prefix is 2708-950925-

HAHN & ASSOCIATES, INC.
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PROJECT:
 Northwest Natural Gas Co.
 Gasco Facility
 Portland, Oregon

PROJECT #: 2708

SOIL BORING NUMBER B-11

HAI LOGGER: Rob Ede

SAMPLING METHOD: 3" OD Split Spoon/4" OD Core Barrel

DRILLING METHOD: 4 1/4-inch ID Hollow Stem Auger

EQUIPMENT TYPE: B-59 Mobile Drill

DRILLER: Brad James

DRILLING CONTRACTOR: Geo-Tech Explorations, Inc.

DRILL START	DRILL FINISH
Time: 10:30	Time: 11:40
Date: 9/28/95	Date: 9/28/95

ABANDONMENT DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHS (ppm)	SPT (blows/6 in) or Core Interval	RECOVERY or INTERVAL	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	BORING DIAMETER:	CASING DIAMETER:	SURFACE ELEVATION:	TOP OF CASING ELEVATION:	SOIL DESCRIPTION
3/4" Bentonite Chips	B11-01	10:30	9.2	-			1		SP	8-inch	Not Applicable	36.5 feet MSL	Not Applicable	Silty SAND with Gravel - brown, moist, no hydrocarbon odor, no sheen
							2							
							3							
	B11-01	10:40	7.2	-	15	100	4							
					18	70	5							
					8	100	6							
	B11-03	10:42	20	-	13	100	7							
					13	95	8							
	B11-04	10:45	21.6	-			9							
							10							
	B11-05	10:48	119	-			11							
							12							
	B11-06	10:55	260	973			13							
							14							
							15							
							16							
							17							
							18							
	B11-07	11:00	97	-			19							
							20							

HAHN & ASSOCIATES, INC.
 434 NW Sixth Avenue
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PROJECT:
 Northwest Natural Gas Co.
 Gasco Facility
 Portland, Oregon

PROJECT #: 2708

SOIL BORING NUMBER B-11

HAI LOGGER: Rob Ede

SAMPLING METHOD: 3" OD Split Spoon/4" OD Core Barrel

DRILLING METHOD: 4 1/4-inch ID Hollow Stem Auger

EQUIPMENT TYPE: B-59 Mobile Drill

DRILLER: Brad James

DRILLING CONTRACTOR: Geo-Tech Explorations, Inc.

DRILL START	DRILL FINISH
Time: 10:30	Time: 11:40
Date: 9/28/95	Date: 9/28/95

ABANDONMENT DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHS (ppm)	SPT (blows/6 in) or Core Interval	RECOVERY or INTERVAL	DEPTH (feet)	GROUNDWATER	STRATA (USCS)
3/4" Bentonite Chips	B11-08	11:10	17.1	-			21		SP
							22		
							23		
	B11-09	11:15	2.1	1.1			24		
							25		
							26		SP
	B11-10	11:20	0.4	-			27		
							28		
	B11-11	11:25	0.7	-			29		
	B11-12	11:30	0.5	-			30		
							31		ML
	B11-13	11:40	0	-			32		
							33		
						34			
						35			
						36			
						37			
						38			
						39			
						40			

BORING DIAMETER: 8-inch

CASING DIAMETER: Not Applicable

SURFACE ELEVATION: 36.5 feet MSL

TOP OF CASING ELEVATION: Not Applicable

SOIL DESCRIPTION

SAND - as above, wet, (froth no longer present)

SAND - as above, no hydrocarbon odor, no sheen

SAND - as above, hydrocarbon odor and sheen from 25' to 27' bgs

SAND - as above, no hydrocarbon odor, no sheen

SILT - green to gray, moist, stiff, no hydrocarbon odor, no sheen

SILT - as above

Drilled to 32 feet bgs
 Sampled to 32 feet bgs

* Sample Number Prefix is 2708-950921-

HAHN & ASSOCIATES, INC.
 434 NW Sixth Avenue
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 (503) 796-0717

PROJECT:
 Northwest Natural Gas Co.
 Gasco Facility
 Portland, Oregon

PROJECT #: 2708

SOIL BORING NUMBER **B-13**

HAI LOGGER: Rob Ede

SAMPLING METHOD: 4" OD Core Barrel

DRILLING METHOD: 4 1/4-inch ID Hollow Stem Auger

EQUIPMENT TYPE: B-59 Mobile Drill

DRILLER: Brad James

DRILLING CONTRACTOR: Geo-Tech Explorations, Inc.

DRILL START	DRILL FINISH
Time: 12:10	Time: 13:00
Date: 10/6/95	Date: 10/6/95

ABANDONMENT DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHS (ppm)	CORE INTERVAL	SAMPLE RECOVERY	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	BORING DIAMETER: 8-inch	
										CASING DIAMETER: Not Applicable	
										SURFACE ELEVATION: 36.4 feet msl	
										TOP OF CASING ELEVATION: Not Applicable	
										SOIL DESCRIPTION	
3/4" Bentonite Chips							1				
							2				
							3		SP		
	B13-01	12:15		-			4			SAND - brown, moist, loose, poorly graded, medium grained, no hydrocarbon odor, no sheen	
				285.0			5				
							6				
							7				
							8		SP		
							9				
	B13-02	12:27		-			10			SAND - olive gray, moist to wet, saturated with hydrocarbon product, strong sheen throughout core	
				300.0			11				
	B13-03	12:33		-	29,378		12		ML	SAND - black, wet, loose, saturated with hydrocarbon product, wood fragments at sand/silt interface	
				368.0			13				
	B13-04	12:37		226.0	-		14			Sandy SILT - olive gray, moist, hydrocarbon odor, slight sheen, roots present, (11-11.5 feet bgs)	
	B13-05 Dup	12:39		203.0	-		15		SP	SAND - olive gray, moist, loose, poorly graded, medium grained, no hydrocarbon odor, no sheen	
							16				
	B13-06	12:44		552.0	-		17		ML	SILT - green with brown mottling, orange spots present throughout, stiff, black oily tar fingering through via root zones	
							18				
	B13-07	12:50			ND		19			SILT - as above, black tar fingers not present, no sheen	
				124.0			20				

HAHN & ASSOCIATES, INC.
 434 NW Sixth Avenue
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SOIL BORING NUMBER

B-13

PROJECT:
 Northwest Natural Gas Co.
 Gasco Facility
 Portland, Oregon
PROJECT #: 2708

HAI LOGGER: Rob Ede
SAMPLING METHOD: 4" OD Core Barrel
DRILLING METHOD: 4 1/4-inch ID Hollow Stem Auger
EQUIPMENT TYPE: B-59 Mobile Drill
DRILLER: Brad James
DRILLING CONTRACTOR: Geo-Tech Explorations, Inc.

DRILL START	DRILL FINISH
Time: 12:10	Time: 13:00
Date: 10/6/95	Date: 10/6/95

ABANDONMENT DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHS (ppm)	CORE INTERVAL	SAMPLE RECOVERY	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	BORING DIAMETER: 8-inch
										CASING DIAMETER: Not Applicable
										SURFACE ELEVATION: 36.4 feet msl
										TOP OF CASING ELEVATION: Not Applicable
SOIL DESCRIPTION										

3/4" Bentonite Chips							21	10/6/95	ML
							22		SP
	B13-08	12:55	124.0	-			23		ML
	B13-09 Dup	12:58	98.1	-			24		SP
	B13-10	13:00	112.0	ND			25		ML

SILT - brown, moist, stiff, slightly plastic, no hydrocarbon odor, no sheen

SAND - brown, wet, poorly graded, no hydrocarbon odor, no sheen

SILT - brown, moist, stiff, slightly plastic, no hydrocarbon odor, no sheen

SAND - brown, wet, loose, poorly graded, fine grained, ho hydrocarbon odor, no sheen

							26		
							27		
							28		
							29		
							30		
							31		
							32		
							33		
							34		
							35		
							36		
							37		
							38		
							39		
							40		

Drilled to 25 feet bgs
 Sampled to 24.5 feet bgs

* Sample Number Prefix is 2708-951006-

HAHN & ASSOCIATES, INC.

434 NW Sixth Avenue
Portland, Oregon
(503) 796-0717

SOIL BORING NUMBER

B-14

PROJECT:
Northwest Natural Gas Co.
Gasco Facility
Portland, Oregon
PROJECT #: 2708

HAI LOGGER:	Rob Ede	DRILL START	DRILL FINISH
SAMPLING METHOD:	3" OD Split Spoon/4" OD Core Barrel	Time:	Time:
DRILLING METHOD:	4 1/4-inch ID Hollow Stem Auger	8:25	9:30
EQUIPMENT TYPE	B-59 Mobile Drill	Date:	Date:
DRILLER:	Brad James	9/28/95	9/28/95
DRILLING CONTRACTOR:	Geo-Tech Explorations, Inc.		

ABANDONMENT DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHS (ppm)	SPT (blows/6 in) or Core Interval	RECOVERY or INTERVAL	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	BORING DIAMETER: 8-inch	
										CASING DIAMETER: Not Applicable	
										SURFACE ELEVATION: 36.1 feet msl	
										TOP OF CASING ELEVATION: Not Applicable	
										SOIL DESCRIPTION	
3/4" Bentonite Chips	B14-01	8:20	4.6	-						SM	Silty SAND with Gravel - brown, moist (surface sample)
							1				
							2				
	B14-02	8:30		-	11	100				SP	Silty SAND with Gravel - olive gray, moist, dense, hydrocarbon odor, sheen
				8.4	23	100		3			
					35	90		4			
					5	100		5			
	B14-03	8:35		ND	8	100				ML	Sandy SILT - brown, moist, stiff, slightly plastic, no hydrocarbon odor, no sheen
				3.0	13	95		6			
					6	100		7			
	B14-04	8:40		-	6	100				SP	SAND - olive gray, moist, loose, poorly graded, fine grained, no hydrocarbon odor, no sheen
				3.4	7	90		8			
								9			
								10			
	B14-05	9:00		-						SP	SAND - as above, (10-11 feet bgs)
				4.1				11			
								12		ML	SILT - brown, moist, stiff, slightly plastic, no hydrocarbon odor, no sheen, (11-12 feet bgs)
								13		SP	SAND - olive gray, moist, medium dense, poorly graded, fine grained, no hydrocarbon odor, no sheen, (12-13 feet bgs)
	B14-06	9:05		-						ML	SILT - brown, moist, very stiff, slightly plastic, no hydrocarbon odor, no sheen
				4.6				14			
							15		ML		
B14-07	9:20		-						SP	Sandy SILT - brown and tan mottled, moist, no hydrocarbon odor, no sheen, (piece of bark present)	
			3.7				16				
							17		SP	SAND with some Silt - brown, wet, medium dense, poorly graded, fine grained, no hydrocarbon odor, no sheen (16.5-17.5 feet bgs)	
B14-08	9:25		-						ML	SILT - brown, moist, stiff, no hydrocarbon odor, no sheen, (17.5-18 feet bgs)	
			4.8				18				
B14-09	9:30		-						SP	SAND - brown, wet, poorly graded, fine grained, no hydrocarbon odor, no sheen, (18-19 feet bgs)	
			4.9				19				
							20				

HAHN & ASSOCIATES, INC. 434 NW Sixth Avenue Portland, Oregon (503) 796-0717				SOIL BORING NUMBER B-14						
PROJECT: Northwest Natural Gas Co. Gasco Facility Portland, Oregon				HAI LOGGER: Rob Ede		DRILL START	DRILL FINISH			
PROJECT #: 2708				SAMPLING METHOD: 3" OD Split Spoon/4" OD Core Barrel		Time:	Time:			
				DRILLING METHOD: 4 1/4-inch ID Hollow Stem Auger		8:25	9:30			
				EQUIPMENT TYPE: B-59 Mobile Drill		Date:	Date:			
				DRILLER: Brad James		9/28/95	9/28/95			
				DRILLING CONTRACTOR: Geo-Tech Explorations, Inc.						
ABANDONMENT DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHS (ppm)	SPT (blows/6 in) or Core Interval	RECOVERY or INTERVAL	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	BORING DIAMETER: 8-inch
							21			CASING DIAMETER: Not Applicable
							22			SURFACE ELEVATION: 36.1 feet msl
							23			TOP OF CASING ELEVATION: Not Applicable
							24			SOIL DESCRIPTION
							25			Drilled to 20 feet bgs Sampled to 19 feet bgs * Sample Number Prefix is 2708-950928-
							26			
							27			
							28			
							29			
							30			
							31			
							32			
							33			
							34			
							35			
							36			
							37			
							38			
							39			
							40			

HAHN & ASSOCIATES, INC. 434 NW Sixth Avenue Portland, Oregon (503) 796-0717				SOIL BORING NUMBER B-15							
PROJECT: Northwest Natural Gas Co. Gasco Facility Portland, Oregon				HAI LOGGER: Rob Ede		DRILL START	DRILL FINISH				
PROJECT #: 2708				SAMPLING METHOD: 4" OD Core Barrel		Time:	Time:				
				DRILLING METHOD: 4 1/4-inch ID Hollow Stem Auger		13:45	15:05				
				EQUIPMENT TYPE: B-59 Mobile Drill		Date:	Date:				
				DRILLER: Brad James		10/6/95	10/6/95				
				DRILLING CONTRACTOR: Geo-Tech Explorations, Inc.							
ABANDONMENT DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHS (ppm)	CORE INTERVAL	SAMPLE RECOVERY	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	BORING DIAMETER: 8-inch	
										CASING DIAMETER: Not Applicable	
										SURFACE ELEVATION: 35.5 feet msl	
										TOP OF CASING ELEVATION: Not Applicable	
										SOIL DESCRIPTION	
3/4" Bentonite Chips							1		SP		
							2				
							3		SP		
							4			SAND - brown, moist, loose, poorly graded, medium grained, no hydrocarbon odor, no sheen, (2.5-5 feet bgs)	
	B15-01	13:57					5				
				97.0				6			Silty SAND with Gravel - olive gray, moist, hydrocarbon odor, sheen, (5-6 feet bgs - brick in end of sampler)
								7			(Switch to 1.5" OD Split Spoon sampling device)
							50/5"	60	8	SM	Silty SAND - olive gray, moist, hydrocarbon odor, sheen, (7.5-8 feet bgs - wood fragment in end of sampler)
								9			
								10			(Switch back to 4" OD Core Barrel sampling device)
	B15-02	14:17						11			
				21.1				12			SILT - green, moist, firm, no hydrocarbon odor, no sheen, rootlets throughout, (10-15 feet bgs)
								13			
	B15-03	14:20						14		ML	
				59.9				15			SILT - as above (15-15.5 feet bgs)
								16			
								17			Sandy SILT - green with black patches of hydrocarbon product, moist, hydrocarbon odor, sheen, (15.5-17.5 feet bgs)
	B15-04	14:25						18		ML	SILT - wet, soft, saturated with product (17.5-18.5 feet bgs)
				83.1				19			
								20			SILT - green, hydrocarbon odor, sheen, (18.5-20 feet bgs)

HAHN & ASSOCIATES, INC.
 434 NW Sixth Avenue
 Portland, Oregon
 (503) 796-0717

PROJECT:
 Northwest Natural Gas Co.
 Gasco Facility
 Portland, Oregon

SOIL BORING NUMBER B-15

HAI LOGGER:	Rob Ede	DRILL START	DRILL FINISH
SAMPLING METHOD:	4" OD Core Barrel	Time:	Time:
DRILLING METHOD:	4 1/4-inch ID Hollow Stem Auger	13:45	15:05
EQUIPMENT TYPE	B-59 Mobile Drill	Date:	Date:
DRILLER:	Brad James	10/6/95	10/6/95
PROJECT #:	2708	DRILLING CONTRACTOR: Geo-Tech Explorations, Inc.	

ABANDONMENT DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHS (ppm)	CORE INTERVAL	SAMPLE RECOVERY	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	BORING DIAMETER: 8-inch		
										CASING DIAMETER: Not Applicable		
										SURFACE ELEVATION: 35.5 feet msl		
										TOP OF CASING ELEVATION: Not Applicable		
										SOIL DESCRIPTION		
3/4" Bentonite Chips							21		ML	SILT - green, moist, firm, hydrocarbon odor, no sheen, (20-21 feet bgs)		
	B15-05	14:33		638			22		SM	Silty SAND - olive gray, wet, poorly graded, fine grained, hydrocarbon odor, sheen, (21-21.5 feet bgs)		
				97.6				23		ML	SILT - brown and olive mottled, fingers of black oily substance in rootlet zones, (21.5-25 feet bgs)	
								24				
	B15-06	14:38		-			25			SAND - olive gray, wet, loose, no hydrocarbon odor, no sheen, (25-27 feet bgs)		
								26		SM	Sandy SILT - olive gray, moist, stiff, hydrocarbon odor, no sheen, (27-27.5 feet bgs)	
				15.8				27		ML	SAND - olive gray, wet, loose, fine grained, no hydrocarbon odor, no sheen, (27.5-29 feet bgs)	
	B15-08	15:00		1.8				28		SP	SILT - brown, moist no hydrocarbon odor, no sheen, (29-29.5 feet bgs)	
				13.6				29			SAND - brown, wet, loose, fine grained, no hydrocarbon odor, no sheen, (29.5-30 feet bgs)	
	B15-09	15:04		-			30			ML SP		
			31.3				31					
							32					
							33			Drilled to 30 feet bgs Sampled to 30 feet bgs		
							34					
							35					
							36					
							37					
							38					
							39					
							40					

* Sample Number Prefix is 2708-951006-

HAHN & ASSOCIATES, INC.
 434 NW Sixth Avenue
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PROJECT:
 Northwest Natural Gas Co.
 Gasco Facility
 Portland, Oregon

PROJECT #: 2708

SOIL BORING NUMBER B-17

HAI LOGGER:	Rob Ede	DRILL START	DRILL FINISH
SAMPLING METHOD:	1.5" OD Split Spoon/4" OD Core Barrel	Time:	Time:
DRILLING METHOD:	4 1/4-inch ID Hollow Stem Auger	9:55	10:40
EQUIPMENT TYPE	B-59 Mobile Drill	Date:	Date:
DRILLER:	Brad James	9/29/95	9/29/95
DRILLING CONTRACTOR:	Geo-Tech Explorations, Inc.		

ABANDONMENT DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHS (ppm)	SPT (blows/6 in) or Core Interval	RECOVERY or INTERVAL	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	SOIL DESCRIPTION
							1			Surface - GRAVEL fill (surface)
							2		SM	
	B17-01	10:00		59	2	100	3			Silty SAND - brown, moist, no sheen
			421		2	90	4			
							5		ML	
							6			Sandy SILT - olive gray, moist, firm, no sheen
	B17-02	10:10		-			7			
			603				8			
							9			SAND - olive gray, moist, poorly graded, medium grained, no sheen
	B17-03	10:12		-			10			
			213				11		SP	
							12			SAND - olive gray, poorly graded, strong sheen, brown product and froth when water added to sample, some wood fragments
							13			
							14			
							15			
							16		SP	
	B17-05	10:30		1,814			17			SAND - as above, wet, saturated with brown, oily product
			1478				18			
							19			
							20			

Hahn & Associates, Inc.
 434 NW Sixth Avenue
 Portland, Oregon
 (503) 796-0717

SOIL BORING NUMBER B-17

PROJECT:
 Northwest Natural Gas Co.
 Gasco Facility
 Portland, Oregon
PROJECT #: 2708

HAI LOGGER:	Rob Ede	DRILL START	DRILL FINISH
SAMPLING METHOD:	1.5" OD Split Spoon/4" OD Core Barrel	Time:	Time:
DRILLING METHOD:	4 1/4-inch ID Hollow Stem Auger	9:55	10:40
EQUIPMENT TYPE	B-59 Mobile Drill	Date:	Date:
DRILLER:	Brad James	9/29/95	9/29/95
DRILLING CONTRACTOR:	Geo-Tech Explorations, Inc.		

ABANDONMENT DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHS (ppm)	SPT (blows/6 in) or Core Interval	RECOVERY or INTERVAL	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	BORING DIAMETER: 8-inch
										CASING DIAMETER: Not Applicable
										SURFACE ELEVATION: 36.9 feet msl
										TOP OF CASING ELEVATION: Not Applicable
SOIL DESCRIPTION										

3/4" Bentonite Chips							21		
	B17-06	10:35					22		
			145				23		
	B17-07	10:40		0.89			24		
			65.8				25		
							26		
							27		
							28		
							29		
							30		
						31			
						32			
						33			
						34			
						35			
						36			
						37			
						38			
						39			
						40			

SP

SAND - as above, wet, contains brown product, strong sheen, many roots at sand/silt interface

ML

SILT - olive gray, moist, very stiff, no hydrocarbon odor, no sheen, some brown root casts

Drilled to 25 feet bgs
 Sampled to 24 feet bgs

* Sample Number Prefix is 2708-950929-

Hahn & Associates, Inc.
 434 NW Sixth Avenue
 Portland, Oregon
 (503) 796-0717

SOIL BORING NUMBER B-18

PROJECT:
 Northwest Natural Gas Co.
 Gasco Facility
 Portland, Oregon
PROJECT #: 2708

HAI LOGGER:	Rob Ede	DRILL	DRILL
SAMPLING METHOD:	Split Spoon	START	FINISH
DRILLING METHOD:	4 1/4-inch ID Hollow Stem Auger	Time:	Time:
EQUIPMENT TYPE	B-59 Mobile Drill	10:05	11:45
DRILLER:	Brad James	Date:	Date:
DRILLING CONTRACTOR:	Geo-Tech Explorations, Inc.	9/19/95	9/19/95

ABANDONMENT DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHS (ppm)	SPT (blows/0.5 feet)	RECOVERY (%)	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	BORING DIAMETER:	8-inch
										CASING DIAMETER:	Not Applicable
										SURFACE ELEVATION:	36.4 feet MSL
										TOP OF CASING ELEVATION:	Not Applicable

ABANDONMENT DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHS (ppm)	SPT (blows/0.5 feet)	RECOVERY (%)	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	SOIL DESCRIPTION
3/4" Bentonite Chips							1			Sandy GRAVEL - dry, road fill (surface)
							2			
		B18-01	10:15	74	-	50/5"	80	3	ML	Sandy SILT - brown and olive gray, moist, hard, slightly plastic, slight sheen
								4		
		B18-02	10:20	1772	-	11	100	5		SILT - brown, gray mottling, moist, stiff, plastic, no sheen
						14	100	6		
						4	100	7		
		B18-03	10:30		-	7	100	8	SM	Silty SAND with Clay - brown, moist, loose, plastic, slight sheen
				2500		8	50	8		
								9		
		B18-04	10:35		-	4	100	10		Sandy SILT with some Clay - brown, moist, medium stiff, poorly graded, slightly plastic, slight sheen
				2500+		4	100	11	ML	
						2	100	12		Sandy SILT - as above
		B18-05	10:40		59.3	5	100	13		
				2500+		6	100	14		
						2	100	15		
		B18-06	10:50		-	2	100	16		SAND - brown, wet, very loose, poorly graded, fine grained, sheen observed on surface of core
				2500+		4	100	17		
						4	100	18	SP	
		B18-07	11:00		-	5	100	19		SAND - as above
			2500+		5	100	20			
					4	100				
	B18-08	11:05		-	6	100			SAND - olive gray, wet, loose, poorly graded, slight sheen on core	

ABANDONMENT DETAILS			SPT (blows/0.5 feet)	RECOVERY (%)	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	BORING DIAMETER: 8-inch	
SAMPLE NUMBER*	TIME	HEADSPACE (ppm)						LAB RESULTS TOTAL PAHS (ppm)	CASING DIAMETER: Not Applicable
HAI LOGGER: Rob Ede								DRILL START	DRILL FINISH
PROJECT: Northwest Natural Gas Co. Gasco Facility Portland, Oregon								Time: 10:05	Time: 11:45
PROJECT #: 2708								Date: 9/19/95	Date: 9/19/95
SAMPLING METHOD: Split Spoon								SOIL DESCRIPTION	
DRILLING METHOD: 4 1/4-inch ID Hollow Stem Auger								SAND - as above, no sheen	
EQUIPMENT TYPE: B-59 Mobile Drill								SAND - as above	
DRILLER: Brad James								SAND - as above	
DRILLING CONTRACTOR: Geo-Tech Explorations, Inc.								Drilled to 28 feet bgs Sampled to 28 feet bgs	
		224	7	100	21		SP		
			3	100	22				
	B18-09	11:10	-	8	100				
		2500+		12	100	23			
						24			
			7	100					
	B18-10	11:30	ND	17	100	25			
		14.4		14	100	26	SP		
						27			
			12	100					
	B18-11	11:40		21	100				
		24.0		16	100	28			
						29			
						30			
						31			
						32			
						33			
						34			
						35			
						36			
						37			
						38			
						39			
						40			

HAHN & ASSOCIATES, INC. 434 NW Sixth Avenue Portland, Oregon (503) 796-0717					SOIL BORING NUMBER B-19						
PROJECT: Northwest Natural Gas Co. Gasco Facility Portland, Oregon PROJECT #: 2708					HAI LOGGER: Rob Ede			DRILL START	DRILL FINISH		
					SAMPLING METHOD: 4" OD Core Barrel			Time: 13:30	Time: 9:30		
					DRILLING METHOD: 4 1/4-inch ID Hollow Stem Auger			Date: 9/19/95	Date: 9/20/95		
					EQUIPMENT TYPE: B-59 Mobile Drill						
					DRILLER: Brad James						
					DRILLING CONTRACTOR: Geo-Tech Explorations, Inc.						
ABANDONMENT DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHs (ppm)	CORE INTERVAL	SAMPLE RECOVERY	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	BORING DIAMETER: 8-inch	
3/4" Bentonite Chips	B19-01	13:10	34.0	933			1		ML	Sandy SILT - brown, dry, (surface - just below sod root zone)	
							2				
							3		SP		
						↑	↑	4			
	B19-02	13:40	382.0	-			5			SAND - black, moist, well graded, fine grained, grains appear to be coated with oily substance, sheen evident	
						↓	↓	6			
	B19-03	13:55	623.0	408			7		SP	SAND - as above	
							8				
							9				
						↓	↓	10		Installed a 2-inch diameter 0.010-inch slotted stainless steel well screen at 10 to 13 feet bgs. Purged zero gallons of water prior to groundwater sampling. GROUNDWATER SAMPLE (2708-950920-BW19-01) collected at 8:15 hrs, 9/20/95. Well point was removed and drilling was resumed.	
						↑	↑	11	9/20/95	ML	Clayey SILT - brown, dry, very stiff, slight sheen
								12			
	B19-04	14:10	2500+	-				13		SP	SAND - black, moist to wet, poorly graded, sheen
								14			
	B19-05	14:20	2500+	-				15			
						↑	↑	16			
	B19-06	14:30	2500+	-				17		ML	SILT - brown, dry, stiff, no sheen
								18			
	B19-07	8:50	2500+	80				19			Sandy SILT - olive gray, moist, poorly graded, fine grained, no sheen
						↓	↓	20			

HAHN & ASSOCIATES, INC.
 434 NW Sixth Avenue
 Portland, Oregon
 (503) 796-0717

PROJECT:
 Northwest Natural Gas Co.
 Gasco Facility
 Portland, Oregon

PROJECT #: 2708

SOIL BORING NUMBER B-19

HAI LOGGER:	Rob Ede	DRILL START	DRILL FINISH
SAMPLING METHOD:	4" OD Core Barrel	Time:	Time:
DRILLING METHOD:	4 1/4-inch ID Hollow Stem Auger	13:30	9:30
EQUIPMENT TYPE	B-59 Mobile Drill	Date:	Date:
DRILLER:	Brad James	9/19/95	9/20/95
DRILLING CONTRACTOR:	Geo-Tech Explorations, Inc.		

ABANDONMENT DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHs (ppm)	CORE INTERVAL	SAMPLE RECOVERY	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	BORING DIAMETER:	CASING DIAMETER:	SURFACE ELEVATION:	TOP OF CASING ELEVATION:	SOIL DESCRIPTION
3/4" Bentonite Chips							21		ML	8-inch	Not Applicable	35.4	Not Applicable	<p>Sandy SILT - as above, wet</p> <p>Installed a 2-inch diameter 0.010-inch slotted stainless steel well screen at 25 to 28 feet bgs. Purged eight gallons of water using a peristaltic pump prior to groundwater sampling. GROUNDWATER SAMPLE (2708-950920-BW19-02) collected at 12:05 hrs, 9/20/95. Well point was removed prior to abandonment.</p> <p>Silty SAND - brown, wet, poorly graded, fine grained, coarsening downward</p> <p>Drilled to 29 feet bgs Sampled to 29 feet bgs</p> <p>* Sample Number Prefix is 2708-950919- for samples B19-01 to B19-06. Sample Number Prefix is 2708-950920- for samples B19-07 and B19-08.</p>
							22							
								23						
								24						
								25						
								26	SP					
								27						
	B19-08	9:22	717.0	2.0				28						
								29						
								30						
							31							
							32							
							33							
							34							
							35							
							36							
							37							
							38							
							39							
							40							

HAHN & ASSOCIATES, INC.

434 NW Sixth Avenue

Portland, Oregon

(503) 796-0717

SOIL BORING NUMBER

B-20

HAI LOGGER:

Rob Ede

DRILL

DRILL

PROJECT:

SAMPLING METHOD:

1.5" OD Split Spoon/4" OD Core Barrel

START

FINISH

Northwest Natural Gas Co.

DRILLING METHOD:

4 1/4-inch ID Hollow Stem Auger

Time:

Time:

Gasco Facility

EQUIPMENT TYPE

B-59 Mobile Drill

14:00

15:00

Portland, Oregon

DRILLER:

Brad James

Date:

Date:

PROJECT #: 2708

DRILLING CONTRACTOR:

Geo-Tech Explorations, Inc.

9/29/95

9/29/95

ABANDONMENT DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHS (ppm)	SPT (blows/6 in) or Core Interval	RECOVERY or INTERVAL	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	BORING DIAMETER: 8-inch
										CASING DIAMETER: Not Applicable
										SURFACE ELEVATION: 35.4 feet msl
										TOP OF CASING ELEVATION: Not Applicable
										SOIL DESCRIPTION

3/4" Bentonite Chips	Asphalt								Asphalt	Asphalt (surface)
									SP	
						5	100			
	B20-01	14:05		-	5	100				SAND - brown, moist, loose, poorly graded, no sheen
			355		5	50				
	B20-02	14:10		-					SP	SAND - as above, large rock in sand at depth of 7.5 feet bgs
			1166							
	B20-03	14:15		1,093						SAND - olive gray, moist, poorly graded, medium grained, no sheen
			2500+							
	B20-04	14:20		-						SAND - gray, wet, poorly graded, saturated with hydrocarbon product, metallic sheen, (10-11 feet bgs)
			2500+							
B20-05	14:25		-					SP	SAND - brown, moist, poorly graded, fine grained, no product saturation, sheen is present, (11-13 feet bgs)	
		1270								

HAHN & ASSOCIATES, INC.
 434 NW Sixth Avenue
 Portland, Oregon
 (503) 796-0717

SOIL BORING NUMBER

B-20

PROJECT:
 Northwest Natural Gas Co.
 Gasco Facility
 Portland, Oregon

HAI LOGGER: Rob Ede
SAMPLING METHOD: 1.5" OD Split Spoon/4" OD Core Barrel
DRILLING METHOD: 4 1/4-inch ID Hollow Stem Auger
EQUIPMENT TYPE: B-59 Mobile Drill
DRILLER: Brad James
DRILLING CONTRACTOR: Geo-Tech Explorations, Inc.

DRILL START	DRILL FINISH
Time: 14:00	Time: 15:00
Date: 9/29/95	Date: 9/29/95

PROJECT #: 2708

ABANDONMENT DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHS (ppm)	SPT (blows/6 in) or Core Interval	RECOVERY or INTERVAL	DEPTH (feet)	GROUNDWATER	STRATA (USCS)
3/4" Bentonite Chips							21		SP
							22		
	B20-06	14:30		-			23		ML
	B20-07	14:35	2500+	13			24		
			1010				25		
							26		
							27		
							28		
							29		
							30		
							31		
							32		
							33		
							34		
							35		
							36		
							37		
							38		
							39		
							40		

BORING DIAMETER: 8-inch
CASING DIAMETER: Not Applicable
SURFACE ELEVATION: 35.4 feet msl
TOP OF CASING ELEVATION: Not Applicable

SOIL DESCRIPTION

SAND - brown to metallic gray, wet, strong sheen

SILT - brown, very stiff, brown pockets of organic material

Drilled to 25 feet bgs
 Sampled to 24 feet bgs

* Sample Number Prefix is 2708-950929-

HAHN & ASSOCIATES, INC. 434 NW Sixth Avenue Portland, Oregon (503) 796-0717				SOIL BORING NUMBER B-21									
PROJECT: Northwest Natural Gas Co. Gasco Facility Portland, Oregon				HAI LOGGER: Rob Ede		DRILL START	DRILL FINISH						
PROJECT #: 2708				SAMPLING METHOD: 4" OD Core Barrel		Time:	Time:						
				DRILLING METHOD: 4 1/4-inch ID Hollow Stem Auger		8:50	9:40						
				EQUIPMENT TYPE B-59 Mobile Drill		Date:	Date:						
				DRILLER: Brad James		10/3/95	10/3/95						
				DRILLING CONTRACTOR: Geo-Tech Explorations, Inc.									
ABANDONMENT DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHS (ppm)	CORE INTERVAL	SAMPLE RECOVERY	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	BORING DIAMETER: 8-inch	CASING DIAMETER: Not Applicable	SURFACE ELEVATION: 38.0	TOP OF CASING ELEVATION: Not Applicable
										SOIL DESCRIPTION			
							1						
							2						
	B21-01	9:00		-			3		ML	SILT - brown and green mottled, slightly moist, stiff, roots present, slight sheen			
			3.4				4						
							5						
	B21-02	9:05		-			6			SILT - as above, moist			
			2.3				7						
							8						
	B21-03	9:10		-			9		SP	Silty SAND - brown, moist to wet, medium dense, poorly graded, fine grained, no sheen			
			1.7				10						
							11		ML	Sandy SILT - brown with olive gray mottling, moist, firm, slight sheen			
	B21-04	9:15		-			12						
			34.2				13		SP	SAND - brown, wet, loose, poorly graded, fine grained, no sheen			
	B21-05	9:20		-			14						
			23.2				15		SM	Silty SAND - brown, moist, medium dense, fine grained, no sheen			
							16						
	B21-06	9:30		-			17			SAND - brown, wet, loose, poorly graded, fine grained, no sheen			
			1.5				18						
	B21-07	9:35		-			19		SP	Installed a 2-inch diameter 0.010-inch slotted stainless steel well screen from 15.5 to 19.5 feet bgs. Purged five gallons of water using a peristaltic pump prior to groundwater sampling. GROUNDWATER SAMPLE (2708-951003-BW21-01) collected at 10:48 hrs, 10/3/95. Well point was removed prior to abandonment.			
			1.5				20						

HAHN & ASSOCIATES, INC. 434 NW Sixth Avenue Portland, Oregon (503) 796-0717						SOIL BORING NUMBER B-21					
PROJECT: Northwest Natural Gas Co. Gasco Facility Portland, Oregon PROJECT #: 2708						HAI LOGGER: Rob Ede			DRILL	DRILL	
						SAMPLING METHOD: 4" OD Core Barrel			START	FINISH	
						DRILLING METHOD: 4 1/4-inch ID Hollow Stem Auger			Time:	Time:	
						EQUIPMENT TYPE B-59 Mobile Drill			8:50	9:40	
						DRILLER: Brad James			Date:	Date:	
						DRILLING CONTRACTOR: Geo-Tech Explorations, Inc.			10/3/95	10/3/95	
ABANDONMENT DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHS (ppm)	CORE INTERVAL	SAMPLE RECOVERY	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	BORING DIAMETER: 8-inch	
										CASING DIAMETER: Not Applicable	
										SURFACE ELEVATION: 38.0	
										TOP OF CASING ELEVATION: Not Applicable	
										SOIL DESCRIPTION	
										Drilled to 30 feet bgs Sampled to 29.5 feet bgs * Sample Number Prefix is 2708-951003-	
										21	
										22	
										23	
										24	
										25	
										26	
										27	
										28	
										29	
										30	
										31	
										32	
										33	
										34	
										35	
										36	
										37	
										38	
										39	
										40	

HAHN & ASSOCIATES, INC. 434 NW Sixth Avenue Portland, Oregon (503) 796-0717				SOIL BORING NUMBER B-22						
PROJECT: Northwest Natural Gas Co. Gasco Facility Portland, Oregon				HAI LOGGER: Rob Ede		DRILL START	DRILL FINISH			
PROJECT #: 2708				SAMPLING METHOD: 4" OD Core Barrel		Time: 12:00	Time: 13:00			
				DRILLING METHOD: 4 1/4-inch ID Hollow Stem Auger		Date: 10/3/95	Date: 10/3/95			
				EQUIPMENT TYPE B-59 Mobile Drill						
				DRILLER: Brad James						
				DRILLING CONTRACTOR: Geo-Tech Explorations, Inc.						
ABANDONMENT DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHS (ppm)	CORE INTERVAL	SAMPLE RECOVERY	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	BORING DIAMETER: 8-inch
										CASING DIAMETER: Not Applicable
										SURFACE ELEVATION: 37.1 feet msl
										TOP OF CASING ELEVATION: Not Applicable
										SOIL DESCRIPTION
							1			
							2			
	B22-01	12:05		-	↑	↑	3		ML	SILT with Sand and Gravel - moist to wet, oily substance present, strong sheen, metal wire present
			81.8		↓	↓	4			
					↓	↓	5			
	B22-02	12:12		-	↑	↑	6			
			212.0				7			SILT - green with brown mottling, stiff, strong sheen
							8			
	B23-03	12:15		-	↑	↑	9		ML	
			253.0		↓	↓	10			
					↓	↓	11			
	B22-04	12:25		-	↑	↑	12			Sandy SILT - brown, moist, stiff, strong sheen
			18.6				13			
							14			
	B22-05	12:30		40	↑	↑	15			Sandy SILT - olive gray to green, moist to wet, stiff, strong sheen
			18.4		↓	↓	16			
					↓	↓	17			
	B22-06	12:35		-	↑	↑	18		ML	SILT - olive gray, moist, stiff, strong sheen, black oily product throughout core)
			15.8				19			
							20			
	B22-07	12:40		-	↑	↑				
			4.8		↓	↓				

HAHN & ASSOCIATES, INC. 434 NW Sixth Avenue Portland, Oregon (503) 796-0717					SOIL BORING NUMBER B-22				
PROJECT: Northwest Natural Gas Co. Gasco Facility Portland, Oregon PROJECT #: 2708					HAI LOGGER: Rob Ede			DRILL	DRILL
					SAMPLING METHOD: 4" OD Core Barrel			START	FINISH
					DRILLING METHOD: 4 1/4-inch ID Hollow Stem Auger			Time:	Time:
					EQUIPMENT TYPE: B-59 Mobile Drill			12:00	13:00
					DRILLER: Brad James			Date:	Date:
					DRILLING CONTRACTOR: Geo-Tech Explorations, Inc.			10/3/95	10/3/95
ABANDONMENT DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHS (ppm)	CORE INTERVAL	SAMPLE RECOVERY	DEPTH (feet)	GROUNDWATER	STRATA (USCS)
3/4" Bentonite Chips	B22-08	12:45		-			21		ML
			53.2				22		SP
							23		
							24		
	B22-09	12:50		485			25		
				16.0			26		ML
							27		
	B22-10	12:55		-			28		
				8.7			29		SP
							30		
		B22-11	1:00		-			31	
			8.4				32		
							33		
							34		
							35		
							36		
							37		
							38		
							39		
							40		

BORING DIAMETER: 8-inch
CASING DIAMETER: Not Applicable
SURFACE ELEVATION: 37.1 feet msl
TOP OF CASING ELEVATION: Not Applicable

SOIL DESCRIPTION

SILT - as above, moist to wet, pockets of brown product within core

SAND - olive gray, wet, fine grained, black product at 24-25 feet bgs, (see photo 14)

Sandy SILT - brown, moist, stiff, no sheen

SAND - brown, wet, loose, poorly graded, fine grained, muscovite present, no sheen

Drilled to 30 feet bgs
Sampled to 29.5 feet bgs

* Sample Number Prefix is 2708-951003-

HAHN & ASSOCIATES, INC.
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PROJECT:
 Northwest Natural Gas Co.
 Gasco Facility
 Portland, Oregon
PROJECT #: 2708

SOIL BORING NUMBER B-23

HAI LOGGER: Rob Ede

SAMPLING METHOD: 4" OD Core Barrel

DRILLING METHOD: 4 1/4-inch ID Hollow Stem Auger

EQUIPMENT TYPE: B-59 Mobile Drill

DRILLER: Brad James

DRILLING CONTRACTOR: Geo-Tech Explorations, Inc.

DRILL START	DRILL FINISH
Time: 14:17	Time: 15:40
Date: 10/3/95	Date: 10/3/95

ABANDONMENT DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHs (ppm)	CORE INTERVAL	SAMPLE RECOVERY	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	BORING DIAMETER: 8-inch
										CASING DIAMETER: Not Applicable
										SURFACE ELEVATION: 35.1 feet msl
										TOP OF CASING ELEVATION: Not Applicable

ABANDONMENT DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHs (ppm)	CORE INTERVAL	SAMPLE RECOVERY	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	SOIL DESCRIPTION
Asphalt							1		Asphalt	
							2			
							3		Concrete	Concrete
							4			
							5			
	B23-01	14:38					6			
			190.0	-			7		SP	SAND - brown, moist, loose, poorly graded, medium grained, slight sheen
							8			
							9			
							10			
	B23-02	14:47	2500+	-			11			
							12			
	B23-03	14:50	1439	-			13		ML	Sandy SILT - green with brown mottling, moist to wet, stiff, lower 6 inches of core is saturated with product, strong sheen
							14			
							15			
							16			
	B23-04	14:57					17			
			9.7				18			
							19			
	B23-05	15:00					20		ML	Sandy SILT - green with brown mottling, stiff, roots present, saturated with product 15-17 feet bgs, strong sheen
			589.0							

HAHN & ASSOCIATES, INC.
 434 NW Sixth Avenue
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SOIL BORING NUMBER B-23

PROJECT:
 Northwest Natural Gas Co.
 Gasco Facility
 Portland, Oregon
PROJECT #: 2708

HAI LOGGER:	Rob Ede	DRILL START	DRILL FINISH
SAMPLING METHOD:	4" OD Core Barrel	Time:	Time:
DRILLING METHOD:	4 1/4-inch ID Hollow Stem Auger	14:17	15:40
EQUIPMENT TYPE	B-59 Mobile Drill	Date:	Date:
DRILLER:	Brad James	10/3/95	10/3/95
DRILLING CONTRACTOR:	Geo-Tech Explorations, Inc.		

ABANDONMENT DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHs (ppm)	CORE INTERVAL	SAMPLE RECOVERY	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	BORING DIAMETER: 8-inch
			2500+				21			CASING DIAMETER: Not Applicable
							22		ML	SURFACE ELEVATION: 35.1 feet msl
							23			TOP OF CASING ELEVATION: Not Applicable
							24			
	B23-07	15:10	682.0	-			25			
							26			
							27		SP	
	B23-08	15:20		77			28			SOIL DESCRIPTION
			2500+				29		ML	SILT - brown with orange spots, moist, very stiff, sheen
							30			
	B23-09	15:25		-			31			
			822.0				32			
							33			
	B23-10	15:30		-			34		SP	SAND with some Silt - wet, fine grained, brown oily product present, sheen
							35			
							36			
							37			
							38			
							39			
							40			

3/4" Bentonite Chips

SAND with some Silt - wet, fine grained, brown oily product present, sheen

Sandy SILT - brown, moist, stiff, strong sheen

SAND - olive gray, wet, loose, fine grained, no sheen

SILT - brown, moist, stiff, no sheen

Drilled to 35 feet bgs
 Sampled to 35 feet bgs

* Sample Number Prefix is 2708-951003-

HAHN & ASSOCIATES, INC.

434 NW Sixth Avenue

Portland, Oregon

(503) 796-0717

SOIL BORING NUMBER

B-24

PROJECT:

Northwest Natural Gas Co.

Gasco Facility

Portland, Oregon

PROJECT #: 2708

HAI LOGGER:

Rob Ede

SAMPLING METHOD:

4" OD Core Barrel

DRILLING METHOD:

4 1/4-inch ID Hollow Stem Auger

EQUIPMENT TYPE

B-59 Mobile Drill

DRILLER:

Brad James

DRILLING CONTRACTOR:

Geo-Tech Explorations, Inc.

DRILL

START

Time:

9:15

Date:

10/2/95

DRILL

FINISH

Time:

10:15

Date:

10/2/95

ABANDONMENT DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHs (ppm)	CORE INTERVAL	SAMPLE RECOVERY	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	BORING DIAMETER:	CASING DIAMETER:	SURFACE ELEVATION:	TOP OF CASING ELEVATION:	SOIL DESCRIPTION
3/4" Bentonite Chips							1		Concrete	8-inch	Not Applicable	34.5 feet msl	Not Applicable	Sidewalk at surface.
							2							
								3	SP					Lampblack - black, dry, hydrophobic, no sheen (2.5-3.0 feet bgs)
	B24-01	9:23	211.0	-	7	100	4							SAND - brown, dry, loose, poorly graded, medium grained, no sheen, (3-4 feet bgs)
								5						
	B24-02	9:30					6							
			40.0				7							SAND - as above, some pebbles, moist, no sheen, (5-10 feet bgs)
							8							
							9		SP					
							10							
	B24-03	9:40			1,092		11							SAND - olive gray, moist, loose, black droplets of tar-like substance at base of sand, wood chips present (10-11.5 feet bgs)
				1406			12							
	B24-04	9:45			-		13							Sandy SILT - olive gray, moist, slightly plastic, slight sheen, (11.5-15 feet bgs)
				71.1			14							
							15							
							16			ML				
	B24-05	9:50			-		17							Sandy SILT - olive gray to green, moist, stiff, strong sheen, (15-20 feet bgs)
				636.0			18							
							19							
	B24-06	9:53			-		20							
			796											

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PROJECT:
 Northwest Natural Gas Co.
 Gasco Facility
 Portland, Oregon

PROJECT #: 2708

SOIL BORING NUMBER B-24

HAI LOGGER: Rob Ede

SAMPLING METHOD: 4" OD Core Barrel

DRILLING METHOD: 4 1/4-inch ID Hollow Stem Auger

EQUIPMENT TYPE: B-59 Mobile Drill

DRILLER: Brad James

DRILLING CONTRACTOR: Geo-Tech Explorations, Inc.

DRILL START	DRILL FINISH
Time: 9:15	Time: 10:15
Date: 10/2/95	Date: 10/2/95

ABANDONMENT DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHs (ppm)	CORE INTERVAL	SAMPLE RECOVERY	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	BORING DIAMETER: 8-inch
										CASING DIAMETER: Not Applicable
										SURFACE ELEVATION: 34.5 feet msl
										TOP OF CASING ELEVATION: Not Applicable
SOIL DESCRIPTION										

3/4" Bentonite Chips										ML	Sandy SILT - brown with green mottles, moist, sheen on core - smeared from above, (20-22 feet bgs)
	B24-07	10:00					21				
				390				22		SP	SAND - brown, wet, loose, poorly graded, fine grained, no sheen (22-23 feet bgs)
								23			
	B24-08	10:03					24		ML	Sandy SILT - brown with green mottles, moist, no sheen (23-24 feet bgs)	
				907				25			
								26			
	B24-09	10:05					27		SP	SAND - brown, wet, loose, poorly graded, no sheen (24-30 feet bgs), 2 inch Silt zone at 27 feet bgs	
				1654				28			
								29			
	B24-10	10:10	834	0.14			30			Drilled to 30 feet bgs Sampled to 29.5 feet bgs	
							31				
							32				
							33				
							34				
							35				
							36				
							37				
							38				
							39				
							40				

* Sample Number Prefix is 2708-951002-

HAHN & ASSOCIATES, INC. 434 NW Sixth Avenue Portland, Oregon (503) 796-0717				SOIL BORING NUMBER B-25						
PROJECT: Northwest Natural Gas Co. Gasco Facility Portland, Oregon				HAI LOGGER: Rob Ede			DRILL START	DRILL FINISH		
PROJECT #: 2708				SAMPLING METHOD: 4" OD Core Barrel			Time:	Time:		
				DRILLING METHOD: 4 1/4-inch ID Hollow Stem Auger			12:05	12:45		
				EQUIPMENT TYPE: B-59 Mobile Drill			Date:	Date:		
				DRILLER: Brad James			10/2/95	10/2/95		
				DRILLING CONTRACTOR: Geo-Tech Explorations, Inc.						
ABANDONMENT DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHs (ppm)	CORE INTERVAL	SAMPLE RECOVERY	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	BORING DIAMETER: 8-inch
	B25-05	12:40	191	0.45	↑	↑	21		ML	CASING DIAMETER: Not Applicable
							22			SURFACE ELEVATION: 35.0 feet msl
							23			TOP OF CASING ELEVATION: Not Applicable
	B25-06	12:43	24.4	-	↓	↓	24		ML	SOIL DESCRIPTION
							25			Sandy SILT - olive gray, wet, slightly stiff, slightly plastic, no sheen, (20-22 feet bgs)
							26			
							27			
							28			
							29			
							30			Drilled to 25 feet bgs Sampled to 24 feet bgs
							31			
							32			
							33			* Sample Number Prefix is 2708-951002-
							34			
							35			
							36			
							37			
							38			
							39			
							40			

HAHN & ASSOCIATES, INC.

434 NW Sixth Avenue
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SOIL BORING NUMBER

B-26

PROJECT:
 Northwest Natural Gas Co.
 Gasco Facility
 Portland, Oregon

PROJECT #: 2708

HAI LOGGER:	Rob Ede	DRILL START	DRILL FINISH
SAMPLING METHOD:	4" OD Core Barrel	Time:	Time:
DRILLING METHOD:	4 1/4-inch ID Hollow Stem Auger	8:20	10:20
EQUIPMENT TYPE	B-59 Mobile Drill	Date:	Date:
DRILLER:	Brad James	10/4/95	10/4/95
DRILLING CONTRACTOR:	Geo-Tech Explorations, Inc.		

ABANDONMENT DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHs (ppm)	CORE INTERVAL	SAMPLE RECOVERY	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	BORING DIAMETER: 8-inch		
										CASING DIAMETER: Not Applicable		
										SURFACE ELEVATION: 34.9 feet MSL		
										TOP OF CASING ELEVATION: Not Applicable		
										SOIL DESCRIPTION		
3/4" Bentonite Chips	B26-01	8:15	753	9.3			1		SM	Silty SAND with Gravel - brown, moist, no hydrocarbon odor		
							2					
							3		SP	Lampblack - black, hydrophobic, slight sheen, slight hydrocarbon odor		
	B26-02	8:30	1191	-			4					
							5					
							6	33	10		Brick in end of sampler, also pieces of hardened tar	
							7	34	0			
							8	19	0			
	B26-03	8:45					9			SP	SAND - olive gray, moist, loose, medium grained, strong hydrocarbon odor, sheen	
				771			10					
							11					
	B26-04	8:55					12				SAND - olive gray, moist, loose, medium grained, strong sheen, brown froth via sheen test, hydrocarbon odor	
				997			13					
							14					
							15					
							16					
	B26-05	9:08					17			SP	SAND - olive gray, wet, loose, poorly graded, medium grained, saturated with product, strong sheen on sampler	
				1611			18					
							19					
							20					

HAHN & ASSOCIATES, INC.
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 Portland, Oregon
 (503) 796-0717

PROJECT:
 Northwest Natural Gas Co.
 Gasco Facility
 Portland, Oregon

PROJECT #: 2708

SOIL BORING NUMBER B-26

HAI LOGGER: Rob Ede

SAMPLING METHOD: 4" OD Core Barrel

DRILLING METHOD: 4 1/4-inch ID Hollow Stem Auger

EQUIPMENT TYPE: B-59 Mobile Drill

DRILLER: Brad James

DRILLING CONTRACTOR: Geo-Tech Explorations, Inc.

DRILL START: 8:20
DRILL FINISH: 10:20

Date: 10/4/95

BORING DIAMETER: 8-inch

CASING DIAMETER: Not Applicable

SURFACE ELEVATION: 34.9 feet MSL

TOP OF CASING ELEVATION: Not Applicable

ABANDONMENT DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHs (ppm)	CORE INTERVAL	SAMPLE RECOVERY	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	SOIL DESCRIPTION
3/4" Bentonite Chips	B26-06	9:15		15,530	↑	↑	21		SP	SAND - olive gray, wet, loose, poorly graded, medium grained, strong sheen, much brown product, (20-23 feet bgs)
			2500+				22			
							23			
	B26-07	9:18		-		↓	24			SILT - brown with dark gray mottling, moist, contains wood fragments, (23-24 feet bgs)
			2500+				25			
	B26-08	9:30		-		↑	26		ML	SILT - brown, moist, stiff, strong sheen on sampler, root zones present, black, oily product appears to be migrating through root zones
			959				27			
							28			
	B26-09	9:45		-		↓	29			
				2500+			30			
	B26-10	10:05		-		↑	31			Sandy SILT - olive gray to green, medium stiff, large amount of black staining appears to be migrating through root zones
			2500+				32		ML	
							33			
	B26-11	10:10		-		↓	34			
			2500+				35			
						↑	36			
	B26-12	10:15		-		↓	37			Sandy SILT - olive gray to green, medium stiff, sheen from 35-37 feet bgs, no sheen from 37-40 feet bgs
			2500+				38		ML	
							39			
	B26-13	10:20			1.1	↓	40			
			771							

Hahn & Associates, Inc.
 434 NW Sixth Avenue
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 (503) 796-0717

SOIL BORING NUMBER

B-27

PROJECT:
 Northwest Natural Gas Co.
 Gasco Facility
 Portland, Oregon
PROJECT #: 2708

HAI LOGGER: Rob Ede
SAMPLING METHOD: Split Spoon
DRILLING METHOD: 4 1/4-inch ID Hollow Stem Auger
EQUIPMENT TYPE: B-59 Mobile Drill
DRILLER: Brad James
DRILLING CONTRACTOR: Geo-Tech Explorations, Inc.

DRILL START	DRILL FINISH
Time: 12:40	Time: 13:30
Date: 9/20/95	Date: 9/20/95

ABANDONMENT DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHs (ppm)	SPT (blows/0.5 feet)	RECOVERY (%)	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	BORING DIAMETER: 8-inch	
										CASING DIAMETER: Not Applicable	
										SURFACE ELEVATION: 37.0 feet msl	
										TOP OF CASING ELEVATION: Not Applicable	
										SOIL DESCRIPTION	
3/4" Bentonite Chips	B27-01	12:15		-			1		GP	Sandy GRAVEL - brown, dry, fill (surface)	
							2				
	B27-02	12:50		-	13	100	3		SM	Silty SAND - brown, dry, dense, pieces of coal? present, no petroleum odor, no sheen	
				7.6	17	0	4				
					18	0	5				
	B27-03	12:55		-	16	100	6		SP	SAND - brown, dry, medium dense, poorly graded, fine grained, some coal in upper 6 inches, no sheen, black colored hydrophobic particulates float via sheen test (lampblack?)	
				6.5	20	50	7				
					10	100	8				
	B27-04	13:00		-	10	100	9			SAND - black, moist, medium dense, poorly graded, fine grained, strong petroleum hydrocarbon odor, sheen via sheen test	
				21.5	12	50	10				
					4	100	11				
	B27-05	13:03		-	8	70	12		SP	SAND - as above, loose, strong petroleum hydrocarbon odor, sheen via sheen test	
					8	0	13				
					6	100	14				
	B27-06	13:05		-	10	100	15			SAND - as above, strong petroleum hydrocarbon odor, sheen via sheen test	
				36.4	13	50	16				
					4	100	17				
	B27-07	13:10		-	6	100	18		SP	SAND - olive gray to black, wet, loose, petroleum hydrocarbon odor, slight sheen via sheen test	
				13.2	8	60	19				
					2	100	20				
B27-08	13:15		-	4	100				SAND - as above, slight petroleum hydrocarbon odor, no sheen via sheen test		
			35.2	7	100						

HAHN & ASSOCIATES, INC.

434 NW Sixth Avenue
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SOIL BORING NUMBER

B-27

PROJECT:
Northwest Natural Gas Co.
Gasco Facility
Portland, Oregon

HAI LOGGER:	Rob Ede	DRILL START	DRILL FINISH
SAMPLING METHOD:	Split Spoon	Time:	Time:
DRILLING METHOD:	4 1/4-inch ID Hollow Stem Auger	12:40	13:30
EQUIPMENT TYPE:	B-59 Mobile Drill	Date:	Date:
DRILLER:	Brad James	9/20/95	9/20/95
PROJECT #:	2708	DRILLING CONTRACTOR: Geo-Tech Explorations, Inc.	

ABANDONMENT DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHs (ppm)	SPT (blows/0.5 feet)	RECOVERY (%)	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	BORING DIAMETER: 8-inch
										CASING DIAMETER: Not Applicable
										SURFACE ELEVATION: 37.0 feet msl
										TOP OF CASING ELEVATION: Not Applicable

SOIL DESCRIPTION

3/4" Bentonite Chips	B27-09	13:30		-	11	100	21		SP	SAND - black, wet, dense, sheen on core, sheen via sheen test
			2031		24	100	22			
					16	100	23			
	B27-10	13:40		1,243	2	100	24		ML	SAND - black, wet, loose, saturated with oily substance, (22.5-23.5 feet bgs)
			2500+		3	100	25			SILT - brown, wet, medium stiff, plastic, sheen via sheen test, (23.5-24 feet bgs)
					3	100	26		SP	SAND with some Silt - black, wet, loose, sheen on sampler, (25-25.5 feet bgs)
	B27-11	13:45		-	2	100	27			SILT with some Clay - brown, wet, soft, plastic, sheen via sheen test, (25.5-26.5 feet bgs)
			392		2	50	28		ML	
					4	100	29			Clayey SILT - brown, moist, medium stiff, plastic, no sheen via sheen test
	B27-12	13:55		125	5	100	30			
			120		5	70	31			Clayey SILT - as above, slight sheen via sheen test, (outside of core smeared with petroleum product from shallower depths)
					3	100	32			
	B27-13	14:05		-	3	100	33		ML	Clayey SILT - olive gray, moist, soft, sheen via sheen test, (outside of core smeared with petroleum product from shallower depths)
			861		5	100	34			
					3	100	35			
	B27-14	14:15		-	4	100	36			SILT - olive gray, moist, soft, no petroleum hydrocarbon odor, no sheen via sheen test
		714		5	10	37				
				3	100	38				
B27-15	14:40		12.2	3	80	39				
		254		3	0	40				

Drilled to 36.5 feet bgs
Sampled to 36.5 feet bgs
* Sample Number Prefix is 2708-950920-

HAHN & ASSOCIATES, INC.
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SOIL BORING NUMBER

B-28

PROJECT:
 Northwest Natural Gas Co.
 Gasco Facility
 Portland, Oregon
PROJECT #: 2708

HAI LOGGER:	Rob Ede	DRILL START	DRILL FINISH
SAMPLING METHOD:	4" OD Core Barrel	Time:	Time:
DRILLING METHOD:	4 1/4-inch ID Hollow Stem Auger	14:00	15:00
EQUIPMENT TYPE	B-59 Mobile Drill	Date:	Date:
DRILLER:	Brad James	10/2/95	10/2/95
DRILLING CONTRACTOR:	Geo-Tech Explorations, Inc.		

ABANDONMENT DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHs (ppm)	CORE INTERVAL	SAMPLE RECOVERY	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	BORING DIAMETER:	CASING DIAMETER:	SURFACE ELEVATION:	TOP OF CASING ELEVATION:	SOIL DESCRIPTION	
3/4" Bentonite Chips	B28-01	13:45	614	87			1			8-inch	Not Applicable	34.4 feet msl	Not Applicable	Silty SAND with Gravel - brown, moist, fine grained, non plastic, no hydrocarbon odor, no sheen via sheen test (surface)	
	B28-02	13:47	105	135			2								
								3		SP				SAND with some Gravel and Lampblack - (black, very solid/hard pieces that are hydrophobic), slight hydrocarbon odor, no sheen via sheen test, (2.5-5 feet bgs)	
	B28-03	14:10	95.4	-			4								
							5								
							6								
								7		GM					GRAVEL with Lampblack - black, dry, lampblack is hydrophobic, no hydrocarbon odor, no sheen via sheen test, (5-10 feet bgs)
	B28-04	14:15	111	-			8								
								9							
								10							
								11							GRAVEL with Lampblack - sticky, tar-like pieces present, hard, with sheen on surface, strong hydrocarbon odor (10-12 feet bgs)
	B28-05	14:20	36.2	-			12								
								13							
								14							
								15		SP					SAND - olive gray, moist, loose, poorly graded, strong hydrocarbon odor, sheen via sheen test, (12-15 feet bgs)
	B28-06	14:25	71.4	-			16								
								17		SM					SAND with some SILT - olive gray, wet, saturated with product, metallic sheen, (15-15.5 feet bgs) Sandy SILT - brown, moist, no sheen, (15.5-16 feet bgs)
							18			ML					
								19							SAND - olive gray, wet, loose, poorly graded, medium grained, no sheen via sheen test, (16-20 feet bgs)
							20			SP					
	B28-07	14:30	372	612											
	B28-08	14:35	53.7	-											

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PROJECT:
 Northwest Natural Gas Co.
 Gasco Facility
 Portland, Oregon

PROJECT #: 2708

SOIL BORING NUMBER B-28

HAI LOGGER:	Rob Ede	DRILL START	DRILL FINISH
SAMPLING METHOD:	4" OD Core Barrel	Time:	Time:
DRILLING METHOD:	4 1/4-inch ID Hollow Stem Auger	14:00	15:00
EQUIPMENT TYPE	B-59 Mobile Drill	Date:	Date:
DRILLER:	Brad James	10/2/95	10/2/95
DRILLING CONTRACTOR:	Geo-Tech Explorations, Inc.		

ABANDONMENT DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHs (ppm)	CORE INTERVAL	SAMPLE RECOVERY	DEPTH (feet)	GROUNDWATER	STRATA (USCS)
3/4" Bentonite Chips	B28-09	14:45		-			21		ML
			236				22		
	B28-10	14:50		-			23		
			462				24		
	B28-11	14:53	261	2.3			25		
							26		
							27		
							28		
							29		
							30		
							31		
							32		
							33		
							34		
							35		
							36		
							37		
							38		
							39		
							40		

BORING DIAMETER: 8-inch

CASING DIAMETER: Not Applicable

SURFACE ELEVATION: 34.4 feet msl

TOP OF CASING ELEVATION: Not Applicable

SOIL DESCRIPTION

Sandy SILT - olive gray with brown, metallic luster, saturated with product, strong sheen via sheen test (20-22 feet bgs)

Sandy SILT - as above, brown with brown/orange blebs, no sheen via sheen test, (22-23.5 feet bgs)

Sandy SILT - as above, olive gray, wet (23.5-25 feet bgs)

Drilled to 25 feet bgs
 Sampled to 24.5 feet bgs

* Sample Number Prefix is 2708-951002-

HAHN & ASSOCIATES, INC. 434 NW Sixth Avenue Portland, Oregon (503) 796-0717					SOIL BORING NUMBER B-29									
PROJECT: Northwest Natural Gas Co. Gasco Facility Portland, Oregon PROJECT #: 2708					HAI LOGGER: Roger Brown			DRILL START Time: 14:15 Date: 9/22/95	DRILL FINISH Time: 9:30 Date: 9/25/95					
SAMPLING METHOD: Split Spoon					DRILLING METHOD: 4 1/4-inch ID Hollow Stem Auger			EQUIPMENT TYPE B-59 Mobile Drill						
DRILLER: Brad James					DRILLING CONTRACTOR: Geo-Tech Explorations, Inc.									
ABANDONMENT DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHs (ppm)	SPT (blows/0.5 feet)	RECOVERY (%)	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	BORING DIAMETER: 8-inch	CASING DIAMETER: Not Applicable	SURFACE ELEVATION: 31.1 feet msl	TOP OF CASING ELEVATION: Not Applicable	
3/4" Bentonite Chips	B29-01	14:08	-	230	-	-	1			Silty GRAVEL - brown, dry, fill, no sheen via sheen test (surface)				
							2							
						27	100	3						
	B29-02	14:18			27	100	4		GM	Sandy Silty GRAVEL - gray/brown, damp, dense, non-plastic, well graded, no hydrocarbon odor, no sheen via sheen test				
						32	0	5						
	B29-03	14:22			6	100	6			Sandy Silty GRAVEL - as above, no hydrocarbon odor, no sheen via sheen test				
						9	0	7						
						5	0	8						
	B29-04	14:26			11	100	9		GW	Sandy GRAVEL with Silt - dark gray, moist to wet, medium dense, non-plastic, well graded, possible petroleum hydrocarbon odor, no sheen via sheen test				
						5	60	10						
						11	0	11						
	B29-05	14:30			3	100	12		GM	Silty Sandy GRAVEL - brown, wet, dense, slightly plastic, well graded, no petroleum hydrocarbon odor, no sheen via sheen test				
						13	20	13						
						20	0	14						
	B29-06	14:35			11	100	15				Silty Sandy GRAVEL - as above, slight naphthalene odor, turning to dark gray at 13.2 feet, no sheen via sheen test			
						14	20	16						
						30	0	17						
	B29-07	15:05			5	100	18							
						8	100	19		ML	SILT with some Sand and Gravel - brown, moist, stiff, slightly plastic, possible petroleum hydrocarbon odor, no sheen via sheen test			
						12	100	20						
B29-08	15:11			6	100					SILT with some Sand and Gravel - as above, more Gravel, brown with slight odor to 18.25 feet bgs, dark gray with distinct odor to 19 feet bgs with wood fragments and occasional tar globs, no sheen via sheen test				
					12	100								
					15	100								

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PROJECT:
 Northwest Natural Gas Co.
 Gasco Facility
 Portland, Oregon

PROJECT #: 2708

SOIL BORING NUMBER

B-29

HAI LOGGER:	Roger Brown	DRILL	DRILL
SAMPLING METHOD:	Split Spoon	START	FINISH
DRILLING METHOD:	4 1/4-inch ID Hollow Stem Auger	Time:	Time:
EQUIPMENT TYPE	B-59 Mobile Drill	14:15	9:30
DRILLER:	Brad James	Date:	Date:
DRILLING CONTRACTOR:	Geo-Tech Explorations, Inc.	9/22/95	9/25/95

ABANDONMENT DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHs (ppm)	SPT (blows/0.5 feet)	RECOVERY (%)	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	BORING DIAMETER: 8-inch		
										CASING DIAMETER: Not Applicable		
										SURFACE ELEVATION: 31.1 feet msl		
										TOP OF CASING ELEVATION: Not Applicable		
										SOIL DESCRIPTION		
3/4" Bentonite Chips	B29-09	15:17			12	100	21		ML	Gravelly SILT - gray/brown with gray mottling, moist, very stiff, slightly plastic, slight petroleum hydrocarbon odor, no sheen via sheen test, tip of core is black		
					13	100	22		ML + tar	Gravelly SILT - black, moist, strong hydrocarbon odor, sheen via sheen test, tarry globs (22.5-22.75 feet bgs)		
	B29-10A				-	100	23		SP	SILT - gray with red-brown mottling, non-plastic, slight hydrocarbon odor (22.75-23 feet bgs)		
	B29-10	15:23			-	100	24		SP	SAND - dark gray, moist to wet, poorly graded (23-24 feet bgs)		
					3	100	25		tar	SILT and SAND - as above, tarry (25-25.25 feet bgs)		
	B29-11	15:30			9	100	26		ML	SILT - gray, as above (25.25-26.25 feet bgs)		
					12	100	27		tar	SILT and SAND - black, tarry, hydrocarbon odor, sheen via sheen test (26.25-27 feet bgs)		
	B29-12	15:40			3	100	28		ML	SILT - olive-gray with red-brown mottling, medium stiff, organic matter or root zones with brown product in them, petroleum hydrocarbon odor, sheen via sheen test, brown product present (27.5-29 feet bgs)		
					5	100	29					
					6	100	30					
	B29-13	15:50			3	100	31			SM	Silty SAND with occasional Silt zones - olive-gray, loose, non-plastic, rootlets present, strong hydrocarbon odor, brown product via sheen test (30-31.5 feet bgs)	
					2	100	32					
					5	100	33					
	B29-14	16:00			9	100	34			SAND - black, wet, medium dense, poorly graded, entire core covered with brown product (32.5-34 feet bgs)		
					7	100	35			SP		
					9	100	36					
	B29-15	16:08			4	100	37			SAND - as above, product saturated throughout core (35-36.5 feet bgs)		
					58,822	9	100	38		Drilling resumes at 8:40, 9/25/95		
					12	100	39					
	B29-16	9:00					40			SAND - black, wet, saturated with product to 39 feet bgs, less staining from 39-40 feet bgs, some brown bedding or zones of oxidation, sheen throughout (36.5-40 feet bgs)		

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PROJECT:
 Northwest Natural Gas Co.
 Gasco Facility
 Portland, Oregon

PROJECT #: 2708

SOIL BORING NUMBER B-29

HAI LOGGER: Roger Brown

SAMPLING METHOD: Split Spoon

DRILLING METHOD: 4 1/4-inch ID Hollow Stem Auger

EQUIPMENT TYPE: B-59 Mobile Drill

DRILLER: Brad James

DRILLING CONTRACTOR: Geo-Tech Explorations, Inc.

DRILL START	DRILL FINISH
Time: 14:15	Time: 9:30
Date: 9/22/95	Date: 9/25/95

ABANDONMENT DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHs (ppm)	SPT (blows/0.5 feet)	RECOVERY (%)	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	BORING DIAMETER: 8-inch
										CASING DIAMETER: Not Applicable
										SURFACE ELEVATION: 31.1 feet msl
										TOP OF CASING ELEVATION: Not Applicable
SOIL DESCRIPTION										

3/4" Bentonite Chisps							41		SP	SAND - olive-gray, wet, sheen via sheen test, strong sheen on drill stem (40-44 feet bgs)		
							42					
							43					
	B29-17	9:10		16.5			44					
			69.0				45				SP	SAND with some Silt - gray, moist, no sheen via sheen test, no sheen on drill stem (44-45 feet bgs)
							46					
	B29-18	9:25		0.18			47					
			28.1				48					
							49					
							50					
						51						
						52						
						53						
						54						
						55						
						56						
						57						
						58						
						59						
						60						

Drilled to 50 feet bgs
 Sampled to 48 feet bgs
 * Sample Number Prefix is 2708-950922-

HAHN & ASSOCIATES, INC.
 434 NW Sixth Avenue
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SOIL BORING NUMBER B-30

PROJECT:
 Northwest Natural Gas Co.
 Gasco Facility
 Portland, Oregon
PROJECT #: 2708

HAI LOGGER: Hans Feige	DRILL START	DRILL FINISH
SAMPLING METHOD: 4" OD Core Barrel	Time: 10:15	Time: 12:40
DRILLING METHOD: 4 1/4-inch ID Hollow Stem Auger	Date: 9/22/95	Date: 9/22/95
EQUIPMENT TYPE: B-59 Mobile Drill		
DRILLER: Brad James		
DRILLING CONTRACTOR: Geo-Tech Explorations, Inc.		

ABANDONMENT DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TPH-G/418.1 M (ppm)	CORE INTERVAL	SAMPLE RECOVERY	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	BORING DIAMETER: 6-inch
										CASING DIAMETER: Not Applicable
										SURFACE ELEVATION: 33.9 feet msl
										TOP OF CASING ELEVATION: Not Applicable
SOIL DESCRIPTION										

3/4" Bentonite Chips							1				
							2				
							3		GM		
							4				
							5				
		B30-04	10:20	345	-			6			Silty GRAVEL with Sand - black, moist, some wet zones, plastic, hydrocarbon odor, sheen via sheen test
								7			
								8		GM	
								9			Silty GRAVEL with Sand - as above, hydrocarbon odor, sheen via sheen test
		B30-05	10:25	28.4	-			10			
								11			Silty GRAVEL with Sand - black, wet, plastic, slight sheen
		B30-06	10:35	52.4	6,776			12			
								13			
		B30-07	10:45	9.0	-			14			Silty GRAVEL with Sand - brown, wet, plastic, no sheen via sheen test
								15			
								16		GM	
								17			Silty GRAVEL with Sand - brown, wet, stiff, plastic, hydrocarbon odor
		B30-08	10:55	17.6	-			18			
								19			Silty GRAVEL with Sand - as above, hydrocarbon odor
		B30-09	11:20	24.2	-			20			

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SOIL BORING NUMBER

B-30

PROJECT:
 Northwest Natural Gas Co.
 Gasco Facility
 Portland, Oregon
PROJECT #: 2708

HAI LOGGER:	Hans Feige	DRILL	DRILL
SAMPLING METHOD:	4" OD Core Barrel	START	FINISH
DRILLING METHOD:	4 1/4-inch ID Hollow Stem Auger	Time:	Time:
EQUIPMENT TYPE	B-59 Mobile Drill	10:15	12:40
DRILLER:	Brad James	Date:	Date:
DRILLING CONTRACTOR:	Geo-Tech Explorations, Inc.	9/22/95	9/22/95

ABANDONMENT DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TPH-G/418.1 M (ppm)	CORE INTERVAL	SAMPLE RECOVERY	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	BORING DIAMETER:	6-inch
3/4" Bentonite Chips	B30-10	11:30	35.1	-	21		21		GM	Silty GRAVEL with Sand - as above, hydrocarbon odor, no sheen via sheen test	
					22		22				
					23		23		SP	SAND - gray/black, wet, dense, non-plastic, sheen via sheen test	
	B30-11	11:40	337	-	24		24			SILT - gray, wet, stiff, plactic, hydrocarbon odor	
					25		25		ML		
					26		26			SILT - gray, wet, stiff, slight plastic odor	
					27		27				
					28		28				
	B30-12	11:50	202	853	29		29		ML	Sandy SILT - as above, strong sheen via sheen test	
					30		30				
					31		31				
					32		32				
					33		33		SM	Silty SAND - brown, wet, dense, slightly plastic, hydrocarbon odor, no sheen via sheen test	
	B30-13	12:20	184	-	34		34				
				35		35					
				36		36				Boring terminated at 35 feet bgs Sample to 34 feet bgs	
				37		37					
				38		38				* Sample Number Prefix is 2708-950922-	
				39		39					
				40		40					

Hahn & Associates, Inc.

434 NW Sixth Avenue

Portland, Oregon

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SOIL BORING NUMBER

B-30-A

PROJECT:

Northwest Natural Gas Co.

Gasco Facility

Portland, Oregon

PROJECT #: 2708

HAI LOGGER:

Hans Feige

SAMPLING METHOD:

4" OD Core Barrel

DRILLING METHOD:

4 1/4-inch ID Hollow Stem Auger

EQUIPMENT TYPE

B-59 Mobile Drill

DRILLER:

Brad James

DRILLING CONTRACTOR:

Geo-Tech Explorations, Inc.

DRILL START

Time: 9:00

Date: 9/22/95

DRILL FINISH

Time: 9:40

Date: 9/22/95

ABANDONMENT DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHS (ppm)	CORE INTERVAL	SAMPLE RECOVERY	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	BORING DIAMETER:	6-inch
										CASING DIAMETER:	Not Applicable
										SURFACE ELEVATION:	33.9 feet msl
										TOP OF CASING ELEVATION:	Not Applicable
SOIL DESCRIPTION											
	B30-01	8:55	20.6	965			1			Surface sample	
							2		ML		
							3				
							4			Sandy SILT - black, moist, tarry, hydrocarbon odor	
	B30-02	9:20	304	-			5				
							6				
							7			Fill material, low recovery in sampler	
							8				
							9				
	B30-03	9:30	155	-			10		GP		
							11				
							12			Fill material - as above, little gravels, moist to wet, tarry, hydrocarbon odor	
							13				
							14				
							15				
							16			Boring terminated at 15 feet bgs due to lack of recovery in sample barrels.	
							17				
							18				
							19				
							20				

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 (503) 796-0717

PROJECT:
 Northwest Natural Gas Co.
 Gasco Facility
 Portland, Oregon
PROJECT #: 2708

SOIL BORING NUMBER B-31

HAI LOGGER: Rob Ede
SAMPLING METHOD: 4" OD Core Barrel
DRILLING METHOD: 4 1/4-inch ID Hollow Stem Auger
EQUIPMENT TYPE: B-59 Mobile Drill
DRILLER: Brad James
DRILLING CONTRACTOR: Geo-Tech Explorations, Inc.

DRILL START	DRILL FINISH
Time: 14:20	Time: 15:45
Date: 9/25/95	Date: 9/25/95

ABANDONMENT DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHS (ppm)	CORE INTERVAL	SAMPLE RECOVERY	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	BORING DIAMETER:	CASING DIAMETER:	SURFACE ELEVATION:	TOP OF CASING ELEVATION:	SOIL DESCRIPTION	
3/4" Bentonite Chips	B31-01	13:50		38			1		GM	8-inch	Not Applicable	25.4 feet msl	Not Applicable	Silty SAND and GRAVEL - brown, dry, well graded, no hydrocarbon odor (surface sample)	
							2								
								3							
	B31-02	14:30		-			4							SILT with Gravel - brownish-yellow, moist, slightly plastic, no hydrocarbon odor, no sheen via sheen test (2-5 feet bgs)	
				57.5				5							
								6		ML					
	B31-03	14:35		-			7							SILT with Gravel - as above, no hydrocarbon odor, no sheen via sheen test (5-10 feet bgs)	
				41.2				8							
								9							
								10							
	B31-04	14:50		-				11						Sandy GRAVEL with Silt - gray, moist	
				117				12							
								13							
								14		GM					
								15							
								16							
								17							
								18							SAND with Gravel - olive-gray, moist to wet (17-18 feet bgs)
	B31-05	15:10		-				19		SP					Black, hard material (lampblack), coal-like, with slight petroleum hydrocarbon odor and slight sheen at 18-19.5 feet bgs
				135				20							

HAHN & ASSOCIATES, INC.

434 NW Sixth Avenue

Portland, Oregon

(503) 796-0717

SOIL BORING NUMBER

B-31

PROJECT:

Northwest Natural Gas Co.

Gasco Facility

Portland, Oregon

PROJECT #: 2708

HAI LOGGER:

Rob Ede

SAMPLING METHOD:

4" OD Core Barrel

DRILLING METHOD:

4 1/4-inch ID Hollow Stem Auger

EQUIPMENT TYPE

B-59 Mobile Drill

DRILLER:

Brad James

DRILLING CONTRACTOR:

Geo-Tech Explorations, Inc.

DRILL

START

Time:

14:20

Date:

9/25/95

DRILL

FINISH

Time:

15:45

Date:

9/25/95

ABANDONMENT DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHS (ppm)	CORE INTERVAL	SAMPLE RECOVERY	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	BORING DIAMETER:	CASING DIAMETER:	SURFACE ELEVATION:	TOP OF CASING ELEVATION:	SOIL DESCRIPTION
3/4" Bentonite Chips	B31-06	15:20		12,666			21	9/25/9	SP	8-inch	Not Applicable	25.4 feet msl	Not Applicable	SAND - black, moist, tarry, poorly graded, hydrophobic, sheen via sheen test (20-21 feet bgs)
			697.0				22		ML	Sandy SILT - brown, moist, stiff, plastic, some organic matter, no hydrocarbon odor, no sheen via sheen test (21-24 feet bgs)				
	B31-07	15:25					23							
				175			24							
	B31-08	15:30		5.5			25			SAND with some Silt - olive-gray, poorly graded, no hydrocarbon odor, no sheen via sheen test (24-25 feet bgs)				
				207			26		SP	SAND - brown, wet, poorly graded, fine grained, slight hydrocarbon odor (25-28 feet bgs)				
	B31-09	15:35		61.1			27							
	B31-10	15:40		ND			28							
	B31-11	15:45		59.2	ND		29		ML	Clayey SILT with some Sand - olive-gray, slightly plastic, no hydrocarbon odor, no sheen via sheen test (28-28.25 feet bgs)				
							30		SP	SAND - olive-gray, wet, poorly graded, fine to medium grained, no hydrocarbon odor, no sheen via sheen test (28.25-30 feet bgs)				
							31				Installed a 2-inch diameter 0.010-inch slotted stainless steel well screen from 26 to 29 feet bgs. Purged twenty five gallons of water using a peristaltic pump prior to groundwater sampling. GROUNDWATER SAMPLE (2708-950925-BW31-01) collected at 17:20 hrs, 9/25/95. Well point was removed prior to abandonment.			
						32								
						33								
						34								
						35								
						36								
						37								
						38								
						39								
						40								

Boring terminated at 30 feet bgs
Sample to 29 feet bgs

* Sample Number Prefix is 2708-950925-

HAHN & ASSOCIATES, INC.
 434 NW Sixth Avenue
 Portland, Oregon
 (503) 796-0717

PROJECT:
 Northwest Natural Gas Co.
 Gasco Facility
 Portland, Oregon

PROJECT #: 2708

SOIL BORING NUMBER		B-32	
HAI LOGGER:		Rob Ede	
SAMPLING METHOD:		Core Barrel	
DRILLING METHOD:		4 1/4-inch ID Hollow Stem Auger	
EQUIPMENT TYPE:		B-59 Mobile Drill	
DRILLER:		Brad James	
DRILLING CONTRACTOR:		Geo-Tech Explorations, Inc.	
DRILL START	DRILL FINISH	Date:	Date:
		11:50	15:40
		10/4/95	10/4/95

ABANDONMENT DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHs (ppm)	SPT (blows/0.5 feet)	RECOVERY (%)	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	BORING DIAMETER:	CASING DIAMETER:	SURFACE ELEVATION:	TOP OF CASING ELEVATION:	SOIL DESCRIPTION						
3/4" Bentonite Chips	B32-01	11:45	1067	61			1		GM	8-inch	Not Applicable	36.9 feet msl	Not Applicable	Silty SAND with Gravel - brown, moist, no hydrocarbon odor, no sheen via sheen test (surface)						
							2													
						17	0	3												
						18	0	4												
						15	0	5												
						7	0	6	ML					Sandy SILT and GRAVEL - black, moist, slightly plastic, hydrocarbon odor, sheen via shen test (5-6.5 feet bgs)						
						8	0	7												
						4	10	8												
	B32-02	12:08		296				9	SM										Silty SAND with Gravel - olive-gray to black, moist, hydrocarbon odor (6.5-10 feet bgs)	
								10												
								11												
		B32-03	12:15	785	28,772			12	GP										Sandy GRAVEL - brown, wet, no sheen via sheen test (10-11.5 feet bgs)	
		B32-04	12:18	-				13												
								14												
								15												
								16												
		B32-05	12:25					17	GP					SAND and GRAVEL with some Silt - black, matrix is tar material, highly viscous, strong sheen via sheen test (11.5-15 feet bgs)						
								18												
				809				19												
								20												

HAHN & ASSOCIATES, INC.

434 NW Sixth Avenue
 Portland, Oregon
 (503) 796-0717

SOIL BORING NUMBER

B-32

PROJECT:
 Northwest Natural Gas Co.
 Gasco Facility
 Portland, Oregon

HAI LOGGER: Rob Ede
SAMPLING METHOD: Core Barrel
DRILLING METHOD: 4 1/4-inch ID Hollow Stem Auger
EQUIPMENT TYPE: B-59 Mobile Drill
DRILLER: Brad James
DRILLING CONTRACTOR: Geo-Tech Explorations, Inc.

DRILL START	DRILL FINISH
Time: 11:50	Time: 15:40
Date: 10/4/95	Date: 10/4/95

PROJECT #: 2708

ABANDONMENT DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHs (ppm)	SPT (blows/0.5 feet)	RECOVERY (%)	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	BORING DIAMETER: 8-inch
										CASING DIAMETER: Not Applicable
										SURFACE ELEVATION: 36.9 feet msl
										TOP OF CASING ELEVATION: Not Applicable

SOIL DESCRIPTION

3/4" Bentonite Chips							21		ML + tar	SILT and TAR - black, moist, plastic, smooth texture, highly viscous (20-25 feet bgs) Sandy SILT - black, wet, poorly graded, matrix is tar material, highly viscous, roots present (25-26 feet bgs) Sandy SILT - olive-gray, moist, tar seams present - preferential in areas of roots, cracks (26-30 feet bgs) Sandy SILT - olive-gray to green, moist, firm, slightly plastic, pockets of brown product - lighter in color and less viscous than above, brown froth via sheen test (30-35 feet bgs) SAND - black, wet, poorly graded, fine grained, saturated with product, sheen via sheen test (35-37.5 feet bgs) Sandy SILT - brown with orange pockets, saturated with oily, black product (35-37.5 feet bgs)
	B32-06	12:32	1072	-			22		ML + tar	
	B32-07	12:34	-	-			23		ML + tar	
							24		ML + tar	
							25		ML + tar	
							26		ML + tar	
							27		ML + tar	
							28		ML	
	B32-08	12:46		-			29		ML	
				1321			30		ML	
							31		ML	
	B32-09	13:15		-			32		ML	
				1219			33		ML	
						34		ML		
B32-10	13:20		-			35		ML		
			1355			36		ML		
						37		ML		
B32-11	13:29		-			38		SP		
			499			39		ML		
B32-12	13:33		-			40		ML		
			745.0					ML		
B32-13	13:36	1041	-					ML		

HAHN & ASSOCIATES, INC. 434 NW Sixth Avenue Portland, Oregon (503) 796-0717				SOIL BORING NUMBER B-32						
PROJECT: Northwest Natural Gas Co. Gasco Facility Portland, Oregon				HAI LOGGER: Rob Ede		DRILL START	DRILL FINISH			
PROJECT #: 2708				SAMPLING METHOD: Core Barrel		Time: 11:50	Time: 15:40			
				DRILLING METHOD: 4 1/4-inch ID Hollow Stem Auger		Date: 10/4/95	Date: 10/4/95			
				EQUIPMENT TYPE: B-59 Mobile Drill						
				DRILLER: Brad James						
				DRILLING CONTRACTOR: Geo-Tech Explorations, Inc.						
ABANDONMENT DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHs (ppm)	SPT (blows/0.5 feet)	RECOVERY (%)	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	BORING DIAMETER: 8-inch
										CASING DIAMETER: Not Applicable
										SURFACE ELEVATION: 36.9 feet msl
										TOP OF CASING ELEVATION: Not Applicable
										SOIL DESCRIPTION
3/4 Bentonite Chips							41		SM	Silty SAND - olive-gray, wet, firm, fine grained, strong sheen via sheen test (40-42.5 feet bgs)
							42			
							43		SP	SAND - olive-gray, wet, poorly graded, fine grained, saturated with oily product (42.5-43 feet bgs)
	B32-14	13:45		-			44		ML	Sandy SILT - olive-gray, wet, wood fragments present, saturated with oily product (43-44.5 feet bgs)
				287			45			
							46			
	B32-15	14:26	1230	21,961			47		SP	
							48			SAND - olive-gray, wet, poorly graded, fine grained, saturated with oily product (44.5-50.5 feet bgs)
							49			
							50			
	B32-16	14:47		-			51			SAND with lenses of Silt - as above, saturated with oily product (50.5-52.5 feet bgs)
				562			52		SP	
							53			SAND - olive-gray, wet, poorly graded, fine grained, saturated with oily product (52.5-54 feet bgs)
							54			
							55		SM	Silty SAND - olive-gray, moist, sheen via sheen test (54-55 feet bgs)
							56		SP	SAND - olive-gray, wet, saturated with product (55-56 feet bgs)
	B32-17	15:04		-			57		SM	Silty SAND - olive-gray, moist, no sheen via sheen test (56-57.5 feet bgs)
				461			58			
						59		SP	SAND - olive-gray, wet, loose, poorly graded, fine grained, slight sheen on core (57.5-59 feet bgs)	
	B32-18	15:29	954	1.2			60			

* Sample Number Prefix is 2708-951004-

HAHN & ASSOCIATES, INC.

434 NW Sixth Avenue
Portland, Oregon
(503) 796-0717

SOIL BORING NUMBER

B-33

PROJECT:
Northwest Natural Gas Co.
Gasco Facility
Portland, Oregon

PROJECT #: 2708

HAI LOGGER: Rob Ede
SAMPLING METHOD: Core Barrel
DRILLING METHOD: 4 1/4-inch ID Hollow Stem Auger
EQUIPMENT TYPE: B-59 Mobile Drill
DRILLER: Brad James
DRILLING CONTRACTOR: Geo-Tech Explorations, Inc.

DRILL START	DRILL FINISH
Time: 13:50	Time: 9:10
Date: 10/5/95	Date: 10/6/96

ABANDONMENT DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS Total PAHs (ppm)	SPT (blows/0.5 feet)	RECOVERY (%)	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	BORING DIAMETER:	CASING DIAMETER:	SURFACE ELEVATION:	TOP OF CASING ELEVATION:	SOIL DESCRIPTION
							21			8-inch	Not Applicable	34.8 feet msl	Not Applicable	
	B33-07	14:50	701	-			22		tar					TAR - some gravel and wood fragments at 21.5 feet bgs
							23							
							24							
							25							
	B33-08	15:00	2500+	-			26		SM					Silty SAND - black, moist, many rootlets and wood fragments, tar in matrix, strong sheen (25-27 feet bgs)
							27							
							28							
	B33-09	15:03	1475	-			29		ML					Sandy SILT - brown with green mottling, moist, stiff, rootlets and cracks contain wet, viscous tar (27-30 feet bgs)
							30							
							31							Sandy SILT - brown with orange oxidation spots, moist, tar seams present - preferential in areas of rootlets and cracks
							32							
	B33-10	15:34	1383	-			33							
							34							
							35							
							36		ML					Sandy SILT - green, moist, stiff, black tarry patches throughout core, tarry sand seam at 38.5 feet bgs
							37							
							38							
	B33-11	15:45	2500+	-			39							
							40							

HAHN & ASSOCIATES, INC.
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 (503) 796-0717

PROJECT:
 Northwest Natural Gas Co.
 Gasco Facility
 Portland, Oregon

PROJECT #: 2708

SOIL BORING NUMBER

B-33

HAI LOGGER:	Rob Ede	DRILL	DRILL
SAMPLING METHOD:	Core Barrel	START	FINISH
DRILLING METHOD:	4 1/4-inch ID Hollow Stem Auger	Time:	Time:
EQUIPMENT TYPE	B-59 Mobile Drill	13:50	9:10
DRILLER:	Brad James	Date:	Date:
DRILLING CONTRACTOR:	Geo-Tech Explorations, Inc.	10/5/95	10/6/96

ABANDONMENT DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS Total PAHs (ppm)	SPT (blows/0.5 feet)	RECOVERY (%)	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	SOIL DESCRIPTION
							41		ML	Sandy SILT - as above, moist, fingers of tar throughout core (40 - 43 feet bgs)
							42			
							43			
							44			SAND - olive gray and green mottled, moist, medium dense, fine grained, strong sheen (43 - 45 feet bgs)
	B33-12	15:55					45			
			819.0				46		SP	SAND with some Silt- olive gray, moist, medium dense, fingers of tar throughout core, sheen
							47			
							48			
							49			
	B33-13	16:05					50			
			692				51		SM	Silty SAND - olive gray, moist, medium dense, fine grained, fingers of tar throughout core, sheen
							52			
							53			
							54			
	B33-14	16:25		65			55			
			793				56			Sandy SILT - olive gray, moist, thin fine grained sand lenses, roots at 57 feet bgs, less product than above
							57		ML	
							58			
	B33-15	8:27					59			
			2500+				60			

HAHN & ASSOCIATES, INC.

434 NW Sixth Avenue

Portland, Oregon

(503) 796-0717

SOIL BORING NUMBER

B-33

HAI LOGGER: Rob Ede		DRILL START	DRILL FINISH
SAMPLING METHOD: Core Barrel		Time: 13:50	Time: 9:10
DRILLING METHOD: 4 1/4-inch ID Hollow Stem Auger		Date: 10/5/95	Date: 10/6/96
EQUIPMENT TYPE: B-59 Mobile Drill			
DRILLER: Brad James			
DRILLING CONTRACTOR: Geo-Tech Explorations, Inc.			

PROJECT:
Northwest Natural Gas Co.
Gasco Facility
Portland, Oregon
PROJECT #: 2708

ABANDONMENT DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS Total PAHs (ppm)	SPT (blows/0.5 feet)	RECOVERY (%)	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	BORING DIAMETER: 8-inch	CASING DIAMETER: Not Applicable	SURFACE ELEVATION: 34.8 feet msl	TOP OF CASING ELEVATION: Not Applicable	SOIL DESCRIPTION
[Hatched Area]							61		ML	Sandy SILT - as above, black oily product within rootlet zones (60-62 feet bgs)				
							62							
	B33-16	8:40		-			63		SP	SAND - olive gray to black, wet, saturated with black, oily product (62 - 63 feet bgs)				
				2500+			64		ML	Sandy SILT - green, moist, stiff, many rootlets present, product within rootlet zones (63 - 65 feet bgs)				
							65							
							66		SM	Silty SAND - olive gray and green mottled, wet, fine grained, saturated with brown/black product, sand lens at 67 feet bgs is saturated with product (65 - 67 feet bgs)				
	B33-17	8:55		-			67							
				407			68							
							69		ML	SILT - olive gray, moist, stiff, bark and rootlets present, no product, no sheen (67 - 70 feet bgs)				
	B33-18	9:00		5.7			70							
			133											
							71		Drilled to 70 feet bgs Sampled to 70 feet bgs * Sample Number Prefix is 2708-951005-					
							72							
							73							
							74							
							75							
							76							
							77							
							78							
							79							
							80							

Hahn & Associates, Inc.
 434 NW Sixth Avenue
 Portland, Oregon
 (503) 796-0717

SOIL BORING NUMBER B-34

PROJECT:
 Northwest Natural Gas Co.
 Gasco Facility
 Portland, Oregon
PROJECT #: 2708

HAI LOGGER:	Rob Ede	DRILL START	DRILL FINISH
SAMPLING METHOD:	4" OD Core Barrel	Time:	Time:
DRILLING METHOD:	10 1/4-inch ID Hollow Stem Auger	9:45	13:15
EQUIPMENT TYPE	B-59 Mobile Drill	Date:	Date:
DRILLER:	Brad James	9/26/95	9/26/95
DRILLING CONTRACTOR:	Geo-Tech Explorations, Inc.		

ABANDONMENT DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHs (ppm)	CORE INTERVAL	SAMPLE RECOVERY	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	BORING DIAMETER: 12-inch	
										CASING DIAMETER: Not Applicable	
										SURFACE ELEVATION: 34.9 feet msl	
										TOP OF CASING ELEVATION: Not Applicable	
										SOIL DESCRIPTION	
3/4" Bentonite Chips	B34-01	8:45	-	94	↑				SM	Silty SAND with Gravel - brown, moist, no hydrocarbon odor (surface)	
	B34-02 (dup)	8:50	-				1				
								2			
								3	GM	No Recovery-Gravels and Cobbles (0 to 5 feet bgs)	
								4			
								5			
	B34-03	10:00	-	-	↓	↓		6		Silty Sandy GRAVEL with Cobbles, olive grey, moist, wood fragmernts, sheen	
								7			
								8		Silty Sandy GRAVEL with Cobbles, as above, brown, sheen, cobble fragment in end of sampler	
	B34-04	10:20		-	↑	↑		9	GP + tar	Tarry Sandy GRAVEL - black, hard, sheen, large brick or slag at 9 feet bgs	
				1344				10			
								11		Tarry Sandy GRAVEL - black, less hard than above, tar oozing from sand, large brick at 12.5 feet bgs	
	B34-05	10:30			13,499	↓		12			
				2,500+				13			
								14			
								15			
								16		Tarry Sandy with GRAVEL - black, moist, tar content less than above, aluminum strips from 17 to 17.5 feet bgs.	
	B34-06	10:45			-	↓		17			
				260				18	GP + tar		
								19			
							20				

Hahn & Associates, Inc.
 434 NW Sixth Avenue
 Portland, Oregon
 (503) 796-0717

SOIL BORING NUMBER B-34

PROJECT:
 Northwest Natural Gas Co.
 Gasco Facility
 Portland, Oregon
PROJECT #: 2708

HAI LOGGER:	Rob Ede	DRILL	DRILL
SAMPLING METHOD:	4" OD Core Barrel	START	FINISH
DRILLING METHOD:	10 1/4-inch ID Hollow Stem Auger	Time:	Time:
EQUIPMENT TYPE	B-59 Mobile Drill	9:45	13:15
DRILLER:	Brad James	Date:	Date:
DRILLING CONTRACTOR:	Geo-Tech Explorations, Inc.	9/26/95	9/26/95

ABANDONMENT DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHs (ppm)	CORE INTERVAL	SAMPLE RECOVERY	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	BORING DIAMETER: 12-inch
										CASING DIAMETER: Not Applicable
										SURFACE ELEVATION: 34.9 feet msl
										TOP OF CASING ELEVATION: Not Applicable
SOIL DESCRIPTION										

3/4" Bentonite Chips							21		SP	SAND - black, wet, loose, medium grained, poorly graded, sheen throughout, brick at 20.5 feet bgs.		
							22					
	B34-07	11:35		-			23					
			1,107				24					
							25					
	B34-08	12:00		-			26					
			1,422				27					
							28					
	B34-09	12:05		-			29				ML	Sandy SILT - light brown, moist, organic matter and oxidized zones, thin tarry beds throughout core (27.5 - 30 feet bgs)
			2,500+				30					
							31				SM	Silty SAND - olive gray, wet, fine to medium grained, wood fragments, patches of black oil throughout
	B34-10	12:30		-			32					
			2,500+				33					
B34-11	12:35		-			34		ML	SILT - green and gray mottled with brown oily pockets, sheen, product is more oil-like and less tar-like at this depth			
		2,500+				35						
						36						
B34-12	13:00		-			37			Drilled to 37 feet bgs Sampled to 37 feet bgs * Sample Number Prefix is 2708-950926-			
		2,500+				38						
						39						
						40						

HAHN & ASSOCIATES, INC. 434 NW Sixth Avenue Portland, Oregon (503) 796-0717				SOIL BORING NUMBER B-35						
PROJECT: Northwest Natural Gas Co. Gasco Facility Portland, Oregon				HAI LOGGER: Rob Ede						
PROJECT #: 2708				SAMPLING METHOD: 4" OD Core Barrel						
				DRILLING METHOD: 4 1/4-inch ID Hollow Stem Auger						
				EQUIPMENT TYPE: B-59 Mobile Drill						
				DRILLER: Brad James						
				DRILLING CONTRACTOR: Geo-Tech Explorations, Inc.						
ABANDONMENT DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHs (ppm)	CORE INTERVAL	SAMPLE RECOVERY	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	BORING DIAMETER: 8-inch
3/4" Bentonite Chips	B35-01	10:20	38	39			1		GM	Sandy GRAVEL with Silt - brown, moist, no hydrocarbon odor (surface)
							2			
	B35-02	10:35	235	-	5	90	3		SP + tar	Sandy GRAVEL with Silt, brown, wet, hardened tar in end of sampler, no sheen
					5	0	4			
					7	0	5			
					31	5	6			
					34	0	7			No Recovery - Rock blocking end of sampler
	B35-03	10:44			7	100	8		SP + tar	Tarry SAND with Gravel and Silt, moist, black, tar throughout matrix, sheen
			520		5	10	9			
					8	0	10			
	B35-04	10:50					11		SP + tar	Tarry SAND with Gravel and Silt, as above
			715				12			
							13			
							14			
							15			
							16			
							17			
							18			
							19			
						20				

HAHN & ASSOCIATES, INC.

434 NW Sixth Avenue

Portland, Oregon

(503) 796-0717

SOIL BORING NUMBER

GT-1

HAI LOGGER: Rob Ede

DRILL START	DRILL FINISH
Time: 9:30	Time: 12:30
Date: 11/17/97	Date: 11/17/97

PROJECT: Northwest Natural - Gasco Facility
7900 NW St. Helens Road
Portland, Oregon

SAMPLING METHOD: 2" OD Split Spoon
DRILLING METHOD: 4 1/4-inch OD Mud Rotary
EQUIPMENT TYPE: B-61 Mobile Drill

DRILLER: Jim Clark
DRILLING CONTRACTOR: Subterranean, Inc.

PROJECT #: 2708

BORING DIAMETER:	4 1/4-inch
CASING DIAMETER:	Not Applicable
SURFACE ELEVATION:	20.67 feet MSL
TOP OF CASING ELEVATION:	Not Applicable

ABANDONMENT DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHS (ppm)	SPT (blows/0.5 feet)	RECOVERY (%)	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	SOIL DESCRIPTION
Bentonite / Cement Grout							1		GM	Silty GRAVEL - as indicated from drill cuttings and drilling conditions.
							2			
						4	100	3	ML	Sandy SILT- brown, moist, soft, no hydrocarbon odor or discoloration, no sheen.
	001	10:20	2.3	4.3	7	50	4			SAND - brown, slightly moist, fine grained, medium dense, no hydrocarbon odor or discoloration, no sheen.
						10	0	4		
								5		
	002	10:30	3.7	-	7	100	6		SP	SAND - as above, no hydrocarbon odor or discoloration, no sheen.
						7	0	7		
								8		
	003	10:39	16.2	-	5	100				SAND - as above, hydrocarbon odor, sheen, liquid non-viscous black oily product from 8'4" to 8'6".
						5	0	9		
								10		
	004	10:45	7.0	6.2	5	100				SAND - as above, wet, loose, saturated with oil-like product, petroleum odor, brown product observed via sheen test.
						4	75	11		
						1	0	12		
						1	100	13		
	005	10:54	5.0	-	1	75				Silty SAND - olive grey, moist, very loose, non-plastic, no product, no sheen, petroleum odor exists.
						0	0	14		
								15		
						1	100	16		SM
006	11:00	7.4	ND	1	100					
					3	50	17			
					1	100	18			
007	11:05		-	1	100				Silty SAND - grey to olive grey, loose, wood fragment at 18' 6", no sheen, hydrocarbon odor exists.	
		6.6		3	50		19			
							20			

HAHN & ASSOCIATES, INC. 434 NW Sixth Avenue Portland, Oregon (503) 796-0717					SOIL BORING NUMBER GT-1					
PROJECT: Northwest Natural - Gasco Facility 7900 NW St. Helens Road Portland, Oregon PROJECT #: 2708					HAI LOGGER: Rob Ede			DRILL START	DRILL FINISH	
					SAMPLING METHOD: 2" OD Split Spoon			Time: 9:30	Time: 12:30	
					DRILLING METHOD: 4 1/4-inch OD Mud Rotary			Date: 11/17/97	Date: 11/17/97	
					EQUIPMENT TYPE: B-61 Mobile Drill					
					DRILLER: Jim Clark					
					DRILLING CONTRACTOR: Subterranean, Inc.					
ABANDONMENT DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHS (ppm)	SPT (blows/0.5 feet)	RECOVERY (%)	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	
Bentonite / Cement Grout	008	11:12	2.6	ND	3	100	21		SP	
					7	100	22			
						7	0	23		
								24		
								25		
						3	100			
						8	100	26		
	009	11:20	1.5	-	12	50		27		
								28		
								29		
								30		
						3	100			
	010	11:28	1.6	-	4	100		31		
						4	0	32		
								33		
								34		
								35		
						6	100			
	011	11:35	1.4	ND	6	100		36		
						11	0	37		
							38			
							39			
							40			

BORING DIAMETER: 4 1/4-inch
CASING DIAMETER: Not Applicable
SURFACE ELEVATION: 20.67 feet MSL
TOP OF CASING ELEVATION: Not Applicable

SOIL DESCRIPTION

SAND - grey with some brown to orange oxidation zones, wet, medium dense, fine grained, no sheen, no hydrocarbon odor.

SAND - as above, brown to 26', grey below 26', muscovite present in gray sand, slight sheen and hydrocarbon odor below 26'

SAND - as above, grey, loose, fine grained, no sheen, slight reducing odor.

SAND - as above, medium dense, no sheen, no hydrocarbon odor.

Drilled to 35.0 feet bgs
Sampled to 36.5 feet bgs

* Sample Number Prefix is 2708-971117-

HAHN & ASSOCIATES, INC.
 434 NW Sixth Avenue
 Portland, Oregon
 (503) 796-0717

SOIL BORING NUMBER

GT-2

PROJECT:
 Northwest Natural - Gasco Facility
 7900 NW St. Helens Road
 Portland, Oregon
PROJECT #: 2708

HAI LOGGER: Rob Ede
SAMPLING METHOD: 2" OD Split Spoon
DRILLING METHOD: 4 1/4-inch OD Mud Rotary
EQUIPMENT TYPE: B-61 Mobile Drill
DRILLER: Jim Clark
DRILLING CONTRACTOR: Subterranean, Inc.

DRILL START	DRILL FINISH
Time: 14:30	Time: 16:00
Date: 11/17/97	Date: 11/17/97

ABANDONMENT DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHs (ppm)	SPT (blows/0.5 feet)	RECOVERY (%)	DEPTH (feet)	GROUNDWATER	STRATA (USCS)
Bentonite / Cement Grout					4	100			SP
	018	1515	3.6	-	5	100	21		
								22	
								23	
								24	
								25	
						4	100		
						4	100	26	
	019	1521	3.6	-	7	50		27	
								28	
								29	
								30	
						2	100		
	020	1529				1	100	31	
				2.2		7	25	32	
						7	100	33	
	021	1534			ND	8	100	34	
				2.6		9	25	35	
						5	100		
						10	100	36	
	022	1540	2.7	-		6	50	37	
								38	
							39		
							40		

BORING DIAMETER: 4 1/4-inch
CASING DIAMETER: Not Applicable
SURFACE ELEVATION: 20.68 feet MSL
TOP OF CASING ELEVATION: Not Applicable

SOIL DESCRIPTION

SAND - as above, medium dense, no hydrocarbon odor, no sheen, slight organic decay odor.

SAND - as above, grey, few thin grey silt lenses, no sheen, slight organic decay odor.

SAND - as above, many thin grey silt lenses, no hydrocarbon odor, no sheen.

SAND - as above, no hydrocarbon odor, no sheen.

SAND - as above, no hydrocarbon odor, no sheen.

Drilled to 35.0 feet bgs
 Sampled to 36.5 feet bgs

* Sample Number Prefix is 2708-971117-

Hahn & Associates, Inc.

434 NW Sixth Avenue
 Portland, Oregon
 (503) 796-0717

SOIL BORING NUMBER

GT-3

PROJECT:
 Northwest Natural - Gasco Facility
 7900 NW St. Helens Road
 Portland, Oregon

HAI LOGGER:	Rob Ede	DRILL	DRILL
SAMPLING METHOD:	2" OD Split Spoon	START	FINISH
DRILLING METHOD:	4 1/4-inch OD Mud Rotary	Time:	Time:
EQUIPMENT TYPE	B-61 Mobile Drill	8:20	12:00
DRILLER:	Jim Clark	Date:	Date:
DRILLING CONTRACTOR:	Subterranean, Inc.	11/18/97	11/18/97

PROJECT #: 2708

ABANDONMENT DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHS (ppm)	SPT (blows/0.5 feet)	RECOVERY (%)	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	BORING DIAMETER:	4 1/4-inch
										CASING DIAMETER:	Not Applicable
										SURFACE ELEVATION:	19.44 feet MSL
										TOP OF CASING ELEVATION:	Not Applicable

SOIL DESCRIPTION

Bentonite / Cement Grout							1			GM	Silty GRAVEL - as indicated from drill cuttings and drilling conditions.	
							2					
						2	100	3		ML	SILT with fine Sand and Gravel - olive grey with some brown, moist, stiff, non-plastic, no hydrocarbon odor, no sheen, some wood fragments.	
	023	847		43.1	3	100		4				
			0		7	25		5				
								6				
		024	850	0	-	4	50				SILT with fine Sand and Gravel - as above, brown, no hydrocarbon, no sheen.	
						5	0	7				
						16	0				SILT with fine Sand and Gravel - as above, no hydrocarbon odor, no sheen, some wood fragments.	
						3	100	8				
		025	859	0	-	8	100				SILT with fine sand and gravel - as above, no hydrocarbon odor, no sheen, some wood fragments.	
						11	50	9				
								10			Silty SAND - grey with brown oxidation spots, moist, fine grained, very loose, no hydrocarbon odor, no sheen.	
						3	20					
						2	0				Sandy SILT - grey, moist, very soft, non-plastic, no hydrocarbon odor, no sheen.	
						1	0					
						1	100				SAND - grey, moist, very loose, fine grained, non-plastic, no hydrocarbon odor, no sheen.	
		026	911	0	0.05	1	100	13				
						1	10				ML	
						1	0	14				
					1	0				SP		
							15					
					3	100						
					6	100						
	027	922	0	-	6	75						
							18					
							19					
							20					

HAHN & ASSOCIATES, INC.
 434 NW Sixth Avenue
 Portland, Oregon
 (503) 796-0717

SOIL BORING NUMBER

GT-3

PROJECT:
 Northwest Natural - Gasco Facility
 7900 NW St. Helens Road
 Portland, Oregon
PROJECT #: 2708

HAI LOGGER: Rob Ede
SAMPLING METHOD: 2" OD Split Spoon
DRILLING METHOD: 4 1/4-inch OD Mud Rotary
EQUIPMENT TYPE: B-61 Mobile Drill
DRILLER: Jim Clark
DRILLING CONTRACTOR: Subterranean, Inc.

DRILL START	DRILL FINISH
Time: 8:20	Time: 12:00
Date: 11/18/97	Date: 11/18/97

ABANDONMENT DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHS (ppm)	SPT (blows/0.5 feet)	RECOVERY (%)	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	BORING DIAMETER: 4 1/4-inch
										CASING DIAMETER: Not Applicable
										SURFACE ELEVATION: 19.44 feet MSL
										TOP OF CASING ELEVATION: Not Applicable

SOIL DESCRIPTION

Bentonite / Cement Grout					6	100			SP	SAND - as above, no hydrocarbon odor, slight organic decay odor, no sheen.
					7	100	21			
	028	928	0	-	8	75				
							22			
					1	100				
					6	100				
	029	935	0	-	7	50	24			
							25			
					2	100				
					2	100	26			
	030	943	0	-	2	75				
							27			
							28			
							29			
							30			
					2	100				
031	953		-	1	100	31				
		0		3	75					
						32				
						33				
						34				
						35				
				8	100					
				10	100	36				
032	1000	0	ND	10	100					
						37				
						38				
						39				
						40				

SAND - as above, moist to wet, no hydrocarbon odor, no sheen.

SAND - as above, grey, moist to wet, no hydrocarbon odor, no sheen, fine grained, some grey silt lenses with rootlets.

SAND - as above, many silt lenses, no hydrocarbon odor, no sheen, fine grained.

SAND - as above, wet, no sheen, no hydrocarbon odor.

Drilled to 35.0 feet bgs
 Sampled to 36.5 feet bgs

* Sample Number Prefix is 2708-971118-

HAHN & ASSOCIATES, INC.

434 NW Sixth Avenue

Portland, Oregon

(503) 796-0717

SOIL BORING NUMBER

GT-4

HAI LOGGER: Rob Ede

DRILL START	DRILL FINISH
Time: 12:45	Time: 16:00
Date: 11/18/97	Date: 11/18/97

PROJECT: Northwest Natural - Gasco Facility
7900 NW St. Helens Road
Portland, Oregon

SAMPLING METHOD: 2" OD Split Spoon
DRILLING METHOD: 4 1/4-inch OD Mud Rotary
EQUIPMENT TYPE: B-61 Mobile Drill

DRILLER: Jim Clark
DRILLING CONTRACTOR: Subterranean, Inc.

PROJECT #: 2708

ABANDONMENT DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHS (ppm)	SPT (blows/0.5 feet)	RECOVERY (%)	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	BORING DIAMETER: 4 1/4-inch	CASING DIAMETER: Not Applicable	SURFACE ELEVATION: 19.64 feet MSL	TOP OF CASING ELEVATION: Not Applicable
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ABANDONMENT DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHS (ppm)	SPT (blows/0.5 feet)	RECOVERY (%)	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	SOIL DESCRIPTION
							1		GM	
							2			
					8	10	3			
					5	0	4			Silty GRAVEL with brick fragments - no sheen, driller lost mud at 4.0 feet (voids in fill).
					7	0	4			
							5			
					8	10	6			Silty GRAVEL with brick fragments - no hydrocarbon odor, no sheen.
					12	0	6			
					9	0	7			
					7	20	8			
					14	0	9			Silty GRAVEL with brick fragments - grey and green silt, no hydrocarbon odor, no sheen.
					16	0	9			
							10		GM	
					15	100	11			Sandy GRAVEL with brick - grey, fine grained sand, organic decay odor, no sheen.
	033	1341	0	-	18	50	12			Driller indicates smoother drilling below 11.5 feet
							13			
					1	100	13			SAND with silt lenses - grey, fine grained, no hydrocarbon odor, organic decay odor, no sheen, fine grained.
	034	1350	0	ND	1	50	14			
							15			
							16		SP	
					2	0	17			No Recovery.
					1	0	18			
					1	0	18			
							19			
							20			

HAHN & ASSOCIATES, INC.

434 NW Sixth Avenue

Portland, Oregon

(503) 796-0717

SOIL BORING NUMBER

GT-4

PROJECT:

Northwest Natural - Gasco Facility

7900 NW St. Helens Road

Portland, Oregon

PROJECT #: 2708

HAI LOGGER:

Rob Ede

SAMPLING METHOD:

2" OD Split Spoon

DRILLING METHOD:

4 1/4-inch OD Mud Rotary

EQUIPMENT TYPE

B-61 Mobile Drill

DRILLER:

Jim Clark

DRILLING CONTRACTOR:

Subterranean, Inc.

DRILL

DRILL

START

FINISH

Time:

Time:

12:45

16:00

Date:

Date:

11/18/97

11/18/97

ABANDONMENT DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHS (ppm)	SPT (blows/0.5 feet)	RECOVERY (%)	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	BORING DIAMETER: 4 1/4-inch			
										CASING DIAMETER: Not Applicable			
										SURFACE ELEVATION: 19.64 feet MSL			
										TOP OF CASING ELEVATION: Not Applicable			
										SOIL DESCRIPTION			
Bentonite / Cement Grout	-		0		4	20				SP	SAND - brown, fine grained, medium dense, no hydrocarbon odor, no sheen, appears to be oxidized.		
					5	0	21				No Recovery.		
					7	0	22						
							23						
					6	0							
					12	0	24						
					12	0							
							25						
	035	1417			5	100							SAND - as above, grey, no hydrocarbon odor, no sheen, fine grained, appears to be oxidized.
				0	8	25	26						
					7	0							
							27						
							28						
							29						
							30						
					4	100							SAND - grey, organic decay odor, no hydrocarbon odor, no sheen, fine grained, appears to be oxidized.
	036	1427			5	100	31						
				0	7	25							
							32						
							33						
						34							
						35							
				5	100						SAND - as above, no hydrocarbon odor, no sheen.		
037	1439			5	100	36							
			0	7	25								
						37							
						38							
						39							
						40							

HAHN & ASSOCIATES, INC.

434 NW Sixth Avenue

Portland, Oregon

(503) 796-0717

SOIL BORING NUMBER

GT-4

PROJECT:

Northwest Natural - Gasco Facility

7900 NW St. Helens Road

Portland, Oregon

PROJECT #: 2708

HAI LOGGER:

Rob Ede

SAMPLING METHOD:

2" OD Split Spoon

DRILLING METHOD:

4 1/4-inch OD Mud Rotary

EQUIPMENT TYPE

B-61 Mobile Drill

DRILLER:

Jim Clark

DRILLING CONTRACTOR:

Subterranean, Inc.

DRILL

DRILL

START

FINISH

Time:

Time:

12:45

16:00

Date:

Date:

11/18/97

11/18/97

ABANDONMENT DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHS (ppm)	SPT (blows/0.5 feet)	RECOVERY (%)	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	BORING DIAMETER: 4 1/4-inch			
										CASING DIAMETER: Not Applicable			
										SURFACE ELEVATION: 19.64 feet MSL			
										TOP OF CASING ELEVATION: Not Applicable			
										SOIL DESCRIPTION			
Bentonite / Cement Grout	038	1517		ND	8	100	41		SP	SAND - as above, dense, no hydrocarbon odor, no sheen.			
			0		15	100	42						
					17	25	43						
							44						
							45						
	039	1525		-	7	100	46			SP	SAND - grey, fine grained, medium dense, some shell fragments, no hydrocarbon odor, no sheen.		
			0		7	100	47						
					11	25	48						
							49						
							50						
					8	100	51			SAND - as above, no hydrocarbon odor, no sheen.			
					8	100	52						
					8	0	53						
							54			Drilled to 50.0 feet bgs Sampled to 51.5 feet bgs			
							55			* Sample Number Prefix is 2708-971118-			
							56						
							57						
							58						
							59						
							60						

HAHN & ASSOCIATES, INC.
 434 NW Sixth Avenue
 Portland, Oregon
 (503) 796-0717

SOIL BORING NUMBER M-11

PROJECT:
 Northwest Natural Gas Co.
 Gasco Facility
 Portland, Oregon
PROJECT #: 2708

HAI LOGGER:	Rob Ede	DRILL START	DRILL FINISH
SAMPLING METHOD:	3-inch Split Spoon/4-inch OD Core Barrel	Time:	Time:
DRILLING METHOD:	6 1/4-inch ID Hollow Stem Auger	13:17	10:30
EQUIPMENT TYPE	B-59 Mobile Drill	Date:	Date:
DRILLER:	Brad James	2-Nov-95	3-Nov-95
DRILLING CONTRACTOR:	Geo-Tech Explorations, Inc.		

ABANDONMENT DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHs (ppm)	CORE INTERVAL	RECOVERY INTERVAL	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	BORING DIAMETER: 10-inch		
										CASING DIAMETER: Not Applicable		
										SURFACE ELEVATION: 35.4 feet MSL		
										TOP OF CASING ELEVATION: Not Applicable		
										SOIL DESCRIPTION		
Bentonite Chips	M11-01	1315	-	106						GP	Surface: Sandy Silty GRAVEL - brown, slightly moist, grass covered area.	
						18	100					
20 % Solids Bentonite Grout	M11-02	1330		-	27	100				SP	SAND with gravel (3.5-4.0 Feet bgs) - brown, loose, moist, coarse grained, pieces of brick SAND with lampblack (4.0-5.0 feet bgs) - black, loose, hydrophobic, hydrocarbon odor, no sheen.	
			11.5		21	70						
						14	100					
						8	100			GP	Sandy GRAVEL (5.0-6.5 feet bgs) - black (Lampblack), no sheen, pieces of brick, large pieces of slag looking material .	
						7	30					
						8	100					
		M11-03	1335		-	5	100				SP	SAND with gravel (7.5-9.0 feet bgs) - black (Lampblack), pieces of brick, slag looking material (blue coloration), black, moist, hydrocarbon odor, no sheen.
				194		6	30					
												SAND (10.0-10.5 feet bgs) - Lampblack
												SAND (10.5-11.0 feet bgs) - brown, moist to wet, medium grained, loose, poorly graded, slight sheen.
											SAND (11.0-15.0 feet bgs) - black/metallic, moist to wet, strong hydrocarbon odor, sheen, brown froth via sheen test saturated with product, silt layers encountered at 12.5 and 13.5 feet bgs approximately 1 inch thick.	
	M11-04	1350		-								
			2500+									
											SAND (15.0-20.0 feet bgs) - saturated with black oily product, wet, medium grained, loose, 2 inches of moist silt, olive grey with orange oxidation spots at 18.5 feet bgs.	
	M11-05	1400		-								
			2500+							SP		

HAHN & ASSOCIATES, INC. 434 NW Sixth Avenue Portland, Oregon (503) 796-0717				SOIL BORING NUMBER M-11						
PROJECT: Northwest Natural Gas Co. Gasco Facility Portland, Oregon				HAI LOGGER: Rob Ede		DRILL START	DRILL FINISH			
PROJECT #: 2708				SAMPLING METHOD: 3-inch Split Spoon/4-inch OD Core Barrel		Time: 13:17	Time: 10:30			
				DRILLING METHOD: 6 1/4-inch ID Hollow Stem Auger		Date: 2-Nov-95	Date: 3-Nov-95			
				EQUIPMENT TYPE: B-59 Mobile Drill						
				DRILLER: Brad James						
				DRILLING CONTRACTOR: Geo-Tech Explorations, Inc.						
ABANDONMENT DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHs (ppm)	CORE INTERVAL	RECOVERY INTERVAL	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	BORING DIAMETER: 10-inch
										CASING DIAMETER: Not Applicable
										SURFACE ELEVATION: 35.4 feet MSL
										TOP OF CASING ELEVATION: Not Applicable
										SOIL DESCRIPTION
20 % Solids Bentonite Grout							41			SILT (40.0-45.0 feet bgs) - olive grey, moist, stiff, root zones present, no product observed, no sheen via sheen test.
							42			
							43		ML	
	M11-10	1500		10.9			44			
				23.1			45			
							46			SILT (45.0-49.0 feet bgs) - olive grey, moist, stiff, root zones present, no product, no sheen, large 6-inch tree limb/trunk at 45 feet bgs.
							47			
							48			
							49			
	M11-11	1513		-			50			Sandy SILT (49.0-50.0 feet bgs) - as above.
							51			Sandy SILT (50.0-51.0 feet bgs) - olive grey, soft, moist to wet, sheen?.
							52			SILT (51.0-53.0 feet bgs) - olive grey, moist, stiff, root zones, wood fragments.
							53			SILT (53.0-55.0 feet bgs) - green, slightly moist, stiff, no sheen.
						54			1540 - stop for day 11/3/95 - start drilling at 0825.	
M11-12	1524		-			55				
						56			SILT (55.0-60.0 feet bgs) - green, slightly moist, stiff, no sheen, no product, 6-inch sandy silt zone at 58 feet bgs.	
						57				
						58		ML		
M11-13	840		-			59				
			3.8			60				

HAHN & ASSOCIATES, INC.

434 NW Sixth Avenue

Portland, Oregon

(503) 796-0717

SOIL BORING NUMBER

M-11

PROJECT:

Northwest Natural Gas Co.

Gasco Facility

Portland, Oregon

PROJECT #: 2708

HAI LOGGER:

Rob Ede

SAMPLING METHOD:

3-inch Split Spoon/4-inch OD Core Barrel

DRILLING METHOD:

6 1/4-inch ID Hollow Stem Auger

EQUIPMENT TYPE

B-59 Mobile Drill

DRILLER:

Brad James

DRILLING CONTRACTOR:

Geo-Tech Explorations, Inc.

DRILL

DRILL

START

FINISH

Time:

Time:

13:17

10:30

Date:

Date:

2-Nov-95

3-Nov-95

ABANDONMENT DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHs (ppm)	CORE INTERVAL	RECOVERY INTERVAL	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	BORING DIAMETER: 10-inch	
										CASING DIAMETER: Not Applicable	
										SURFACE ELEVATION: 35.4 feet MSL	
										TOP OF CASING ELEVATION: Not Applicable	
										SOIL DESCRIPTION	
20 % Solids Bentonite Grout							61				Sandy SILT (60.0-65.0 feet bgs) - olive grey, moist, stiff, sheen on outside of core from water in hole, no sheen inside core.
							62				
							63		ML		
							64				
							65				Sandy SILT (65.0-67.5 feet bgs) - olive grey, moist, stiff, sheen on outside of core from water in hole, no sheen inside core, approximately 1/4-inch of sand in end of core.
							66				Silty SAND (66.0-66.5 feet bgs) - olive grey, wet, moderately dense, no sheen.
	M11-14	1020		7.8			67		SM		
							68		ML		
							69		SM		SAND (67.5-68.5 feet bgs) - brown, wet, moderately dense, no sheen, fine grained.
	M11-15	1030		2.3			70		SP		SAND (68.5-70.0 feet bgs) - brown, wet, loose, poorly graded, no sheen, fine grained.
						71					
						72					
						73					
						74					
						75					
						76					
						77					
						78					
						79					
						80					

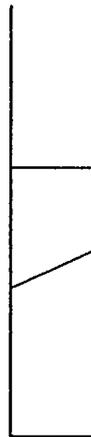
Boring terminated at 70.0 feet bgs.

*Sample prefix is 2708-951102-

LABORATORY TESTS:

- AL Atterberg limits
- CP Compaction
- CS Consolidation
- DS Direct Shear
- GS Grain - size
- %F Percent fines
- HA Hydrometer analysis
- SK Permeability
- SM Moisture content
- MD Moisture and density
- SP Swelling pressure
- TX Triaxial compression
- UC Unconfined compression
- CA Chemical analysis

SOIL GRAPH:



- SM Soil Group Symbol
(See Note 2)
- Distinct Contact Between
Soil Strata
- Gradual or Approximate
Location of Change
Between Soil Strata
- ▽ Water Level
- Bottom of Boring

BLOW-COUNT/SAMPLE DATA:

Blows required to drive a 2.4-inch I.D. split-barrel sampler 12 inches or other indicated distances using a 300-pound hammer falling 30 inches.

- 22 ■ Location of relatively undisturbed sample
- 12 ☒ Location of disturbed sample
- 17 □ Location of sampling attempt with no recovery

Blows required to drive a 1.5-inch I.D. (SPT) split-barrel sampler 12 inches or other indicated distances using a 140-pound hammer falling 30 inches.

- 10 □ Location of sample obtained in general accordance with Standard Penetration Test (ASTM D 1586) procedures
- 26 □ Location of SPT sampling attempt with no recovery

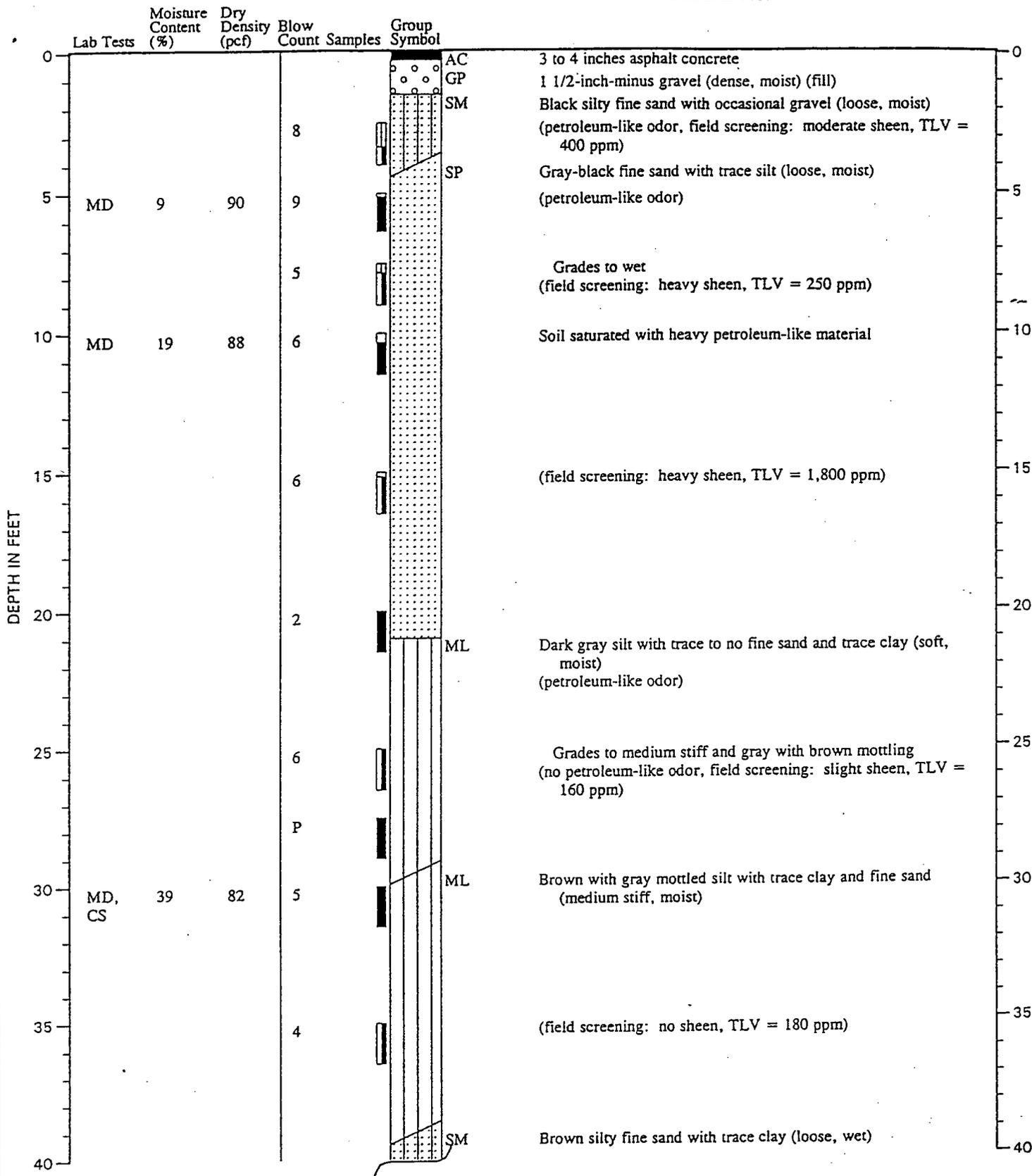
"P" indicates sampler pushed with weight of hammer or against weight of drill rig.

- P I Location of relatively undisturbed sample obtained using a 3-inch-diameter thin-wall sample tube. Sample obtained in general accordance with ASTM D 1587.
- ☒ Location of grab sample

NOTES:

1. The reader must refer to the discussion in the report text, the Key to Boring Log Symbols and the exploration logs for a proper understanding of subsurface conditions.
2. Soil classification system is summarized in Figure 3.

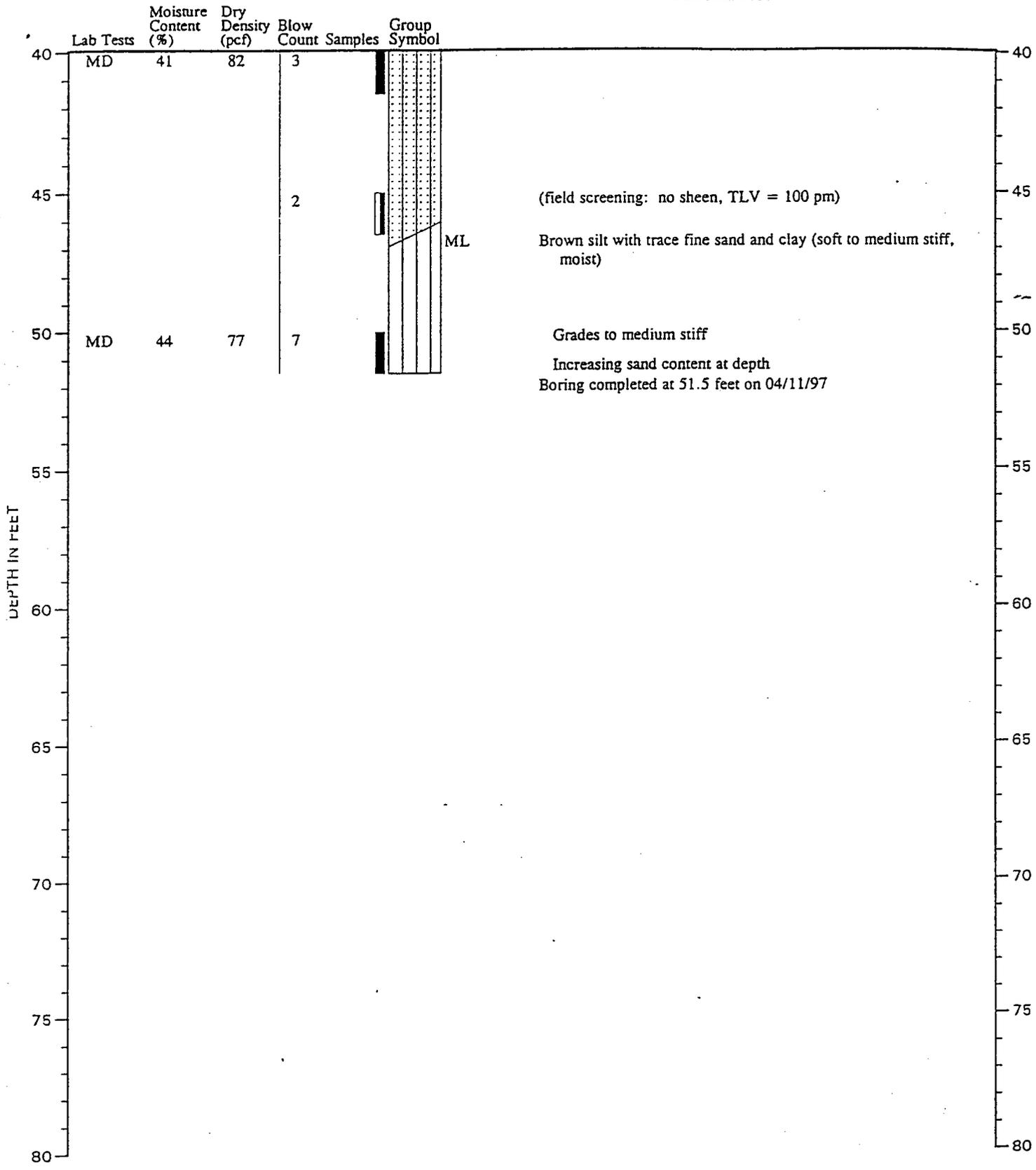
DESCRIPTION



Note: See Figure 2 for explanation of symbols

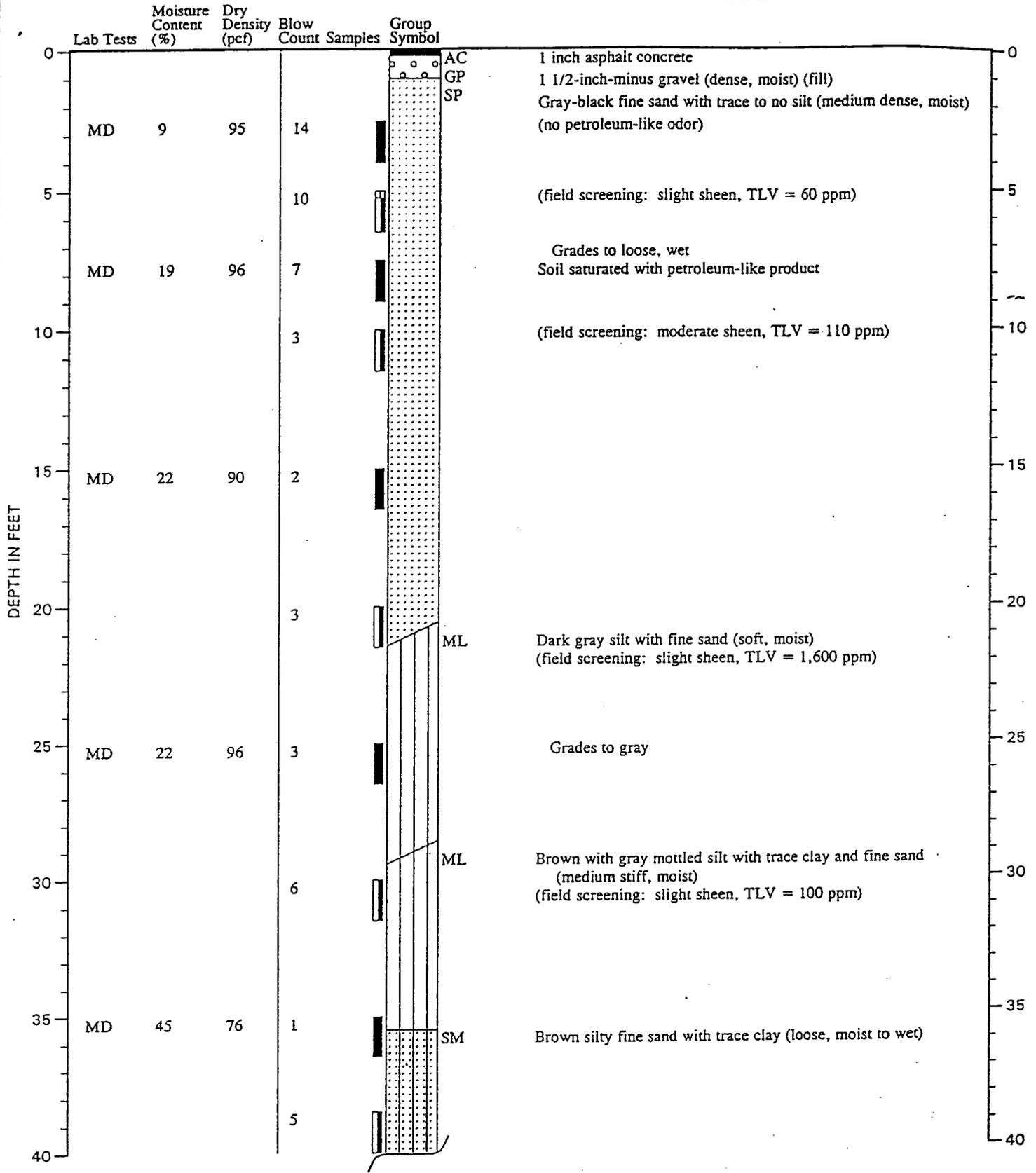
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DESCRIPTION

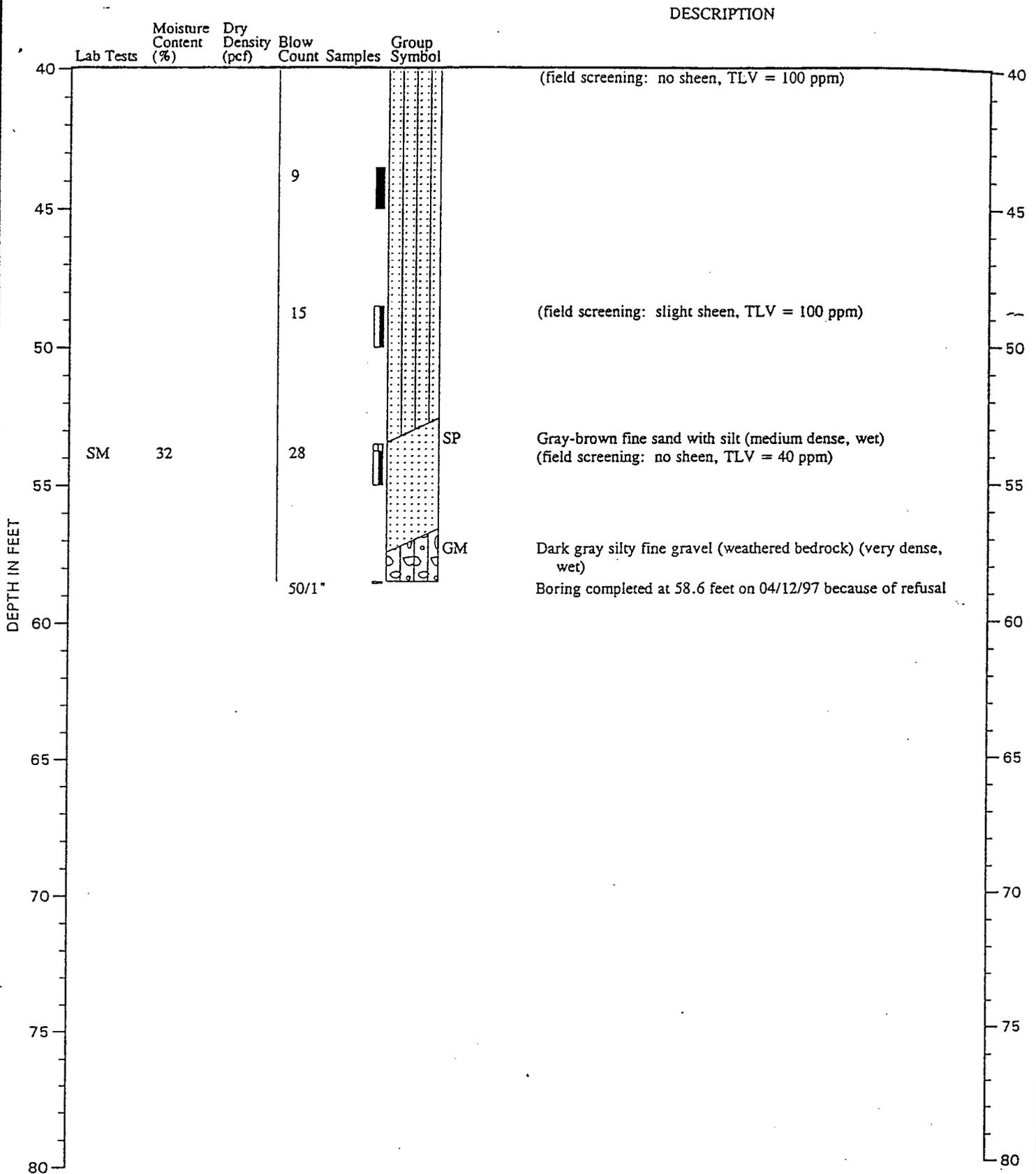


Note: See Figure 2 for explanation of symbols

DESCRIPTION



Note: See Figure 2 for explanation of symbols



Note: See Figure 2 for explanation of symbols

Vandehy Soil EX LLC

Operator : S.VAN/S.MES/W.MC
 Location : P1/KOPPERS PORT

CPT Date : 04-12-97 11:01
 Client : GEO ENGINEERS

Sounding : SND433 Pg 1 / 1
 Job No. : 582?

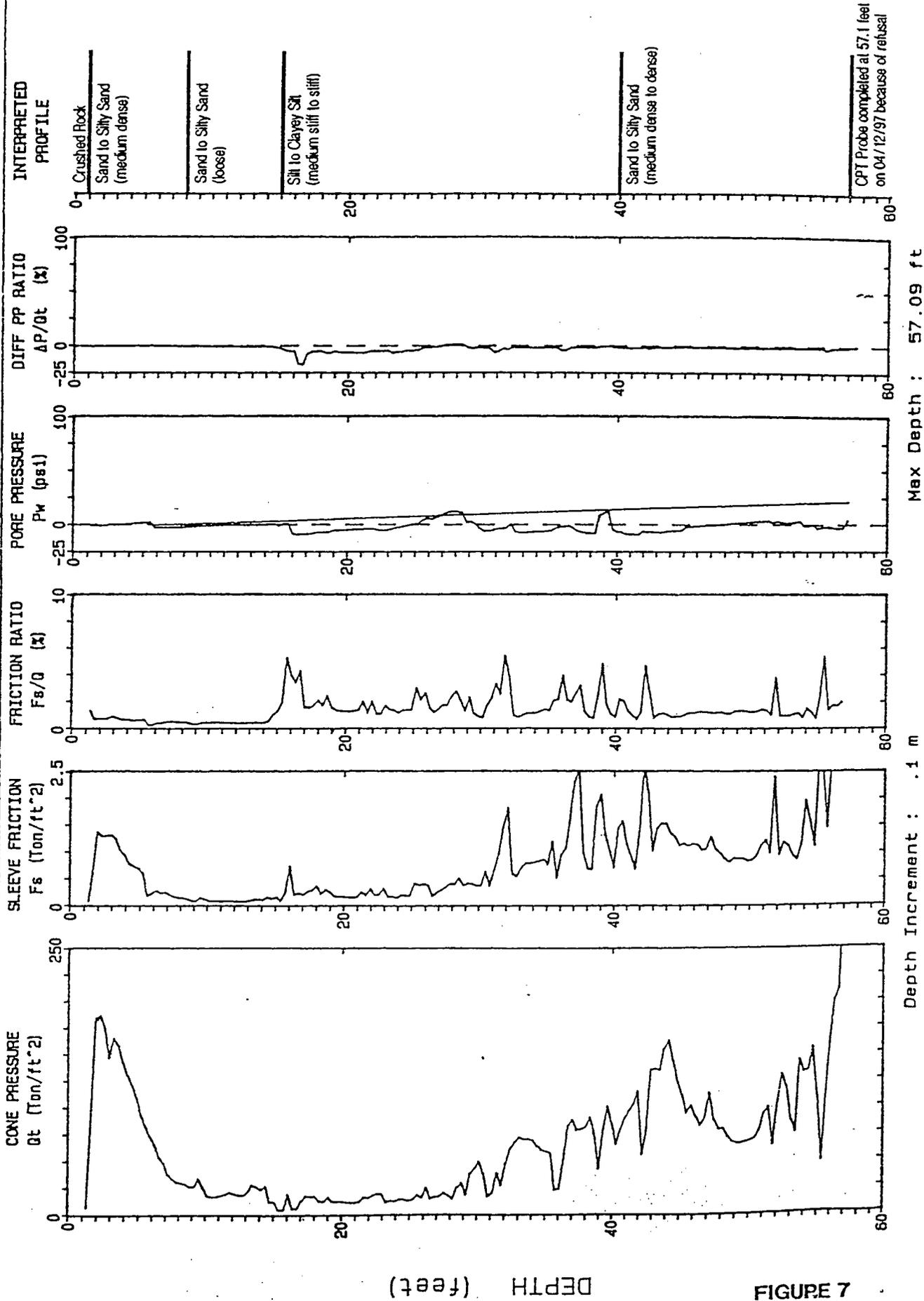
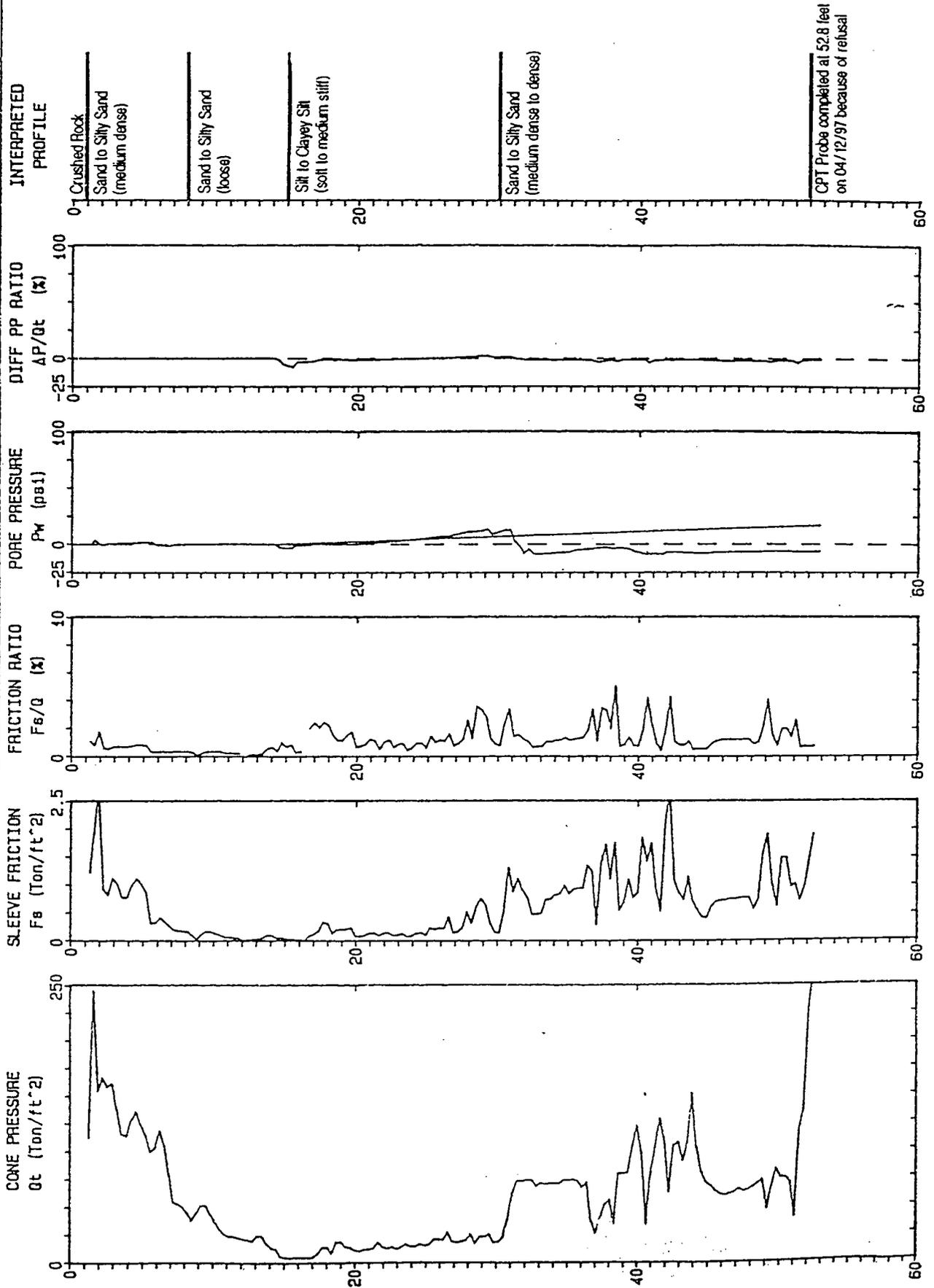


FIGURE 7

Vandehney Soil EX LLC

Operator : S.VAN/S.MES/W.MC CPT Date : 04-12-97 14:59 Sounding : SND434 Pg 1 / 1
 Location : P2/KOPPERS PORT Client : GEO ENGINEERS Job No. : 5823-001-43



Depth Increment : 1 m Max Depth : 52.82 ft

DEPTH (feet)

FIGURE 8

APPENDIX B

Monitoring Well Construction Summary

Monitoring Well Logs

TABLE B1 - Monitoring Well Construction Summary

Remedial Investigation
 Northwest Natural - Gasco Facility
 7900 NW St. Helens Road
 Portland, Oregon

Project #2708

Well Number	Date Installed	Date Decommissioned	Installation Method	Monument Type	Screen Type	Slot Size	Sand Pack	Well Diam.	Ground Surface	Top of Casing		Boring Depth		Top Screen		Base Screen		Water Level 1-Jun-98		Top Silt Unit	
						(inches)	(Colorado)	(inches)	(feet msl)	(feet msl)	(feet bgs)	(feet bgs)	(feet msl)	(feet bgs)	(feet msl)	(feet bgs)	(feet msl)	(feet btc)	(feet msl)	(feet bgs)	(feet msl)
MW-1-22	24-Oct-95	-	Hollow-Stem Auger	Above-grade	Slotted PVC	0.020	10-20	2	32.0	34.75	(2.8)	22.0	10.0	11.0	21.0	21.0	11.0	14.49	20.26	22.5	9.5
MW-2-32	6-Nov-95	-	Hollow-Stem Auger	Flush	Slotted PVC	0.020	10-20	2	35.8	34.46	1.3	32.5	3.3	21.5	14.3	31.5	4.3	16.97	17.49	31.5	4.3
MW-3-26	1-Nov-95	-	Hollow-Stem Auger	Above-grade	Continuous wrap stainless steel	0.020	10-20	2	31.2	34.11	(2.9)	26.0	5.2	15.0	16.2	25.0	6.2	16.61	17.50	25.0	6.2
MW-3-56	1-Nov-95	-	Hollow-Stem Auger	Above-grade	Continuous wrap stainless steel	0.020	10-20	2	31.2	34.07	(2.9)	56.0	-24.8	45.0	-13.8	55.0	-23.8	16.51	17.56	25.0	6.2
MW-4-35	31-Oct-95	-	Hollow-Stem Auger	Above-grade	Continuous wrap stainless steel	0.020	10-20	2	31.7	34.54	(2.8)	35.0	-3.3	24.0	7.7	34.0	-2.3	16.90	17.64	25.0	6.7
MW-4-57	30-Oct-95	-	Hollow-Stem Auger	Above-grade	Continuous wrap stainless steel	0.020	10-20	2	31.7	34.53	(2.8)	57.0	-25.3	46.0	-14.3	56.0	-24.3	17.00	17.53	25.0	6.7
MW-5-32	27-Oct-95	-	Hollow-Stem Auger	Above-grade	Slotted PVC	0.020	10-20	2	25.1	27.83	(2.7)	32.0	-6.9	21.0	4.1	31.0	-5.9	10.33	17.50	16.0	9.1
MW-6-32	9-Nov-95	-	Hollow-Stem Auger	Flush	Continuous wrap stainless steel	0.020	10-20	2	35.8	35.51	0.3	32.0	3.8	21.0	14.8	31.0	4.8	15.75	19.76	30.5	5.3
MW-6-61	7-Nov-95	22-Dec-97	Hollow-Stem Auger	Flush	Continuous wrap stainless steel	0.020	10-20	2	35.8	34.50	1.3	61.0	-25.2	50.0	-14.2	60.0	-24.2	-	-	30.5	5.3
MW-8-29	26-Oct-95	-	Hollow-Stem Auger	Above-grade	Continuous wrap stainless steel	0.020	10-20	2	36.5	39.09	(2.6)	29.0	7.5	18.0	18.5	28.0	8.5	20.05	19.04	27.5	9.0
MW-8-56	25-Oct-95	-	Hollow-Stem Auger	Above-grade	Continuous wrap stainless steel	0.020	10-20	2	36.5	39.13	(2.6)	56.0	-19.5	45.0	-8.5	55.0	-18.5	21.63	17.50	27.5	9.0
MW-9-29	23-Oct-95	-	Hollow-Stem Auger	Flush	Slotted PVC	0.020	10-20	2	37.9	37.65	0.3	29.0	8.9	18.0	19.9	28.0	9.9	7.25	30.40	11.0	26.9
MW-10-25	9-Nov-95	-	Hollow-Stem Auger	Above-grade	Continuous wrap stainless steel	0.020	10-20	2	36.5	39.22	(2.7)	25.0	11.5	14.0	22.5	24.0	12.5	14.63	24.59	23.5	13.0
MW-10-61	8-Nov-95	-	Hollow-Stem Auger	Above-grade	Continuous wrap stainless steel	0.020	10-20	2	36.5	39.33	(2.8)	61.0	-24.5	50.0	-13.5	60.0	-23.5	14.36	24.97	23.5	13.0
MW-11-32	3-Nov-95	-	Hollow-Stem Auger	Above-grade	Continuous wrap stainless steel	0.020	10-20	2	35.4	38.39	(3.0)	32.0	3.4	21.0	14.4	31.0	4.4	12.85	25.54	30.5	4.9
MW-12-36	23-Oct-95	-	Hollow-Stem Auger	Above-grade	Slotted PVC	0.020	10-20	2	35.9	38.69	(2.8)	36.0	-0.1	25.0	10.9	35.0	0.9	9.83	28.86	4.5	31.4
MW-13-30	19-Dec-97	-	Hollow-Stem Auger	Flush	Continuous wrap stainless steel	0.020	10-20	2	35.2	34.86	0.4	30.0	5.2	19.0	16.2	29.0	6.2	15.69	19.17	28.5	6.7
MW-13-61	18-Dec-97	-	Hollow-Stem Auger	Flush	Continuous wrap stainless steel	0.020	10-20	2	35.2	34.78	0.4	61.0	-25.8	50.0	-14.8	60.0	-24.8	17.11	17.67	28.5	6.7

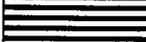
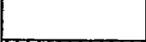
Note: bgs = below ground surface btc = below top of casing msl = mean sea level PVC = polyvinyl chloride

KEY TO BORING LOGS

Soil classification in this report is based upon visual and manual field observations which include moisture, consistency, plasticity and grading estimates and should not be construed to imply field or laboratory testing unless presented herein. Soils are classified in accordance with the Unified Soil Classification System. Stratigraphic boundaries are approximate representations only. No warranty is provided as to the continuity of soil strata between borings.

UNIFIED SOIL CLASSIFICATION SYSTEM (USCS)					
MAJOR DIVISIONS			GROUP SYMBOLS		TYPICAL NAMES
COURSE GRAINED SOILS More Than Half is Larger Than #200 Sieve	GRAVELS More Than Half the Course Fraction is Larger Than No. 4 Sieve Size	Clean Gravels With Little or No Fines	GW		Well Graded Gravels, Gravel-Sand Mixtures
			GP		Poorly Graded Gravels, Gravel-Sand Mixtures
		Gravels With Over 12% Fines	GM		Silty Gravels, Poorly Graded Gravel-Sand-Silt Mixtures
			GC		Clayey Gravels, Poorly Graded Gravel-Sand-Clay Mixtures
	SANDS More Than Half the Course Fraction is Smaller Than No. 4 Sieve Size	Clean Sands With Little or No Fines	SW		Well Graded Sands, Gravelly Sands
			SP		Poorly Graded Sands, Gravelly Sands
		Sands With Over 12% Fines	SM		Silty Sands, Poorly Graded Sand-Silt Mixtures
			SC		Clayey Sands, Poorly Graded Sand-Clay Mixtures
FINE GRAINED SOILS More Than Half is Smaller Than #200 Sieve	SILTS AND CLAYS Liquid Limit Less Than 50%		ML		Inorganic Silts and Very Fine Sands, Rock Flour, Silty or Clayey Fine Sands, or Clayey Silts with Slight Plasticity
			CL		Inorganic Clays of Low to Medium Plasticity, Gravelly Clays, Sandy Clays, Silty Clays, Lean Clays
			OL		Organic Clays and Organic Silty Clays of Low Plasticity
	SILTS AND CLAYS Liquid Limit Greater Than 50%		MH		Inorganic Silts, Micaceous or Diatomaceous Fine Sandy or Silty Soils, Elastic Silts
			CH		Inorganic Clays of High Plasticity, Fat Clays
			OH		Organic Clays of Medium to High Plasticity, Organic Silts
HIGHLY ORGANIC SOILS			Pt		Peat and Other Highly Organic Soils

LEGEND FOR BORING LOGS

	Blank Casing
	Slotted Screen
	Cement Grout
	Concrete
	Bentonite
	Sand Pack
	Fill Material

ABBREVIATIONS

NA	Not Applicable
ND	Not Detected Above Detection Limit
NS	Not Sampled
PAH	Polynuclear Aromatic Hydrocarbons
ppm	Parts Per Million
SPT	Standard Penetration Test
	Measured Static Water Level in Well
	Estimated Water Level During Drilling

WELL CONSTRUCTION DETAILS				LAB RESULTS Total PAHs (ppm)				SPT (blows/0.5 feet)		RECOVERY (%)		DEPTH (feet)		GROUNDWATER		STRATA (USCS)		BORING DIAMETER: 10-inch		CASING DIAMETER: 2-inch ID		SURFACE ELEVATION: 32.0 Feet MSL		TOP OF CASING ELEVATION: 34.75 feet MSL	
HAI LOGGER: Rob Ede				SAMPLING METHOD: Core Barrel				DRILLING METHOD: 6 1/4-inch ID Hollow Stem Auger		EQUIPMENT TYPE: B-59 Mobile Drill		DRILLER: Brad James		DRILLING CONTRACTOR: Geo-Tech Explorations		DRILL START: 11:30		DRILL FINISH: 13:10		Date: 24-Oct-95		Date: 24-Oct-95			
PROJECT: Northwest Natural Gas Co. Gasco Facility Portland, Oregon				PROJECT: 2708																					
10-20 Sand								21				21		SP		SAND (20.0-21.4 feet bgs) - black, wet, loose, poorly graded, fine grained, oily product coated, wood fragments.									
Cap								9				21				SILT (21.4-21.5 feet bgs) - moist, slight sheen?, wood fragments.									
								20				22													
												23													
3/8-inch Bentonite				0.46				↑		↑		24		ML		SILT (21.5-25.0 feet bgs) - olive grey, moist, slightly plastic, no sheen, mild hydrocarbon odor									
				0.7				↓		↓		25													
												26													
												27													
												28													
												29													
												30													
												31													
												32													
												33													
												34													
												35													
												36													
												37													
												38													
												39													
												40													

Boring terminated at 20.0 feet bgs
 Boring sampled to 20.5 feet
 Monitoring well installed to 20.0 feet bgs

Materials:
 10 feet 2-inch diameter, 0.010-inch PVC slotted screen
 15 feet 2-inch diameter PVC blank casing
 14 50# bags 10/20 sand
 6 50# bags bentonite chips
 1 end cap
 1 locking cap
 above-grade steel monument
 3 guard posts

Well depth is 25.0 feet below top of casing

* Sample Prefix Number is 2708-951024

HAHN & ASSOCIATES, INC.
 434 NW Sixth Avenue
 Portland, Oregon
 (503) 796-0717

MONITORING WELL NUMBER **MW-2-32**
OWRD # 84235

PROJECT:
 Northwest Natural Gas Co.
 Gasco Facility
 Portland, Oregon
PROJECT: 2708

HAI LOGGER:	Rob Ede	DRILL	DRILL
SAMPLING METHOD:	3-inch Split Spoon/4-inch Core Barrel	START	FINISH
DRILLING METHOD:	6 1/4-inch ID Hollow Stem Auger	Time:	Time:
EQUIPMENT TYPE	B-59 Mobile Drill	11:20	13:00
DRILLER:	Brad James	Date:	Date:
DRILLING CONTRACTOR:	Geo-Tech Explorations, Inc.	6-Nov-95	6-Nov-95

WELL CONSTRUCTION DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS Total PAHs (ppm)	SPT (blows/0.5 feet)	RECOVERY (%)	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	BORING DIAMETER: 10-inch
										CASING DIAMETER: 2-inch
										SURFACE ELEVATION: 35.8 feet MSL
										TOP OF CASING ELEVATION: 34.46 feet MSL

SOIL DESCRIPTION

Flush Monument	Ground surface											
	M2-01	1115	9.3	10.3						1	GM	Surface: Sandy, Silty, GRAVEL - moist, brown, well graded, stone for parking lot.
										2		
										3		
	M2-02	1125		-						4	SP	SAND (1.5-4.0 feet bgs) - brown, slightly moist, loose, poorly graded, fine/medium grained, no hydrocarbon odor, slight sheen?.
			40.4							5		
					9	60				6		
					7	0				7		
	M2-03	1135		-						8		SANDY, SILTY, GRAVEL (5.0-6.5 feet bgs) - brown, slightly moist, loose, poorly graded, fine/medium grained, no hydrocarbon odor, slight sheen, lamplblack in end of sampler.
			43.7							9		
										10	GM	Sandy, Silty, GRAVEL (6.5-7.5 feet bgs) - lamplblack, pieces of brick, concrete.
										11		
					7	50				12		
					9	0				13		
					9	0				14		
										15	GP	Sandy GRAVEL (10.0-11.5 feet bgs) - as above, some lamplblack, hydrocarbon odor, slight sheen.
					5	50				16		
					9	0				17		
					6	0				18		
					9	0				19		
					50/5"					20		
	M2-04	1200	25.9	-	7	70					SP	Sandy GRAVEL (12.5-14.0 feet bgs) - olive grey, moist, loose, hydrocarbon odor, sheen, brick in end of sampler.
					11	0						
					15	0						

Concrete
Bentonite Chips
2-inch ID Blank PVC Casing

HAHN & ASSOCIATES, INC.
 434 NW Sixth Avenue
 Portland, Oregon
 (503) 796-0717

MONITORING WELL NUMBER

MW-2-32

OWRD # 84235

PROJECT:
 Northwest Natural Gas Co.
 Gasco Facility
 Portland, Oregon
PROJECT: 2708

HAI LOGGER:	Rob Ede	DRILL	DRILL
SAMPLING METHOD:	3-inch Split Spoon/4-inch Core Barrel	START	FINISH
DRILLING METHOD:	6 1/4-inch ID Hollow Stem Auger	Time:	Time:
EQUIPMENT TYPE	B-59 Mobile Drill	11:20	13:00
DRILLER:	Brad James	Date:	Date:
DRILLING CONTRACTOR:	Geo-Tech Explorations, Inc.	6-Nov-95	6-Nov-95

WELL CONSTRUCTION DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS Total PAHs (ppm)	SPT (blows/0.5 feet)	RECOVERY (%)	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	BORING DIAMETER: 10-inch		
										CASING DIAMETER: 2-inch		
										SURFACE ELEVATION: 35.8 feet MSL		
										TOP OF CASING ELEVATION: 34.46 feet MSL		
										SOIL DESCRIPTION		
Colorado 10/20 Sand Pack 2-inch ID 0.020-inch PVC Slotted Screen	PVC	M2-05	1210	24.7	-	10 8	100 100	21	11/6/95	SP	SAND (20.0-21.5 feet bgs) - orange/brown, moist, loose, poorly graded, medium grained, no hydrocarbon odor, no sheen.	
						9	0	22			SAND (22.5-23.0 feet bgs) - as above, wet, no hydrocarbon odor, no sheen.	
						7	100	23			SAND (23.0-24.0 feet bgs) - olive grey, wet, loose, fine grained, no hydrocarbon odor, no sheen.	
						8	100	24			Silty SAND (24.0-25.0 feet bgs) - wet, slightly dense, hydrocarbon odor?, no sheen, olive grey silt lenses.	
		M2-06	1223	25.4	0.43	↑	↑	25			Silty SAND (25.0-27.5 feet bgs) - wet, slightly dense, fine grained, slight hydrocarbon odor?, no sheen.	
						↑	↑	26			SM	Silty SAND (27.5-28.5 feet bgs) - olive grey, wet, loose, fine grained, no hydrocarbon odor, no sheen.
		M2-07	1240		-	↓	↓	27			SP	Sandy SILT (31.5-32.5 feet bgs) - olive grey, orange oxidation spots, no hydrocarbon odor, no sheen, thin lenses of fine grained sand.
				17.8		↓	↓	28			SM	
		M2-08	1250		-	↓	↓	29			ML	
				23.1		↓	↓	30				
Cap	M2-09	1255		-	↓	↓	32			Boring terminated at 32.5 feet bgs Boring sampled to 32.5 feet Monitoring well installed to 31.5 feet bgs Well depth is 31.5 feet below top of casing		
			25.7		↓	↓	33					
							34					
							35					
							36					
							37					
							38					
							39					
							40					

Materials:
 10 feet 2-inch diameter, 0.020-inch PVC slotted screen
 21.5 feet 2-inch diameter PVC blank casing
 12 50# bags 10/20 sand
 13 50# bags bentonite chips
 1 end cap
 1 locking cap
 Flush steel monument

* Sample Prefix Number is 2708-951106-

HAHN & ASSOCIATES, INC.
 434 NW Sixth Avenue
 Portland, Oregon
 (503) 796-0717

MONITORING WELL NUMBER
 OWRD # 84232

MW-3-26

PROJECT:
 Northwest Natural Gas Co.
 Gasco Facility
 Portland, Oregon

HAI LOGGER: Rob Ede
SAMPLING METHOD: Not Sampled
DRILLING METHOD: 6 1/4-inch ID Hollow Stem Auger
EQUIPMENT TYPE: B-59 Mobile Drill
DRILLER: Brad James
DRILLING CONTRACTOR: Geo-Tech Explorations

DRILL START	DRILL FINISH
Time: 15:10	Time: 9:00
Date: 1-Nov-95	Date: 2-Nov-95

PROJECT: 2708

WELL CONSTRUCTION DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHs (ppm)	SPT (blows/0.5 feet)	RECOVERY (%)	DEPTH (feet)	GROUNDWATER	STRATA (USCS)
BORING DIAMETER: 10-inch									
CASING DIAMETER: 2-inch ID									
SURFACE ELEVATION: 31.20 feet MSL									
TOP OF CASING ELEVATION: 34.11 feet MSL									

SOIL DESCRIPTION

WELL CONSTRUCTION DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHs (ppm)	SPT (blows/0.5 feet)	RECOVERY (%)	DEPTH (feet)	GROUNDWATER	STRATA (USCS)
Steel Monument							-3		
							-2		
							-1		
							1		
							2		
							3		
							4		
							5		
							6		
							7		
							8		
							9		
							10		
							11		
							12		
							13		
							14		
							15		
							16		
							17		
							18		
							19		
							20		

See boring log for well MW-3-56 for soil description.

Concrete
 2-inch ID Blank PVC Casing
 Bentonite Chips
 2-inch ID Stainless Steel Casing
 Colorado 10-20 Sand Pack
 Stainless Steel Continuous Silt
 Screen

11/2/95

HAHN & ASSOCIATES, INC. 434 NW Sixth Avenue Portland, Oregon (503) 796-0717				MONITORING WELL NUMBER OWRD # 84231				MW-3-56					
PROJECT: Northwest Natural Gas Co. Gasco Facility Portland, Oregon				HAI LOGGER: Rob Ede				DRILL START	DRILL FINISH				
PROJECT: 2708				SAMPLING METHOD: Core Barrel				Time: 8:00	Time: 11:00				
PROJECT: 2708				DRILLING METHOD: 6 1/4-inch ID Hollow Stem Auger				Date: 1-Nov-95	Date: 1-Nov-95				
PROJECT: 2708				EQUIPMENT TYPE: B-59 Mobile Drill									
PROJECT: 2708				DRILLER: Brad James									
PROJECT: 2708				DRILLING CONTRACTOR: Geo-Tech Explorations									
WELL CONSTRUCTION DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHs (ppm)	SPT (blows/0.5 feet)	RECOVERY (%)	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	BORING DIAMETER: 10-inch	CASING DIAMETER: 2-inch ID	SURFACE ELEVATION: 31.20 feet MSL	TOP OF CASING ELEVATION: 34.07 feet MSL
SOIL DESCRIPTION													
Steel Monument													
-3													
-2													
-1													
Ground surface													
Concrete													
2-inch ID Blank PVC Casing													
M3-01 758 1.7													
1													
2													
11 0 3													
12 0 4													
15 0 4													
5													
M3-02 810 251 16 100													
M3-03 812 282 17 70													
14 0 6													
7													
M3-04 817 9 100 8													
247 11 100													
17 50 9													
10													
11													
50/3" 0 12													
50/3" 0 13													
14													
15													
M3-05 840 16 100													
59.7 38 100 16													
50/3" 0 17													
11/1/95													
M3-06 850 12 100 18													
15.9 7 30													
4 0 19													
17 100													
M3-07 9:00 18 100 20													
Benotite Crout													
2-inch ID Blank Stainless Steel Casing													
Large Gravels.													
Sandy Silty GRAVEL (5.0-6.5 feet bgs) - brown with black tarry staining, moist, hydrocarbon odor, sheen, pockets of moist tar.													
GM													
No Recovery (2.5-4.0 feet bgs).													
Sandy Silty GRAVEL (7.5-9.0 feet bgs) - black and tarry, moist, hydrocarbon odor, sheen.													
Sandy GRAVEL with silt (15.0-16.5 feet bgs) - black, slightly moist, loose, hydrocarbon odor, sheen, brick and wood fragments.													
GM													
Sandy GRAVEL (17.5-19.0 feet bgs) - olive grey, wet, loose, slight hydrocarbon odor, slight sheen, brick and wood fragments.													
GP													
Sandy Gravel (19.0-20.5 feet bgs) - as above, hydrocarbon odor, sheen.													

Hahn & Associates, Inc.
 434 NW Sixth Avenue
 Portland, Oregon
 (503) 796-0717

PROJECT:
 Northwest Natural Gas Co.
 Gasco Facility
 Portland, Oregon

PROJECT: 2708

MONITORING WELL NUMBER **MW-3-56**
OWRD # 84231

HAI LOGGER: Rob Ede

SAMPLING METHOD: Core Barrel

DRILLING METHOD: 6 1/4-inch ID Hollow Stem Auger

EQUIPMENT TYPE: B-59 Mobile Drill

DRILLER: Brad James

DRILLING CONTRACTOR: Geo-Tech Explorations

DRILL	DRILL
START	FINISH
Time:	Time:
8:00	11:00
Date:	Date:
1-Nov-95	1-Nov-95

WELL CONSTRUCTION DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHs (ppm)	SPT (blows/0.5 feet)	RECOVERY (%)	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	BORING DIAMETER: 10-inch
										CASING DIAMETER: 2-inch ID
										SURFACE ELEVATION: 31.20 feet MSL
										TOP OF CASING ELEVATION: 34.07 feet MSL
										SOIL DESCRIPTION

Bent. Bentonite Grout 2-inch ID Blank Stainless Steel Casing			7.9		20	100			ML GP ML SP SM	<p>SILT with some gravel (20.5-21.0 feet bgs) - brown, moist, stiff, slight hydrocarbon odor, sheen.</p> <p>SILT with gravel (21.0-25.0 feet bgs) - black tarry substance, moist to wet, hydrocarbon odor, sheen, 22.5-23.0 feet bgs is wet and tarry.</p> <p>Sandy SILT (25.0-29.9 feet bgs) - olive grey with orange oxidized zones, moist, no hydrocarbon odor, no sheen, sand lens at 25.5 feet bgs.</p> <p>SAND (29.9-34.0 feet bgs) - olive grey, wet, loose, medium grained, slight hydrocarbon odor, slight sheen, sand lens at 25.5 feet bgs.</p> <p>SAND (34.0-35.0 feet bgs) - brown, wet, loose, fine grained, no hydrocarbon odor, no sheen, thin silt lenses present.</p> <p>SAND (35.0-37.5 feet bgs) - olive grey, wet, loose, poorly graded, fine grained, no hydrocarbon odor, no sheen.</p> <p>SAND (37.5-39.0 feet bgs) - brown, wet, medium dense, fine grained, no hydrocarbon odor, no sheen, silt layers</p> <p>Silty SAND (39.0-40.0 feet bgs) - brown, moist to wet, dense, fine grained, no hydrocarbon odor, no sheen.</p>
					8	20		21		
								22		
	M3-08	910						23		
			45.7					24		
								25		
								26		
								27		
	M3-09	915						28		
			5.8					29		
								30		
								31		
	M3-10	925						32		
			9.8					33		
								34		
	M3-11	930						35		
			2.8					36		
								37		
	M3-12	955						38		
			9.8					39		
M3-13	1000						40			
		5.9								

WELL CONSTRUCTION DETAILS			HEADSPACE (ppm)	LAB RESULTS TOTAL PAHs (ppm)	SPT (blows/0.5 feet)	RECOVERY (%)	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	BORING DIAMETER: 10-inch	
SAMPLE NUMBER*	TIME	DRILL START								DRILL FINISH	
HAI LOGGER: Rob Ede			SAMPLING METHOD: Core Barrel		DRILLING METHOD: 6 1/4-inch ID Hollow Stem Auger		EQUIPMENT TYPE: B-59 Mobile Drill		DRILLER: Brad James		Date: 1-Nov-95
PROJECT: Northwest Natural Gas Co. Gasco Facility Portland, Oregon			DRILLING CONTRACTOR: Geo-Tech Explorations		DRILLER: Brad James		EQUIPMENT TYPE: B-59 Mobile Drill		DRILLER: Brad James		Date: 1-Nov-95
PROJECT: 2708			DRILLING CONTRACTOR: Geo-Tech Explorations		DRILLER: Brad James		EQUIPMENT TYPE: B-59 Mobile Drill		DRILLER: Brad James		Date: 1-Nov-95
SOIL DESCRIPTION										BORING DIAMETER: 10-inch	
SOIL DESCRIPTION										CASING DIAMETER: 2-inch ID	
SOIL DESCRIPTION										SURFACE ELEVATION: 31.20 feet MSL	
SOIL DESCRIPTION										TOP OF CASING ELEVATION: 34.07 feet MSL	
SOIL DESCRIPTION										SOIL DESCRIPTION	
SOIL DESCRIPTION										SAND (40.0-41.5 feet bgs) - olive grey, wet, loose, medium grained, no hydrocarbon odor, no sheen.	
SOIL DESCRIPTION										SAND (41.5-45.0 feet bgs) - olive grey, wet, fine grained, silt layers.	
SOIL DESCRIPTION										SAND (45.0-49.0 feet bgs) - olive grey, wet, loose, poorly graded, medium grained, no hydrocarbon odor, no sheen.	
SOIL DESCRIPTION										SAND (49.0-50.0 feet bgs) - as above, silt layers, no hydrocarbon odor, no sheen.	
SOIL DESCRIPTION										SAND (50.0-55.0 feet bgs) - olive grey, wet, loose, poorly graded, medium grained, no hydrocarbon odor, no sheen, olive grey silt layers. Heaving sands reported by driller.	
SOIL DESCRIPTION										Boring terminated at 56.5 feet bgs Boring sampled to 56.5 feet Monitoring well installed to 55 feet bgs	
SOIL DESCRIPTION										Materials: 10 feet 2-inch diameter, 0.010-inch PVC slotted screen 6.5 feet 2-inch diameter PVC blank casing 39.5 feet 2-inch diameter stainless steel blank casing 12 50# bags 10/20 sand 3 50# bags bentonite chips 4 bags bentonite grout 1 end cap 1 locking cap above-grade steel monument 3 guard posts	
SOIL DESCRIPTION										* Sample Prefix Number is 2708-951101-	

HAHN & ASSOCIATES, INC. 434 NW Sixth Avenue Portland, Oregon (503) 796-0717				MONITORING WELL NUMBER				MW-4-35																																																																																																																																																																																																										
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PROJECT: 2708				SAMPLING METHOD: Not Sampled			Time: 10:30	Time: 13:17																																																																																																																																																																																																										
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				DRILLER: Brad James			Date: 31-Oct-95	Date: 31-Oct-95																																																																																																																																																																																																										
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<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 10%; text-align: center;">21</td> <td style="width: 10%;"></td> <td rowspan="10" style="vertical-align: top; padding: 5px;"> Boring terminated at 35.0 feet bgs Monitoring well installed to 35.0 feet bgs Materials: 10 feet 2-inch diameter, 0.010-inch stainless steel slotted screen 14 feet 2-inch diameter stainless steel blank casing 8 feet 2-inch diameter PVC blank casing 11 50# bags 10/20 sand 14 50# bags bentonite chips 1 end cap 1 locking cap above-grade steel monument 3 guard posts </td> </tr> <tr><td style="text-align: center;">22</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr> <tr><td style="text-align: center;">23</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr> <tr><td style="text-align: center;">24</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr> <tr><td style="text-align: center;">25</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr> <tr><td style="text-align: center;">26</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr> <tr><td style="text-align: center;">27</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr> <tr><td style="text-align: center;">28</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr> <tr><td style="text-align: center;">29</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr> <tr><td style="text-align: center;">30</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr> <tr><td style="text-align: center;">31</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr> <tr><td style="text-align: center;">32</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr> <tr><td style="text-align: center;">33</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr> <tr><td style="text-align: center;">34</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr> <tr><td style="text-align: center;">35</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr> <tr><td style="text-align: center;">36</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr> <tr><td style="text-align: center;">37</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr> <tr><td style="text-align: center;">38</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr> <tr><td style="text-align: center;">39</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr> <tr><td style="text-align: center;">40</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr> </table>										21										Boring terminated at 35.0 feet bgs Monitoring well installed to 35.0 feet bgs Materials: 10 feet 2-inch diameter, 0.010-inch stainless steel slotted screen 14 feet 2-inch diameter stainless steel blank casing 8 feet 2-inch diameter PVC blank casing 11 50# bags 10/20 sand 14 50# bags bentonite chips 1 end cap 1 locking cap above-grade steel monument 3 guard posts	22										23										24										25										26										27										28										29										30										31										32										33										34										35										36										37										38										39										40									
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Hahn & Associates, Inc.
 434 NW Sixth Avenue
 Portland, Oregon
 (503) 796-0717

MONITORING WELL NUMBER

MW-4-57

OWRD # 84229

PROJECT:
 Northwest Natural Gas Co.
 Gasco Facility
 Portland, Oregon

HAI LOGGER: Rob Ede
SAMPLING METHOD: 3-inch Split Spoon/Core Barrel
DRILLING METHOD: 6 1/4-inch ID Hollow Stem Auger
EQUIPMENT TYPE: B-59 Mobile Drill
DRILLER: Brad James

DRILL
DRILL
START
FINISH
Time:
Time:
Date:
Date:

PROJECT: 2708

DRILLING CONTRACTOR: Geo-Tech Explorations
 30-Oct-95 30-Oct-95

WELL CONSTRUCTION DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHs (ppm)	SPT (blows/0.5 feet)	RECOVERY (%)	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	BORING DIAMETER:	CASING DIAMETER:	SURFACE ELEVATION:	TOP OF CASING ELEVATION:
										10-inch	2-inch ID	31.7 feet MSL	34.53 feet MSL
SOIL DESCRIPTION													

														Ground surface
	M4-01	1005	1.9	195										Surface: Silty SAND with gravel - brown, moist, pieces of brick, grass covered area, no hydrocarbon odor, no sheen.
										SM				
					50/5.5"	60								Silty Sandy GRAVEL (2.5 feet bgs) - brown, moist, well graded, no hydrocarbon odor, no sheen.
										GM				
						23	70							Sandy GRAVEL (5.0-6.5 feet bgs) - dry, loose, poorly graded, no hydrocarbon odor, no sheen.
						27	0			GP				
						27	0							
	M4-02	1035		-	4	100								Silty GRAVEL with sand (7.5-8.5 feet bgs) - brown, moist, well graded, no hydrocarbon odor, no sheen.
			2.8		50/5.5"	50				GM				
														Concrete (8.5-9.5 feet bgs)
					38	0				GM				
														No recovery (12.5-14.5 feet bgs)
					7	0								
					6	0								
					6	0								
					5	0								
	M4-03	1104		-	2	100								Silty GRAVEL with sand (15.0-16.5 feet bgs) - olive grey with some black staining, wet, well graded, slight hydrocarbon odor, slight sheen.
					4	0								
					5	0								
														Silty GRAVEL with sand (16.5-20 feet bgs) - as above, moist, hydrocarbon odor, slight sheen, pieces of brick, switch to core barrel sampler.
	M4-04	1110		-										
			10.2							GM				

HAHN & ASSOCIATES, INC. 434 NW Sixth Avenue Portland, Oregon (503) 796-0717				MONITORING WELL NUMBER OWRD # 84229		MW-4-57				
PROJECT: Northwest Natural Gas Co. Gasco Facility Portland, Oregon				HAI LOGGER: SAMPLING METHOD: DRILLING METHOD: EQUIPMENT TYPE DRILLER: DRILLING CONTRACTOR:		DRILL START Time: 10:15 Date: 30-Oct-95	DRILL FINISH Time: 13:15 Date: 30-Oct-95			
PROJECT: 2708				HAI LOGGER: Rob Ede						
PROJECT: 2708				SAMPLING METHOD: 3-inch Split Spoon/Core Barrel						
PROJECT: 2708				DRILLING METHOD: 6 1/4-inch ID Hollow Stem Auger						
PROJECT: 2708				EQUIPMENT TYPE: B-59 Mobile Drill						
PROJECT: 2708				DRILLER: Brad James						
PROJECT: 2708				DRILLING CONTRACTOR: Geo-Tech Explorations						
WELL CONSTRUCTION DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHs (ppm)	SPT (blows/0.5 feet)	RECOVERY (%)	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	BORING DIAMETER: CASING DIAMETER: SURFACE ELEVATION: TOP OF CASING ELEVATION:
Bentonite Slurry 2-inch ID Blank Stainless Steel Casing	M4-05	1115		-			21			10-inch 2-inch ID 31.7 feet MSL 34.53 feet MSL
			7.0				22		ML	SILT with sand and gravel (20.0-25.0 feet bgs) - brown, moist, slightly plastic, no hydrocarbon odor, no sheen.
							23		ML	
							24		ML	
							25		ML	
	M4-06	1135		3,261			26		SM	Silty SAND (25.0-27.0 feet bgs) - olive grey, moist to wet, wood fragments, hydrocarbon odor, sheen.
				10.2			27		ML	
							28		ML	Sandy SILT (27.0-28.0 feet bgs) - olive grey with brown and orange oxidation spots, root zones, no hydrocarbon odor, no sheen.
	M4-07	1140		-			29	10/30/95	SM	Silty SAND (28.0-30.0 feet bgs) - olive grey with brown mottling, moist to wet, fine grained, root zones, no hydrocarbon odor, no sheen.
				2.1			30		SM	
							31		SP	SAND (30.0-32.5 feet bgs) - olive grey, wet, loose, poorly graded, fine grained, root zones, hydrocarbon odor, sheen.
							32		SP	
							33		ML	SILT (32.5-33.0 feet bgs) - brown with orange oxidized zones, moist, slightly plastic, no hydrocarbon odor, no sheen.
	M4-09	1155		-			34		SM	Silty SAND (33.0-33.5 feet bgs) - brown with bright orange oxidized zones, moist to wet, dense, fine grained.
				2.6			35		ML	SILT (33.5-35.0 feet bgs) - olive grey, moist, stiff, no hydrocarbon odor, no sheen.
							36		ML	
							37		ML	SILT with fine sand (35.0-39.0 feet bgs) - olive grey, moist, stiff, root zones, no hydrocarbon odor, no sheen.
							38		ML	
							39		ML	
	M4-10	1210		-	-		40		SP	SAND (39.0-40.0 feet bgs) - olive grey, wet, loose, medium grained, no hydrocarbon odor, no sheen.

WELL CONSTRUCTION DETAILS			SPT (blows/0.5 feet)	RECOVERY (%)	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	BORING DIAMETER: 10-inch	
SAMPLE NUMBER*	TIME	HEADSPACE (ppm)						LAB RESULTS TOTAL PAHs (ppm)	CASING DIAMETER: 2-inch ID
PROJECT: 2708			DRILLING CONTRACTOR: Geo-Tech Explorations		DRILLER: Brad James		Date: 27-Oct-95		
PROJECT: Northwest Natural Gas Co. Gasco Facility Portland, Oregon			SAMPLING METHOD: Split Spoon/Core Barrel		DRILLING METHOD: 6 1/4-inch ID Hollow Stem Auger		Time: 13:03 15:00		
HAI LOGGER: Rob Ede			EQUIPMENT TYPE: B-59 Mobile Drill		Date: 27-Oct-95		Date: 27-Oct-95		
Hahn & Associates, Inc. 434 NW Sixth Avenue Portland, Oregon (503) 796-0717			MONITORING WELL NUMBER OWRD # 84228		MW-5-32				
Steel Monument					-3				
					-2				
					-1		Ground surface		
Concrete			M5-01 1306 1.4		1		Surface: Silty GRAVEL - brown, moist, well graded, no hydrocarbon odor, no sheen.		
			1107		2				
					3		GP		
			50/5" 50		4		GRAVEL (2.5-3.0 feet bgs) - grey, damp, loose, poorly graded, no hydrocarbon odor, no sheen.		
					5				
			M5-02 1320		6		Silty GRAVEL (5.0-6.0 feet bgs) - brown, moist, well graded, no hydrocarbon odor, no sheen.		
			874		7		GM		
					8				
					9		GRAVEL (7.5-9.0 feet bgs) - brown, wet, loose, well graded, no hydrocarbon odor, no sheen.		
					10				
			M5-03 1330		11		GP		
			279		12		GRAVEL with coarse sand and silt (10.0-13.0 feet bgs) - brown, wet, no hydrocarbon odor, no sheen.		
					13		Switch to core barrel sampler.		
			M5-04 1340		14		SAND with lampblack (13.0-15.0 feet bgs) - black, dry, hard, fine grained, hydrophobic, hydrocarbon odor.		
			383		15				
					16		SP		
			M5-05 1350 1,942		17		SAND (15.0-20.0 feet bgs) - dark grey, moist, medium dense, poorly graded, fine grained, pieces of bark, hydrocarbon odor?, olive grey sandy silt on core bottom.		
			81.1		18				
					19				
					20				

Hahn & Associates, Inc.

434 NW Sixth Avenue
Portland, Oregon
(503) 796-0717

MONITORING WELL NUMBER

MW-5-32

OWRD # 84228

PROJECT:
Northwest Natural Gas Co.
Gasco Facility
Portland, Oregon

HAI LOGGER: Rob Ede
SAMPLING METHOD: Split Spoon/Core Barrel
DRILLING METHOD: 6 1/4-inch ID Hollow Stem Auger
EQUIPMENT TYPE: B-59 Mobile Drill
DRILLER: Brad James
DRILLING CONTRACTOR: Geo-Tech Explorations

DRILL START	DRILL FINISH
Time: 13:03	Time: 15:00
Date: 27-Oct-95	Date: 27-Oct-95

PROJECT: 2708

WELL CONSTRUCTION DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHs (ppm)	SPT (blows/0.5 feet)	RECOVERY (%)	DEPTH (feet)	GROUNDWATER	STRATA (USCS)
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BORING DIAMETER: 10-inch
CASING DIAMETER: 2-inch ID
SURFACE ELEVATION: 25.1 feet MSL
TOP OF CASING ELEVATION: 28.05 feet MSL

SOIL DESCRIPTION

Colorado 10-20 Sand Pack 2-inch ID 0.020-inch PVC Slotted Screen	M5-06	1357		-	↑	↑	21	ML
			117					
	M5-07	1400	18.1	0.91	↓	↓	22	
					↑	↑	23	
					↓	↓	24	
	M5-08	1406		-	↓	↓	25	
				62.1	↑	↑	26	
					↓	↓	27	
					↑	↑	28	
					↓	↓	29	
Cap	M5-09	1425		-	↓	↓	29	SP
							30	
					1	100	31	
					3	100	31	
	M5-10	1448		ND	4	70	32	
			29.4				33	
							34	
							35	
							36	
							37	
							38	
							39	
							40	

Sandy SILT (20.0-22.0 feet bgs) - brown with orange mottling, moist, non-plastic, no hydrocarbon odor, no sheen, some root zones.

SAND (22.5-22.5 feet bgs) - brown, wet, fine grained, no hydrocarbon odor, no sheen.

SAND (22.5-23.5 feet bgs) - as above, no hydrocarbon odor, no sheen.

Silty SAND (23.5-25.0 feet bgs) - brown with orange oxidation spots, wet, loose, no hydrocarbon odor, no sheen.

SAND (25.0-26.5 feet bgs) - brown with orange oxidation spots, wet, loose, fine grained, some thin silt layers no hydrocarbon odor, no sheen.

SAND (26.5-27.5 feet bgs) - olive grey, wet, loose, poorly graded, some thin silt layers, no hydrocarbon odor, no sheen.

SAND with thin silt layers (27.5-30.0 feet bgs) - olive grey, wet, loose, no hydrocarbon odor, no sheen.

SAND with thin silt (30.0-32.0 feet bgs) - olive grey, wet, loose, poorly graded, fine grained, no hydrocarbon odor, no sheen.

Boring terminated at 32.0 feet bgs
Boring sampled to 32.0 feet
Monitoring well installed to 32.0 feet bgs

Materials:
10 feet 2-inch diameter, 0.020-inch PVC slotted screen
21 feet 2-inch diameter PVC blank casing
12.5 50# bags 10/20 sand
10 50# bags 3/8-inch bentonite chips
1 end cap
1 locking cap
above-grade steel monument
3 guard posts

* Sample Prefix Number is 2708-951027-

HAHN & ASSOCIATES, INC.

434 NW Sixth Avenue

Portland, Oregon

(503) 796-0717

MONITORING WELL NUMBER

MW-6-32

OWRD # 84239

PROJECT:

Northwest Natural Gas Co.

Gasco Facility

Portland, Oregon

PROJECT: 2708

HAI LOGGER:

Rob Ede

SAMPLING METHOD:

Not Sampled

DRILLING METHOD:

6 1/4-inch ID Hollow Stem Auger

EQUIPMENT TYPE

B-59 Mobile Drill

DRILLER:

Brad James

DRILLING CONTRACTOR:

Geo-Tech Explorations

DRILL

DRILL

START

FINISH

Time:

Time:

11:40

14:00

Date:

Date:

9-Nov-95

9-Nov-95

WELL CONSTRUCTION DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS	TOTAL PAHs (ppm)	SPT (blows/0.5 feet)	RECOVERY (%)	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	BORING DIAMETER: 10-inch	
											CASING DIAMETER: 2-inch ID	
											SURFACE ELEVATION: 35.8 feet MSL	
											TOP OF CASING ELEVATION: 35.51 feet MSL	
											SOIL DESCRIPTION	
Colorado 10-20 Sand Pack 2-inch ID 0.020 Stainless Steel Continuous Slotted Screen								21			Boring terminated at 32.0 feet bgs Monitoring well installed to 32.0 feet bgs Materials: 15 feet 2-inch diameter, 0.020-inch stainless steel slotted screen 5 feet 2-inch diameter stainless steel blank casing 16 feet 2-inch diameter PVC blank casing 9.5 50# bags 10/20 sand 12 50# bags bentonite chips 1 end cap 1 locking cap flush steel monument 3 guard posts	
								22				
								23				
								24				
								25				
								26				
								27				
								28				
								29				
								30				
Cap								31				
								32				
								33				
								34				
								35				
								36				
								37				
								38				
								39				
								40				

HAHN & ASSOCIATES, INC.

434 NW Sixth Avenue

Portland, Oregon

(503) 796-0717

MONITORING WELL NUMBER

MW-6-61

OWRD # 84236

(ABANDONED)

PROJECT:

Northwest Natural Gas Co.

Gasco Facility

Portland, Oregon

PROJECT: 2708

HAI LOGGER:

Rob Ede

SAMPLING METHOD:

4-inch Core Barrel

DRILLING METHOD:

6 1/4-inch ID Hollow Stem Auger

EQUIPMENT TYPE

B-59 Mobil Drill

DRILLER:

Brad James

DRILLING CONTRACTOR:

Geo-Tech Explorations

DRILL

DRILL

START

FINISH

Time:

Time:

8:50

11:45

Date:

Date:

7-Nov-95

7-Nov-95

WELL CONSTRUCTION DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHs (ppm)	CORE INTERVAL	RECOVERY (%)	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	SOIL DESCRIPTION
							21			SAND (20.0-24.0 feet bgs) - as above, wet, hydrocarbon odor, no sheen.
							22			
	M6-06	945		-			23			SAND (25.0-30.5 feet bgs) - as above, wet, hydrocarbon odor, brown product saturated from 28-30.5 feet bgs, also thin silt layers.
			9.1				24		SP	
							25			SILT (30.5-34.0 feet bgs) - green, stiff, root zones, no product, wood fragments, slight sheen?.
							26			
							27			
							28			
	M6-07	1000		-			29			SILT (35.0-38.0 feet bgs) - green with brown motting (35.0-36.0 feet bgs), olive grey (36.0-38.0 feet bgs), moist, stiff, root zones, no sheen, no product.
				115			30			
							31			Sandy SILT (38.0-39.0 feet bgs) - olive grey, stiff, no sheen. Sandy SILT (39.0-40.0 feet bgs) - olive grey, wet, stiff.
							32			
							33			
							34			
	M6-08	1015		20,614			35			Sandy SILT (38.0-39.0 feet bgs) - olive grey, stiff, no sheen. Sandy SILT (39.0-40.0 feet bgs) - olive grey, wet, stiff.
				634			36		ML	
							37			Sandy SILT (38.0-39.0 feet bgs) - olive grey, stiff, no sheen. Sandy SILT (39.0-40.0 feet bgs) - olive grey, wet, stiff.
							38			
	M6-09	1020		-			39			Sandy SILT (38.0-39.0 feet bgs) - olive grey, stiff, no sheen. Sandy SILT (39.0-40.0 feet bgs) - olive grey, wet, stiff.
				23.9			40			
							40			
	M6-10	1040		1.5			40			
				14.8			40			

Bentonite Slurry
2-inch ID Blank Stainless Steel Casing

WELL CONSTRUCTION DETAILS			HEADSPACE (ppm)	LAB RESULTS TOTAL PAHs (ppm)	CORE INTERVAL	RECOVERY (%)	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	BORING DIAMETER: 10-inch		
SAMPLE NUMBER*	TIME	CASING DIAMETER: 2-inch ID										
HAHN & ASSOCIATES, INC. 434 NW Sixth Avenue Portland, Oregon (503) 796-0717			MONITORING WELL NUMBER OWRD # 84236					MW-6-61 (ABANDONED)		HAI LOGGER: Rob Ede	DRILL START	DRILL FINISH
PROJECT: Northwest Natural Gas Co. Gasco Facility Portland, Oregon			SAMPLING METHOD: 4-inch Core Barrel DRILLING METHOD: 6 1/4-inch ID Hollow Stem Auger EQUIPMENT TYPE: B-59 Mobil Drill DRILLER: Brad James					Time: 8:50 Date: 7-Nov-95		Time: 11:45 Date: 7-Nov-95		
PROJECT: 2708			DRILLING CONTRACTOR: Geo-Tech Explorations									
										SOIL DESCRIPTION		
Bentonite Slurry Bentonite Chip Seal 2-inch ID Blank Stainless Steel Casing 20/40 Sand Colorado 10-20 Sand Pack 2-inch ID 0.020-inch Stainless Steel Slotted Screen										SILT (40.0-49.0 feet bgs) - olive grey, moist, medium stiff, fine grained sand lenses, no sheen.		
	M6-11	1050	14.8				41		ML			
							42					
							43					
							44					
							45					
							46					
							47					
							48					
	M6-12	1100	12.8				49		SP	SAND (49.0-52.0 feet bgs) - olive grey, wet, loose, poorly graded, fine grained, no sheen.		
							50					
							51					
							52					
							53					
	M6-13	1120	8.4				54		SAND (52.0-55.0 feet bgs) - as above, thin, brown silt layers, no sheen.			
							55					
							56					
							57					
	M6-14	1140	7.8				58		SAND (55.0-60.0 feet bgs) - as above, thin olive grey silt layers, no sheen			
							59					
							60					

HAHN & ASSOCIATES, INC.
 434 NW Sixth Avenue
 Portland, Oregon
 (503) 796-0717

MONITORING WELL NUMBER **MW-6-61**
OWRD # 84236 **(ABANDONED)**

PROJECT:
 Northwest Natural Gas Co.
 Gasco Facility
 Portland, Oregon

HAI LOGGER:	Rob Ede	DRILL START	DRILL FINISH
SAMPLING METHOD:	4-inch Core Barrel	Time:	Time:
DRILLING METHOD:	6 1/4-inch ID Hollow Stem Auger	8:50	11:45
EQUIPMENT TYPE	B-59 Mobil Drill	Date:	Date:
DRILLER:	Brad James	7-Nov-95	7-Nov-95
DRILLING CONTRACTOR:	Geo-Tech Explorations		

PROJECT: 2708

WELL CONSTRUCTION DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHs (ppm)	CORE INTERVAL	RECOVERY (%)	DEPTH (feet)	GROUNDWATER	STRATA (USCS)
Sand							61		
Cap							62		
							63		
							64		
							65		
							66		
							67		
							68		
							69		
							70		
							71		
							72		
							73		
							74		
							75		
							76		
							77		
							78		
							79		
							80		

BORING DIAMETER:	10-inch
CASING DIAMETER:	2-inch ID
SURFACE ELEVATION:	35.8 feet MSL
TOP OF CASING ELEVATION:	34.50 feet MSL

SOIL DESCRIPTION

Boring terminated at 61.0 feet bgs
 Boring sampled to 60.0 feet
 Monitoring well installed to 61.0 feet bgs
 Well depth is 61.0 feet below top of casing

Materials:
 10 feet 2-inch diameter, 0.010-inch stainless steel slotted screen
 35 feet 2-inch diameter stainless steel blank casing
 15 feet 2-inch diameter PVC casing
 1 50# bags 20/40 sand
 11 50# bags 10/20 sand
 5 50# bags bentonite chips
 5 bags bentonite grout
 1 end cap
 1 locking cap
 Flush steel monument

* Sample Prefix Number is 2708-951107-

HAHN & ASSOCIATES, INC.
 434 NW Sixth Avenue
 Portland, Oregon
 (503) 796-0717

MONITORING WELL NUMBER MW-8-29
 OWRD # 84226

PROJECT:
 Northwest Natural Gas Co.
 Gasco Facility
 Portland, Oregon

HAI LOGGER: Rob Ede
SAMPLING METHOD: Not Sampled
DRILLING METHOD: 6 1/4-inch ID Hollow Stem Auger
EQUIPMENT TYPE: B-59 Mobile Drill
DRILLER: Brad James
DRILLING CONTRACTOR: Geo-Tech Explorations

DRILL START	DRILL FINISH
Time: 8:30	Time: 11:15
Date: 26-Oct-95	Date: 26-Oct-95

WELL CONSTRUCTION DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHs (ppm)	SPT (blows/0.5 feet)	RECOVERY (%)	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	BORING DIAMETER: 10-inch	CASING DIAMETER: 2-inch ID	SURFACE ELEVATION: 36.5 feet MSL	TOP OF CASING ELEVATION: 39.09 feet MSL
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										SOIL DESCRIPTION			
Colorado 10-20 Sand Pack	2-inch ID 0.020-inch Stainless Steel Slotted Screen												
			Cap										

Boring terminated at 29.0 feet bgs
 Monitoring well installed to 29.0 feet bgs

Materials:
 10 feet 2-inch diameter, 0.010-inch stainless steel slotted screen
 13 feet stainless steel blank casing
 3 feet 2-inch diameter PVC blank casing
 12 50# bags 10/20 sand
 13 50# bags 3/8-inch bentonite chips
 1 end cap
 1 locking cap
 above-grade steel monument
 3 guard posts

HAHN & ASSOCIATES, INC.
 434 NW Sixth Avenue
 Portland, Oregon
 (503) 796-0717

MONITORING WELL NUMBER **MW-8-56**
OWRD # 84226

HAI LOGGER: Rob Ede

SAMPLING METHOD: 3-inch Split Spoon/Core Barrel

DRILLING METHOD: 6 1/4-inch ID Hollow Stem Auger

EQUIPMENT TYPE B-59 Mobil Drill

DRILLER: Brad James

DRILLING CONTRACTOR: Geo-Tech Explorations

PROJECT: Northwest Natural Gas Co.
 Gasco Facility
 Portland, Oregon

PROJECT: 2708

DRILL START: 905
 DRILL FINISH: 1410
 Date: 25-Oct-95 Date: 25-Oct-95

BORING DIAMETER: 10-inch
 CASING DIAMETER: 2-inch ID
 SURFACE ELEVATION: 36.5 feet MSL
 TOP OF CASING ELEVATION: 39.13 feet MSL

SOIL DESCRIPTION

WELL CONSTRUCTION DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHs (ppm)	SPT (blows/0.5 feet)	RECOVERY (%)	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	SOIL DESCRIPTION	
3/4-inch Bentonite Chips 2-inch ID Blank Stainless Steel Casing							21		GM	Silty GRAVEL (20.0-22.0 feet bgs) - brown, wet, brick and wood fragments, no hydrocarbon odor, no sheen.	
	M8-06	1034					22				
				5.0							
	M8-07	1044			9	100	23		SP lampblack	SAND (22.0-25.0 feet bgs) - black, wet, loose, coarse grained, lampblack throughout, hydrocarbon odor, sheen, becoming solid and brittle with a slight sheen from 23.0-23.3 feet bgs.	
				13.3	50/3"	100		24			
								25			
								26		ML	Tarry SILT (25.0-27.5 feet bgs) - black, wet, stiff, mostly tar, strong sheen, vegetation throughout sample.
	M8-08	1115					27				
				225				28			
								29			
								30			
								31			
								32			
								33			
								34			
	M8-09	1134						35			
				81.5				36			
								37			
								38		ML	
	M8-10	1152						39			
							40				

HAHN & ASSOCIATES, INC.
 434 NW Sixth Avenue
 Portland, Oregon
 (503) 796-0717

MONITORING WELL NUMBER
 OWRD # 84226

MW-8-56

PROJECT:
 Northwest Natural Gas Co.
 Gasco Facility
 Portland, Oregon

HAI LOGGER: Rob Ede
 SAMPLING METHOD: 3-inch Split Spoon/Core Barrel
 DRILLING METHOD: 6 1/4-inch ID Hollow Stem Auger
 EQUIPMENT TYPE: B-59 Mobil Drill
 DRILLER: Brad James

DRILL	DRILL
START	FINISH
Time:	Time:
905	1410
Date:	Date:
25-Oct-95	25-Oct-95

PROJECT: 2708

DRILLING CONTRACTOR: Geo-Tech Explorations

WELL CONSTRUCTION DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHs (ppm)	SPT (blows/0.5 feet)	RECOVERY (%)	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	BORING DIAMETER: 10-inch
										CASING DIAMETER: 2-inch ID
										SURFACE ELEVATION: 36.5 feet MSL
										TOP OF CASING ELEVATION: 39.13 feet MSL

SOIL DESCRIPTION

3/4-inch Bentonite Chips	2-inch ID Blank Stainless Steel Casing									ML	Sandy SILT (40.0-42.0 feet bgs) - as above.		
										SP	SAND (42-42.3 feet bgs) - olive grey, medium grained, black product saturated, less viscous than tar.		
										ML	SILT (42.3-42.8 feet bgs) - olive grey, medium grained, black product saturated.		
			M8-11	1202	112	8.1					SP	SAND (42.8-45 feet bgs) - olive grey, wet, loose, poorly graded, medium grained, no product, slight sheen.	
			M8-12	1245									SAND (45.0-47.5 feet bgs) - olive grey, wet, loose, poorly graded, medium grained, no sheen.
					43.7								
			M8-13	1314									SAND (47.5-50.0 feet bgs) - olive grey, wet, loose, poorly graded, medium grained, some thin silt layers, no sheen.
			M8-14	1320									SAND (50.0-54.0 feet bgs) - as above, no hydrocarbon odor, no sheen.
	Cap	M8-15	1400		0.64					SP	SAND (54.0-56.0 feet bgs) - as above, no hydrocarbon odor, no sheen.		

Colorado 10-20 Sand Pack

2-inch ID 0.020-inch Stainless Steel Slotted Screen

WELL CONSTRUCTION DETAILS		SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHs (ppm)	SPT (blows/0.5 feet)	RECOVERY (%)	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	MONITORING WELL NUMBER OWRD # 84226		MW-8-56	
HAHN & ASSOCIATES, INC. 434 NW Sixth Avenue Portland, Oregon (503) 796-0717		PROJECT: Northwest Natural Gas Co. Gasco Facility Portland, Oregon		HAI LOGGER: Rob Ede		SAMPLING METHOD: 3-inch Split Spoon/Core Barrel		DRILLING METHOD: 6 1/4-inch ID Hollow Stem Auger		EQUIPMENT TYPE: B-59 Mobil Drill		DRILL START	DRILL FINISH	
PROJECT: 2708		DRILLER: Brad James		DRILLING CONTRACTOR: Geo-Tech Explorations		Date: 25-Oct-95		Date: 25-Oct-95		BORING DIAMETER: 10-inch		CASING DIAMETER: 2-inch ID		
		SURFACE ELEVATION: 36.5 feet MSL		TOP OF CASING ELEVATION: 39.13 feet MSL		SOIL DESCRIPTION								
		61										Boring terminated at 56.0 feet bgs Boring sampled to 56.0 feet Monitoring well installed to 56.0 feet bgs		
		62										Materials: 10 feet 2-inch diameter, 0.020-inch stainless steel slotted screen 40.5 feet 2-inch diameter stainless steel blank casing 4.5 feet 2-inch diameter PVC blank casing 11 50# bags 10/20 sand 26 50# bags bentonite chips 1 end cap 1 locking cap above-grade steel monument 3 guard posts		
		63										* Sample Prefix Number is 2708-951025-		
		64												
		65												
		66												
		67												
		68												
		69												
		70												
		71												
		72												
		73												
		74												
		75												
		76												
		77												
		78												
		79												
		80												

HAHN & ASSOCIATES, INC.
 434 NW Sixth Avenue
 Portland, Oregon
 (503) 796-0717

MONITORING WELL NUMBER

MW-9-29

OWRD # 84223

PROJECT:
 Northwest Natural Gas Co.
 Gasco Facility
 Portland, Oregon
PROJECT: 2708

HAI LOGGER: Rob Ede
SAMPLING METHOD: 3-inch Split Spoon
DRILLING METHOD: 6 1/4-inch ID Hollow Stem Auger
EQUIPMENT TYPE: B-59 Mobile Drill
DRILLER: Brad James
DRILLING CONTRACTOR: Geo-Tech Explorations

DRILL START	DRILL FINISH
Time: 9:30	Time: 12:30
Date: 23-Oct-95	Date: 23-Oct-95

WELL CONSTRUCTION DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHs (ppm)	SPT (blows/0.5 feet)	RECOVERY (%)	DEPTH (feet)	GROUNDWATER	STRATA (USCS)
BORING DIAMETER: 10-inch OD									
CASING DIAMETER: 2-inch									
SURFACE ELEVATION: 37.9 feet MSL									
TOP OF CASING ELEVATION: 37.65 MSL									
SOIL DESCRIPTION									

Flush Monument Ground surface

Concrete Bentonite Chips 2-inch ID Blank PVC Casing 20-40 Colorado 10-20 Sand Pack	M9-01	855	0.4	21.5					1	GW	Surface: Sandy GRAVEL - grey gravel, olive grey sand, moist, non-plastic, well graded, no hydrocarbon odor, no sheen.	
									2			
						9	100			3	GM	Sandy, Silty GRAVEL (2.0-3.0 feet bgs) - brown, moist, loose, non-plastic, well graded, slight hydrocarbon odor, slight sheen.
	M9-02	935	5.5	-	15	100				4	SP	SAND (3.0-3.5 feet bgs) - brown, moist, loose, poorly graded, fine grained.
						14	50			5	ML	Gravelly SILT (3.5-4.5 feet bgs) - brown, moist, stiff, poorly graded, wire present, no hydrocarbon odor, no sheen.
	M9-03	940	0.7	-	5	100				6	SP	SAND (4.5-5.0 feet bgs) - brown, moist, loose, poorly graded, fine grained, no hydrocarbon odor, no sheen.
						7	70			7	ML	Sandy SILT (5.0-6.5 feet bgs) - orange/brown with black and blue/grey staining, moist, slight hydrocarbon odor?, sheen is blue/green in color.
						50/2"	0			8		
										9		
										10		
										11		CONCRETE
										12		Sandy SILT (11.5-13.0 feet bgs) - brown, moist to wet, slightly plastic, very fine sand, no hydrocarbon odor, no sheen.
	M9-05	1045		0.52	13	100				13		SILT (13.0-15.0 feet bgs) - brown, moist to wet, stiff, slightly plastic, no hydrocarbon odor, no sheen.
				6.7		8	30			14	ML	SILT (15.0-15.5 feet bgs) - as above, no hydrocarbon odor, no sheen.
						5	0			15		Sandy SILT (15.5-16.0 feet bgs) - brown, moist to wet, slightly stiff, no hydrocarbon odor, no sheen.
	M9-06	1055		-	3	100				16		
				8.8		4	100			17	SP	SAND with muscovite (16.0-17.0 feet bgs) - brown, wet, no hydrocarbon odor, no sheen.
						8	50			18		SAND (17.0-18.5 feet bgs) - as above, no hydrocarbon odor, no sheen.
						2	0			19		
						2	100			20	ML	SILT (18.5-20.0 feet bgs) - brown, moist to wet, stiff, no hydrocarbon odor, no sheen.
	M9-07	1120		-	3	100						
					6	100						
					2	100						
					3	100						
					5	100						
					2	100						
					4	100						
					8	100						

Hahn & Associates, Inc.
 434 NW Sixth Avenue
 Portland, Oregon
 (503) 796-0717

MONITORING WELL NUMBER

MW-9-29

OWRD # 84223

PROJECT:
 Northwest Natural Gas Co.
 Gasco Facility
 Portland, Oregon
PROJECT: 2708

HAI LOGGER: Rob Ede
SAMPLING METHOD: 3-inch Split Spoon
DRILLING METHOD: 6 1/4-inch ID Hollow Stem Auger
EQUIPMENT TYPE: B-59 Mobile Drill
DRILLER: Brad James
DRILLING CONTRACTOR: Geo-Tech Explorations

DRILL START	DRILL FINISH
Time: 9:30	Time: 12:30
Date: 23-Oct-95	Date: 23-Oct-95

WELL CONSTRUCTION DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHs (ppm)	SPT (blows/0.5 feet)	RECOVERY (%)	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	BORING DIAMETER: 10-inch OD
										CASING DIAMETER: 2-inch
										SURFACE ELEVATION: 37.9 feet MSL
										TOP OF CASING ELEVATION: 37.65 MSL

SOIL DESCRIPTION

Colorado 10-20 Sand Pack	2-inch ID 0.010-inch PVC Slotted Screen	Cap				2	100		GROUNDWATER	STRATA (USCS)	<p>SAND (20.0-24.0 feet bgs) - brown, wet, stiff, fine grained, muscovite present 20.0-21.5 feet bgs, no hydrocarbon odor, no sheen.</p> <p>Sandy SILT (24.0-25.0 feet bgs) - brown, moist to wet, stiff, no hydrocarbon odor, no sheen.</p> <p>SAND (25.0-26.0 feet bgs) - olive grey, wet, loose, fine grained, no hydrocarbon odor, no sheen.</p> <p>Sandy SILT (26.0-26.5 feet bgs) - brown, wet, stiff, slightly plastic, no hydrocarbon odor, no sheen.</p> <p>SAND (26.7-27.5 feet bgs) - brown, wet, loose, poorly graded, medium grained, no hydrocarbon odor, no sheen.</p> <p>SILT (27.5-28.0 feet bgs) - brown, moist to wet, stiff, no hydrocarbon odor, no sheen.</p> <p>Boring terminated at 29.0 feet bgs Boring sampled to 28.0 feet Monitoring well installed to 29.0 feet bgs</p> <p>Materials: 10 feet 2-inch diameter, 0.010-inch PVC slotted screen 18 feet 2-inch diameter PVC blank casing 1 50# bags 20/40 sand 12 50# bags 10/20 sand 10 50# bags bentonite chips 1 end cap 1 locking cap Flush steel monument</p> <p>* Sample Prefix Number is 2708-961023-</p>				
						3	100	21				SP			
			M9-08	1140				3				100			
						9.5		2				100	22	SP	
								2				100			
								9				90	23	ML	
								3				100			
			M9-09	1200				6				100	24	SP	
								16				100			
								25				90	25	ML	
								5				100			
								8				100	26	SP	
								12				70			
								3				100	27	ML	
			M9-10	1210				5				100			
						2.0		12				80	28	SP	
													29	ML	
													30		
													31		
							32								
							33								
							34								
							35								
							36								
							37								
							38								
							39								
							40								

HAHN & ASSOCIATES, INC.
 434 NW Sixth Avenue
 Portland, Oregon
 (503) 796-0717

MONITORING WELL NUMBER MW-10-25
OWRD # 84238

PROJECT:
 Northwest Natural Gas Co.
 Gasco Facility
 Portland, Oregon

HAI LOGGER:	Rob Ede	DRILL START	DRILL FINISH
SAMPLING METHOD:	Not Sampled	Time:	Time:
DRILLING METHOD:	6 1/4-inch ID Hollow Stem Auger	9:00	10:00
EQUIPMENT TYPE	B-59 Mobil Drill	Date:	Date:
DRILLER:	Brad James	9-Nov-95	9-Nov-95
DRILLING CONTRACTOR:	Geo-Tech Explorations		

PROJECT: 2708

WELL CONSTRUCTION DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHs (ppm)	SPT (blows/0.5 feet)	RECOVERY (%)	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	BORING DIAMETER: 10-inch
										CASING DIAMETER: 2-inch ID
										SURFACE ELEVATION: 36.5 feet MSL
										TOP OF CASING ELEVATION: 39.22 feet MSL

SOIL DESCRIPTION

Steel Monument							-3			Ground surface
							-2			
							-1			

Concrete 2-inch ID Blank PVC Casing Bentonite Chips 2-inch ID Blank Stainless Steel Casing Colorado 10-20 Sand Pack 20-Slot Stainless Steel Continuous Screen							1		See boring log for well MW-10-61 for soi description.
							2		
							3		
							4		
							5		
							6		
							7		
							8		
							9		
							10		
							11		
							12		
							13		
							14		
							15		
							16		
							17		
							18		
							19		
							20		

HAHN & ASSOCIATES, INC. 434 NW Sixth Avenue Portland, Oregon (503) 796-0717				MONITORING WELL NUMBER MW-10-25 OWRD # 84238						
PROJECT: Northwest Natural Gas Co. Gasco Facility Portland, Oregon				HAI LOGGER: Rob Ede		DRILL START	DRILL FINISH			
PROJECT: 2708				SAMPLING METHOD: Not Sampled		Time: 9:00	Time: 10:00			
				DRILLING METHOD: 6 1/4-inch ID Hollow Stem Auger		Date: 9-Nov-95	Date: 9-Nov-95			
				EQUIPMENT TYPE: B-59 Mobil Drill						
				DRILLER: Brad James						
				DRILLING CONTRACTOR: Geo-Tech Explorations						
WELL CONSTRUCTION DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHs (ppm)	SPT (blows/0.5 feet)	RECOVERY (%)	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	BORING DIAMETER: 10-inch
										CASING DIAMETER: 2-inch ID
										SURFACE ELEVATION: 36.5 feet MSL
										TOP OF CASING ELEVATION: 39.22 feet MSL
										SOIL DESCRIPTION
Colorado 10-20 Sand Pack 20-Slot Stainless Steel Screen Cap										
							21			
							22			
							23			
							24			
							25			
							26			
							27			
							28			
							29			
							30			
							31			
							32			
							33			
							34			
							35			
							36			
							37			
							38			
							39			
							40			

Boring terminated at 25.0 feet bgs
 Monitoring well installed to 25.0 feet bgs

Materials:
 10 feet 2-inch diameter, 0.020-inch stainless steel slotted screen
 5 feet 2-inch diameter PVC blank casing
 9 feet stainless steel blank casing
 11 bags 10/20 sand
 6 50# bags bentonite chips
 1 end cap
 1 locking cap
 above-grade steel monument
 3 guard posts

* Sample Prefix Number is 2708-951109-

WELL CONSTRUCTION DETAILS			SAMPLING METHOD: 4-inch Core Barrel		DRILL START	DRILL FINISH
HAHN & ASSOCIATES, INC. 434 NW Sixth Avenue Portland, Oregon (503) 796-0717			MONITORING WELL NUMBER OWRD # 84237		MW-10-61	
PROJECT: Northwest Natural Gas Co. Gasco Facility Portland, Oregon			HAI LOGGER: Rob Ede		Time: 9:00	Time: 12:30
PROJECT: 2708			DRILLING METHOD: 6 1/4-inch ID Hollow Stem Auger		Date: 8-Nov-95	Date: 8-Nov-95
EQUIPMENT TYPE: B-59 Mobil Drill			DRILLER: Brad James		DRILLING CONTRACTOR: Geo-Tech Explorations	
LAB RESULTS TOTAL PAHs (ppm)			SPT (blows/0.5 feet)		RECOVERY (%)	
HEADSPACE (ppm)			DEPTH (feet)		GROUNDWATER	
SAMPLE NUMBER*			STRATA (USCS)		BORING DIAMETER: 10-inch	
TIME			CASING DIAMETER: 2-inch ID		SURFACE ELEVATION: 36.5 feet MSL	
SOIL DESCRIPTION			TOP OF CASING ELEVATION: 39.33 feet MSL			
Steel Monument			Ground surface			
M10-01 850 26.2 78.7			Silty Sandy GRAVEL - grey/brown, wet.		GM	
M10-02 855 57.1 107			SAND (2.5-3.0 feet bgs) - brown, moist, poorly graded, loose, medium grained.		SP	
M10-03 905			SAND (3.0-4.0 feet bgs) - black, poorly graded, loose, medium grained, hydrocarbon odor, sheen.		SP	
M10-04 920			SAND with gravel (5.0-10.0 feet bgs) - black, moist, moderately dense, hydrocarbon odor, strong sheen, tar from 7-8 foot depth, lampblack present?, brick at 8 feet bgs.		SP	
M10-05 930			Tarry SAND with gravel (10.0-15.0 feet bgs) - wet oozing tar saturated sand and gravel from 10-12 feet bgs, very hard tar matrix from 12-15 feet bgs.		SP	
M10-06 950			Tarry SILT with gravel (15.0-16.5 feet bgs) - black, moist, oozing tar, silts are saturated with oily tar, silts repel water.		ML	
2500+			SAND (17.0-20.0 feet bgs) - olive grey, moist to wet, fine grained, product saturated (brown), froth via sheen, large piece of wood in end of sampling core.		SP	

HAHN & ASSOCIATES, INC. 434 NW Sixth Avenue Portland, Oregon (503) 796-0717				MONITORING WELL NUMBER				MW-10-61			
				OWRD # 84237							
PROJECT: Northwest Natural Gas Co. Gasco Facility Portland, Oregon				HAI LOGGER: Rob Ede				DRILL START		DRILL FINISH	
PROJECT: 2708				SAMPLING METHOD: 4-inch Core Barrel				Time: 9:00		Time: 12:30	
				DRILLING METHOD: 6 1/4-inch ID Hollow Stem Auger				Date: 8-Nov-95		Date: 8-Nov-95	
				EQUIPMENT TYPE: B-59 Mobil Drill							
				DRILLER: Brad James							
				DRILLING CONTRACTOR: Geo-Tech Explorations							
WELL CONSTRUCTION DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHs (ppm)	SPT (blows/0.5 feet)	RECOVERY (%)	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	BORING DIAMETER: 10-inch	
										CASING DIAMETER: 2-inch ID	
										SURFACE ELEVATION: 36.5 feet MSL	
										TOP OF CASING ELEVATION: 39.33 feet MSL	
										SOIL DESCRIPTION	
	Cap						61			<p>Boring terminated at 61.0 feet bgs Boring sampled to 60.0 feet Monitoring well installed to 61.0 feet bgs</p> <p>Materials: 10 feet 2-inch diameter, 0.010-inch stainless steel slotted screen 5 feet 2-inch diameter PVC blank casing 45 feet stainless steel blank casing 1 50# bags 20/40 sand 11 bags 10/20 sand 2 50# bags bentonite chips 5 bags bentonite grout 1 end cap 1 locking cap above-grade steel monument 3 guard posts</p> <p>* Sample Prefix Number is 2708-951108-</p>	
							62				
							63				
							64				
							65				
							66				
							67				
							68				
							69				
							70				
							71				
							72				
							73				
							74				
							75				
							76				
							77				
							78				
							79				
							80				

HAHN & ASSOCIATES, INC.
 434 NW Sixth Avenue
 Portland, Oregon
 (503) 796-0717

MONITORING WELL NUMBER MW-11-32
 OWRD # 84232

PROJECT:
 Northwest Natural Gas Co.
 Gasco Facility
 Portland, Oregon

HAI LOGGER:	Rob Ede	DRILL START	DRILL FINISH
SAMPLING METHOD:	Not Sampled	Time:	Time:
DRILLING METHOD:	6 1/4-inch ID Hollow Stem Auger	1350	1430
EQUIPMENT TYPE	B-59 Mobil Drill	Date:	Date:
DRILLER:	Brad James	3-Nov-95	3-Nov-95
PROJECT:	2708	DRILLING CONTRACTOR: Geo-Tech Explorations	

WELL CONSTRUCTION DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHs (ppm)	SPT (blows/0.5 feet)	RECOVERY (%)	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	BORING DIAMETER: 10-inch
										CASING DIAMETER: 2-inch ID
										SURFACE ELEVATION: 35.4 feet MSL
										TOP OF CASING ELEVATION: 38.39 feet MSL

SOIL DESCRIPTION

Steel Monument							-3			Ground surface
							-2			
							-1			
Concrete Casing	2-inch ID Blank PVC Casing						1			See boring log for boring M-11 for soil description.
								2		
								3		
								4		
								5		
								6		
								7		
								8		
								9		
								10		
Bentonite Chips	Stainless Steel Casing						11			
								12		
								13		
								14		
								15		
								16		
								17		
								18		
								19		
								20		

Hahn & Associates, Inc.

434 NW Sixth Avenue
 Portland, Oregon
 (503) 796-0717

MONITORING WELL NUMBER MW-12-36
OWRD # 84224

PROJECT:
 Northwest Natural Gas Co.
 Gasco Facility
 Portland, Oregon

HAI LOGGER:	Rob Ede	DRILL START	DRILL FINISH
SAMPLING METHOD:	4-inch OD Core Barrel	Time:	Time:
DRILLING METHOD:	6 1/4-inch ID Hollow Stem Auger	1410	1550
EQUIPMENT TYPE:	B-59 Mobil Drill	Date:	Date:
DRILLER:	Brad James	23-Oct-95	23-Oct-95
PROJECT:	2708	DRILLING CONTRACTOR: Geo-Tech Explorations	

WELL CONSTRUCTION DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHs (ppm)	SPT (blows/0.5 feet)	RECOVERY (%)	DEPTH (feet)	GROUNDWATER	STRATA (USCS)
							41		
							42		
							43		
							44		
							45		
							46		
							47		
							48		
							49		
							50		
							51		
							52		
							53		
							54		
							55		
							56		
							57		
							58		
							59		
							60		

BORING DIAMETER:	10-inch
CASING DIAMETER:	2-inch ID
SURFACE ELEVATION:	35.9 feet MSL
TOP OF CASING ELEVATION:	38.69 feet MSL

SOIL DESCRIPTION

Boring terminated at 36.0 feet bgs
 Boring sampled to 36.0 feet
 Monitoring well installed to 36.0 feet bgs

Materials:
 10 feet 2-inch diameter, 0.010-inch PVC slotted screen
 10 feet 2-inch diameter PVC blank casing
 16 50# bags 10/20 sand
 14 50# bags bentonite chips
 1 end cap
 1 locking cap
 above-grade steel monument
 3 guard posts

* Sample Prefix Number is 2708-951023-

HAHN & ASSOCIATES, INC.
 434 NW Sixth Avenue
 Portland, Oregon
 (503) 796-0717

MONITORING WELL NUMBER

MW-13-30

OWRD # 100685

PROJECT:
 Northwest Natural
 Gasco Facility
 Portland, Oregon
PROJECT: 2708

HAI LOGGER: Rob Ede
SAMPLING METHOD: Not Sampled
DRILLING METHOD: 6 1/4-inch ID Hollow Stem Auger
EQUIPMENT TYPE: B-59 Mobile Drill
DRILLER: Brad James
DRILLING CONTRACTOR: Geo-Tech Explorations

DRILL START	DRILL FINISH
Time: 8:36	Time: 10:00
Date: 19-Dec-97	Date: 19-Dec-97

WELL CONSTRUCTION DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHs (nm)	SPT (blows/0.5 feet)	RECOVERY (%)	DEPTH (feet)	GROUNDWATER	STRATA (USCS)
----------------------------------	-----------------------	-------------	------------------------	------------------------------------	-----------------------------	---------------------	---------------------	--------------------	----------------------

BORING DIAMETER: 10-inch
CASING DIAMETER: 2-inch ID
SURFACE ELEVATION: 35.23 feet MSL
TOP OF CASING ELEVATION: 34.86 feet MSL

SOIL DESCRIPTION

Flush Monument	Ground surface
----------------	----------------

10-20 3/8-inch Bentonite Chips 2-inch ID Blank PVC Casing Stainless Steel Casing	1								
	2								
	3								
	4								
	5								
	6								
	7								
	8								
	9								
	10								
	11								
	12								
	13								
	14								
	15								
	16								
	17								
	18								
	19								
	20								

See boring log for well MW-13-61 for soil description.

SP

SP

HAHN & ASSOCIATES, INC.
 434 NW Sixth Avenue
 Portland, Oregon
 (503) 796-0717

MONITORING WELL NUMBER

MW-13-30

OWRD # 100685

PROJECT:
 Northwest Natural
 Gasco Facility
 Portland, Oregon

HAI LOGGER: Rob Ede
SAMPLING METHOD: Not Sampled
DRILLING METHOD: 6 1/4-inch ID Hollow Stem Auger
EQUIPMENT TYPE: B-59 Mobile Drill
DRILLER: Brad James
DRILLING CONTRACTOR: Geo-Tech Explorations

DRILL START	DRILL FINISH
Time: 8:36	Time: 10:00
Date: 19-Dec-97	Date: 19-Dec-97

PROJECT: 2708

WELL CONSTRUCTION DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHs (nm)	SPT (blows/0.5 feet)	RECOVERY (%)	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	BORING DIAMETER: 10-inch
										CASING DIAMETER: 2-inch ID
										SURFACE ELEVATION: 35.23 feet MSL
										TOP OF CASING ELEVATION: 34.86 feet MSL

SOIL DESCRIPTION

Colorado 10-20 Sand Pack 2-inch ID 0.020 Stainless Steel Continuous SlotLead Screen Cap							21	SP				
							22					
							23					
							24					
							25					
							26					
							27					
							28					
							29					
							30				ML	Boring terminated at 30.0 feet bgs Monitoring well installed to 30.0 feet bgs Materials: 1 foot stainless steel sump/well cap 10 feet 2-inch diameter, 0.020-inch stainless steel slotted screen 10 feet 2-inch diameter stainless steel blank casing 9 feet 2-inch diameter PVC blank casing 9.5 50# bags 10/20 sand 12 50# bags bentonite chips 1 end cap 1 locking cap flush steel monument
							31					
							32					
							33					
							34					
							35					
							36					
							37					
							38					
							39					
							40					

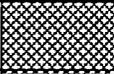
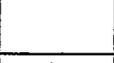
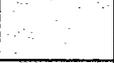
WELL CONSTRUCTION DETAILS			SAMPLE NUMBER*		TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHs (ppm)	CORE INTERVAL	RECOVERY (%)	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	BORING DIAMETER:	10-inch
Flush Monument													SOIL DESCRIPTION	
Ground surface													Surface: concrete.	
Concrete													1	
Concrete													2	
Concrete													3	
Concrete			M13-01	10:04		6.4		↑	↓				4	
Concrete												SP	5	
Concrete													6	
Concrete			M13-02	10:08		5.0	ND	↑	↓				7	
Concrete													8	
Concrete													9	
Concrete													10	
Concrete			M13-03	10:20		5.5	ND	↑	↓				11	
Concrete													12	
Concrete													13	
Concrete			M13-04	10:27		5.2	ND	↑	↓				14	
Concrete													15	
Concrete													16	
Concrete													17	
Concrete			M13-05	10:38		8.1	1.0	↑	↓				18	
Concrete													19	
Concrete													20	
Concrete													20	

HAHN & ASSOCIATES, INC. 434 NW Sixth Avenue Portland, Oregon (503) 796-0717				MONITORING WELL NUMBER OWRD # 100684				MW-13-61					
PROJECT: Northwest Natural Gasco Facility Portland, Oregon PROJECT: 2708				HAI LOGGER: Rob Ede				DRILL START		DRILL FINISH			
				SAMPLING METHOD: 4-inch Core Barrel				Time: 9:30		Time: 14:40			
				DRILLING METHOD: 6 1/4-inch ID Hollow Stem Auger				DRILLER: Brad James		Date: 18-Dec-97		Date: 18-Dec-97	
				EQUIPMENT TYPE: B-59 Mobil Drill				DRILLING CONTRACTOR: Geo-Tech Explorations					
WELL CONSTRUCTION DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHs (ppm)	CORE INTERVAL	RECOVERY (%)	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	BORING DIAMETER: 10-inch CASING DIAMETER: 2-inch ID SURFACE ELEVATION: 35.23 feet MSL TOP OF CASING ELEVATION: 34.78 feet MSL			
SOIL DESCRIPTION													
Sand	Cap				↑↓	↑↓	61	SP	<p>Boring terminated at 61.0 feet bgs Boring sampled to 61.0 feet Monitoring well installed to 61.0 feet bgs</p> <p>Materials: 1 foot stainless steel sump/end cap 10 feet 2-inch diameter, 0.010-inch stainless steel slotted screen 40 feet 2-inch diameter stainless steel blank casing 10 feet 2-inch diameter PVC casing 12 50# bags 10/20 Colorado sand 5 50# bags bentonite chips 5 bags bentonite grout 3 centralizers 1 locking cap Flush steel monument</p> <p>* Sample Prefix Number is 2708-971218-</p>				
							62						
							63						
							64						
							65						
							66						
							67						
							68						
							69						
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							79						
							80						

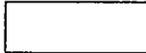
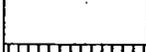
APPENDIX C
Sediment Core Logs

KEY TO BORING LOGS

Soil classification in this report is based upon visual and manual field observations which include moisture, consistency, plasticity and grading estimates and should not be construed to imply field or laboratory testing unless presented herein. Soils are classified in accordance with the Unified Soil Classification System. Stratigraphic boundaries are approximate representations only. No warranty is provided as to the continuity of soil strata between borings.

UNIFIED SOIL CLASSIFICATION SYSTEM (USCS)					
MAJOR DIVISIONS			GROUP SYMBOLS		TYPICAL NAMES
COURSE GRAINED SOILS More Than Half is Larger Than #200 Sieve	GRAVELS More Than Half the Course Fraction is Larger Than No. 4 Sieve Size	Clean Gravels With Little or No Fines	GW		Well Graded Gravels, Gravel-Sand Mixtures
		Gravels With Over 12% Fines	GP		Poorly Graded Gravels, Gravel-Sand Mixtures
		Gravels With Over 12% Fines	GM		Silty Gravels, Poorly Graded Gravel-Sand-Silt Mixtures
		Gravels With Over 12% Fines	GC		Clayey Gravels, Poorly Graded Gravel-Sand-Clay Mixtures
	SANDS More Than Half the Course Fraction is Smaller Than No. 4 Sieve Size	Clean Sands With Little or No Fines	SW		Well Graded Sands, Gravelly Sands
		Sands With Over 12% Fines	SP		Poorly Graded Sands, Gravelly Sands
		Sands With Over 12% Fines	SM		Silty Sands, Poorly Graded Sand-Silt Mixtures
		Sands With Over 12% Fines	SC		Clayey Sands, Poorly Graded Sand-Clay Mixtures
FINE GRAINED SOILS More Than Half is Smaller Than #200 Sieve	SILTS AND CLAYS Liquid Limit Less Than 50%		ML		Inorganic Silts and Very Fine Sands, Rock Flour, Silty or Clayey Fine Sands, or Clayey Silts with Slight Plasticity
	SILTS AND CLAYS Liquid Limit Greater Than 50%		CL		Inorganic Clays of Low to Medium Plasticity, Gravelly Clays, Sandy Clays, Silty Clays, Lean Clays
			OL		Organic Clays and Organic Silty Clays of Low Plasticity
			MH		Inorganic Silts, Micaceous or Diatomaceous Fine Sandy or Silty Soils, Elastic Silts
	SILTS AND CLAYS Liquid Limit Greater Than 50%		CH		Inorganic Clays of High Plasticity, Fat Clays
			OH		Organic Clays of Medium to High Plasticity, Organic Silts
HIGHLY ORGANIC SOILS			Pt		Peat and Other Highly Organic Soils

LEGEND FOR BORING LOGS

	Blank Casing
	Slotted Screen
	Cement Grout
	Concrete
	Bentonite
	Sand Pack
	Fill Material

ABBREVIATIONS

NA	Not Applicable
ND	Not Detected Above Detection Limit
NS	Not Sampled
PAH	Polynuclear Aromatic Hydrocarbons
ppm	Parts Per Million
SPT	Standard Penetration Test
	Measured Static Water Level in Well
	Estimated Water Level During Drilling

Hahn & Associates, Inc.
 434 NW Sixth Avenue
 Portland, Oregon
 (503) 796-0717

PROJECT:
 Northwest Natural Gas Co.
 Gasco Facility
 Portland, Oregon
PROJECT #: 2708

SOIL BORING NUMBER SD-4

HAI LOGGER: Rob Ede

SAMPLING METHOD: 3.75"OD Disposable Core Barrel

DRILLING METHOD: Vibration/Push

EQUIPMENT TYPE: VibraCore attached to barge

DRILLER: Bill Jaworski

DRILLING CONTRACTOR: Marine Sampling Systems

DRILL	DRILL
START	FINISH
Time: 9:33	Time: 9:50
Date: 1/23/96	Date: 1/23/96

SAMPLE NUMBER*	TIME (1/25/96)	HEADSPACE (ppm)	LAB RESULTS total PAHs/total BTEX(ppm)	Core Interval	RECOVERY INTERVAL	DEPTH (feet)	STRATA (USCS)	BORING DIAMETER: 3.75-inch		
								CASING DIAMETER: 3.75-inch		
								SURFACE ELEVATION: Not Surveyed		
								TOP OF CASING ELEVATION: Not Applicable		
SOIL DESCRIPTION										
SD-4-01	12:25	2.3	165/ND	↑	↑	1	ML	SILT-brown, wet, very soft, roots, sheen, hydrocarbon odor (0"-6")		
SD-4-02	12:30	4.0	-			1				
SD-4-03	12:36	9.5	-			2		Sandy SILT-grey, wet, soft, roots, sheen, hydrocarbon odor (6"-3')		
SD-4-04	12:47	13.6	-			3		Sandy SILT with gravel and wood chips-brown, wet, sheen, hydrocarbon odor (3'-4')		
SD-4-05	12:54	24.3	-			4				
SD-4-06	13:00	23.4	-			5		Sandy SILT with fine grained sand seams-grey, moist, rootlets throughout, much vegetative material from 4' to 5', sheen within sand seams only, hydrocarbon odor (4'-6')		
SD-4-07	13:30	16.7	-			6				
SD-4-08	13:32	15.6	-			7		SM	Silty SAND-grey, moist, fine grained, root fragments, no sheen, hydrocarbon odor (6'-7')	
SD-4-09	13:36	13.9	-			8				
SD-4-10	13:38	12.3	-			9			Silty SAND-as above, many root fragments, no sheen, hydrocarbon odor (7'-9.5')	
SD-4-11	13:40	11.6	0.15/ND		↓	10				
				↓		11				
						12				
						13				
						14				
						15				
						16				
						17				
						18				
						19				
						20				

* Sample Number Prefix is 2708-960123-

Core collected and sealed 1/23/96
 Core opened and sampled 1/25/96

BTEX = benzene, toluene, ethyl benzene, xylene
 PAHs = polynuclear aromatic hydrocarbons
 ppm = parts per million
 ND = non-detect

HAI LOGGER:					HAI LOGGER:			DRILL		DRILL			
PROJECT:					SAMPLING METHOD:			START		FINISH			
EQUIPMENT TYPE					DRILLER:			Date:		Date:			
DRILLING CONTRACTOR:					DRILLING CONTRACTOR:			1/23/96		1/23/96			
HAIN & ASSOCIATES, INC.					SOIL BORING NUMBER							SD-5	
434 NW Sixth Avenue													
Portland, Oregon													
(503) 796-0717					Rob Ede								
Northwest Natural Gas Co.					3.75"OD Disposable Core Barrel							10:23	
Gasco Facility					Vibration/Push							10:40	
Portland, Oregon					VibraCore attached to barge								
PROJECT #: 2708					Marine Sampling Systems								
SAMPLE NUMBER*	TIME (1/25/96)	HEADSPACE (ppm)	LAB RESULTS total PAHs/total BTEX(ppm)	Core Interval	RECOVERY INTERVAL	DEPTH (feet)	STRATA (USCS)	BORING DIAMETER: 3.75-inch					
SD-5-01	14:30	4.7	118/ND	↑	↑		SM	CASING DIAMETER: 3.75-inch					
SD-5-02	14:33	4.4	-			1	ML	SURFACE ELEVATION: Not Surveyed					
SD-5-03	14:35	3.5	-			2		TOP OF CASING ELEVATION: Not Applicable					
SD-5-04	14:40	3.7	-			3		SOIL DESCRIPTION					
SD-5-05	14:45	3.4	-			4		Silty SAND-brown, wet, loose, very fine grained, sheen (0"-6")					
SD-5-06	14:50	9.6	-			5		SILT with silty sand lenses-brown, wet, medium stiff, roots, strong sheen (6"-2')					
SD-5-07	15:00	9.4	-			6		SILT-olive grey, wet, very soft, wood chips at 2', slight sheen (2'-3')					
SD-5-08	15:05	19.0	-			7		Sandy SILT-dark brown, moist, medium stiff, rootlets, many wood fragments and dark grey to black discoloration from 6' to 8', sheen (3'-8')					
SD-5-09	15:10	17.4	1,154/ND		↓	8							
						9							
						10							
						11							
						12							
						13							
						14							
						15							
						16							
						17							
						18							
						19							
						20							

* Sample Number Prefix is 2708-960123-

Core collected and sealed 1/23/96
Core opened and sampled 1/25/96

BTEX = benzene, toluene, ethyl benzene, xylene
PAHs = polynuclear aromatic hydrocarbons
ppm = parts per million
ND = non-detect

HAHN & ASSOCIATES, INC.

434 NW Sixth Avenue
 Portland, Oregon
 (503) 796-0717

SOIL BORING NUMBER

SD-6

PROJECT:
 Northwest Natural Gas Co.
 Gasco Facility
 Portland, Oregon

HAI LOGGER:	Rob Ede	DRILL	DRILL
SAMPLING METHOD:	3.75"OD Disposable Core Barrel	START	FINISH
DRILLING METHOD:	Vibration/Push	Time:	Time:
EQUIPMENT TYPE	VibraCore attached to barge	11:02	11:20
DRILLER:	Bill Jaworski	Date:	Date:
DRILLING CONTRACTOR:	Marine Sampling Systems	1/23/96	1/23/96

PROJECT #: 2708

SAMPLE NUMBER*	TIME (1/25/96)	HEADSPACE (ppm)	LAB RESULTS total PAHs/total BTEX(ppm)	Core Interval	RECOVERY INTERVAL	DEPTH (feet)	STRATA (USCS)	BORING DIAMETER: 3.75-inch	
								CASING DIAMETER: 3.75-inch	
								SURFACE ELEVATION: Not Surveyed	
								TOP OF CASING ELEVATION: Not Applicable	
								SOIL DESCRIPTION	
SD-6-01	15:46	6.5	101/ND	↑	↑	1	SP	SAND-brown, wet, loose, medium grained, wood fragments, slight sheen (0'-1')	
SD-6-02	15:48	14.6	-			2		SAND-as above, moist to wet, many wood fragments from 2' to 2.5' with an associated strong sheen (1'-4')	
SD-6-03	15:50	12.0	-			3	SM	Silty SAND-brown, moist to wet, loose, much root material, increasing silt content with depth, sheen (4'-5')	
SD-6-04	15:52	6.8	-			4		SAND with interbedded Silts-grey, moist to wet, loose, silts are dark grey, moist, soft, root material and sheen in sands only(5'-8')	
SD-6-05	15:55	2.6	-			5	SP		
SD-6-06	16:05	4.0	-			6			
SD-6-07	16:10	9.1	-			7			
SD-6-08	16:13	5.3	-			8			
SD-6-09	16:15	3.1	2.2/ND		↓	9			
						10			
						11			
						12			
						13			
						14			
						15			
						16			
						17			
						18			
						19			
						20			

* Sample Number Prefix is 2708-960123-

Core collected and sealed 1/23/96
 Core opened and sampled 1/25/96

BTEX = benzene, toluene, ethyl benzene, xylene
 PAHs = polynuclear aromatic hydrocarbons
 ppm = parts per million
 ND = non-detect

HAI LOGGER:				Rob Ede		DRILL	DRILL
SAMPLING METHOD:				3.75"OD Disposable Core Barrel		START	FINISH
DRILLING METHOD:				Vibration/Push		Time:	Time:
EQUIPMENT TYPE				VibraCore attached to barge		9:33	9:50
DRILLER:				Bill Jaworski		Date:	Date:
DRILLING CONTRACTOR:				Marine Sampling Systems		1/23/96	1/23/96
SD-8-01	9:50	14.3	875/ND	↑	↑		
SD-8-02	9:52	12.9	-				1
SD-8-03	9:56	12.1	-			ML	2
SD-8-04	10:00	11.9	-				3
SD-8-05	10:03	12.3	-				4
SD-8-06	10:15	13.0	-				5
SD-8-07	10:18	13.3	-			SP	6
SD-8-08	10:23	30.4	-				7
SD-8-09	10:30	172.0	-			ML	8
SD-8-10	10:32	59.7	3,254/2.6		↓		9
							10
							11
							12
							13
							14
							15
							16
							17
							18
							19
							20

BORING DIAMETER: 3.75-inch
CASING DIAMETER: 3.75-inch
SURFACE ELEVATION: Not Surveyed
TOP OF CASING ELEVATION: Not Applicable

SOIL DESCRIPTION

Sandy SILT-brown, wet, very soft, some medium grained sand lenses, root material, no sheen (0-2')
Sandy SILT-as above, some gravel, slight sheen (2'-4')
Sandy SILT with fine grained sand seams-olive grey, moist, medium stiff, rootlets throughout, much vegetative material, slight sheen (4'-5')
SAND-grey, moist, medium grained, loose, wood fragments, strong sheen (5'-7')
Tarry Sandy SILT-olive grey, moist, stiff, seams of black viscous tar and hardened tar (7'-8')
Sandy SILT-as above, no tar, strong sheen (8'-9')

* Sample Number Prefix is 2708-960123-

Core collected and sealed 1/23/96
Core opened and sampled 1/26/96

BTEX = benzene, toluene, ethyl benzene, xylene
PAHs = polynuclear aromatic hydrocarbons
ppm = parts per million
ND = non-detect

HAHN & ASSOCIATES, INC.
 434 NW Sixth Avenue
 Portland, Oregon
 (503) 796-0717

SOIL BORING NUMBER

SD-9

PROJECT:
 Northwest Natural Gas Co.
 Gasco Facility
 Portland, Oregon
PROJECT #: 2708

HAI LOGGER: Rob Ede
SAMPLING METHOD: 3.75"OD Disposable Core Barrel
DRILLING METHOD: Vibration/Push
EQUIPMENT TYPE: VibraCore attached to barge
DRILLER: Bill Jaworski
DRILLING CONTRACTOR: Marine Sampling Systems

DRILL START	DRILL FINISH
Time: 13:25	Time: 14:00
Date: 1/24/96	Date: 1/24/96

SAMPLE NUMBER*	TIME (1/26/96)	HEADSPACE (ppm)	LAB RESULTS total PAHs/total BTEX(ppm)	Core Interval	RECOVERY INTERVAL	DEPTH (feet)	STRATA (USCS)	SOIL DESCRIPTION
SD-9-01	10:50	15.8	125/ND	↑	↑			BORING DIAMETER: 3.75-inch CASING DIAMETER: 3.75-inch SURFACE ELEVATION: Not Surveyed TOP OF CASING ELEVATION: Not Applicable SOIL DESCRIPTION Sandy SILT-brown, wet, very soft, some medium grained sand lenses, root material, no sheen (0'-2') Gravel-wet, loose, angular, no sheen (2'-3'.5) Silty SAND-wet, loose, medium grained, root fragments, strong metallic sheen (3.5'-4') Tarry SAND-wet, medium grained, root fragments, bits of solidified tar, sheen (4'-5') * Sample Number Prefix is 2708-960124- Core collected and sealed 1/24/96 Core opened and sampled 1/26/96 BTEX = benzene, toluene, ethyl benzene, xylene PAHs = polynuclear aromatic hydrocarbons ppm = parts per million ND = non-detect
SD-9-2 (dup)	10:55	13.8	94/ND			1	ML	
SD-9-03	10:58	13.0	-			2		
SD-9-04	11:00	13.4	-			3	GP	
SD-9-05	11:02	17.3	-			4	SM	
SD-9-06	11:06	110	5,471/14		↓	5	SP	
						6		
						7		
						8		
						9		
						10		
						11		
						12		
						13		
						14		
						15		
						16		
						17		
						18		
						19		
						20		

HAHN & ASSOCIATES, INC. 434 NW Sixth Avenue Portland, Oregon (503) 796-0717				SOIL BORING NUMBER SD-10			
PROJECT: Northwest Natural Gas Co. Gasco Facility Portland, Oregon				HAI LOGGER: Steve Johnson (FES)		DRILL START	DRILL FINISH
PROJECT #: 2708				SAMPLING METHOD: 3.75"OD Disposable Core Barrel		15:04	15:30
				DRILLING METHOD: Vibration/Push		Date: 1/23/96	Date: 1/23/96
				EQUIPMENT TYPE: VibraCore attached to barge			
				DRILLER: Bill Jaworski			
				DRILLING CONTRACTOR: Marine Sampling Systems			
SAMPLE NUMBER*	TIME (1/26/96)	HEADSPACE (ppm)	LAB RESULTS total PAHs/total BTEX(ppm)	Core Interval	RECOVERY INTERVAL	DEPTH (feet)	STRATA (USCS)
SD-10-01	12:50	2.5	ND/283	↑	↑		ML
SD-10-02	12:55	2.4	-			1	
SD-10-03	13:00	4.4	-			2	SP
SD-10-04	13:05	7.1	-			3	
SD-10-05	13:08	3.6	-			4	
SD-10-06	13:25	3	-			5	
SD-10-07	13:28	2.3	-			6	
SD-10-08	13:22	0.6	-			7	
SD-10-09	13:30	3.2	ND/9.6		↓	8	
						9	
						10	
						11	
						12	
						13	
						14	
						15	
						16	
						17	
						18	
						19	
						20	

BORING DIAMETER: 3.75-inch
CASING DIAMETER: 3.75-inch
SURFACE ELEVATION: Not Surveyed
TOP OF CASING ELEVATION: Not Applicable

SOIL DESCRIPTION

ML
SILT-dark brown, wet, soft, some medium grained sand lenses, some plant material and wood chips, slight hydrocarbon odor and sheen from 0 to 0.5 feet (0-2')

SAND-wet, loose, medium grained, wood chips, no hydrocarbon odor or sheen (2'-3')

SAND-as above, some gravel, no hydrocarbon odor or sheen (3'-5')

SP
SAND- dark brown, loose, medium grained, some silt, wood chips, slight hydrocarbon odor, no sheen (5'-7.5')

* Sample Number Prefix is 2708-960123-
Core collected and sealed 1/23/96
Core opened and sampled 1/26/96

BTEX = benzene, toluene, ethyl benzene, xylene
PAHs = polynuclear aromatic hydrocarbons
ppm = parts per million
ND = non-detect

HAHN & ASSOCIATES, INC. 434 NW Sixth Avenue Portland, Oregon (503) 796-0717					SOIL BORING NUMBER SD-11				
PROJECT: Northwest Natural Gas Co. Gasco Facility Portland, Oregon					HAI LOGGER: Steve Johnson (FES)			DRILL	DRILL
PROJECT #: 2708					SAMPLING METHOD: 3.75"OD Disposable Core Barrel			START	FINISH
					DRILLING METHOD: Vibration/Push			Time:	Time:
					EQUIPMENT TYPE: VibraCore attached to barge			16:00	16:25
					DRILLER: Bill Jaworski			Date:	Date:
					DRILLING CONTRACTOR: Marine Sampling Systems			1/23/96	1/23/96
SAMPLE NUMBER*	TIME (1/26/96)	HEADSPACE (ppm)	LAB RESULTS total PAHs/total BTEX(ppm)	Core Interval	RECOVERY INTERVAL	DEPTH (feet)	STRATA (USCS)	BORING DIAMETER: 3.75-inch	
								CASING DIAMETER: 3.75-inch	
								SURFACE ELEVATION: Not Surveyed	
								TOP OF CASING ELEVATION: Not Applicable	
SOIL DESCRIPTION									
SD-11-01	13:53	366	5.6/ND	↑	↑	1	SP	SAND-brown, wet, loose, medium grained, wood chips on surface, hydrocarbon odor, sheen (0'-1')	
SD-11-02	13:55	34.2	-						
SD-11-03	14:00	13.3	569/ND			2	ML	SILT-dark brown, stiff, medium grained sand lenses, strong hydrocarbon odor and sheen (1'-2')	
SD-11-04	14:03	7.8	-			3		SAND-dark brown, loose, medium grained, some silt, wood chips, hydrocarbon odor and sheen (2'-3')	
SD-11-05	14:11	6.3	-			4	SP	SAND- as above, no wood chips, brick fragments from 5' to 5.5', slight hydrocarbon odor, no sheen, (3'-6')	
SD-11-06	14:14	12.6	-			5			
SD-11-07	14:16	6.3	-		↓	6			
						7			
						8			
						9			
						10			
						11			
						12			
						13			
						14			
						15			
						16			
						17			
						18			
						19			
						20			

* Sample Number Prefix is 2708-960123-

Core collected and sealed 1/23/96
Core opened and sampled 1/26/96

BTEX = benzene, toluene, ethyl benzene, xylene
PAHs = polynuclear aromatic hydrocarbons
ppm = parts per million
ND = non-detect

HAHN & ASSOCIATES, INC. 434 NW Sixth Avenue Portland, Oregon (503) 796-0717					SOIL BORING NUMBER		SD-12	
PROJECT: Northwest Natural Gas Co. Gasco Facility Portland, Oregon PROJECT #: 2708					HAI LOGGER: Steve Johnson (FES)		DRILL	DRILL
					SAMPLING METHOD: 3.75"OD Disposable Core Barrel		START	FINISH
					DRILLING METHOD: Vibration/Push		Time:	Time:
					EQUIPMENT TYPE: VibraCore attached to barge		9:01	9:30
					DRILLER: Bill Jaworski		Date:	Date:
					DRILLING CONTRACTOR: Marine Sampling Systems		1/24/96	1/24/96
SAMPLE NUMBER*	TIME (1/26/96)	HEADSPACE (ppm)	LAB RESULTS total PAHs/total BTEX (ppm)	Core Interval	RECOVERY INTERVAL	DEPTH (feet)	STRATA (USCS)	BORING DIAMETER: 3.75-inch
								CASING DIAMETER: 3.75-inch
								SURFACE ELEVATION: Not Surveyed
								TOP OF CASING ELEVATION: Not Applicable
SOIL DESCRIPTION								
SD-12-01	10:40	0.0	0.72/ND	↑	↑	1	SM	Silty SAND-gray, wet, loose, fine grained, no hydrocarbon odor, no sheen (0'-1')
SD-12-02	10:45	0.0	-			2		Silty SAND-as above, wet, wood chips from 2' to 3', slight hydrocarbon odor, no sheen (1'-4')
SD-12-03	10:50	0.3	-			3		
SD-12-04	11:00	0.1	8.4/ND			4	CL	Clay, greenish gray, moist, some silt, plastic, no hydrocarbon odor, no sheen (4'-5.5')
SD-12-05	11:05	0.0	-			5		
SD-12-06	11:08	0.0	-			6	ML	Sandy SILT- light brown, moist, no hydrocarbon odor, no sheen (5.5'-8')
SD-12-07	11:25	0.0	-			7		
SD-12-08	11:28	0.3	-			8		
SD-12-09	11:41	0.6	-			9	SP	SAND, light brown, moist, fine grained, no hydrocarbon odor, no sheen, (8'-10')
SD-12-10	11:45	0.9	-			10		
SD-12-11	11:50	3.0	-		↓	10		
						11		
						12		
						13		
						14		
						15		
						16		
						17		
						18		
						19		
						20		

* Sample Number Prefix is 2708-960124-

Core collected and sealed 1/24/96
Core opened and sampled 1/26/96

BTEX = benzene, toluene, ethyl benzene, xylene
PAHs = polynuclear aromatic hydrocarbons
ppm = parts per million
ND = non-detect

Hahn & Associates, Inc.
 434 NW Sixth Avenue
 Portland, Oregon
 (503) 796-0717

SOIL BORING NUMBER SD-13

PROJECT:
 Northwest Natural Gas Co.
 Gasco Facility
 Portland, Oregon
PROJECT #: 2708

HAI LOGGER: Steve Johnson (FES)	DRILL	DRILL
SAMPLING METHOD: 3.75"OD Disposable Core Barrel	START	FINISH
DRILLING METHOD: Vibration/Push	Time:	Time:
EQUIPMENT TYPE: VibraCore attached to barge	9:43	10:15
DRILLER: Bill Jaworski	Date:	Date:
DRILLING CONTRACTOR: Marine Sampling Systems	1/24/96	1/24/96

SAMPLE NUMBER*	TIME (1/26/96)	HEADSPACE (ppm)	LAB RESULTS total PAHs/total BTEX(ppm)	Core Interval	RECOVERY INTERVAL	DEPTH (feet)	STRATA (USCS)	SOIL DESCRIPTION
SD-13-01	10:10	0.7	1.4/ND	↑	↑	1	SM	Silty SAND-dark brown to gray, wet, loose, fine grained, no hydrocarbon odor, no sheen (0'-1')
SD-13-02	10:15	2.4	-			2	ML	sandy SILT-dark brown to gray, roots from 1' to 2', large wood chips from 1' to 3', slight hydrocarbon odor from 2' to 3', no sheen (1'-3')
SD-13-03	10:20	4.5	-			3		
SD-13-04	10:25	5.8	-		↓	4	SP	SAND-dark gray, medium grained, hydrocarbon odor, no sheen (3'-3.5')
						5		
						6		
						7		
						8		
						9		
						10		
						11		
						12		
						13		
						14		
						15		
						16		
						17		
						18		
						19		
						20		

* Sample Number Prefix is 2708-960124-
 Core collected and sealed 1/24/96
 Core opened and sampled 1/26/96

BTEX = benzene, toluene, ethyl benzene, xylene
 PAHs = polynuclear aromatic hydrocarbons
 ppm = parts per million
 ND = non-detect

Hahn & Associates, Inc.
 434 NW Sixth Avenue
 Portland, Oregon
 (503) 796-0717

SOIL BORING NUMBER SD-14

PROJECT:
 Northwest Natural Gas Co.
 Gasco Facility
 Portland, Oregon
PROJECT #: 2708

HAI LOGGER:	Steve Johnson (FES)	DRILL	DRILL
SAMPLING METHOD:	3.75"OD Disposable Core Barrel	START	FINISH
DRILLING METHOD:	Vibration/Push	Time:	Time:
EQUIPMENT TYPE	VibraCore attached to barge	12:16	12:25
DRILLER:	Bill Jaworski	Date:	Date:
DRILLING CONTRACTOR:	Marine Sampling Systems	1/24/96	1/24/96

SAMPLE NUMBER*	TIME (1/25/96)	HEADSPACE (ppm)	LAB RESULTS total PAHs/total BTEX(ppm)	Core Interval	RECOVERY INTERVAL	DEPTH (feet)	STRATA (USCS)	DESCRIPTION
SD-14-01	9:00	0.1	0.15/ND	↑	↑	1	ML	SILT-dark brown, wet, root material, no hydrocarbon odor, no sheen (0'-1')
SD-14-02	9:10	1.5	-			2	ML	SILT-as above, some fine grained sand lenses, no hydrocarbon odor, no sheen (1'-2')
SD-14-03	9:20	1.8	-			3	SM	Silty SAND-medium grained, large wood chips, no hydrocarbon odor, no sheen (2'-3.5')
SD-14-04	9:25	2.4				4	SM	Silty SAND-fine grained, small wood chips, no hydrocarbon odor, no sheen (3.5'-4')
SD-14-05	9:35	-	-			5	ML	
SD-14-06	9:40	0.5	-			6	ML	SILT- light brown, moist, painted wood fragment at 4.5', small wood fragments from 5' to 6', shell fragments from 6' to 7', decaying wood odor, no hydrocarbon odor, no sheen (4'-7.5')
SD-14-07	9:50	0.2	-			7	ML	
SD-14-08	9:55	0.4	-			8	SP	SAND, light brown, moist, medium grained, no hydrocarbon odor, no sheen, (7.5'-8.5')
SD-14-09	10:00	5.8	181/ND		↓	9	SP	
						10		
						11		
						12		
						13		
						14		
						15		
						16		
						17		
						18		
						19		
						20		

* Sample Number Prefix is 2708-960124-

Core collected and sealed 1/24/96
 Core opened and sampled 1/25/96

BTEX = benzene, toluene, ethyl benzene, xylene
 PAHs = polynuclear aromatic hydrocarbons
 ppm = parts per million
 ND = non-detect

D

APPENDIX D

**Water Well Logs and
Cathodic Protection Well Logs**

NOTEBOOK SHEET

Name _____ Date _____

Pond, 2 1/2 mi N of Co. fa. 1941

Warden, 1/2 mi S of Co. fa. 1941

basalt at 4000 ft. 1941

12" diameter 1941

Subs. 48 Mar 1941

Pumps 158 gpm at 200 ft. 1941

Flowed when drilled 1941

made Hoopman.

DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

WATER RESOURCES DIVISION

WELL SCHEDULE

Date April, 1954 Field Office _____

Record by J. M. W.

Source of data M. W. Wright, Engineer

1. Location: State Oregon County Mult

Map Walla Walla

1/4 sec. 1 T. N. R.

2. Owner: Red Hat Co. & Co. Inc. Address 2900 NW

Tenant _____ Address _____

Driller A. M. Hoover Address Red Hat

3. Topography Valley plain

4. Elevation 20 ft. below 54. May

5. Type: Dug, drilled, driven, bored, jetted 1948

6. Depth: Rept. 382 ft. Meas. _____ ft.

7. Casing: Diam. 12 in. to 8 in. Type Iron

Depth 63' ft., Finish 140' x 8" Pat.

8. Chief Aquifer Sand From 241 ft

Others _____

9. Water level _____ ft. rept. _____ ft. meas. _____

_____ which is _____ f

10. Pump: Type _____ Capacity _____

Power: Kind _____ Horsepower _____

11. Yield: Flow _____ G. M., Pump 140 G. M., Meas. _____

Drawdown _____ ft. after _____ hours pumping _____

12. Use: Dom., Stock, PS., RR., Irr., Obs. Carriage

Adequacy, permanence Not adequate

13. Quality _____ Taste, odor, color _____ Temp _____

Unfit for _____ Sample _____

14. Remarks: (Log, Analyses, etc.) Well lost about 1/2 in. production after 10 min.

Well was dry 2 hrs. a day a

(over)

increase in production was noticed. Any production over 140 gpm will cause present pump set at 180 ft. to break suction.

Skeleton log:

0-61 sand (12" casing to 63')
 61-241 Rock (basalt?; not cased)
 241-246 Sand and broken rock
 246-258 Sand
 253?-370 Basalt, broken, soft.
 382' total depth of well

Mr. Wright promised to send complete log. R.A.W. 1 Apr. 1954

Log on Ground Information

Material	Depth
Grey clay-dirt	0 - 4
Brown-black sand	4 - 9
Brown clay	9 - 43
Broken black rock-decomposed in places	43 - 102
Broken black rock w/brown clay layers	102 - 114
Black rock	114 - 128
Broken black rock w/layers black lava rock	128 - 162
Black rock	162 - 189
Grey rock	189 - 199
Black lava rock w/thin layer grey clay	199 - 212
Black rock, broken in places	212 - 281
Broken black rock-grey sandy clay	281 - 305
Black lava rock	305 - 344
Black rock/layers grey clay	344 - 350
Black rock-broken in places	350 - 400

Log on Ground Information

Material	Depth
14 anodes 17ft. center 164' to 392	
Coke at 140' , gravel to 80ft.	
Cement to 50 ft. gravel to 0	
Gravel	0 - 1
Clay	1 - 2
Sand	2 - 10
Brown clay	10 - 40
Sand	40 - 50
Broken rock	50 - 78
Black basalt hard some broken lava rock layers	78 - 290
Broken multi colored rock & sandstone, little clay	290 - 310
Black basalt hard	310 - 370
Broken rock sandy clay	370 - 390
Black basalt Hard	390 - 400

NOTICE TO WATER WELL CONTRACTOR
 The original and first copy of this report are to be filed with the
 STATE ENGINEER, SALEM, OREGON 97310
 within 30 days from the date of well completion.

WATER WELL REPORT

STATE OF OREGON
 (Please type or print)

State Well No. 1N/1W-12N

State Permit No. _____

(1) OWNER:

Name Portland Gas & Coke Company
 Address _____

(2) LOCATION OF WELL:

County Multnomah Driller's well number _____
SW ¼ SW ¼ Section 12 T. 1N R. 1W W.M.
 bearing and distance from section or subdivision corner _____

(3) TYPE OF WORK (check):

new Well Deepening Reconditioning Abandon
 At abandonment, describe material and procedure in Item 12.

(4) PROPOSED USE (check):

Domestic Industrial Municipal Irrigation Test Well Other
 Rotary Cable Dug Driven Jetted Bored

(5) TYPE OF WELL:

(6) CASING INSTALLED: Threaded Welded
12 - Diam. from 0 ft. to 63 ft. Gage _____
8 - Diam. from _____ ft. to _____ ft. Gage _____
 _____ - Diam. from _____ ft. to _____ ft. Gage _____

(7) PERFORATIONS:

Perforated? Yes No
 Type of perforator used _____
 Size of perforations in. by in.
 _____ perforations from _____ ft. to _____ ft.
 _____ perforations from _____ ft. to _____ ft.

(8) SCREENS:

Well screen installed? Yes No
 Manufacturer's Name _____
 Type _____ Model No. _____
 Diam. _____ Slot size _____ Set from _____ ft. to _____ ft.
 Diam. _____ Slot size _____ Set from _____ ft. to _____ ft.

(9) CONSTRUCTION:

Well seal—Material used in seal _____
 Depth of seal _____ ft. Was a packer used? _____
 Diameter of well bore to bottom of seal _____ in.
 Were any loose strata cemented off? Yes No Depth _____
 Was a drive shoe used? Yes No
 Was well gravel packed? Yes No Size of gravel: _____
 Gravel placed from _____ ft. to _____ ft.
 Did any strata contain unusable water? Yes No
 Type of water? _____ depth of strata _____
 Method of sealing strata off _____

(10) WATER LEVELS:

Static level 48 ft. below land surface Date 1954
 Artesian pressure _____ lbs. per square inch Date _____

(11) WELL TESTS:

Drawdown is amount water level is lowered below static level
 Was a pump test made? Yes No If yes, by whom? _____
 Yield: 140 gal./min. with _____ ft. drawdown after _____ hrs.
 - 150 - with drawdown to 200 feet
 - - - - -
 Baller test gal./min. with _____ ft. drawdown after _____ hrs.
 Artesian flow _____ g.p.m. Date _____
 Temperature of water _____ Was a chemical analysis made? Yes No

(12) WELL LOG:

Diameter of well below casing _____
 Depth drilled _____ ft. Depth of completed well 382 ft.

Formation: Describe by color, character, size of material and structure, and show thickness of aquifers and the kind and nature of the material in each stratum penetrated, with at least one entry for each change of formation.

MATERIAL	FROM	TO
Sand	0	61
Rock (basalt)	61	241
Sand and broken rock	241	246
Sand	246	258
Basalt, broken, soft	258	370

Data from USGS

Work started _____ 19 _____ Completed _____ 1948
 Date well drilling machine moved off of well _____ 19 _____

(13) PUMP:

Manufacturer's Name _____
 Type: _____ H.P. _____

Water Well Contractor's Certification:

This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.

NAME A. M. Janssen
 (Person, firm or corporation) (Type or print)

Address _____

Drilling Machine Operator's License No. _____

[Signed] _____ (Water Well Contractor)

Contractor's License No. _____ Date _____ 19 _____

6711 N. E. 58th Ave.
Vancouver, Wash. 98661

6711 N. E. 58th Ave.
Vancouver, Wash. 98661

HANSEN DRILLING CO., Inc.

HANSEN DRILLING CO., Inc.

LOG

Name Northwest Natural Gas
Address Gasco Regulator Station St. Helens Rd.

Name Northwest Natural Gas Co. Rect. # 226
Address Gasco Reg. Station Portland

Date Started 11-23-76 Date Finished 12-10-76

Date Started 10-16-85 Date Finished 10-22-85

DESCRIPTION:

- (a) Well Depth 400 ft. Diameter 10"
- (b) Depth from ground surface to water level before pumping ft. Bailer tested GPM
- (c) Drawdown of water level is feet.
(pumping level minus static water level)
- (d) Casing - screen - perforation - shoe - etc.

- (a) Well Depth 400 ft. Diameter 8 3/4
- (b) Depth from ground surface to water level before pumping 0 ft. Bailer tested 0 GPM
- (c) Drawdown of water level is 0 feet.
(pumping level minus static water level)
- (d) Casing - screen - perforation - shoe - etc.

10" casing from 0 - 20'
1" pipe from 0 - 400'
4 sks. cement 37 sks. mud

10" casing 0 - 20'
19 sks. cement 100 sks. 50# coke 99
35 sks. gel (mud) 18 sks. 50# #496
400 ft. 1" pipe 2 yds. gravel
100 ft. 2" sche. 40 vent pipe
30 ft. 2" monitor pipe

Time:
67 hrs...Drilling time
7 hrs....Down time
10 hrs....Set up & clean up
6 1/2 hrs....Circulate anodes, coke, etc..

7 Hrs. Mob., demob., clean-up & surface seal
24 Hrs. Drilllog & chasing
5 Hrs. extra time cementing & setting vent tube & monitor pipe
7 Hrs. anodes, circulate, coke, graphite & gravel

Desmet
Rotary

PLASTER PTC. 10

PLASTER PTC. 10

260/ Hansen

over

NOV 1 1985

006108

12/11/12
 (for official use only)

PLEASE TYPE or PRINT IN INK

1) OWNER:
 Name Northwest Natural Gas Co. Rect. #226
 Address 220 Nw, Second Ave.
 City Portland State Oregon

2) TYPE OF WORK (check): Cathodic Protection
 Well Deepening Reconditioning Abandonment
 abandonment, describe material and procedure in item 2)

3) TYPE OF WELL (4) PROPOSED USE (check)
 Surface Air Driven Domestic Industrial Municipal
 Surface Mud Dug Thermal
 Borehole Bored Other: Withdrawing ReInjection
 Piezometric Grounding Test

5) CASING INSTALLED: Steel Plastic
 Threaded Welded
 10" Diam. from 0 ft. to 20 ft. Gauge .250
 2" Diam. from 0 ft. to 100 ft. Gauge sche. 40

LINER INSTALLED: Steel Plastic
 Threaded Welded
 " Diam. from ft. to ft. Gauge

6) PERFORATIONS: Perforated? Yes No
 Size of perforations in. by in.
 perforations from ft. to ft.
 perforations from ft. to ft.
 perforations from ft. to ft.

7) SCREENS: Well screen installed Yes No
 Manufacturer's Name Model No.
 Depth Slot Size Set from ft. to ft.
 Depth Slot Size Set from ft. to ft.

8) WELL TESTS: Drawdown is amount water level is lowered below static level
 Is a pump test made? Yes No If yes, by whom?
 Yield: gal./min. with ft. drawdown after hrs.
 Pump test: gal./min. with drill stem at ft. hrs.
 Filter test: gal./min. with ft. drawdown after hrs.
 Artesian flow: g.p.m.
 Temperature of water Depth artesian flow encountered ft.

9) CONSTRUCTION: Special standards: Yes No
 Well seal—Material used Cement
 Well sealed from land surface to 20 / 50'-80' ft.
 Diameter of well bore to bottom of seal 14 / 8 3/4 in.
 Diameter of well bore below seal 8 3/4
 Amount of sealing material 8 3/4 back of bounds
 How was cement grout placed? Hand

Is pump installed? Type HP Depth ft.
 Is a drive shoe used? Yes No Plugs Size: location ft.
 Do any strata contain unusable water? Yes No
 Depth of Water? depth of strata
 Method of sealing strata off
 Is well gravel packed? Yes No Size of gravel:
 Gravel placed from ft. to ft.

(10) LOCATION OF WELL by legal description:
 County Multnomah 1/4 of Section 12 of
 Township 1 N Range 1 W WM.
 (Township is North or South) (Range is East or West)
 Tax Lot Lot Block Subdivision

MAILING ADDRESS OF WELL (or nearest address)
Post Office Reg. Station St Helen Rd.

(11) WATER LEVEL of COMPLETED WELL:
 Depth at which water was first found ft.
 Static level ft. below land surface. Date
 Artesian pressure lbs. per square inch. Date

(12) WELL LOG: Diameter of well below casing 8 3/4
 Depth drilled 400 ft. Depth of completed well 0 ft.
 Formation: Describe color, texture, grain size and structure of materials; and show thickness and nature of each stratum and aquifer penetrated, with at least one entry for each change of formation. Report each change in position of Static Water Level and indicate principal water-bearing strata.

MATERIAL	From	To	SWL
Gravel	0	1	GL
Clay	1	2	CC
Sand	2	10	SL
Brown clay	10	40	CC
Sand	40	50	SL
Broken rock	50	78	RC
Black basalt hard some broken lava rock layers	78	290	RC
Broken multi colored clay & sandstone little clay	290	310	SS
Black basalt hard	310	370	RC
Broken rock sandy clay	370	390	SL
Black basalt hard	390	400	RC

Date work started Oct. 10, 1985 completed Oct. 22, 1985
 Date well drilling machine moved off of well Oct. 22, 1985 19

(unbonded) Water Well Constructor Certification (if applicable):
 This well was constructed under my direct supervision. Materials used and information reported above are true to my best knowledge and belief.
 Signed: _____ Date _____, 19____

(bonded) Water Well Constructor Certification:
 Bond 63-0130-11384-57-1 Issued by: UFS&G
 (number) (Surety Company Name)
 On behalf of Jim Hansen / Hansen Drilling Co. Inc.
 (type or print name of Water Well Constructor)

This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief:
 (Signed) Jim Hansen
 (Water Well Constructor)
 (Dated) Oct. 23, 1985