

**Preliminary Analysis
Of Soil Contamination Data**

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October 9, 1998

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

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

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

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

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

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

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

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

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

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

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

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

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

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- Silverman, B.W., 1986, "Density estimation for statistics and data," Chapman and Hall.
- Statistica statistical analysis software, Release 5.1 M, 1998. StatSoft Inc., Tulsa OK.

11. Figures

Figure 1.

Comparison of Duplicate Results for Three Compounds

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

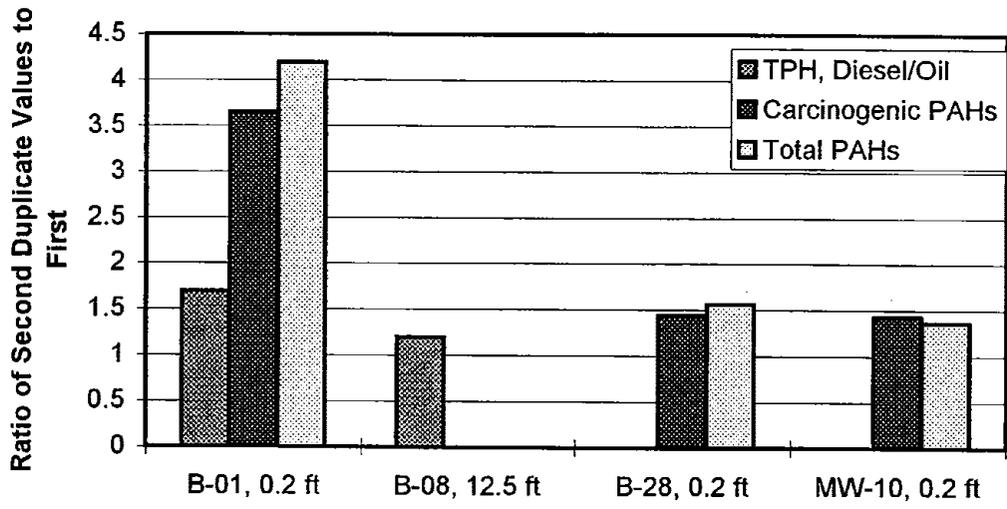


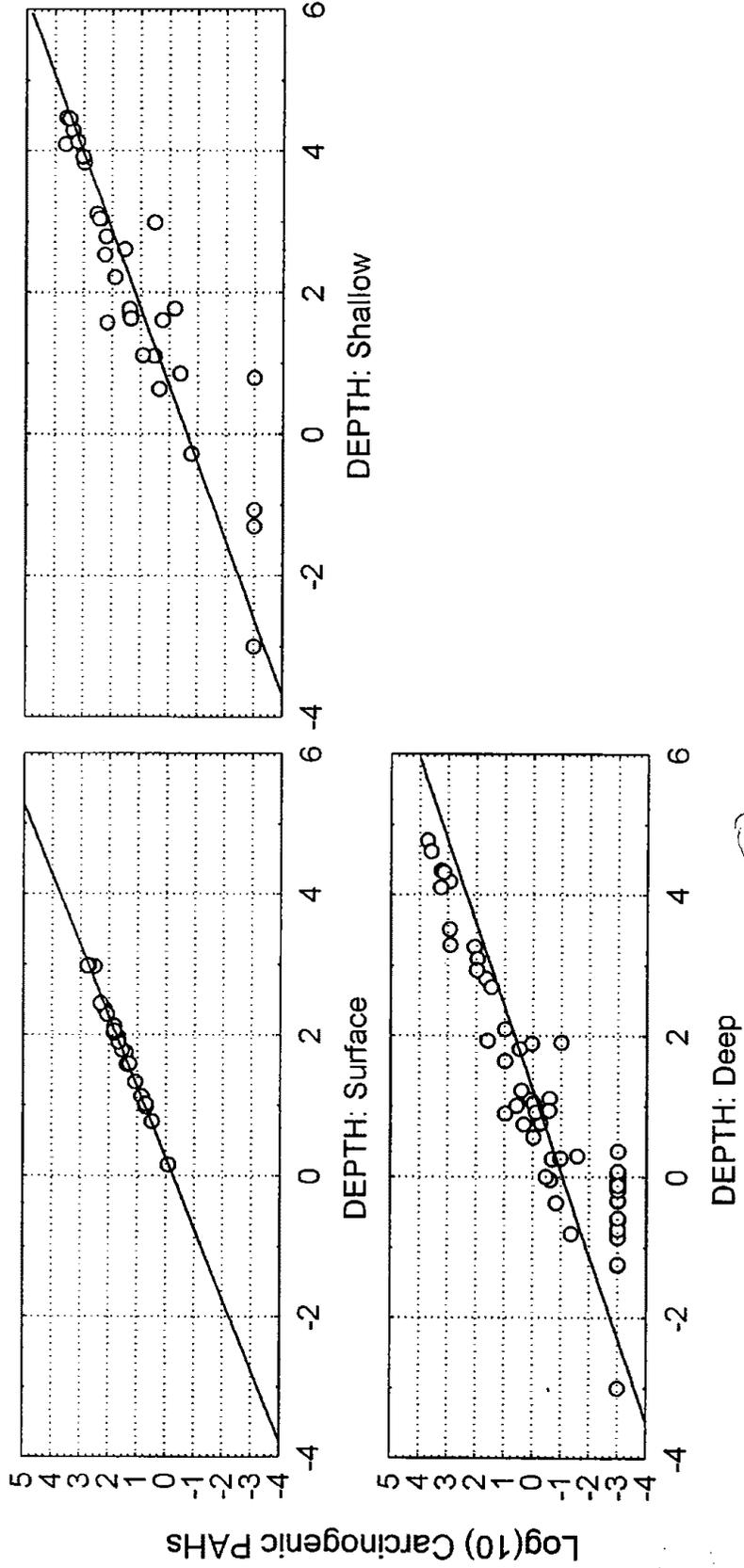
Figure 2.

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

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

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

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



Log(10) Total PAHs

not log

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

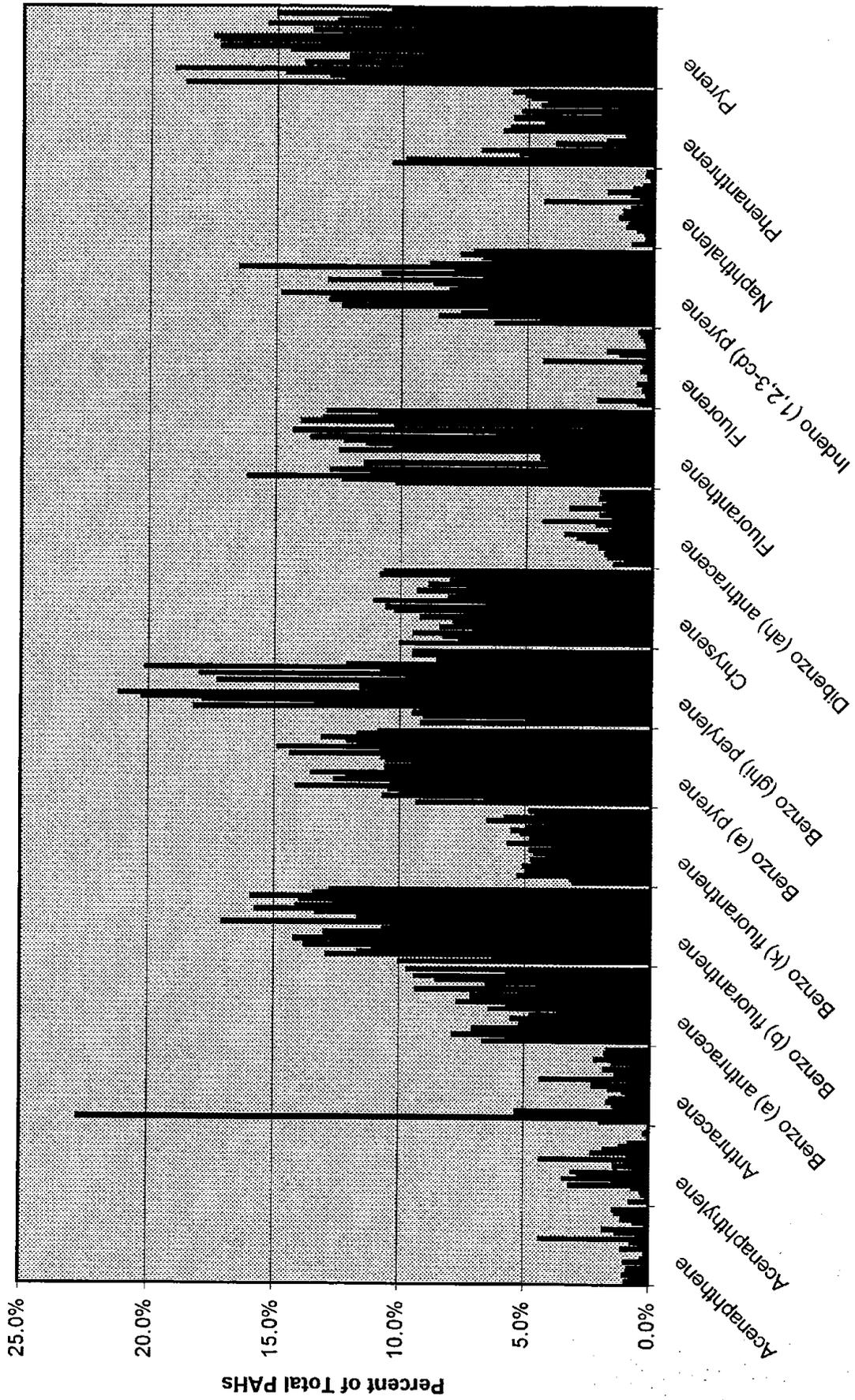


Figure 4.

Comparison of PAH Compound Mix in Shallow Soil Samples

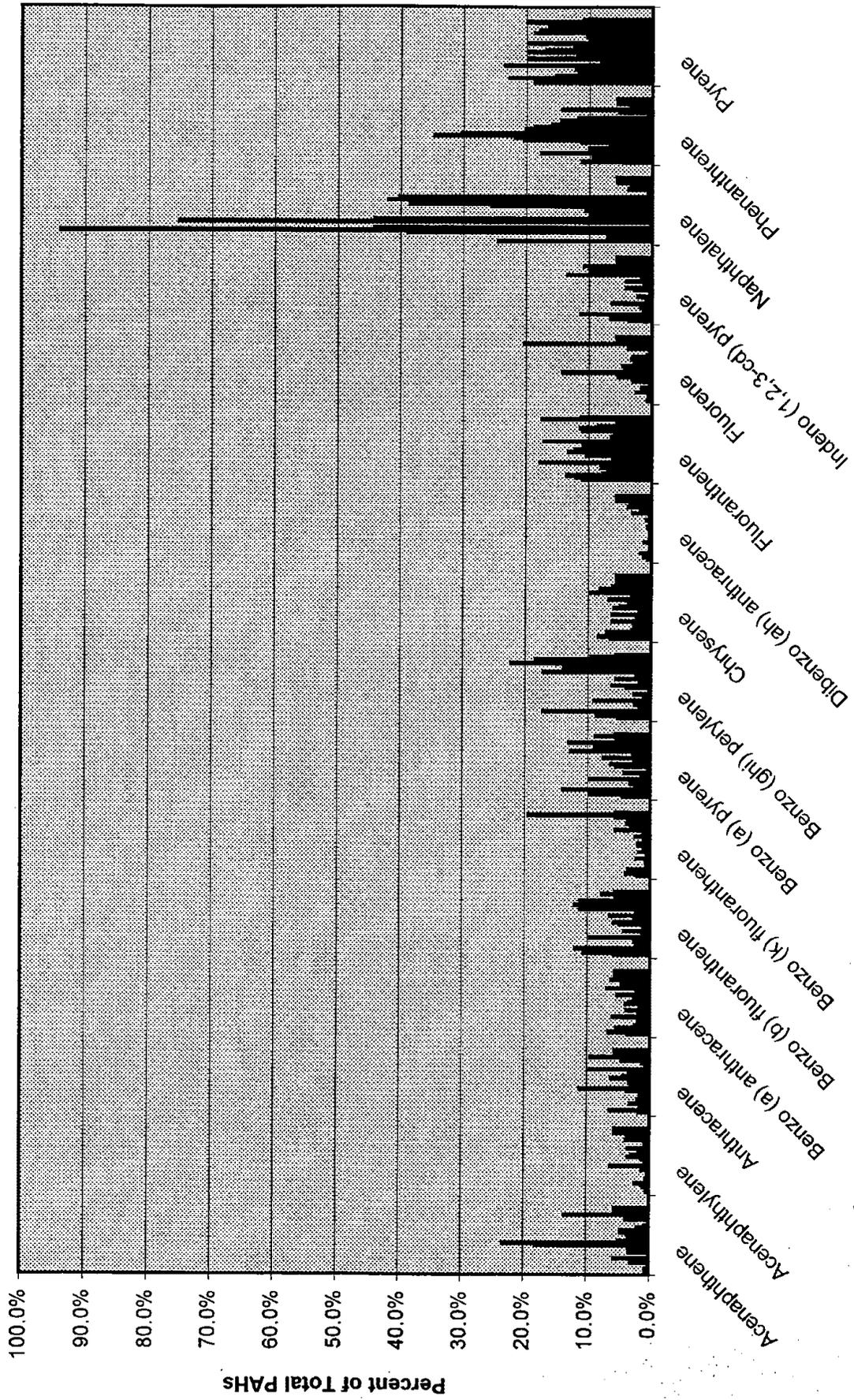


Figure 5.

Comparison of PAH Compound Mix in Deep Soil Samples

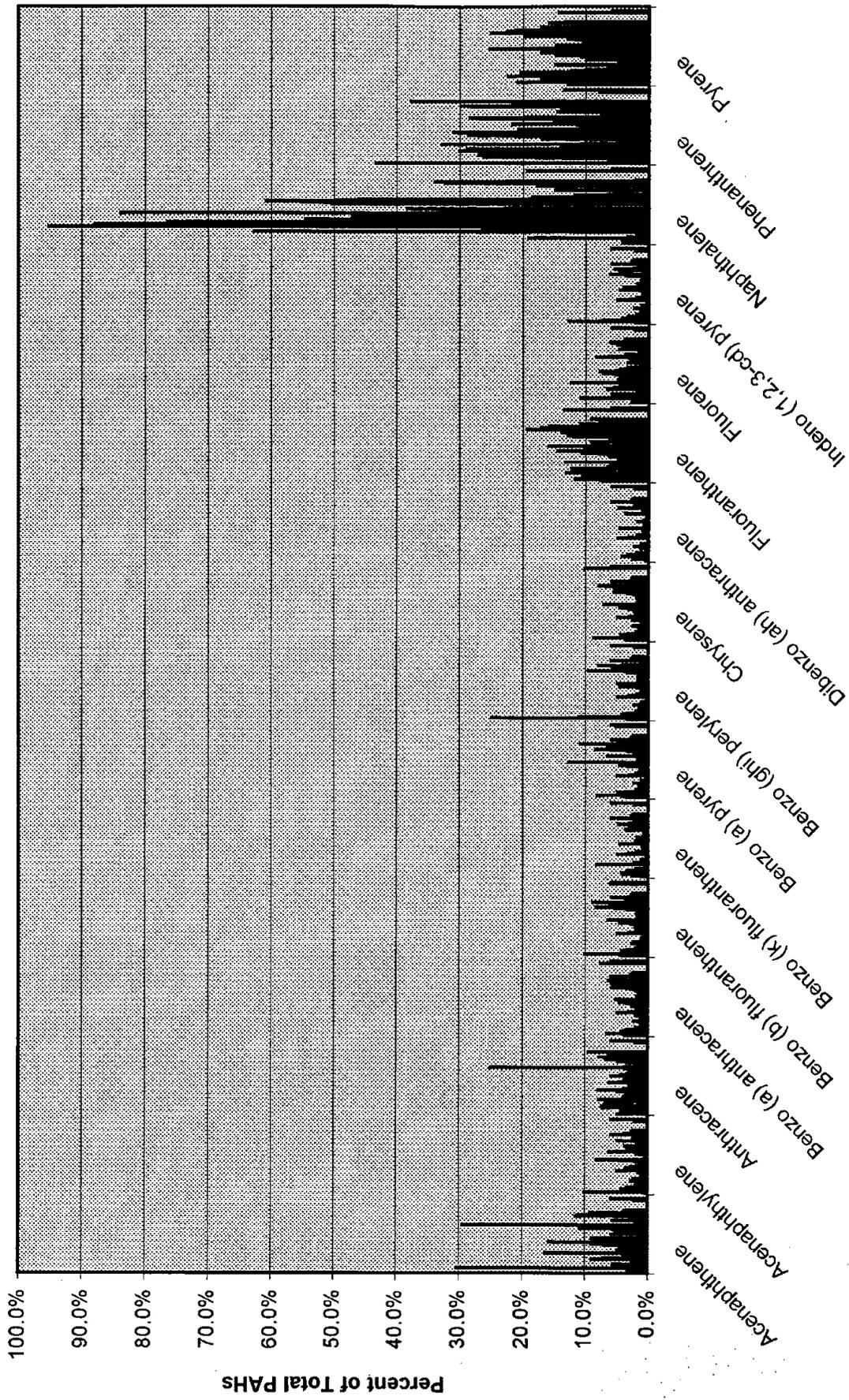


Figure 6.

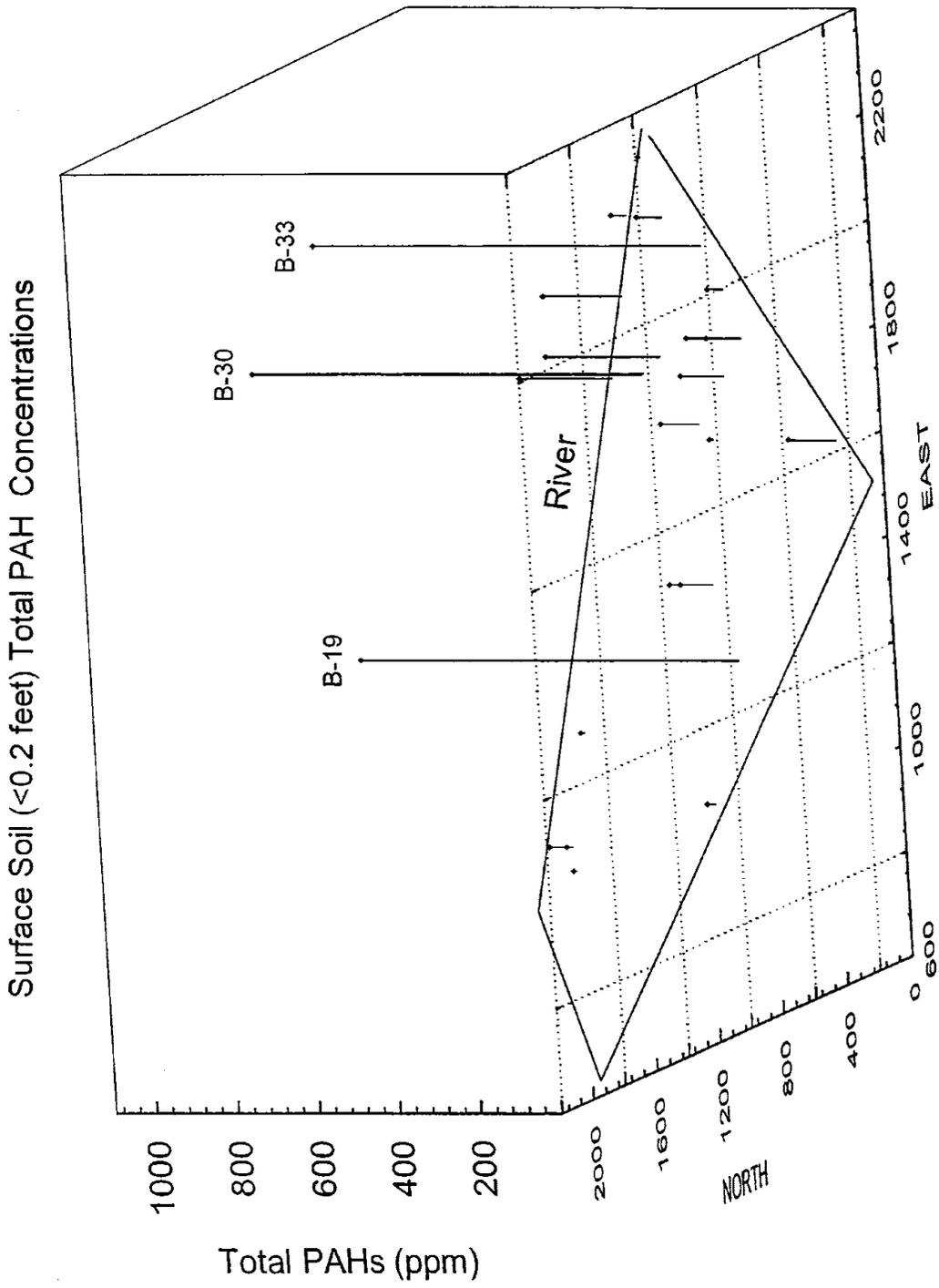


Figure 7.

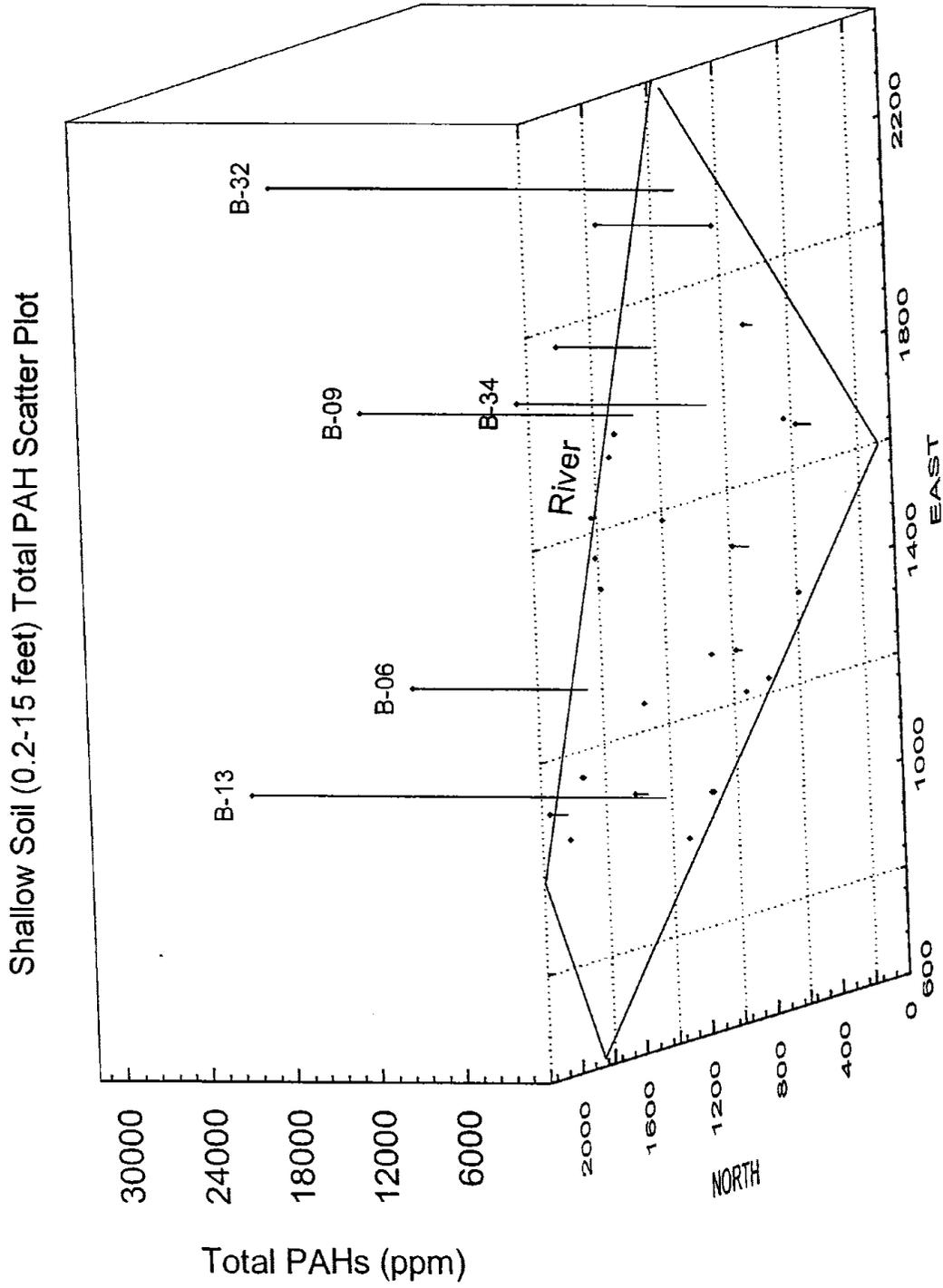


Figure 8.

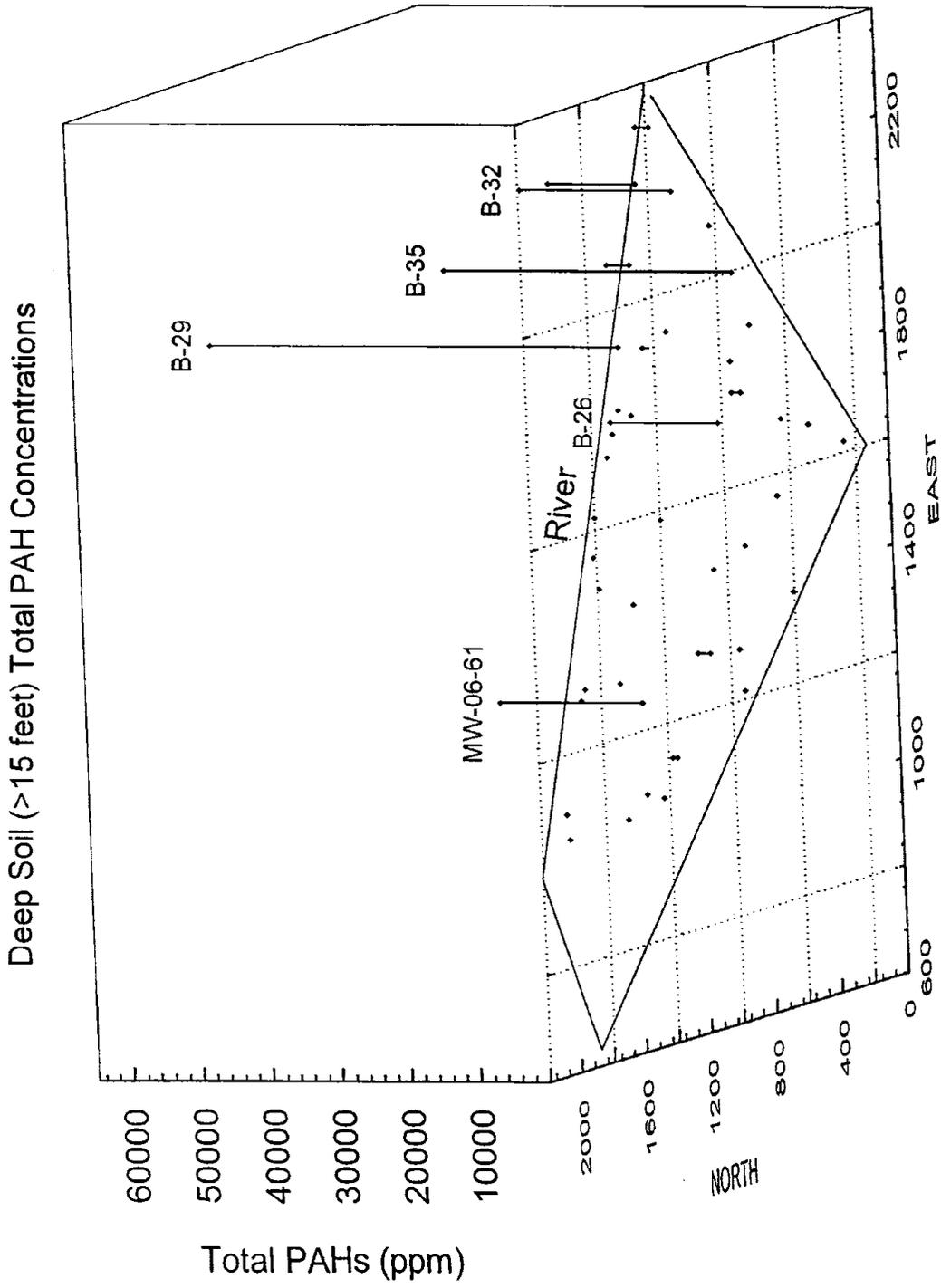


Figure 9.

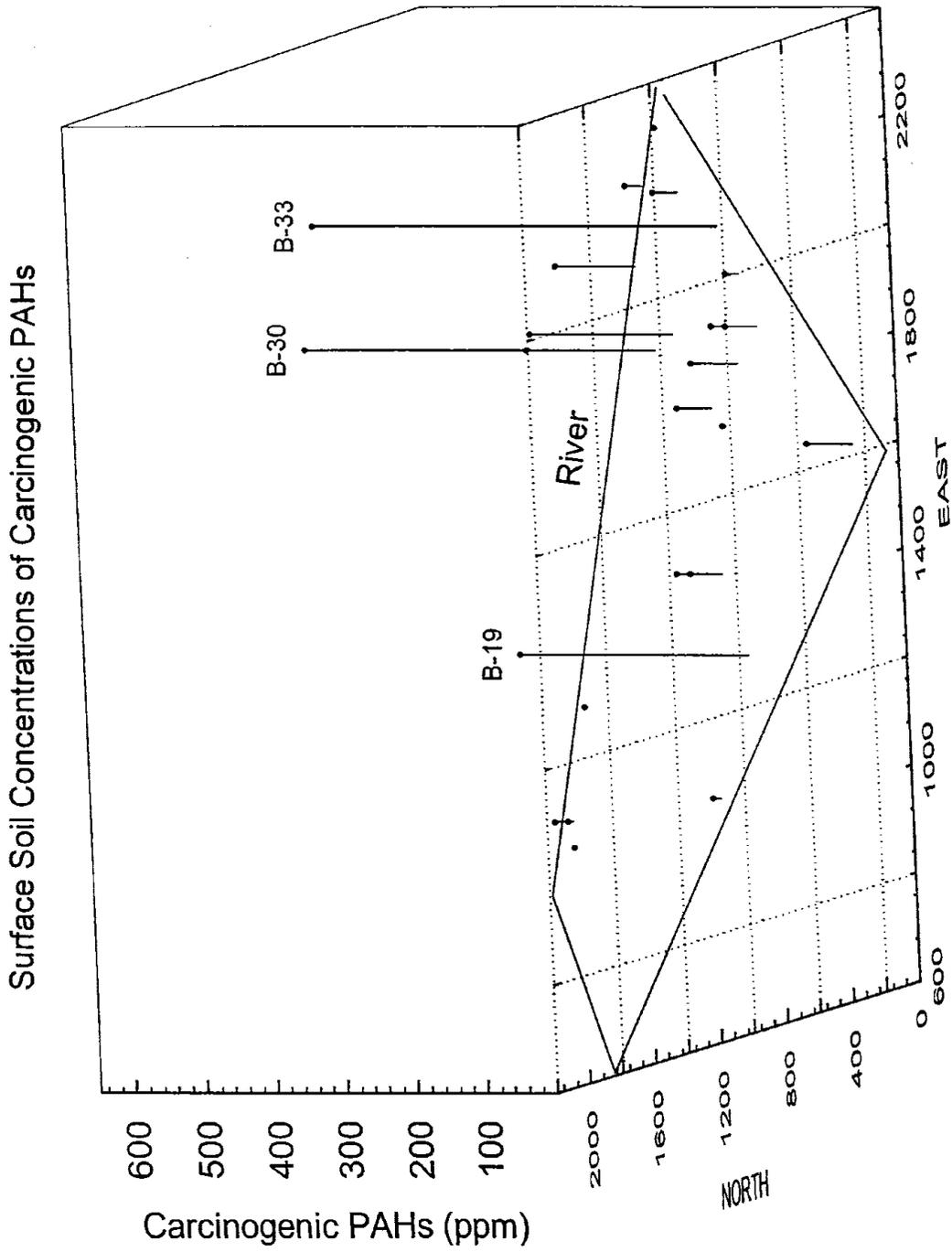


Figure 10.

Shallow Soil (0.2-15 feet) Carcinogenic PAH Concentrations

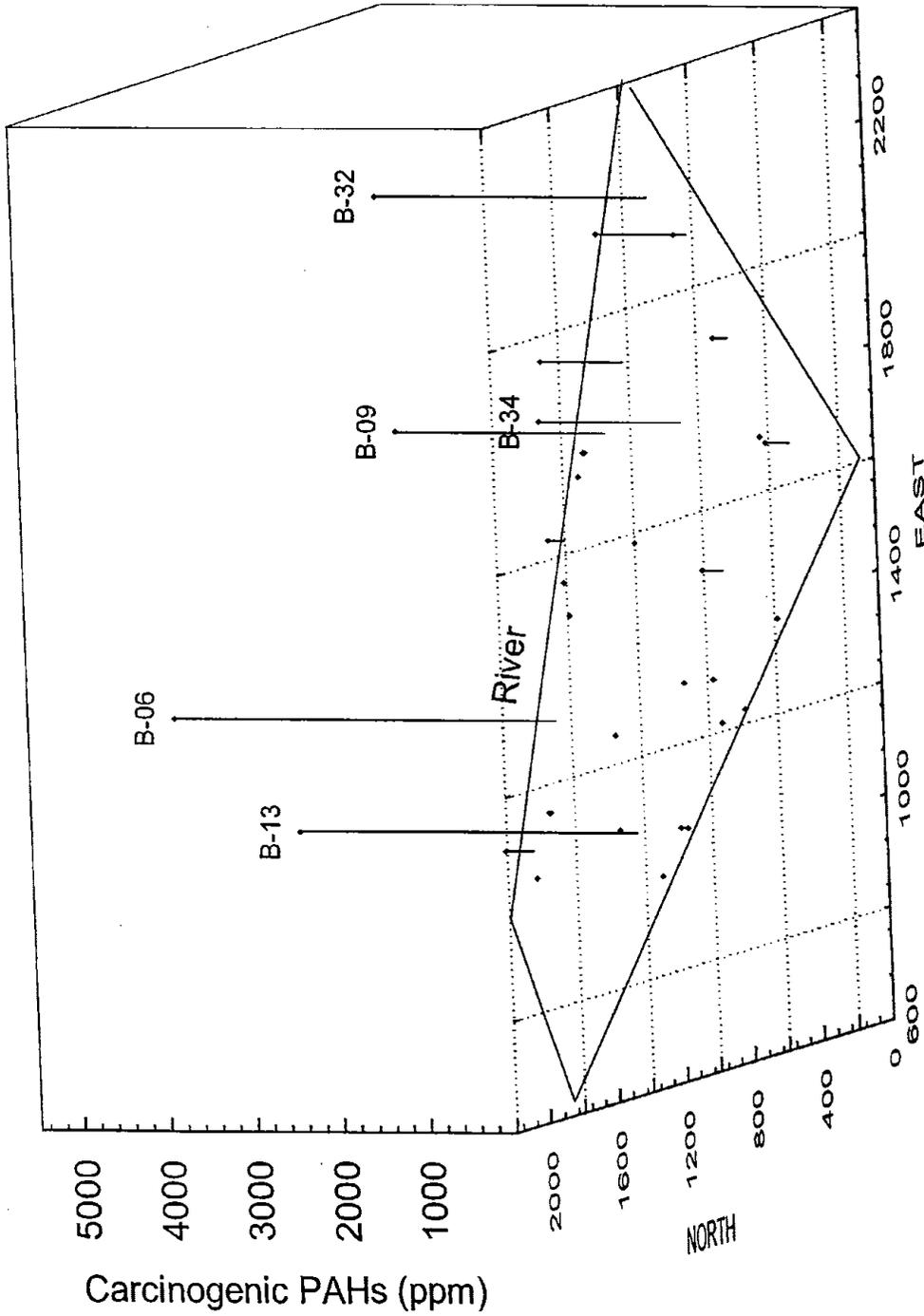


Figure 11.

Deep Soil (>15 feet) Carcinogenic PAH Concentrations

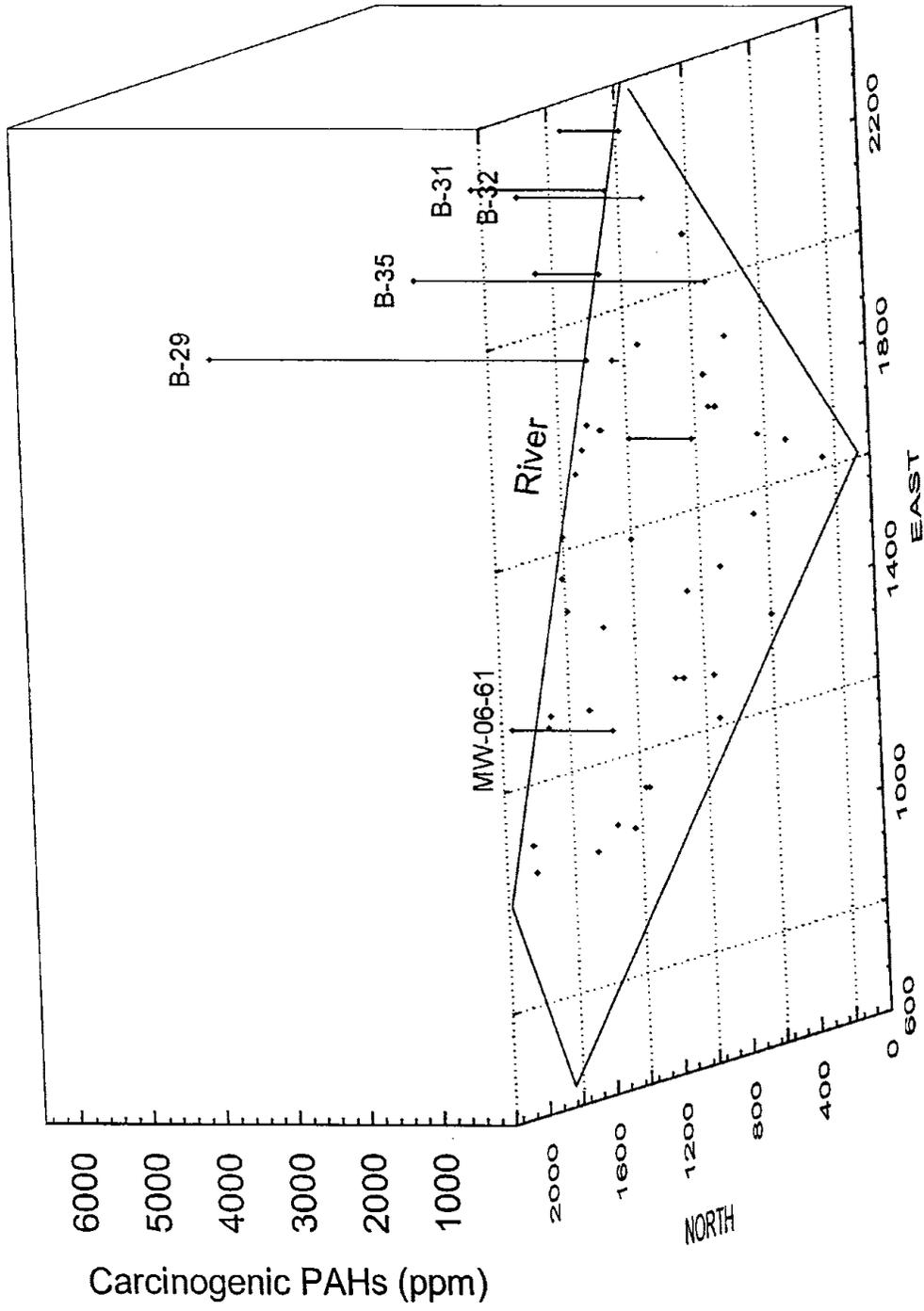


Figure 12.

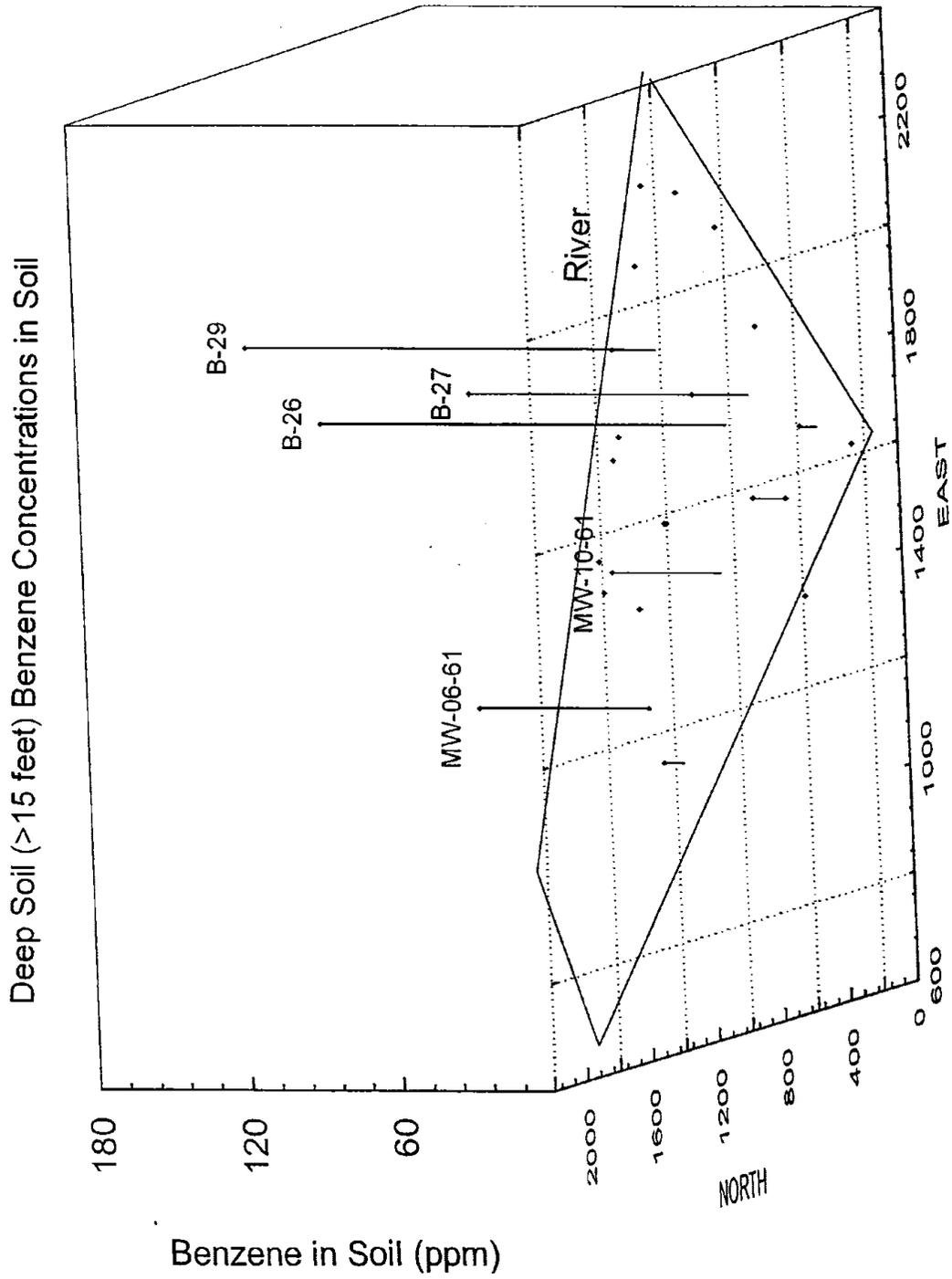


Figure 13.

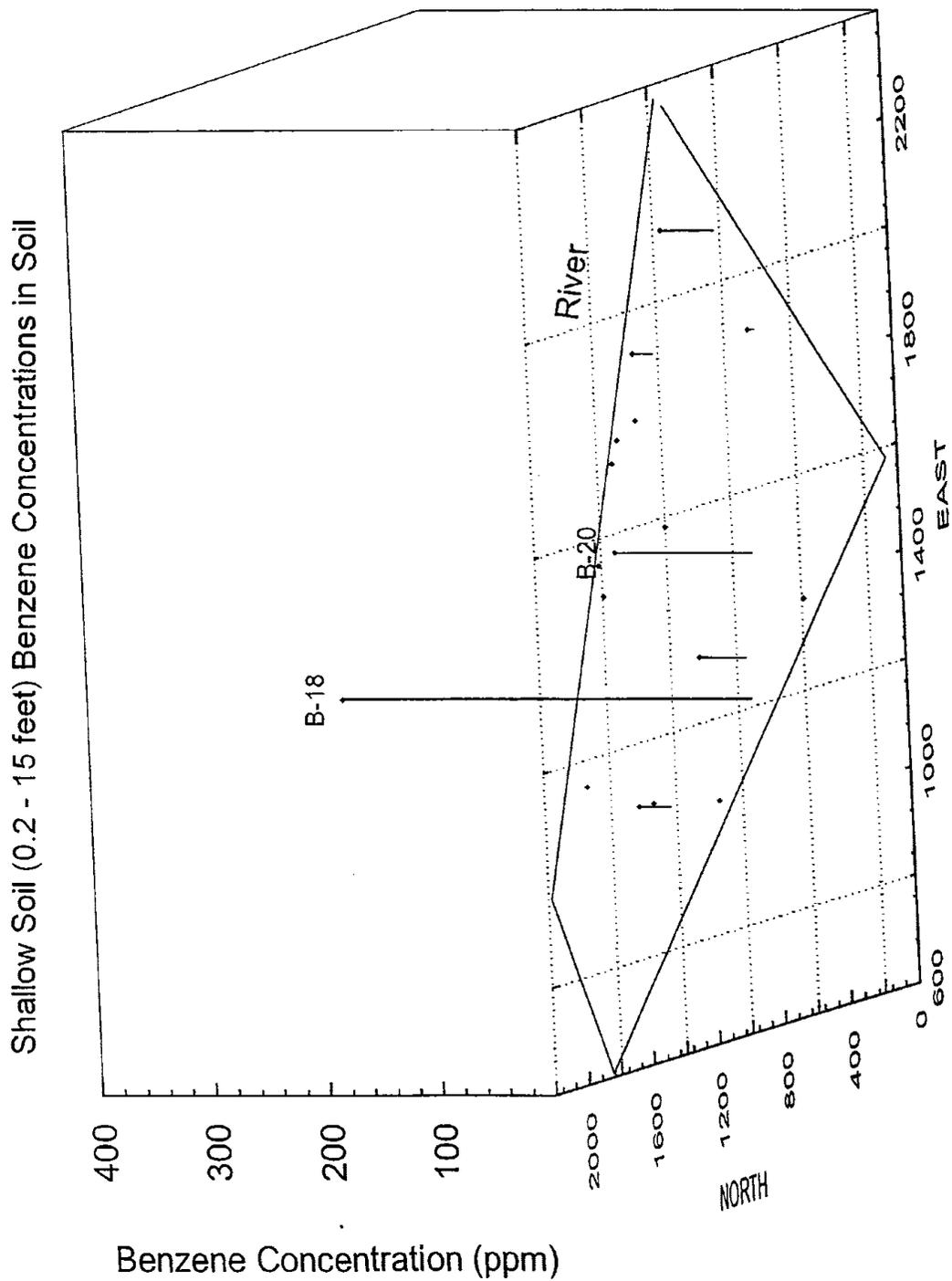
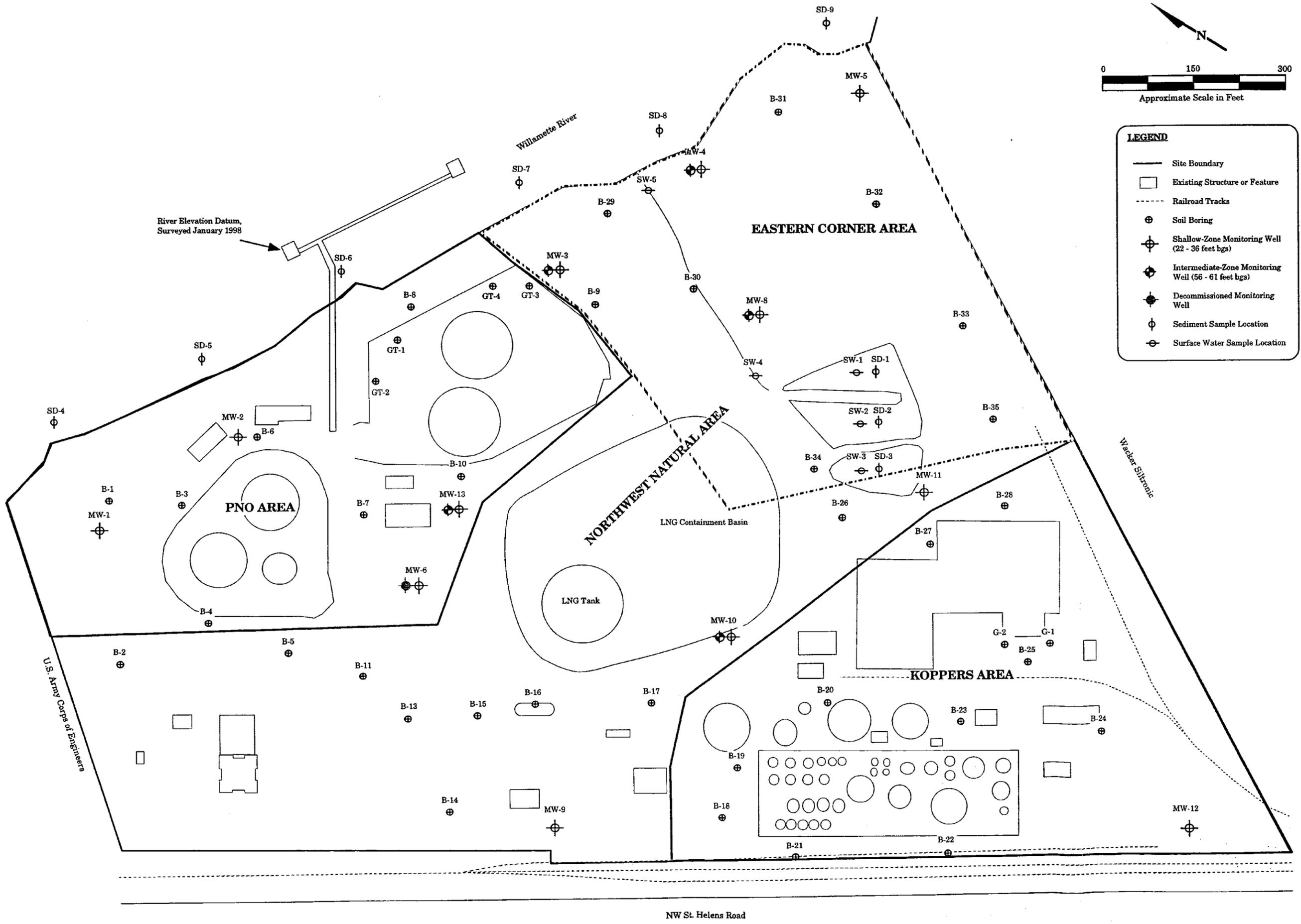


Figure 14



Site Area Breakdown Map

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

HAHN & ASSOCIATES, INC.

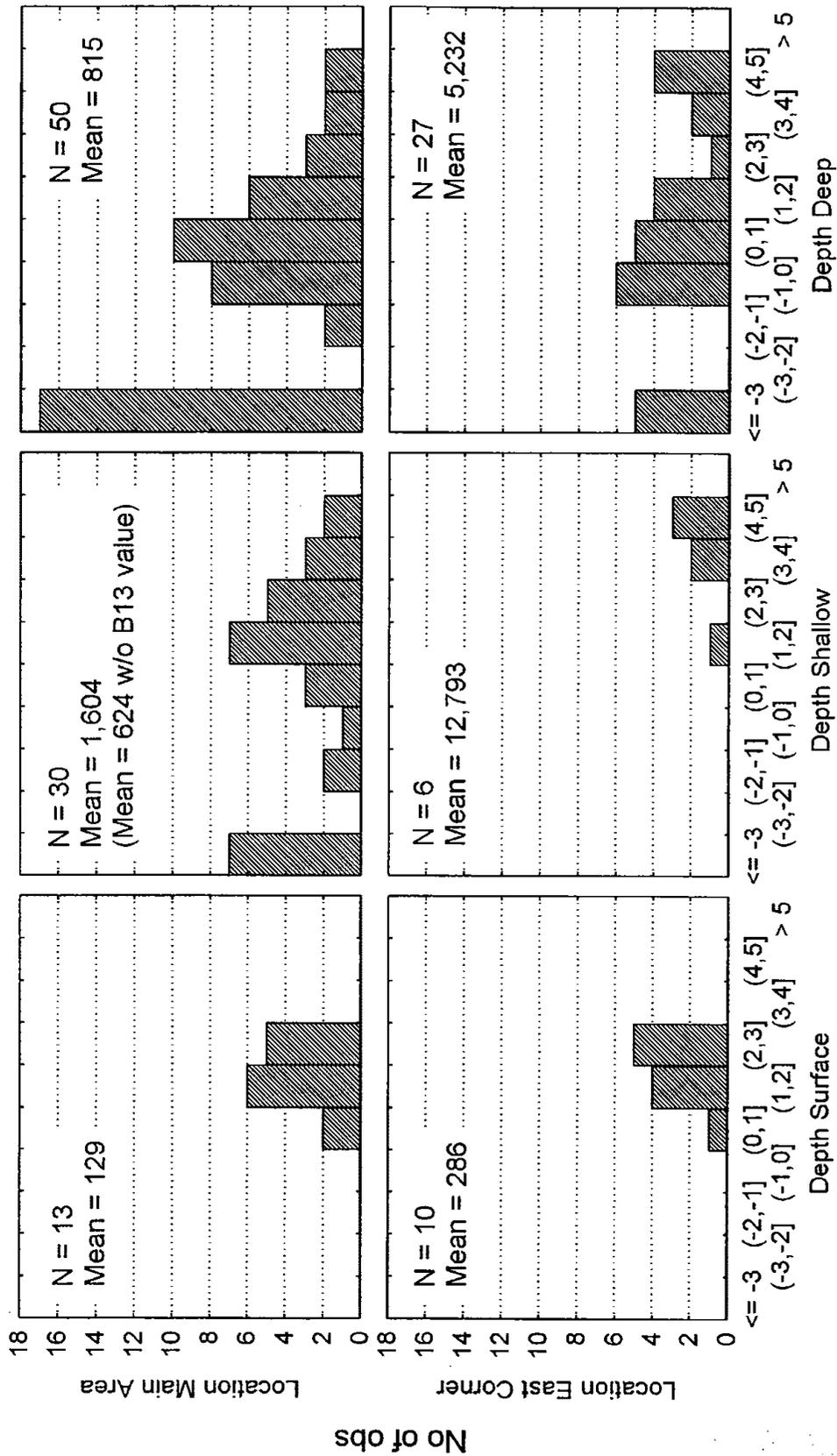
ENVIRONMENTAL MANAGEMENT
 434 NW SIXTH AVENUE, SUITE 203
 PORTLAND, OREGON 97209
 503/796-0717

September 1998

Project #2708

Figure 15.

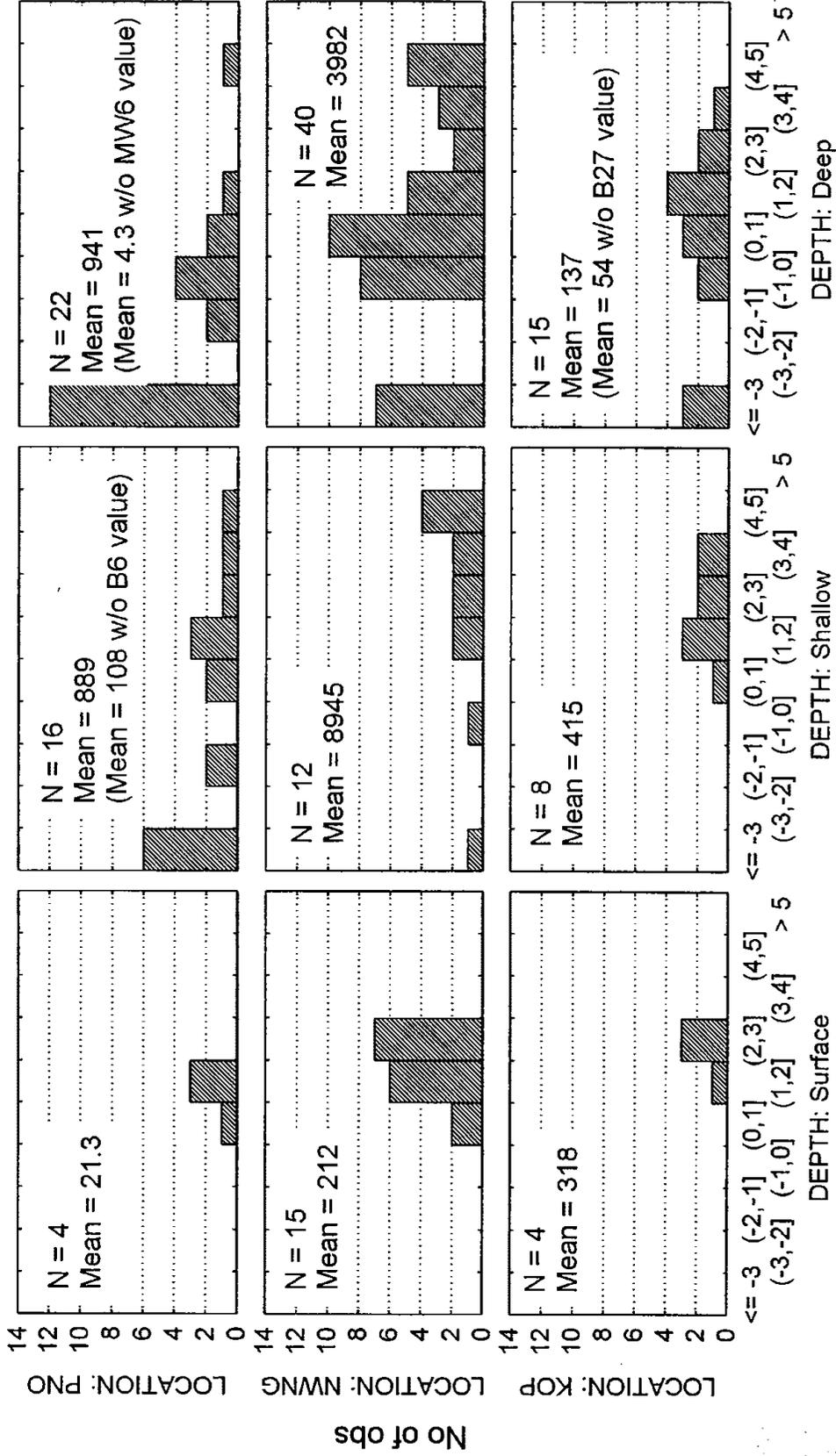
Log Total PAHs in Soil for 2 Areas and 3 Depths



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

DEPTH: Deep

DEPTH: Shallow

DEPTH: Surface

Figure 17.

Log Total PAHs for 4 Locations and Depths

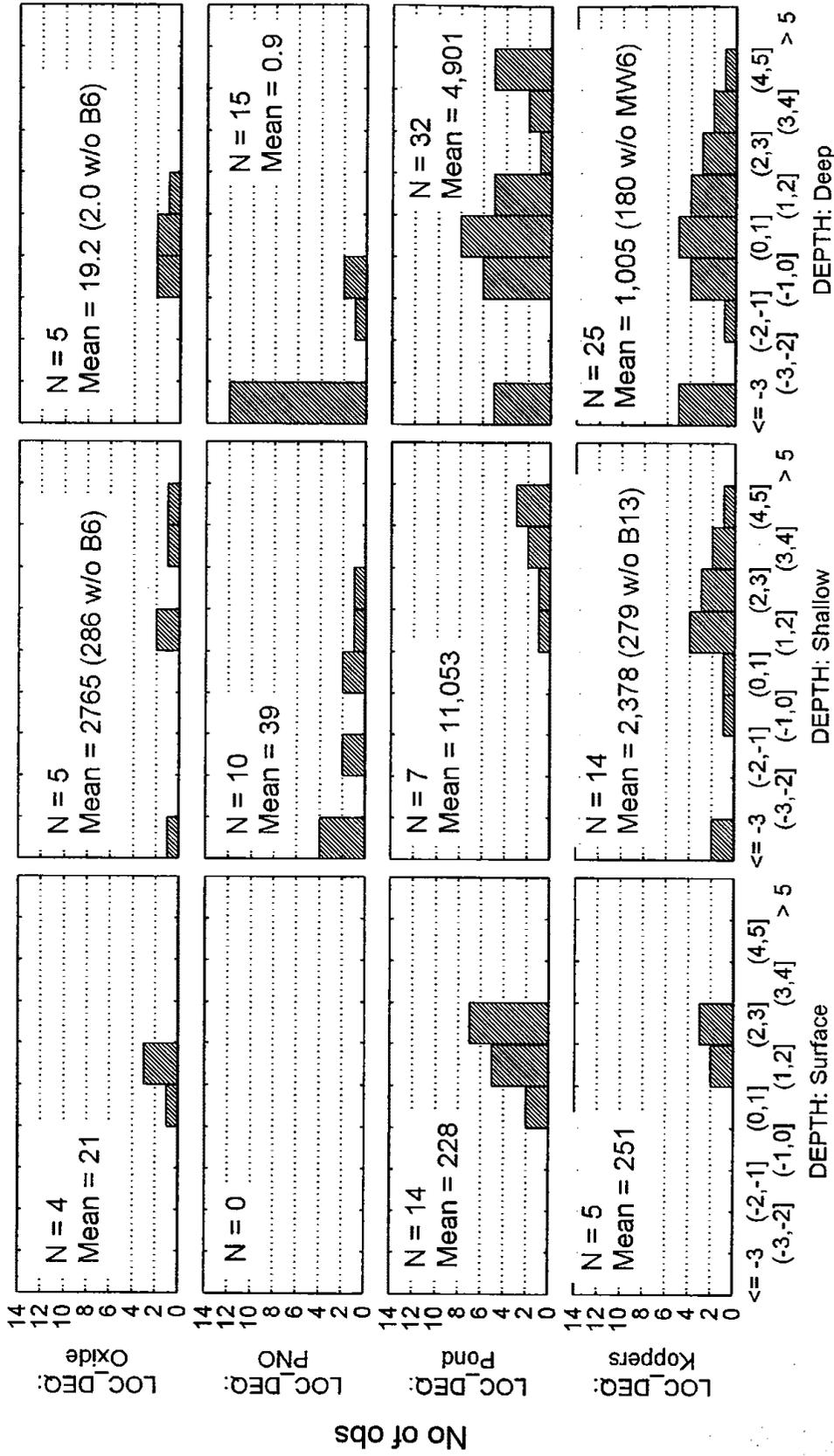
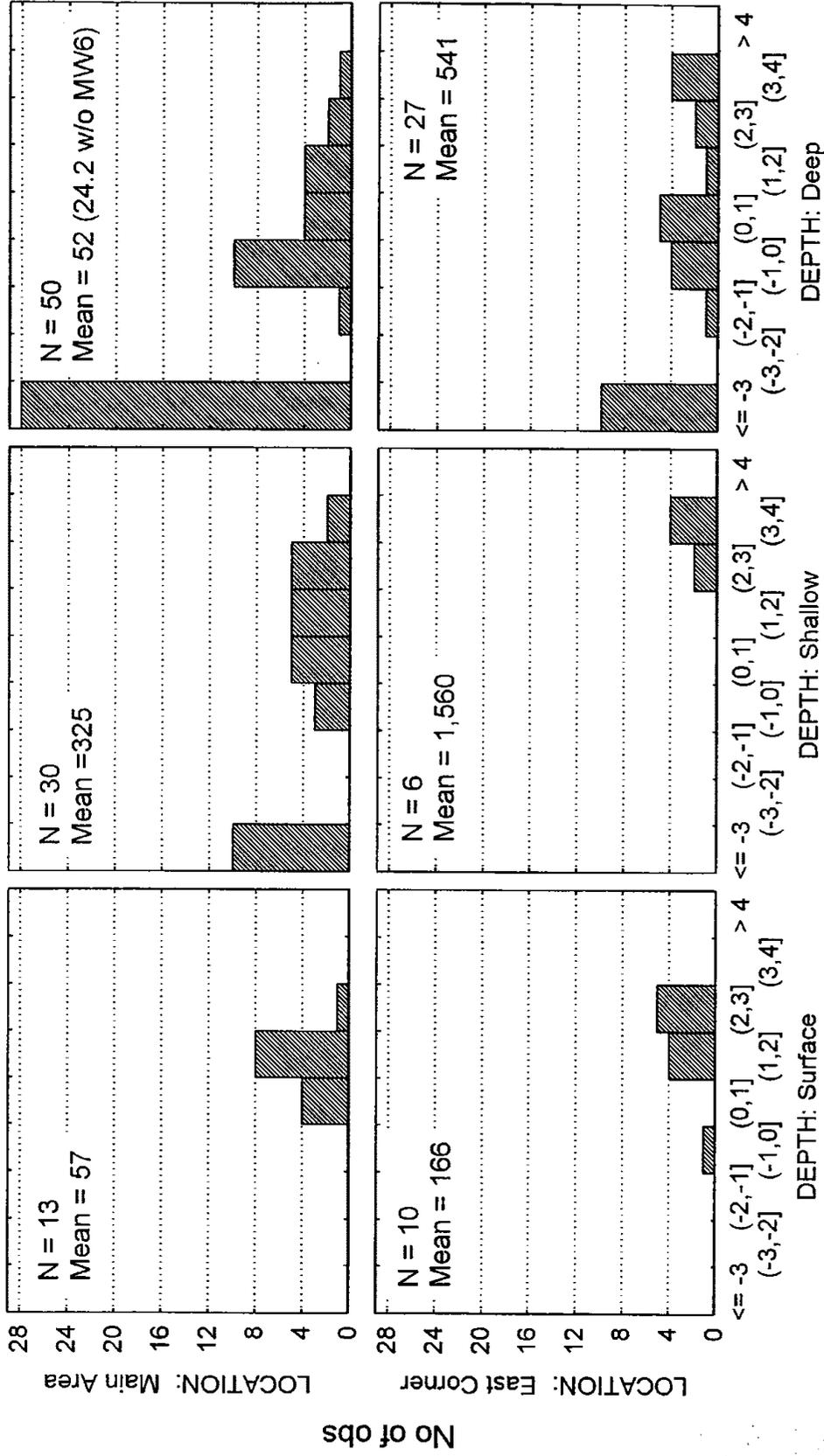


Figure 18.

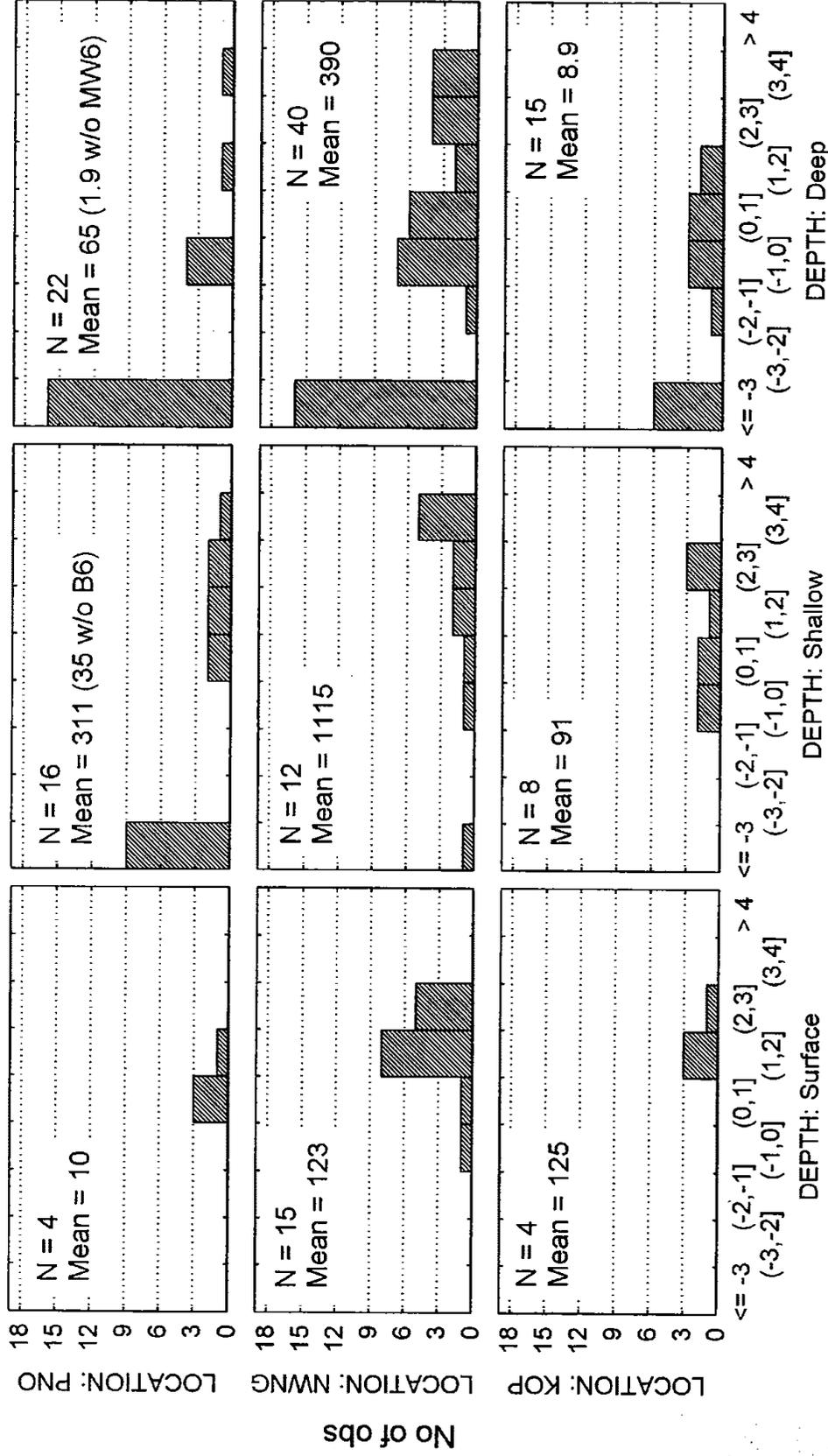
Log Carcinogenic PAHs in Soil for 2 Areas and 3 Depths



Log (10) Carcinogenic PAH Concentrations in Soil

Figure 19.

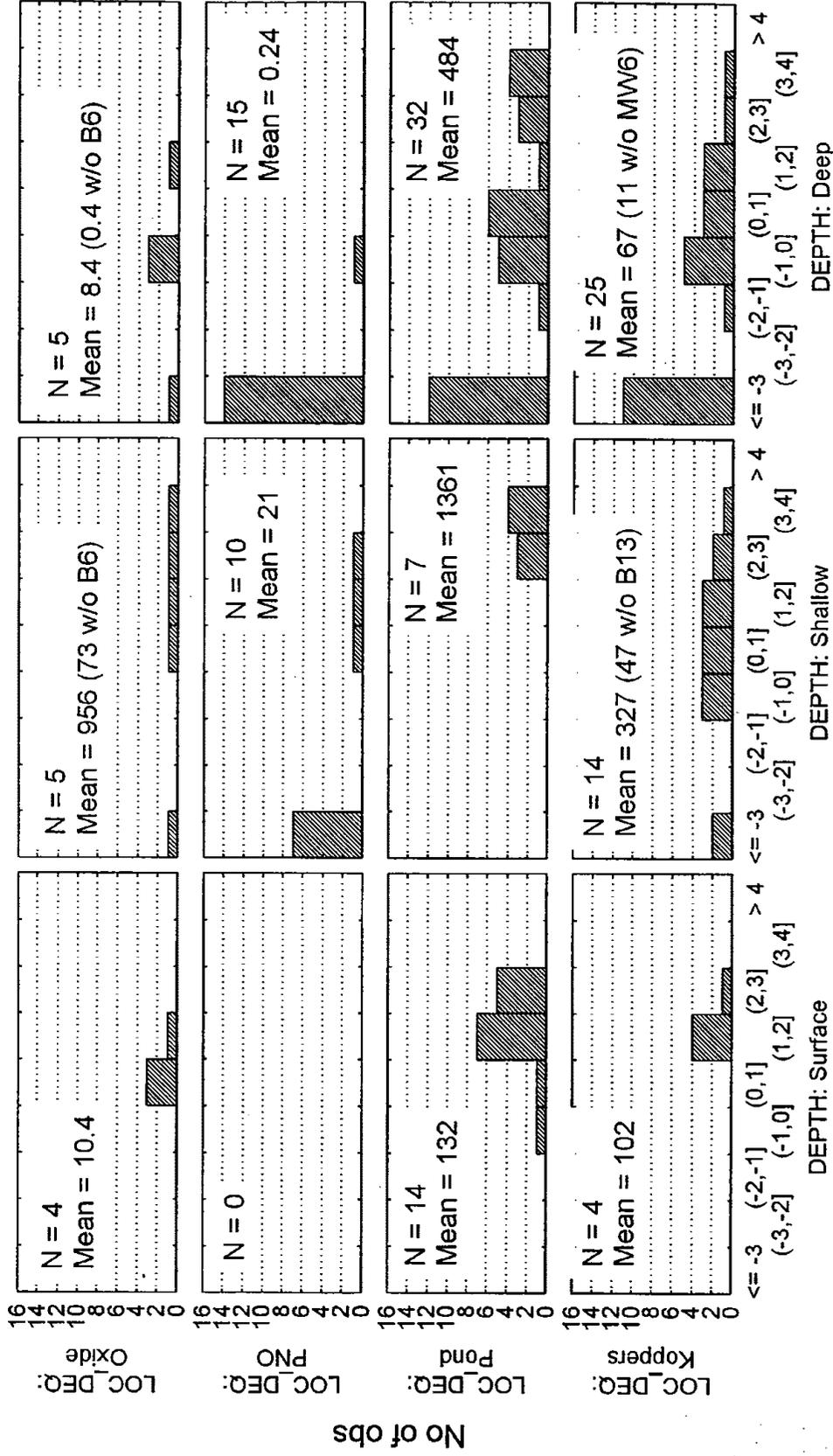
Log Carc PAHs for 3 Locations and for Depths



Log(10) of Carcinogenic PAH Concentrations

Figure 20.

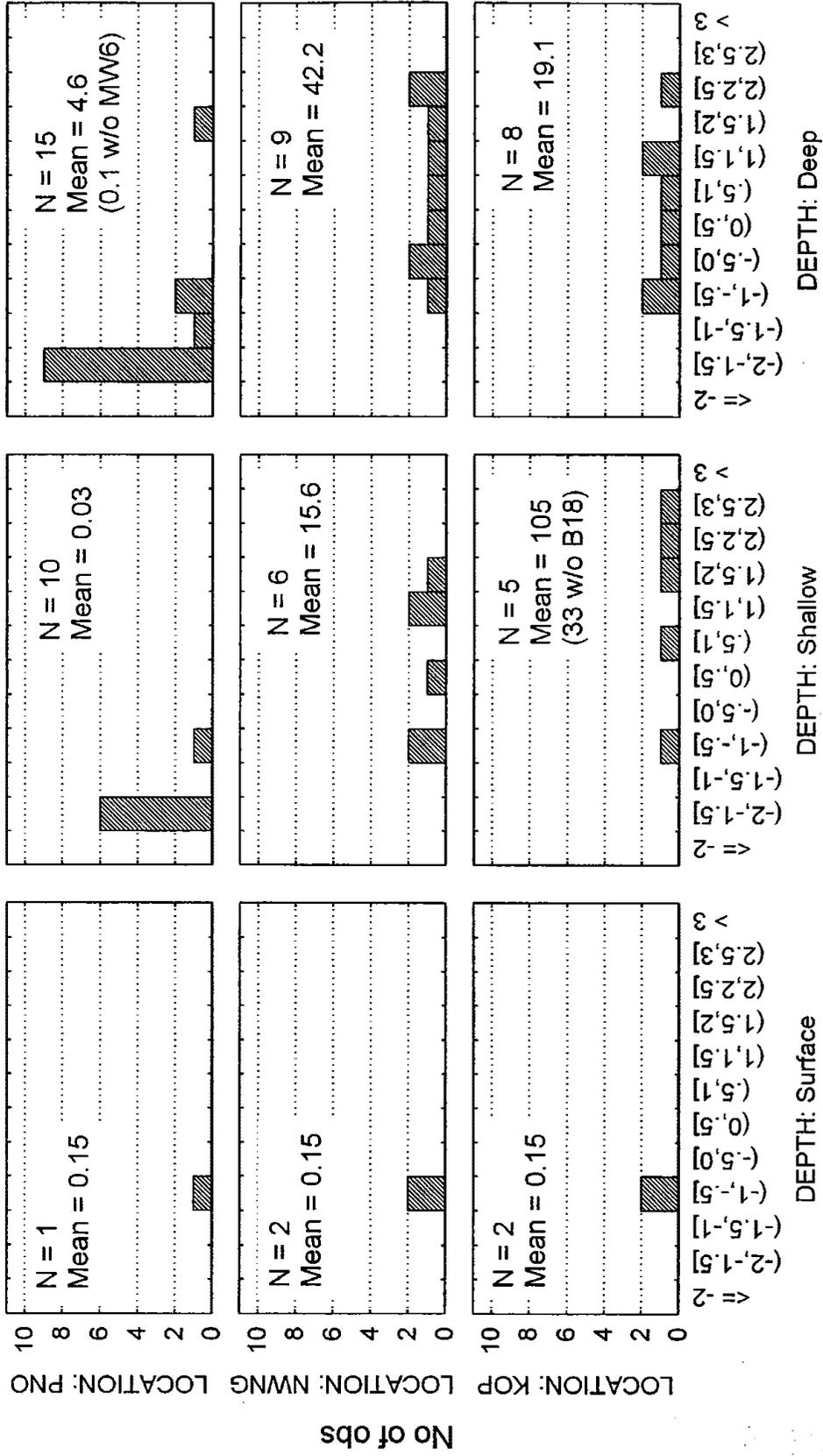
Log Carcinogenic PAHs in Soil for 4 Locations and 3 Depths



Log (10) Carcinogenic PAH Concentrations in Soil

Figure 21.

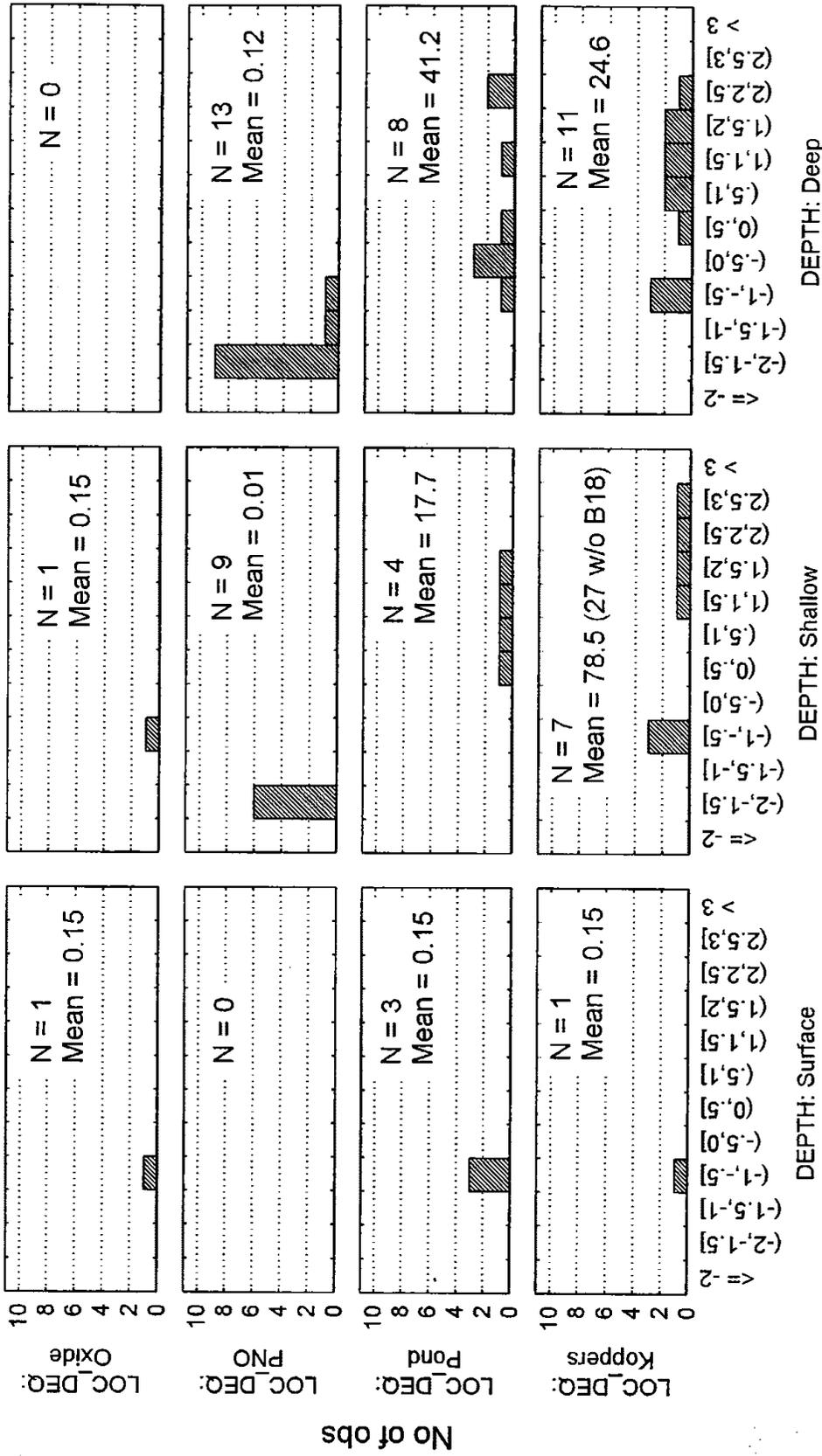
Log Benzene Concentrations in Soil for 3 Locations and 3 Depths



Log(10) Benzene Concentrations in Soil

Figure 22.

Log Benzene for 4 Locations and 3 Depths



Log(10) Benzene Concentrations

Figure 23.

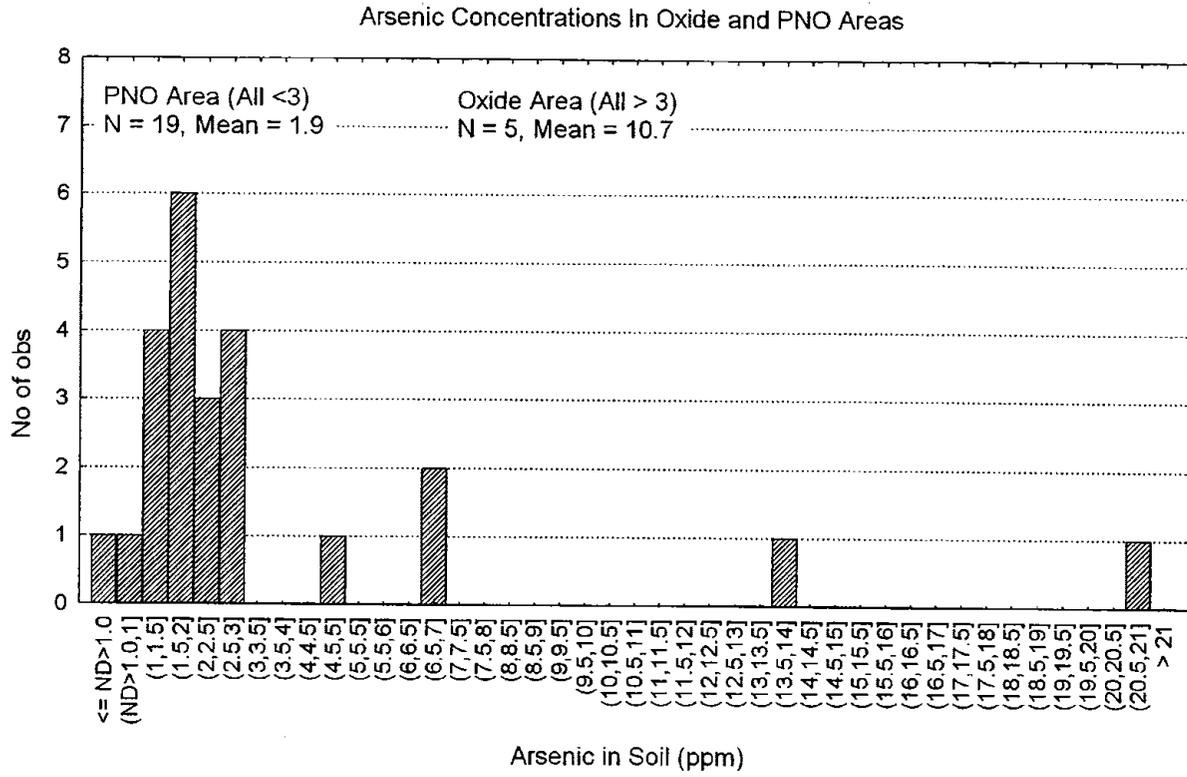


Figure 24.

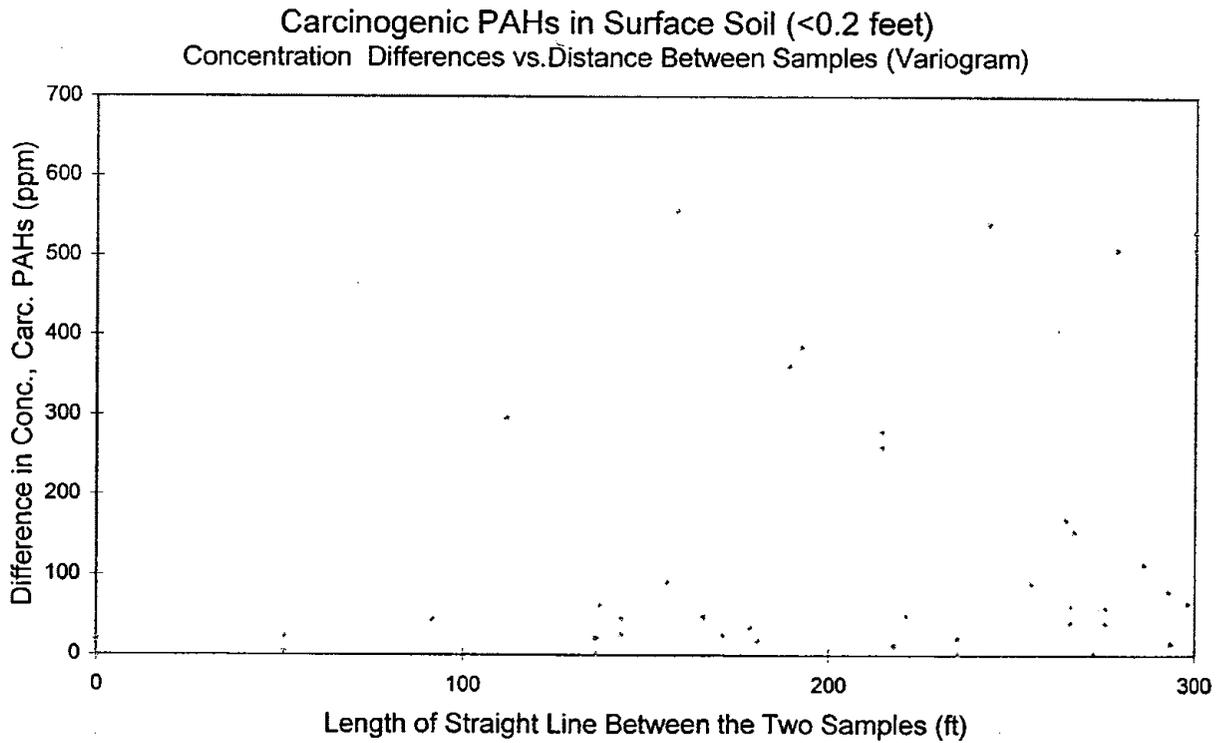
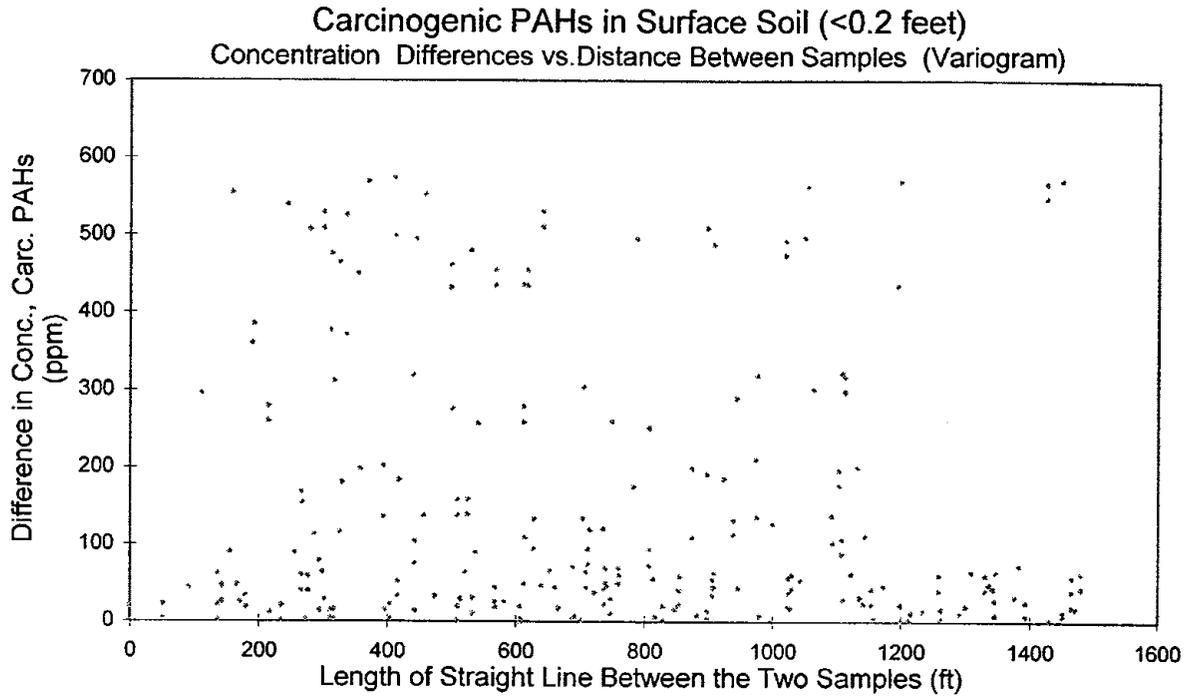
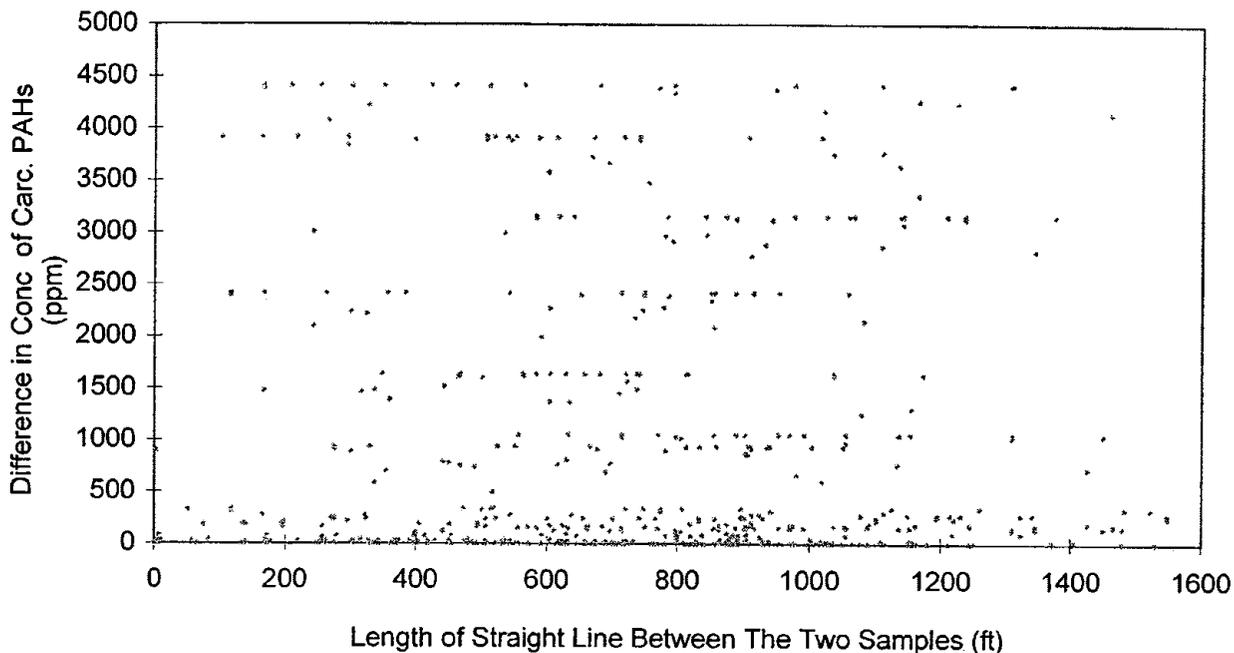


Figure 25.

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)

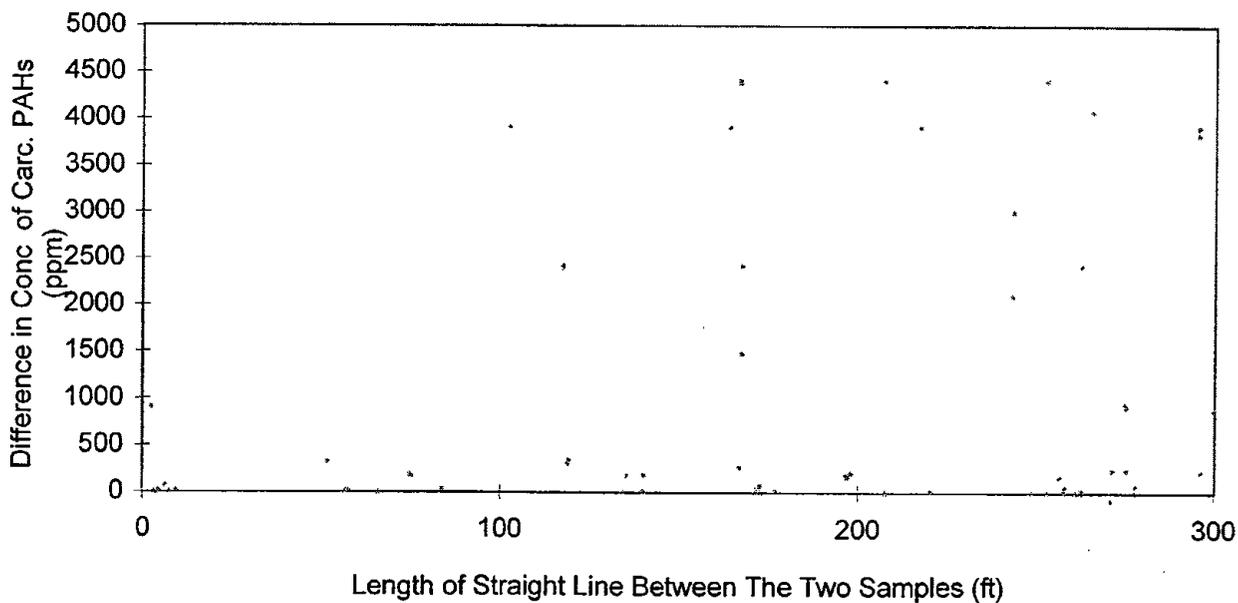
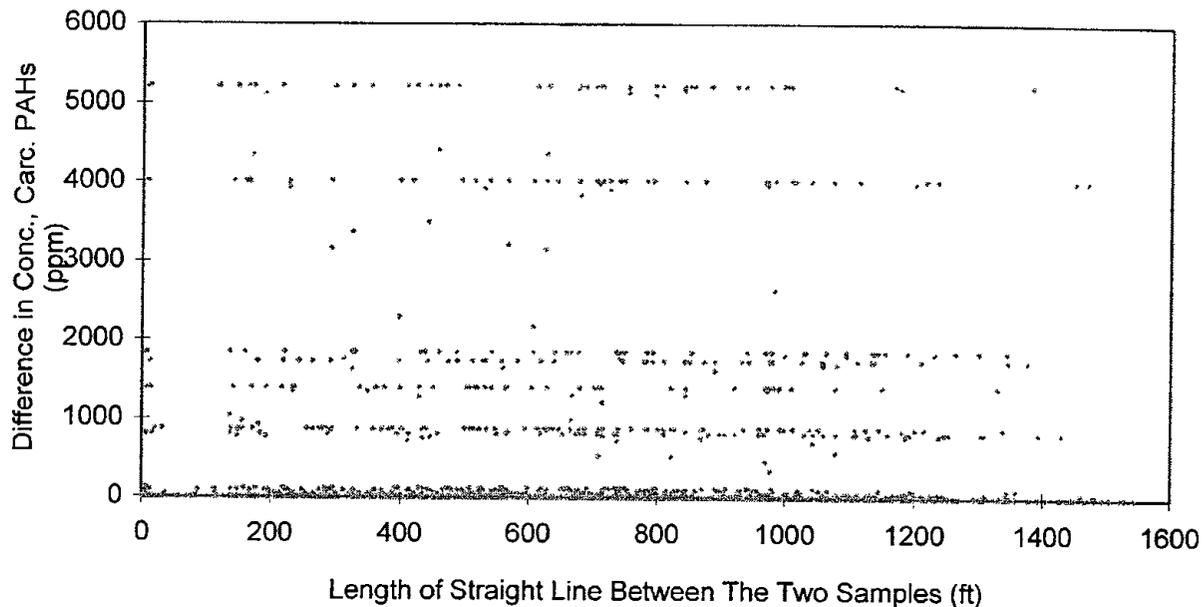


Figure 26.

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)

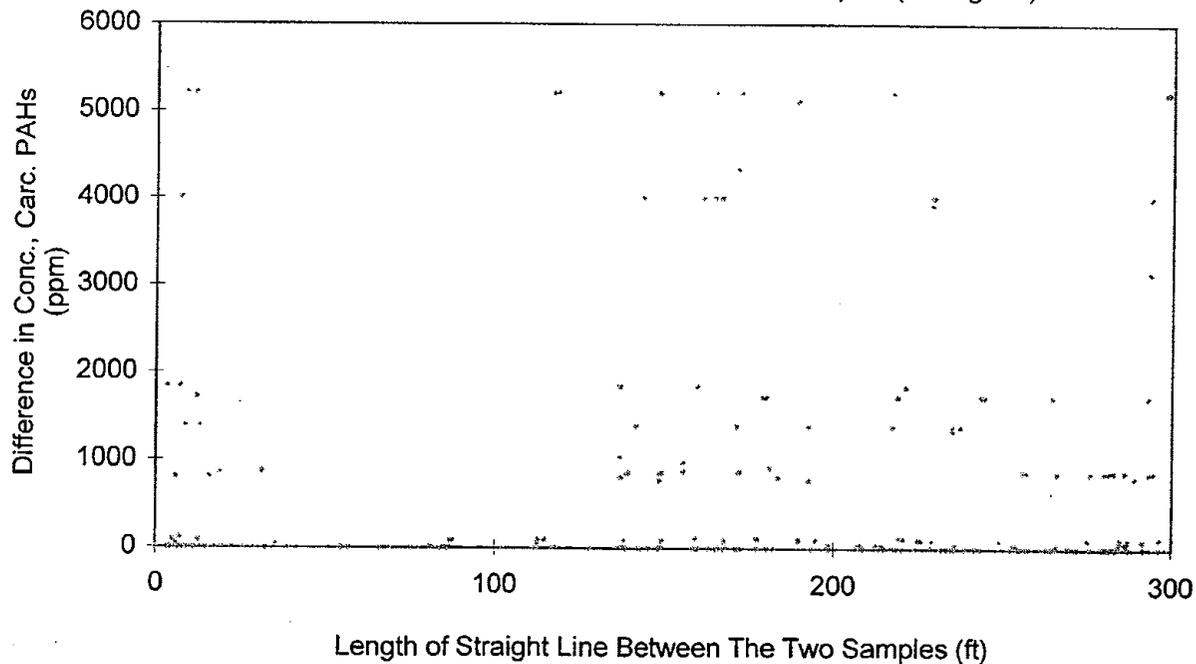
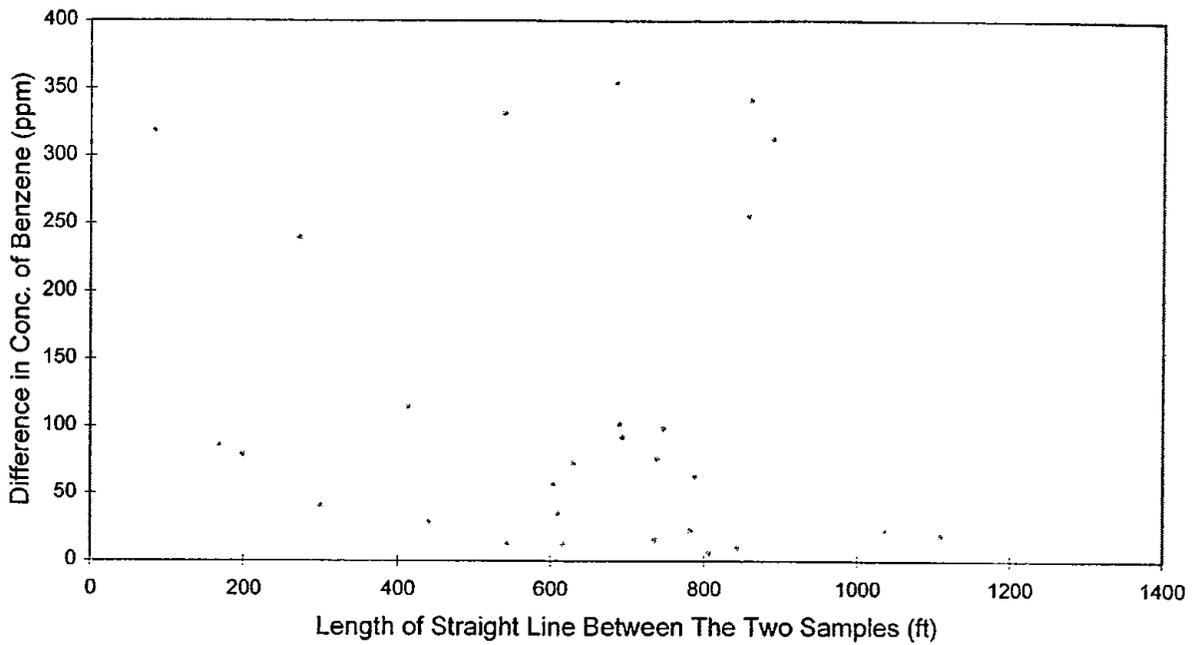


Figure 27.

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)

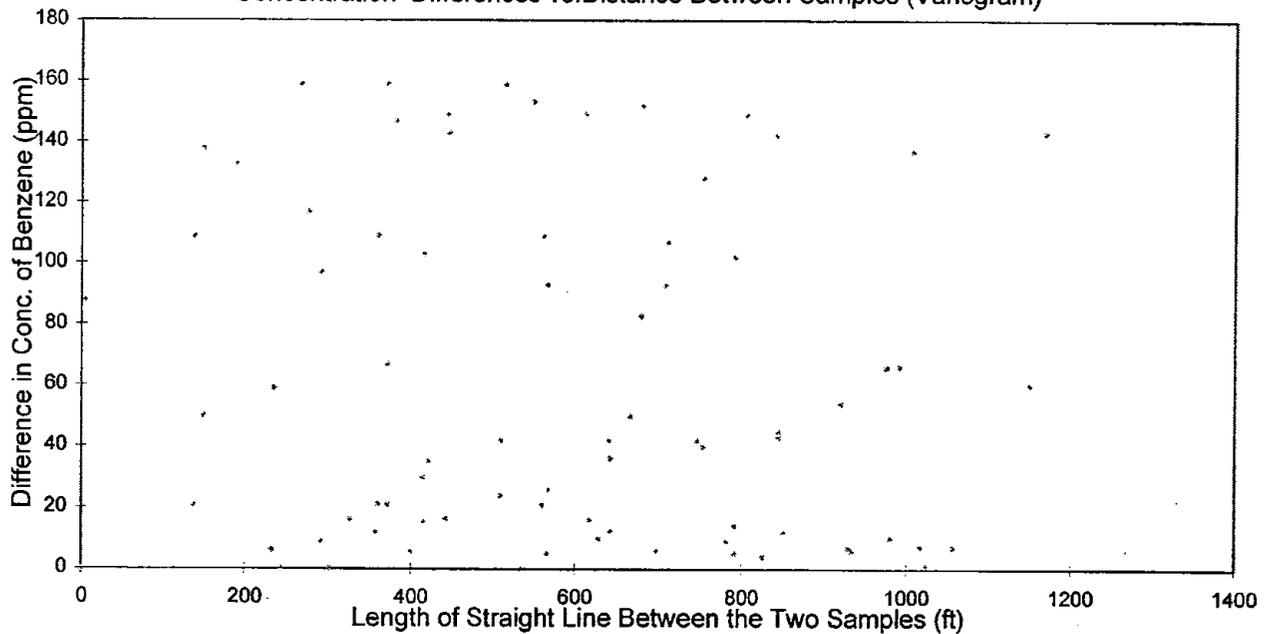


Figure 28.

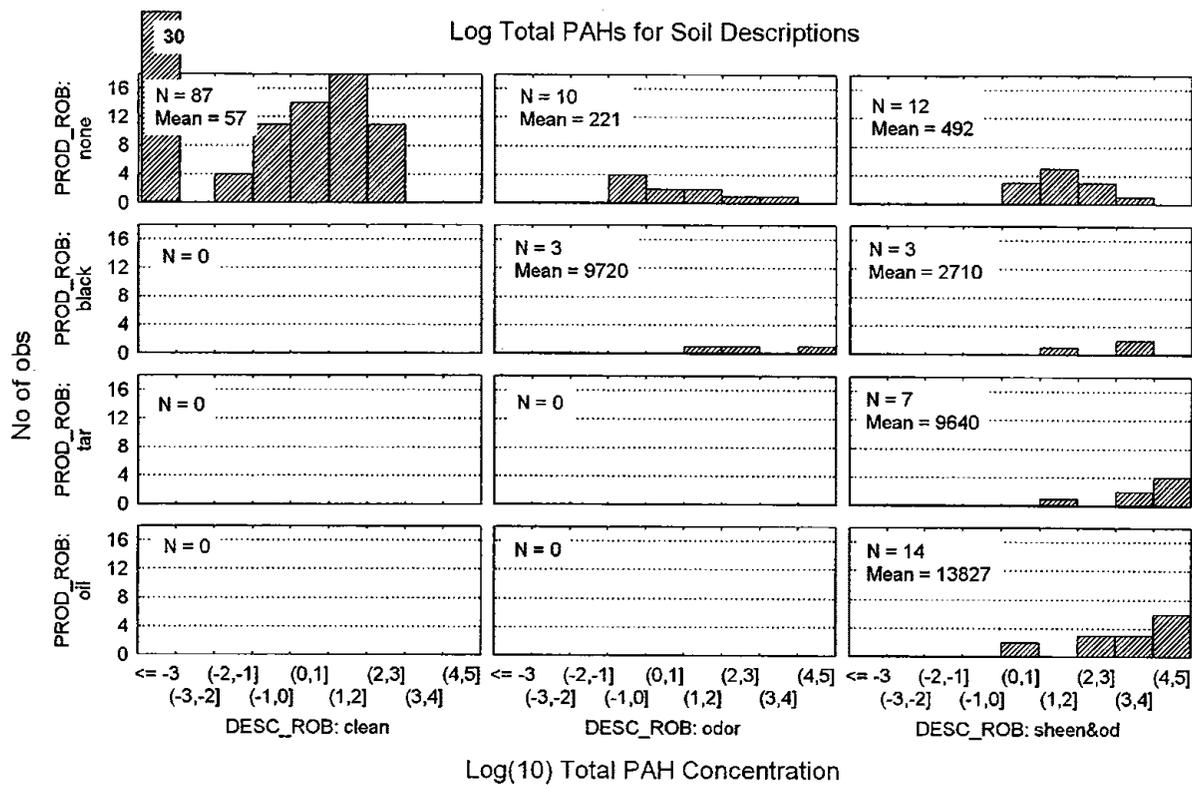


Figure 29.

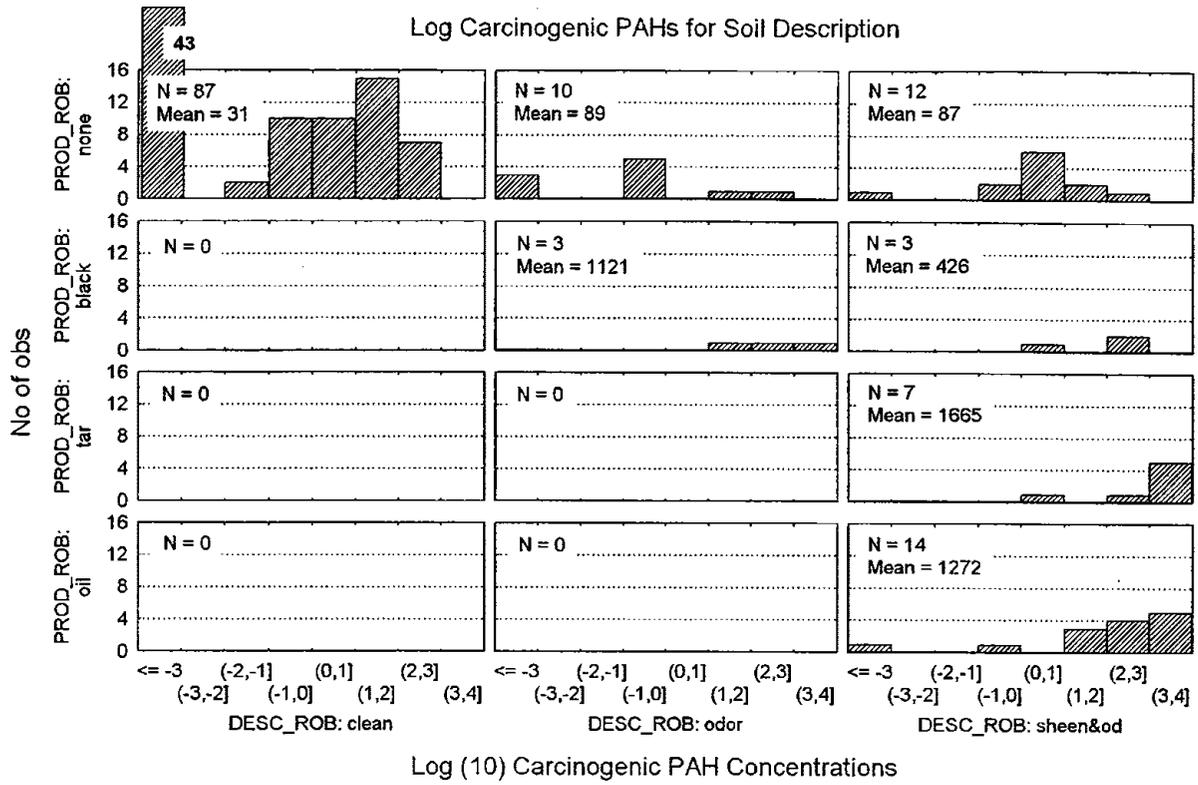


Figure 30.

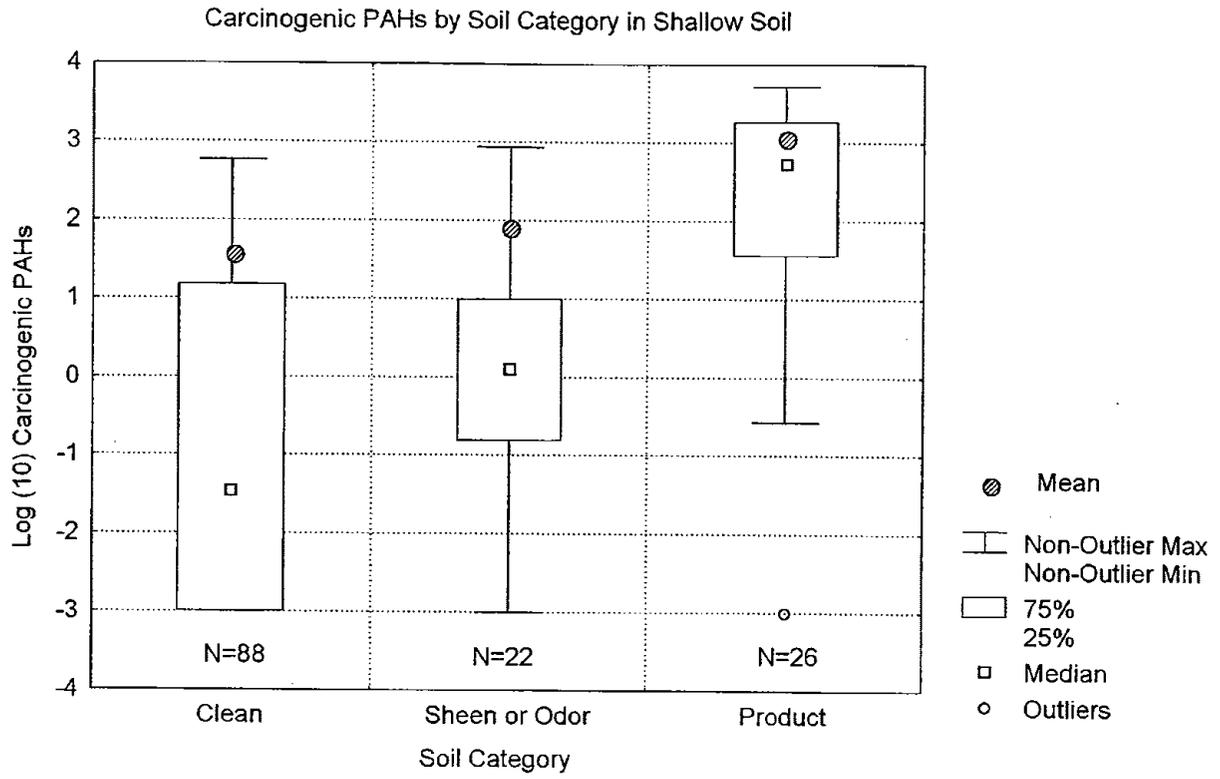


Figure 31.

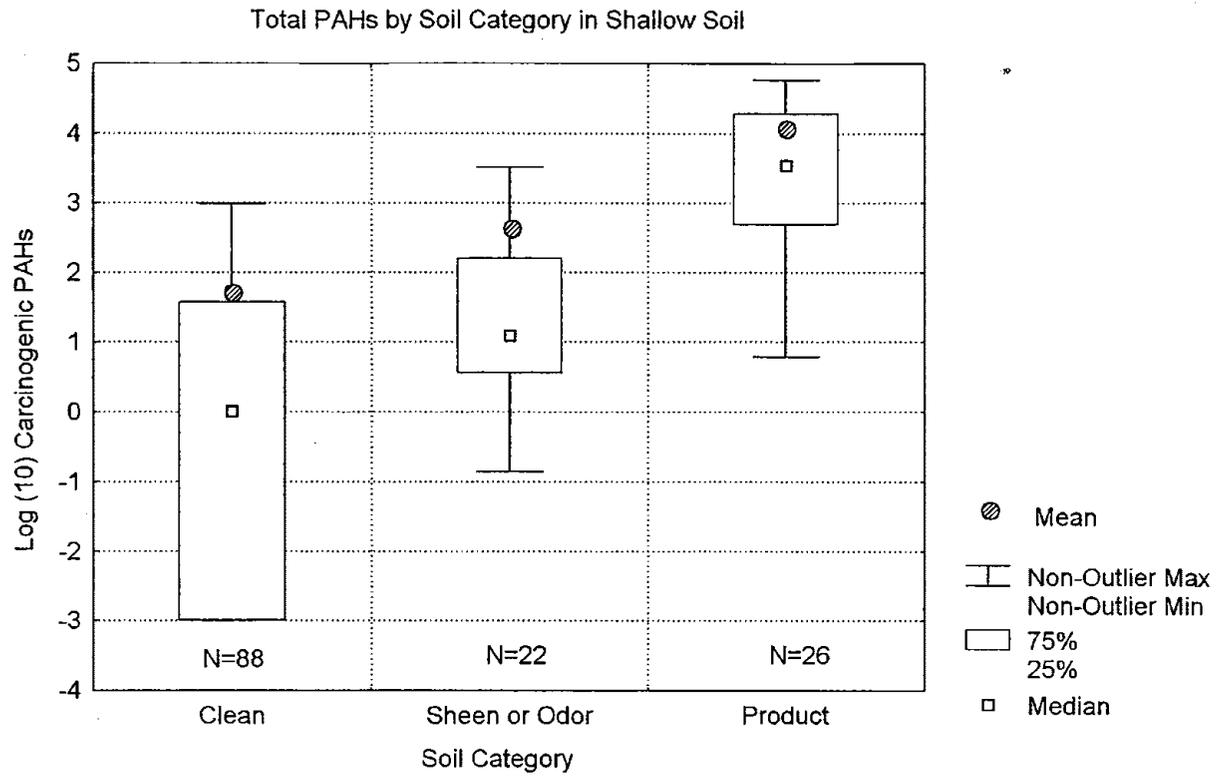


Figure 32.

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

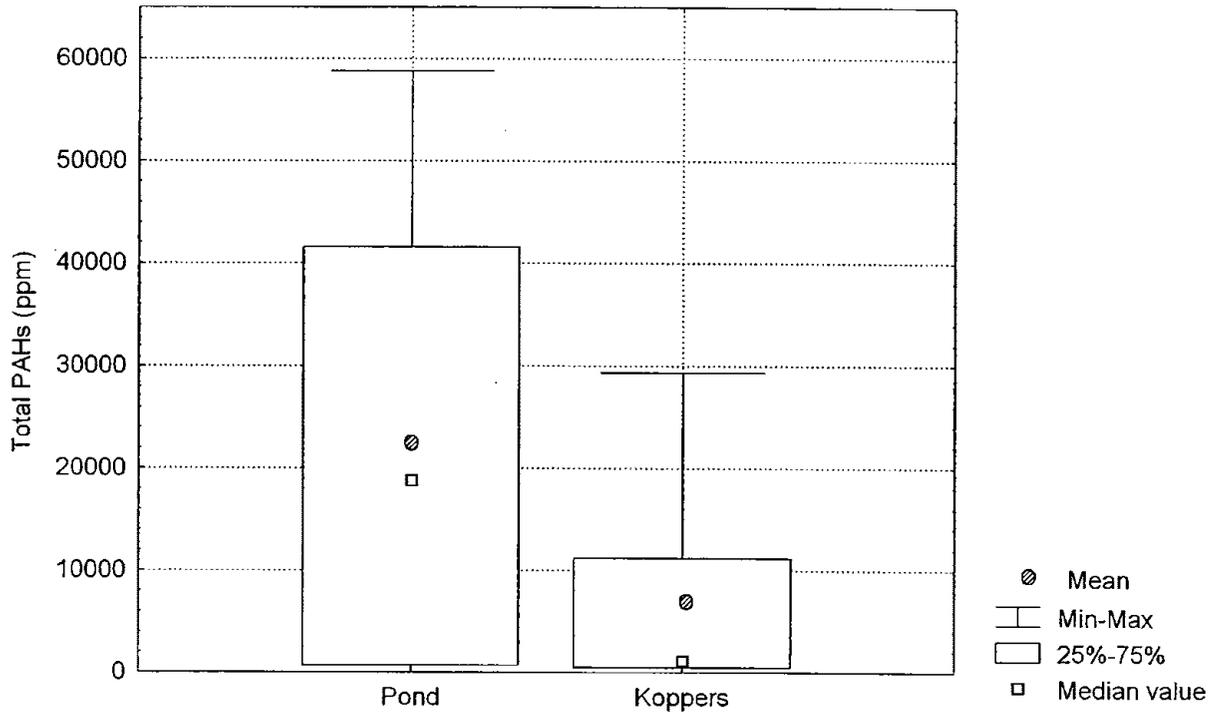


Figure 33.

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

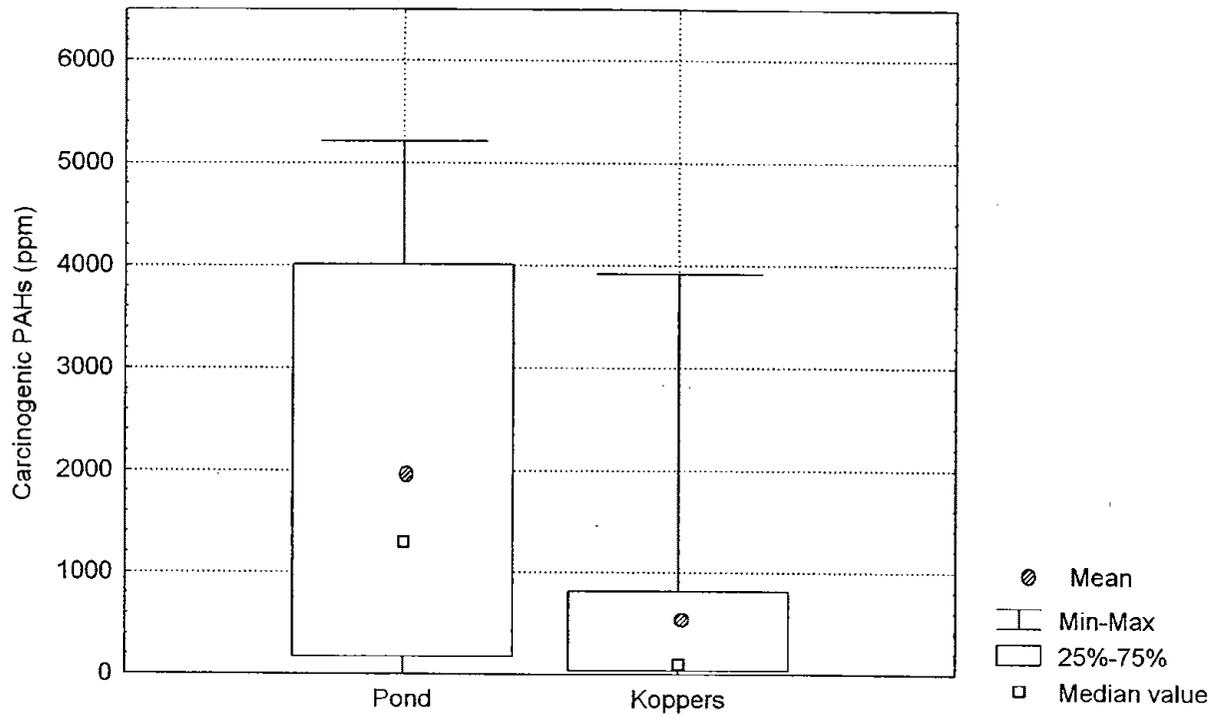


Figure 34.

Shallow Soil with Oil in Pond and Koppers Areas, Benzene

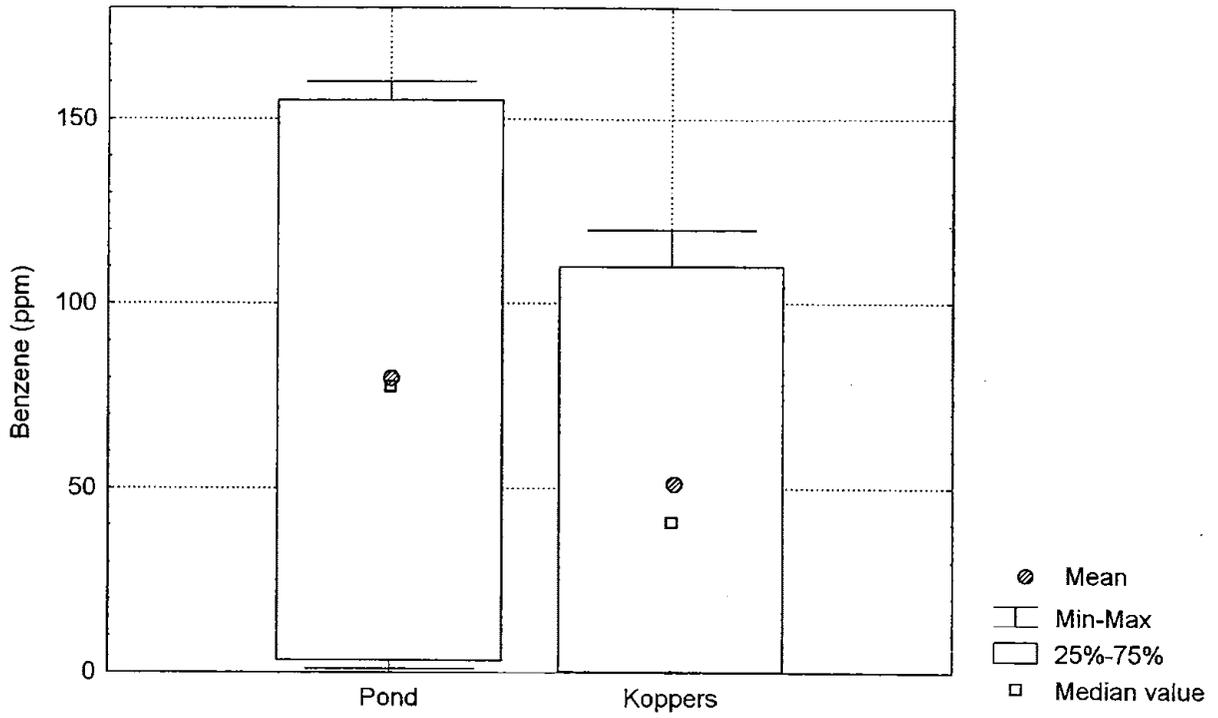


Figure 35.

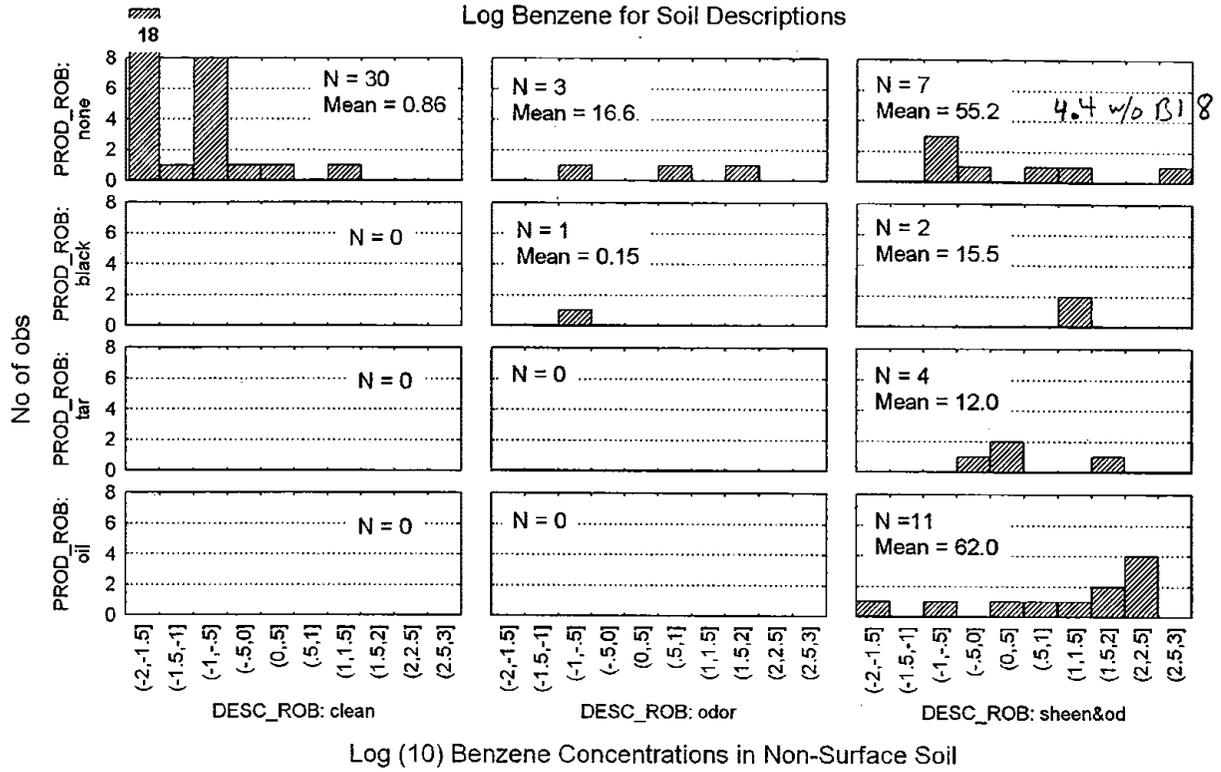


Figure 36.

Benzene Concentrations by Soil Description, Shallow and Deep Soil

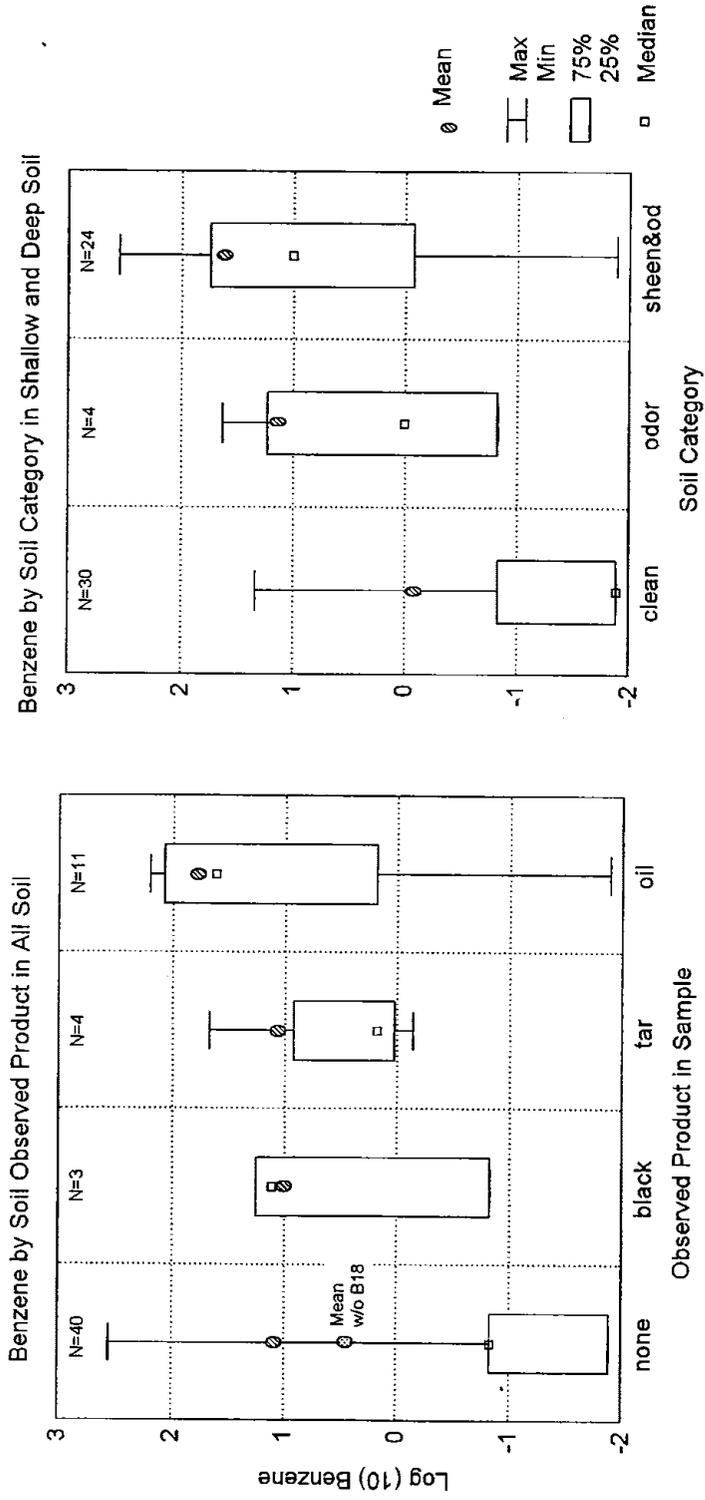


Figure 37.

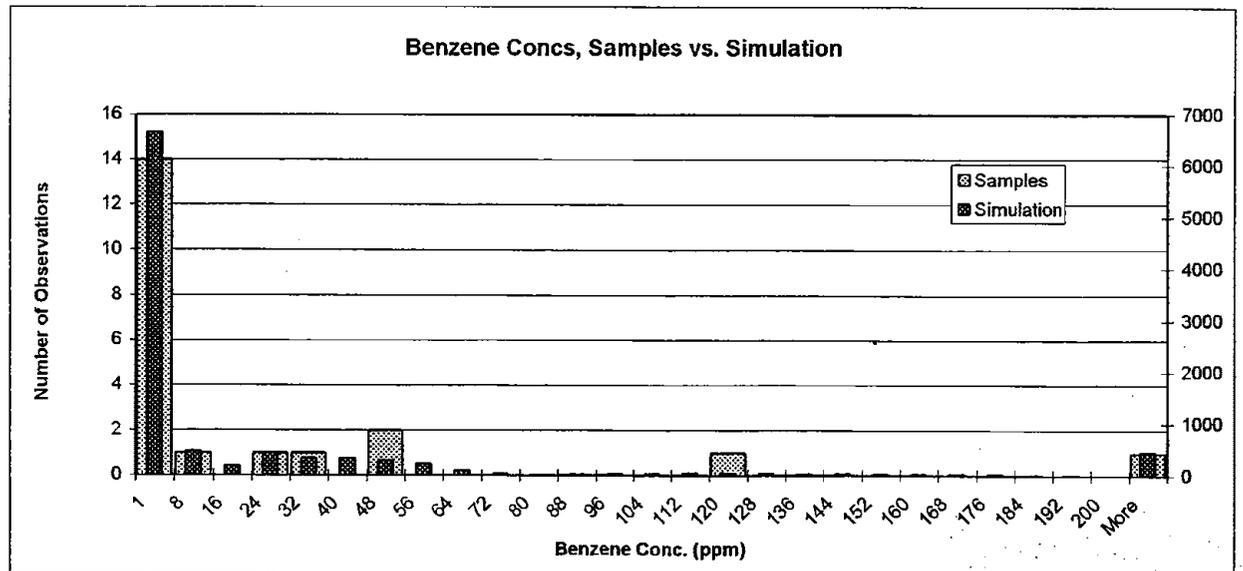
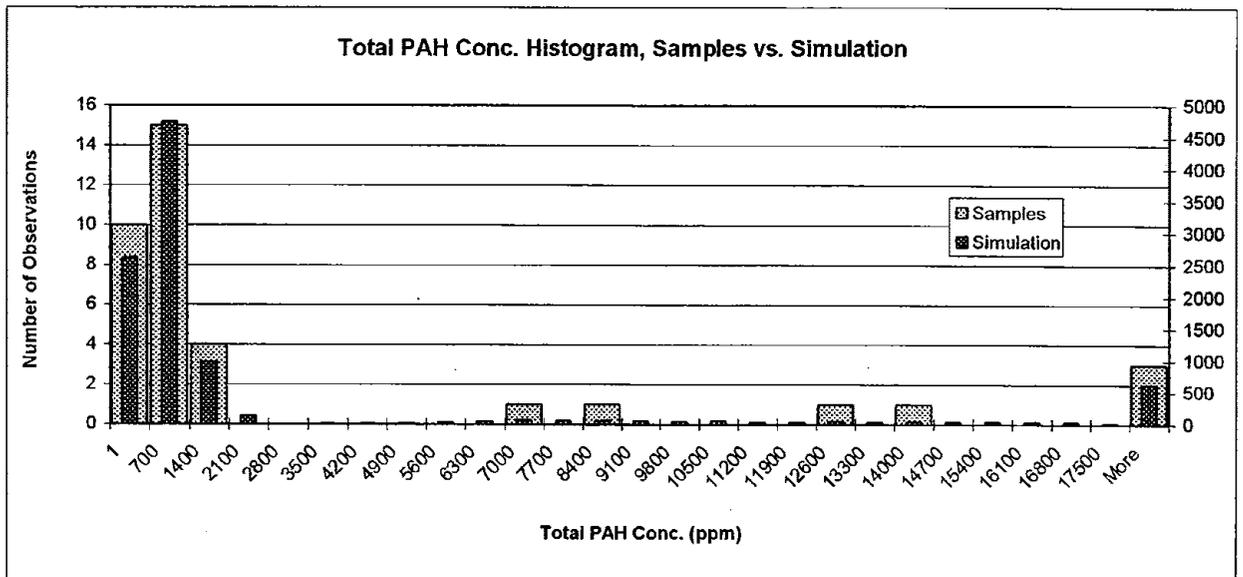
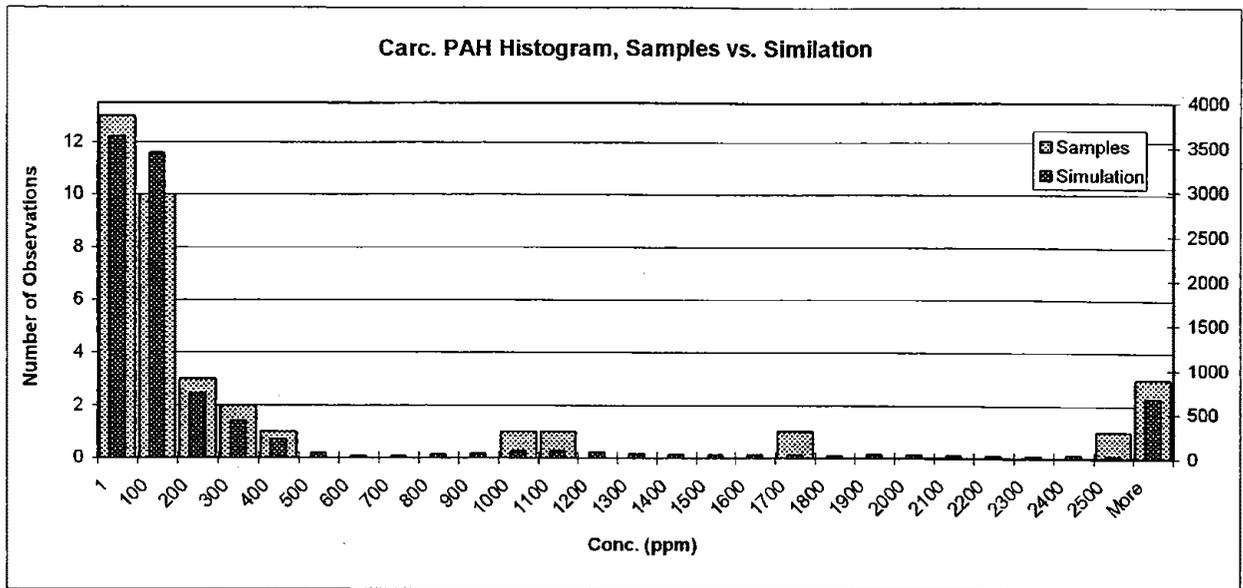


Figure 38.

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

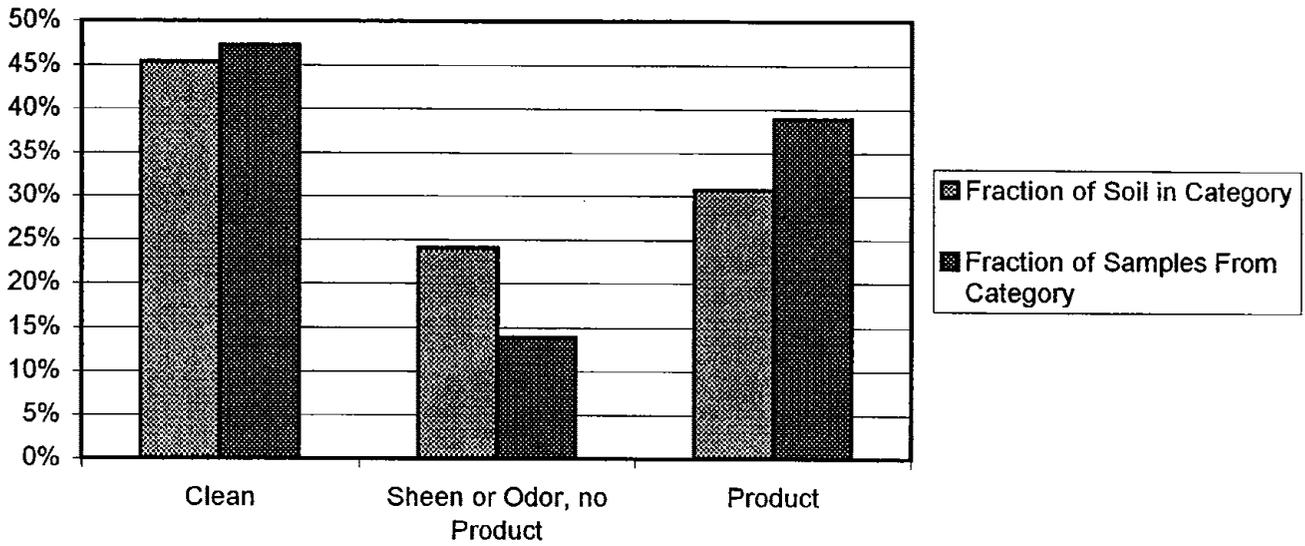


Figure 39.

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

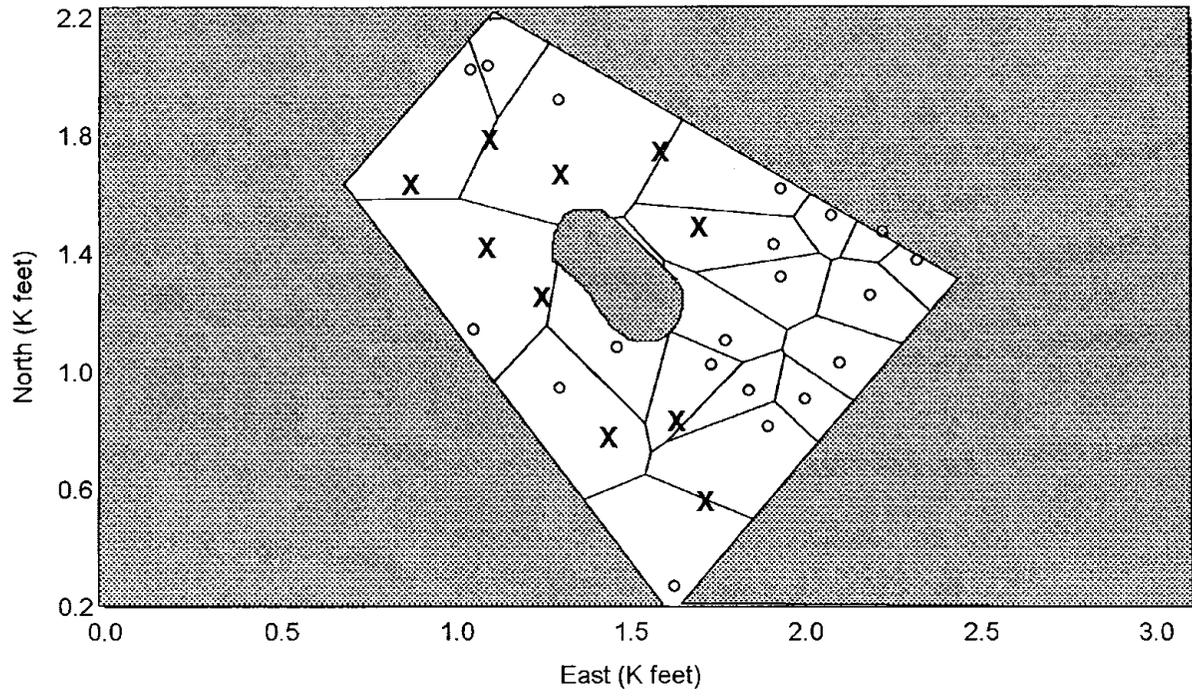


Figure 40.

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

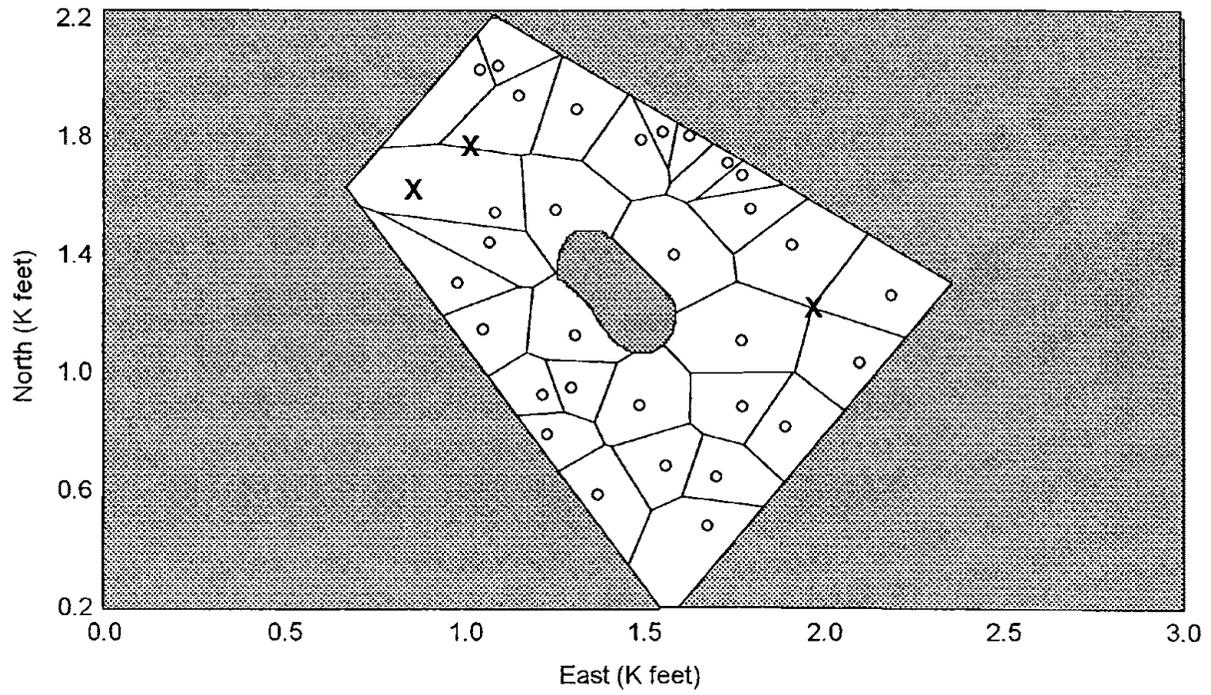


Figure 41.

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

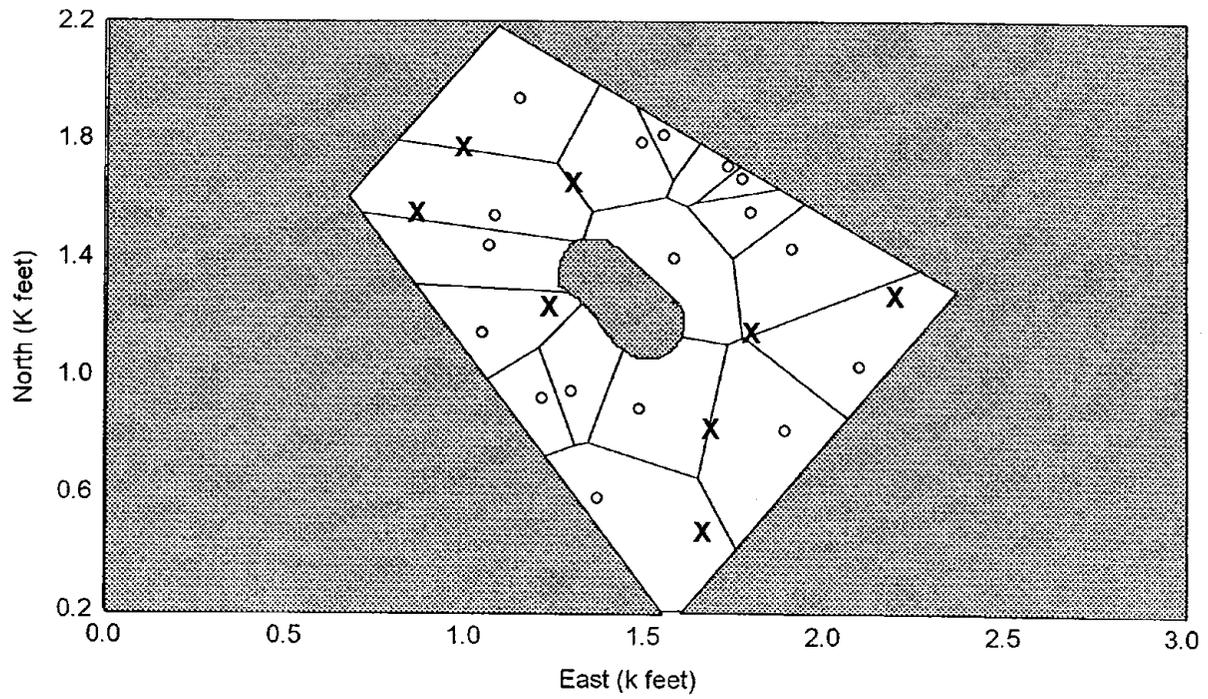


Figure 42.

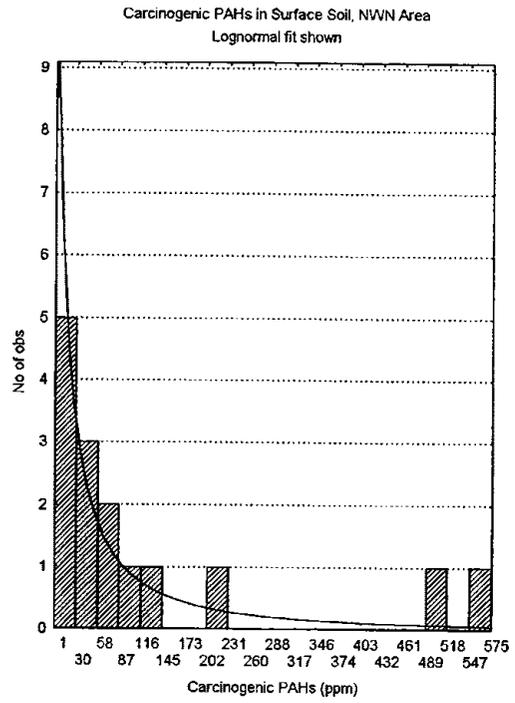
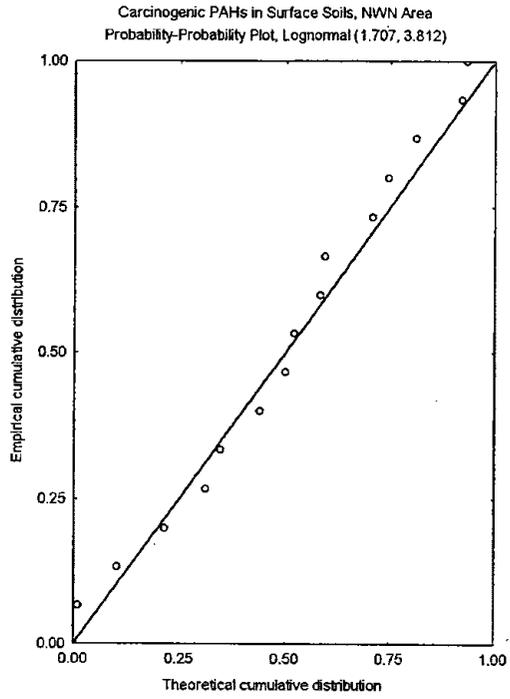
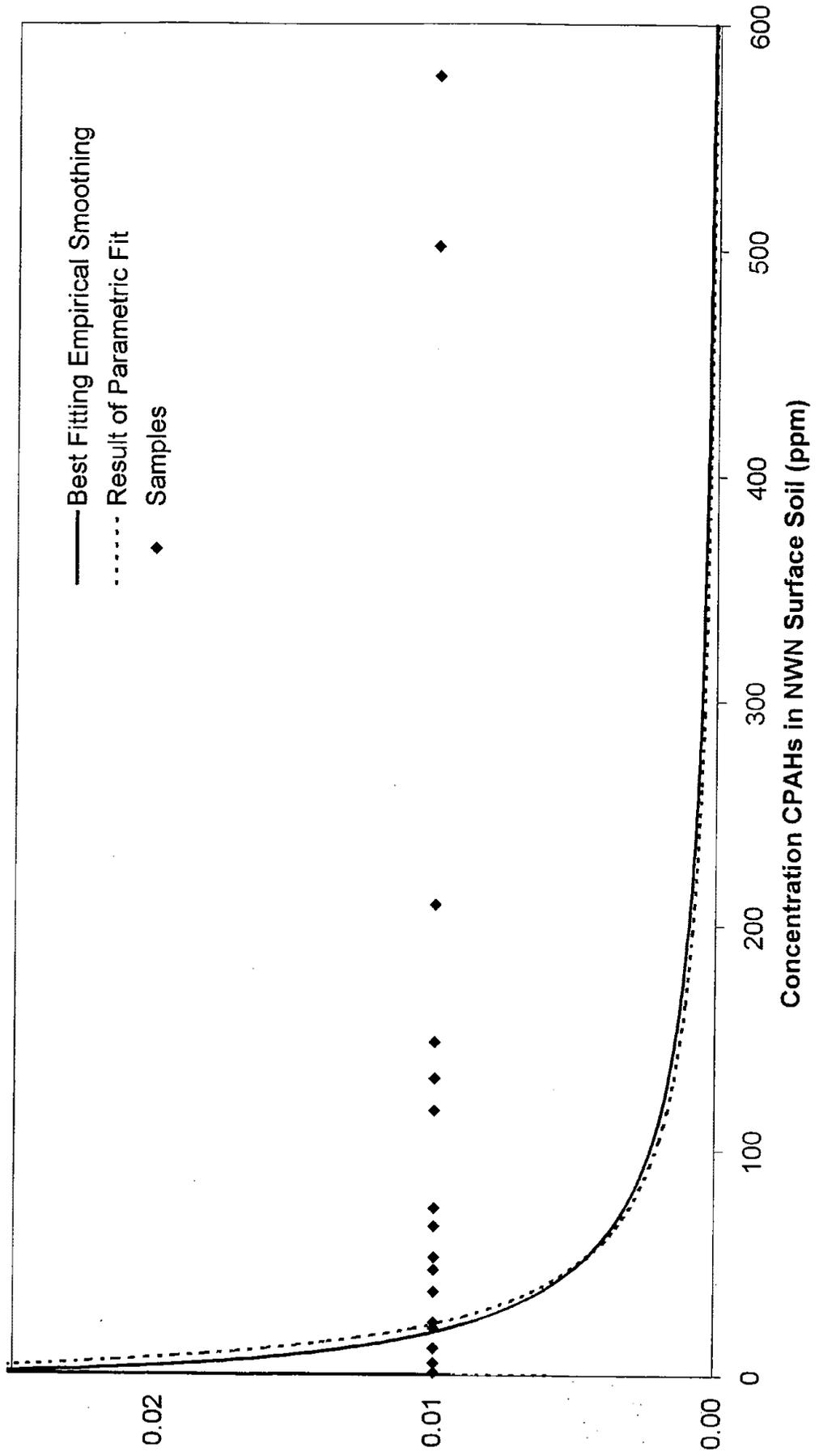


Figure 43.

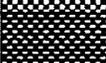
Probability Distribution Fits for Surface CPAHs in NWN Area
Best Fits Using Empirical Smoothing (solid) and Parametric (dotted)



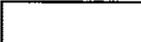
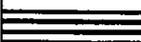
APPENDIX A
Soil Boring Logs

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

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
PROJECT #:	2708	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	B1-01	13:45	5.6	13					SM	8-inch	Not Applicable	30.1 feet msl	Not Applicable	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	14	0							
							7	9	100							Sandy SILT - brown to yellow, moist, stiff, slightly plastic, slight hydrocarbon odor, no sheen
	B1-04	14:10				6	100	8								
				4.7		5	60	9								Concrete encountered at 8.5 to 10 feet bgs.
								10								
						2	100	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	1,280	27	100	12								
						2	100	13								Silty GRAVEL - olive gray, wet, dense, strong hydrocarbon odor, no sheen
	B1-06	14:35				6	100	14		GM						
				26.5		28	100	15								
						16	0	16								
						22	0	17								
						25	0	18								
						4	100	19								
B1-07	14:50	16.8			40	60	20		SP					SAND - black, wet, medium dense, poorly graded, strong hydrocarbon odor, no sheen, appears to be saturated with oily substance		
					4	0										
					6	100										
B1-08	14:57	22.3			6	100										

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
					6	40	21		SP	CASING DIAMETER: Not Applicable
3/4" Bentonite Chips	B1-09	15:20	24.6	21			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 Portland, Oregon (503) 796-0717					SOIL BORING NUMBER B-2					
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			8:50	10:15	
					EQUIPMENT TYPE: B-59 Mobile Drill			Date:	Date:	
					DRILLER: Brad James			9/27/95	9/27/95	
					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
3/4" Bentonite Chips	B2-01	8:50	4.7	-			1		SM	Silty SAND with Gravel - brown, moist, organic matter (surface sample)
							2			
							3			
							4			Silty SAND with some Gravel - green to gray, moist, no sheen, organic matter (pieces of wood)
	B2-02	9:05	5.5	-			5			
							6			
	B2-03	9:10	3.9	-			7		SM	Silty SAND with some Gravel - green to gray, mottled, slight hydrocarbon odor, slight sheen, tar (pieces of asphalt)
							8			
							9			
							10			
							11		GM	Sandy GRAVEL with Silt - moist, no sheen, large pieces of brick, possible pieces of lampblack (hydrophobic material)
							12			
							13			
							14			
	B2-04	9:25	2.5	-			15		SP	SAND - brown, moist, poorly graded, medium grained, moderate hydrocarbon odor, no sheen
							16			
	B2-05	9:35	2.2	-			17			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)
	B2-06	9:38	2.7	-			17			
							18			
							19			
						20		SP	SAND - gray to green, moist, no sheen, black powder is no longer present in sample (17-17.5 feet bgs)	

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-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	5.9	-			21		SP	SAND - gray to green, wet, poorly graded, medium grained, strong hydrocarbon odor, no sheen, (20-22 feet bgs)	
							22				
							23				
	B2-08	9:50	3.1	-			24			SAND - as above, no hydrocarbon odor, no sheen (22-24 feet bgs)	
							25		SP	Heaving sands encountered at 25 feet bgs - re-drill out hole to remove.	
							26				
	B2-09	10:10	3.2	-			27			SAND - gray to green, wet, poorly graded, medium grained, no hydrocarbon odor, no sheen	
							28				
							29			Drilled to 27.5 feet bgs Sampled to 27 feet bgs	
							30				
							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-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.		

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: 34.1 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				
	B3-07	11:20		ND	16	100	16			SAND - brown, dry, medium dense, poorly graded, no hydrocarbon odor, no sheen
				8.0	13	100	17		SP	
							18			
B3-08	11:30		-	4	100	19				
			5.3	9	100	20			SAND - green to gray, moist to wet, stiff, poorly graded, moderate hydrocarbon odor, no sheen	
				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 DRILL FINISH: 12:30							
PROJECT #: 2708		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.	Date: 9/21/95							
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
3/4" Bentonite Chips	B3-09	11:40	2.0	-	17	100	21		SP	SAND - green to gray, wet, medium dense, poorly graded, strong hydrocarbon odor, no sheen
					3	100	22			
	B3-10	12:00	22.0	-	12	100	23			SAND - green to gray, wet, medium dense, poorly graded, strong hydrocarbon odor, no sheen, Clayey SILT in bottom 6 inches of core
					14	100	24			
					4	100	25			
	B3-11	12:05	29.1	-	6	100	26		ML	Clayey SILT, green to gray, wet, loose, plastic, strong hydrocarbon odor, no sheen
					10	100	27			
					4	100	28			
	B3-12	12:24	4.5	-	5	100	29		SP	SAND - green to gray, wet, stiff, poorly graded, fine grained, slight hydrocarbon odor, no sheen
					5	100	30			
							31			
							32			
						33				
						34				
						35				
						36				
						37				
						38				
						39				
						40				

Drilled to 28.5 feet bgs
Sampled to 28.5 feet bgs

* Sample Number Prefix is 2708-950921-

HAHN & ASSOCIATES, INC.

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

SOIL BORING NUMBER

B-4

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

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	8:20	9:40
DRILLER:	Brad James	Date:	Date:
DRILLING CONTRACTOR:	Geo-Tech Explorations, Inc.	9/21/95	9/21/95

PROJECT #: 2708

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			
							20		SP	

HAHN & ASSOCIATES, INC. 434 NW Sixth Avenue Portland, Oregon (503) 796-0717				SOIL BORING NUMBER B-4					
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				DRILLING METHOD: 4 1/4-inch ID Hollow Stem Auger		Time: 8:20	Time: 9:40		
EQUIPMENT TYPE: B-59 Mobile Drill				DRILLER: Brad James		Date: 9/21/95	Date: 9/21/95		
DRILLING CONTRACTOR: Geo-Tech Explorations, Inc.				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)
3/4" Bentonite Chips	B4-06	9:15		-			21		SP
			5.3				22		
							23		
							24		SP
							25		
							26		
	B4-07	9:25		-			27		
				2.5			28		
	B4-08	9:30		-			29		ML
				2.0			30		
						31			
						32			
						33			
						34			
						35			
						36			
						37			
						38			
						39			
						40			

SAND with some Gravel - as above, moist to wet

SAND with some Gravel - as above, green to gray, wet, (25-27 feet bgs)

Clayey SILT - gray, moist, stiff, plastic, no hydrocarbon odor, no sheen (27-30 feet bgs)

Drilled to 30 feet bgs
Sampled to 29.5 feet bgs

* Sample Number Prefix is 2708-950921-

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				HAI LOGGER: Rob Ede		DRILL START	DRILL FINISH			
PROJECT #: 2708				SAMPLING METHOD: 4" OD Core Barrel		Time: 13:35	Time: 14:50			
				DRILLING METHOD: 4 1/4-inch ID Hollow Stem Auger		Date: 9/28/95	Date: 9/28/95			
				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
	B5-01	13:30	1.4	-			1			CASING DIAMETER: Not Applicable
							2			SURFACE ELEVATION: 36.1 feet msl
							3		SP	TOP OF CASING ELEVATION: Not Applicable
	B5-02	13:40	3.9	-			4			SOIL DESCRIPTION
							5			Silty SAND with some Gravel - brown, wet, no hydrocarbon odor, no sheen, (surface)
							6			
							7		SP	
	B5-03	13:50	3.3	-			8			SAND with some Gravel - brown, slightly moist, loose, non-plastic, poorly graded, medium grained, no hydrocarbon odor, no sheen
							9			
							10		SP	
							11			
							12			
	B5-04	14:00	3.8	-			13			SAND with some Gravel - as above, moist
							14		SP	
							15			
							16			
	B5-05	14:08	4.3	3.6			17			SAND with some Gravel - as above, hydrocarbon odor, (15-17 feet bgs)
							18		ML	
	B5-06	14:10	4.9	-			19			SILT - green to gray, moist, hydrocarbon odor, sheen, wood fragments, (17-17.5 feet bgs)
							20		SP	
	B5-07	14:12	3.6	-						SAND - green to gray, moist, loose, slight hydrocarbon odor, no sheen, (17.5-19 feet bgs)

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

DRILL

START

FINISH

Time:

Time:

13:35

14:50

Date:

Date:

9/28/95

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
3/4" Bentonite Chips							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> <p>Drilled to 30 feet bgs Sampled to 30 feet bgs</p> <p>* Sample Number Prefix is 2708-950928-</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:	Time:	
					DRILLING METHOD: 4 1/4-inch ID Hollow Stem Auger			11:15	12:35	
					EQUIPMENT TYPE B-59 Mobile Drill			Date:	Date:	
					DRILLER: Brad James			9/27/95	9/27/95	
					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 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
Concrete							1		GP	GRAVEL - old pavement at surface
							2		SP	
						15	100	3		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			Sandy GRAVEL - black, dense, pieces of lampblack (hydrophobic in water), no hydrocarbon odor, no sheen, (3-4 feet bgs)
							5		GP	
					9	10				
					4	0	6			Sandy GRAVEL - gray, moist, loose, no hydrocarbon odor, no sheen
					2	0	7			
							8		SP	
	B6-02	11:30	38.5	12,487	12	50	9			SAND with Gravel and Brick - black, moist, medium dense, grains stuck together by tarry substance, strong hydrocarbon odor, strong sheen
					10	0	10			
							11			Large Rock in end of sampler - blue matrix, concoidal fracture, specimen retained
					7	10	12			
					11	0	13		SP	
					13	0	14			Weathered Brick in end of tube - moist, stiff, no hydrocarbon odor, no sheen
					5	50	15			
					5	0				
					5	0				
							16			SAND - brown, slightly moist, loose, fine to medium grained, gravels from 16-16.5 feet bgs, no hydrocarbon odor, no sheen
	B6-03	12:00		87	16	100	17			
			8.0		9	80			SP	
							18			
	B6-04	12:10					19			
			7.2				20			SAND - as above, no gravel

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

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 Drilled to 30 feet bgs Sampled to 29.5 feet bgs * Sample Number Prefix is 2708-950927-
	B6-05	12:20	9.4	-			22			
								23		
	B6-06	12:25	8.3	-			24		ML	
								25		
								26		
	B6-07	12:30	9.2	-			27		ML	
								28		
	B6-08	12:35	9.8	-			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-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:	Time:	
					DRILLING METHOD: 4 1/4-inch ID Hollow Stem Auger			13:30	14:30	
					EQUIPMENT TYPE B-59 Mobile Drill			Date:	Date:	
					DRILLER: Brad James			9/27/95	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 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		13:30	14:30
				EQUIPMENT TYPE B-59 Mobile Drill		Date:	Date:
				DRILLER: Brad James		9/27/95	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							
3/4" Bentonite Chips	B7-06	14:10	8.4	-			21
							22
	B7-07	14:12	6.6	-			23
							24
							25
							26
							27
	B7-08	14:20	5.2	-			28
							29
	B7-09	14:30	6.4	-			30
						31	
						32	
						33	
						34	
						35	
						36	
						37	
						38	
						39	
						40	

BORING DIAMETER: 8-inch
CASING DIAMETER: Not Applicable
SURFACE ELEVATION: 36.1 feet msl
TOP OF CASING ELEVATION: Not Applicable

SOIL DESCRIPTION

SAND - brown, wet, poorly graded, medium grained, slight hydrocarbon odor, no sheen, (20-21 feet bgs)

SAND - green to gray, wet, poorly graded, medium grained, no hydrocarbon odor, no sheen, (21-25 feet bgs)

SAND - as above

SILT - green to gray, moist, stiff, plastic, no hydrocarbon odor, no sheen, some brown organic matter

Drilled to 30 feet bgs
Sampled to 29.5 feet bgs

* Sample Number Prefix is 2708-950927-

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 START	DRILL FINISH
					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)
							1		
							2		
					5	100	3		GM
	B8-01	9:35	9.3	-	6	50	4		Silty GRAVEL - brown, moist, loose, non-plastic, slightly graded, no hydrocarbon odor or discoloration, spotty sheen
					8	0	4		
							5		
	B8-02	9:42	-	-	4	100	6		Silty GRAVEL - brown, dry, loose, non-plastic, slightly graded, no hydrocarbon odor or discoloration, spotty sheen
					7	0	6		
					9	0	7		GM
	B8-03	9:44	-	-	9	70	8		Silty GRAVEL - as above, wet, medium dense
					18	0	9		
					23	0	9		
							10		
	B8-04	9:50		338	17	100	11		GM
			7.5		23	20	11		Sandy GRAVEL - brown, moist, medium dense, non-plastic, poorly graded, no hydrocarbon odor, no sheen, large pieces of slag in sampling tube
					17	0	12		
							13		
	B8-05	10:00	8.0	-	11	100	13		
	B8-06 Dup	10:02			10	20	14		SAND - gray, wet, medium dense, non-plastic, poorly graded, fine grained, mild hydrocarbon odor, no sheen
					8	0	14		
							15		Note: Change to 1.5" Split Spoon sampling device
					3	100	16		
	B8-07	10:05		-	4	100	16		SP
					6	50	17		SAND - gray, wet, loose, non-plastic, poorly graded, medium grained, mild hydrocarbon odor, no sheen
			7.3				17		
					3	100	18		
	B8-08	10:15		0.24	3	100	19		Sandy SILT - gray, wet, soft, slightly plastic, no hydrocarbon odor, no sheen
			6.5		3	100	19		
							20		ML

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 START	DRILL FINISH
					SAMPLING METHOD: 1.5" / 3" OD Split Spoon				
					DRILLING METHOD: 4 1/4-inch ID Hollow Stem Auger			Time: 9:30	Time: 12:10
					EQUIPMENT TYPE: B-59 Mobile Drill				
					DRILLER: Brad James			Date: 9/18/95	Date: 9/18/95
					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)
	B8-09	10:20		-	1	100	21		
			6.1		2	100	22		SP
					2	100	23		
	B8-10	11:45	5.1	-	2	100	24		SM
					4	100	24		
							25		
					1	100			
					2	100	26		
	B8-11	12:00	4.1	-	3	100			
							27		
							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				HAI LOGGER: Rob Ede				DRILL START	DRILL FINISH		
PROJECT #: 2708				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:	8-inch
										CASING DIAMETER:	Not Applicable
										SURFACE ELEVATION:	31.6 feet msl
										TOP OF CASING ELEVATION:	Not Applicable
										SOIL DESCRIPTION	
							1				
							2		SP		
							3			See boring log B-9A for 0 to 5 foot soil description.	
							4				
							5				
	B9-01	14:50		-	8	100					
			8:10		10	20	6			SAND with some Gravel - black, dry, medium dense, very strong petroleum hydrocarbon odor, all pores filled with tar-like substance throughout	
					11	0	7				
					18	10	8				
					33	0			SP		
					21	0	9			SAND with some Gravel - as above, dense, large piece of gravel in end of sampler	
							10				
	B9-02	15:00	897	19,438	18	100					
					13	0	11			SAND with some Gravel - as above, moist, dense	
					23	0	12				
	B9-03	15:10	278.0	-	16	100	13				
					6	0				Silty SAND with some Gravel - brown, moist, medium dense, poorly graded, strong petroleum hydrocarbon odor, some tar-like blebs	
					17	0	14				
							15		SM		
	B9-04	15:20	118	-	4	100					
					7	0	16			Silty SAND with Gravel - brown with black mottles, dry, medium dense, tar-like substance mottled throughout, strong petroleum hydrocarbon odor	
					11	0	17				
	B9-05	15:30	211	-	13	100	18				
					50?3"	5			SP		
							19			SAND with some Gravel - black, very dense, possible lampblack	
	B9-06	15:40	363	-	3	100	20				

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					4	0			SP	8-inch	Not Applicable	31.6 feet msl	Not Applicable	<p>SAND - black, wet, very loose, poorly graded, fine to medium grained, slight petroleum hydrocarbon odor</p> <p>SAND with some Gravel - black, wet, very loose, slightly graded, medium grained, strong petroleum hydrocarbon odor, strong sheen</p>
					4	0	21							
								22						
	B9-07	1	100	-	2	100		23						
					3	100		24						
					6	100		25						
								26						
								27						
								28						
	B9-08	16:10	504	-				29		SM				
							30							
B9-09	16:20	33.1	43.5				31	SM	Silty SAND - gray to black, wet, mild petroleum hydrocarbon odor, sheen					
							32			Silty SAND - dark gray, wet, poorly sorted, petroleum hydrocarbon odor, slight sheen				
							33							
							34	SP						
B9-10	16:21	9.1	0.46				35	SP	SAND - green to gray, wet, poorly graded, fine grained, no petroleum hydrocarbon odor, no sheen					
							36							
							37							Drilled to 35 feet bgs Sampled to 35 feet bgs
							38							
							39							
							40							* Sample Number Prefix is 2708-950918-

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)
Bentonite Chips	B9A-01	14:00		-			1		SP
	B9A-02	14:02	614	-			2		
	B9A-03	14:05	274	-			3		
							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
 Portland, Oregon
 (503) 796-0717

SOIL BORING NUMBER		B-10	
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	Date:	Date:
		11:50	12:50
		9/25/95	9/25/95

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

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

							1		
							2		SP
					↑	↑	3		
B10-01	12:10			-			4		
			102.0				5		
					↓	↓	6		
							7		
B10-02	12:20			-			8		SP
			164.0				9		
							10		
					↑	↑	11		
							12		
B10-03	12:30			-			13		SP
			165.0				14		
							15		
					↓	↓	16		
							17		
B10-04	12:40			ND			18		SP
			127.0				19		
							20		

SAND - brown, dry, poorly graded, medium grained, no hydrocarbon odor, no sheen

SAND with some Pebbles - brown, moist, poorly graded, medium grained, no hydrocarbon odor, no sheen

SAND - brown, slightly moist, poorly graded, medium grained, no hydrocarbon odor, no sheen, slight froth via sheen test

SAND - brown, moist, poorly graded, medium grained, no hydrocarbon odor, no sheen

Hahn & Associates, Inc.
 434 NW Sixth Avenue
 Portland, Oregon
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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 START	DRILL FINISH
SAMPLING METHOD:	4" OD Core Barrel	Time:	Time:
DRILLING METHOD:	4 1/4-inch ID Hollow Stem Auger	11:50	12:50
EQUIPMENT TYPE	B-59 Mobile Drill	Date:	Date:
DRILLER:	Brad James	9/25/95	9/25/95
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							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	DRILL START	DRILL FINISH
SAMPLING METHOD: 3" OD Split Spoon/4" OD Core Barrel	Time: 10:30	Time: 11:40
DRILLING METHOD: 4 1/4-inch ID Hollow Stem Auger	Date: 9/28/95	Date: 9/28/95
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)	SOIL DESCRIPTION
3/4" Bentonite Chips	B11-01	10:30	9.2	-			1		SP	Silty SAND with Gravel - brown, moist, no hydrocarbon odor, no sheen
							2			
						8	100	3		
	B11-01	10:40	7.2	-	15	100	4			SAND - brown, slightly moist, medium dense, poorly graded, medium grained, no hydrocarbon odor, no sheen
					18	70	5			
					8	100	6			
	B11-03	10:42	20	-	13	100	7		SP	SAND - dark gray, moist, medium dense, poorly graded, medium grained, hydrocarbon odor, sheen
					13	95	8			
	B11-04	10:45	21.6	-			9			SAND - dark gray, moist, loose, poorly graded, medium grained, hydrocarbon odor, sheen
							10			
	B11-05	10:48	119	-			11			SAND - as above, gray to black, strong hydrocarbon odor, strong sheen
							12		SP	
							13			
	B11-06	10:55	260	973			14			SAND - as above, strong hydrocarbon odor, strong sheen
							15			
							16			
							17			
							18		SP	
	B11-07	11:00	97	-			19			SAND - as above, moist to wet, strong hydrocarbon odor, strong sheen, brown product and froth formed when water was added to sample
							20			

HAHN & ASSOCIATES, INC.
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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.
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SOIL BORING NUMBER B-13

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	12:10	13:00
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: 36.4 feet msl
										TOP OF CASING ELEVATION: Not Applicable
SOIL DESCRIPTION										

3/4" Bentonite Chips							21	10/6/95	ML	SILT - brown, moist, stiff, slightly plastic, no hydrocarbon odor, no sheen
							22			
							23		SP	SAND - brown, wet, poorly graded, no hydrocarbon odor, no sheen
	B13-08	12:55	124.0	-			24		ML	SILT - brown, moist, stiff, slightly plastic, no hydrocarbon odor, no sheen
	B13-09 Dup	12:58	98.1	-			25		SP	SAND - brown, wet, loose, poorly graded, fine grained, ho hydrocarbon odor, no sheen

							26			Drilled to 25 feet bgs Sampled to 24.5 feet bgs * Sample Number Prefix is 2708-951006-
							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-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: 13:45	Time: 15:05			
				DRILLING METHOD: 4 1/4-inch ID Hollow Stem Auger		Date: 10/6/95	Date: 10/6/95			
				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: 35.5 feet msl
										TOP OF CASING ELEVATION: Not Applicable
										SOIL DESCRIPTION
							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)
							8	50/5" 60	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)
							11			
	B15-02	14:17					12			SILT - green, moist, firm, no hydrocarbon odor, no sheen, rootlets throughout, (10-15 feet bgs)
			21.1				13			
							14		ML	
	B15-03	14:20					15			SILT - as above (15-15.5 feet bgs)
			59.9				16			
							17			Sandy SILT - green with black patches of hydrocarbon product, moist, hydrocarbon odor, sheen, (15.5-17.5 feet bgs)
							18		ML	SILT - wet, soft, saturated with product (17.5-18.5 feet bgs)
	B15-04	14:25					19			SILT - green, hydrocarbon odor, sheen, (18.5-20 feet bgs)
			83.1				20			

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

SOIL BORING NUMBER B-15

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	13:45	15:05
DRILLER:	Brad James	Date:	Date:
DRILLING CONTRACTOR:	Geo-Tech Explorations, Inc.	10/6/95	10/6/95

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

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					↑	↑	21		ML	SILT - green, moist, firm, hydrocarbon odor, no sheen, (20-21 feet bgs)	
	B15-05	14:33	97.6	638			22		SM	Silty SAND - olive gray, wet, poorly graded, fine grained, hydrocarbon odor, sheen, (21-21.5 feet bgs)	
							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	13.6	1.8			28		SP	SILT - brown, moist no hydrocarbon odor, no sheen, (29-29.5 feet bgs)	
							29			SAND - brown, wet, loose, fine grained, no hydrocarbon odor, no sheen, (29.5-30 feet bgs)	
	B15-09	15:04	31.3	-	↓	↓	30		ML SP		
						31					
						32					
						33					
						34					
						35					
						36					
						37					
						38					
						39					
						40					

Drilled to 30 feet bgs
 Sampled to 30 feet bgs
 * Sample Number Prefix is 2708-951006-

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

SOIL BORING NUMBER **B-17**

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: 9:55	Time: 10:40
Date: 9/29/95	Date: 9/29/95

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

BORING DIAMETER: 8-inch
 CASING DIAMETER: Not Applicable
 SURFACE ELEVATION: 36.9 feet msl
 TOP OF CASING ELEVATION: Not Applicable

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	
					2	100	3			Silty SAND - brown, moist, no sheen
	B17-01	10:00		59	2	100	4			
			421		2	90	4			
							5		ML	
							6			Sandy SILT - olive gray, moist, firm, no sheen
	B17-02	10:10		-			7			
			603				7			
							8			
	B17-03	10:12		-			9			SAND - olive gray, moist, poorly graded, medium grained, no sheen
			213				9			
							10			
							11		SP	
	B17-04	10:20		-			12			SAND - olive gray, poorly graded, strong sheen, brown product and froth when water added to sample, some wood fragments
			1409				12			
							13			
							14			
							15			
							16			
	B17-05	10:30		1,814			17		SP	
			1478				17			SAND - as above, wet, saturated with brown, oily product
							18			
							19			
							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-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)
3/4" Bentonite Chips							21		SP
	B17-06	10:35	145				22		
							23		
	B17-07	10:40		0.89			24		ML
			65.8				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:	36.9 feet msl
TOP OF CASING ELEVATION:	Not Applicable

SOIL DESCRIPTION

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

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
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SOIL BORING NUMBER

B-18

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: 10:05	Time: 11:45
Date: 9/19/95	Date: 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		
										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			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+		6	100				ML		
								11				
					2	100	12					Sandy SILT - as above
	B18-05	10:40		59.3	5	100						
			2500+		6	100	13					
								14				
	B18-06	10:50		-	2	100	15					SAND - brown, wet, very loose, poorly graded, fine grained, sheen observed on surface of core
			2500+		4	100						
								16				
				4	100	17						
B18-07	11:00		-	5	100				SP		SAND - as above	
		2500+		5	100	18						
							19					
B18-08	11:05		-	4	100						SAND - olive gray, wet, loose, poorly graded, slight sheen on core	
				6	100	20						

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 START	DRILL FINISH								
			SAMPLING METHOD: Split Spoon		Time: 10:05	Time: 11:45								
			DRILLING METHOD: 4 1/4-inch ID Hollow Stem Auger		Date: 9/19/95	Date: 9/19/95								
			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: 36.4 feet MSL	TOP OF CASING ELEVATION: Not Applicable	SOIL DESCRIPTION
			224		7	100								
							21							
					3	100	22		SP					SAND - as above, no sheen
	B18-09	11:10		-	8	100								
			2500+		12	100	23							
							24							
					7	100								SAND - as above
	B18-10	11:30		ND	17	100	25							
			14.4		14	100	26		SP					
					12	100	27							SAND - as above
	B18-11	11:40			21	100								
			24.0		16	100	28							
							29							
							30							Drilled to 28 feet bgs Sampled to 28 feet bgs
							31							* Sample Number Prefix is 2708-950919-
							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		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			SILT - brown, dry, stiff, no sheen
							18		ML	
	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

SOIL BORING NUMBER B-19

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.			

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

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:	CASING DIAMETER:	SURFACE ELEVATION:	TOP OF CASING ELEVATION:
Asphalt							1			8-inch	Not Applicable	35.4 feet msl	Not Applicable
							2						
					5	100	3		SP				
	B20-01	14:05		-	5	100	4			SAND - brown, moist, loose, poorly graded, no sheen			
			355		5	50	5						
							6						
							7			SAND - as above, large rock in sand at depth of 7.5 feet bgs			
	B20-02	14:10		-			8		SP				
			1166				9			SAND - olive gray, moist, poorly graded, medium grained, no sheen			
							10						
	B20-03	14:15		1,093			11			SAND - gray, wet, poorly graded, saturated with hydrocarbon product, metallic sheen, (10-11 feet bgs)			
			2500+				12						
	B20-04	14:20		-			13			SAND - brown, moist, poorly graded, fine grained, no product saturation, sheen is present, (11-13 feet bgs)			
			2500+				14						
							15						
							16						
							17		SP				
	B20-05	14:25		-			18			SAND - olive gray, moist to wet, sheen			
			1270				19						
							20						

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	10/3/95	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						
			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 START	DRILL FINISH
						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
						21			Drilled to 30 feet bgs Sampled to 29.5 feet bgs * Sample Number Prefix is 2708-951003-
						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:	Time:			
				DRILLING METHOD: 4 1/4-inch ID Hollow Stem Auger		12:00	13:00			
				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: 37.1 feet msl
										TOP OF CASING ELEVATION: Not Applicable
										SOIL DESCRIPTION
							1			
							2			
							3		ML	SILT with Sand and Gravel - moist to wet, oily substance present, strong sheen, metal wire present
	B22-01	12:05	81.8	-			4			
							5			
	B22-02	12:12	212.0	-			6			SILT - green with brown mottling, stiff, strong sheen
							7			
							8			
	B23-03	12:15	253.0	-			9		ML	
							10			
							11			
	B22-04	12:25	18.6	-			12			Sandy SILT - brown, moist, stiff, strong sheen
							13			
							14			
	B22-05	12:30	18.4	40			15			Sandy SILT - olive gray to green, moist to wet, stiff, strong sheen
							16		ML	
	B22-06	12:35	15.8	-			17			SILT - olive gray, moist, stiff, strong sheen, black oily product throughout core)
							18			
	B22-07	12:40	4.8	-			19			
							20			

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 START	DRILL FINISH
					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)
3/4" Bentonite Chips	B22-08	12:45		-			21		ML
			53.2				22		
							23		SP
							24		
	B22-09	12:50		485			25		
				16.0			26		ML
	B22-10	12:55		-			27		
				8.7			28		
	B22-11	1:00		-			29		SP
				8.4			30		
							31		
						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	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.		

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	
							4			
							5			
							6			
	B23-01	14:38	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	9.7	-			17			Sandy SILT - green with brown mottling, stiff, roots present, saturated with product 15-17 feet bgs, strong sheen
							18			
	B23-05	15:00	589.0	-			19		ML	
							20			

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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:	CASING DIAMETER:	SURFACE ELEVATION:	TOP OF CASING ELEVATION:	SOIL DESCRIPTION
3/4" Bentonite Chips	B23-06	15:05	2500+	-			21		ML	8-inch	Not Applicable	35.1 feet msl	Not Applicable	SILT - brown with orange spots, moist, very stiff, sheen 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-
							22							
								23						
								24						
	B23-07	15:10	682.0	-			25		SP					
								26						
	B23-08	15:20	77	2500+			27		ML					
								28						
								29						
	B23-09	15:25	822.0				30		SP					
								31						
	B23-10	15:30	108.0				32		ML					
							33							
B23-11	15:35	292.0				34		SP						
							35		ML					
							36							
							37							
							38							
							39							
							40							

HAHN & ASSOCIATES, INC.

434 NW Sixth Avenue

Portland, Oregon

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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

DRILL

START

FINISH

Time:

Time:

9:15

10:15

Date:

Date:

10/2/95

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							1		Concrete	Sidewalk at surface.	
							2				
						9	100	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)	
						9	100	4			
								5			
								6			
	B24-02	9:30						7		SAND - as above, some pebbles, moist, no sheen, (5-10 feet bgs)	
			40.0					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				20				

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SOIL BORING NUMBER B-24

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	9:15	10:15
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
										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	390				21			ML	
										SP	SAND - brown, wet, loose, poorly graded, fine grained, no sheen (22-23 feet bgs)
	B24-08	10:03	907				22			ML	Sandy SILT -brown with green mottles, moist, no sheen (23-24 feet bgs)
	B24-09	10:05	1654				23			SP	SAND - brown, wet, loose, poorly graded, no sheen (24-30 feet bgs), 2 inch Silt zone at 27 feet bgs
	B24-10	10:10	834	0.14			24				
							25				
							26				
							27				
							28				
							29				
							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 2708-951002-

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 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		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
							1		Asphalt	Asphalt at surface.
							2			
							3		SP	
	B25-01	12:15	262	-			4			SAND - brown to gray, moist, loose, poorly graded, medium grained, slight sheen, (2-5 feet bgs)
							5			
							6			
	B25-02	12:20	85.2	-			7			SAND - as above, moist, large piece of decayed wood in end of sampler, slight sheen, (5-10 feet bgs)
							8			
							9		SP	
							10			
							11			
							12			
	B25-03	12:30	90.6	12.5			13			SAND - as above, wet at 14 feet bgs, strong sheen, brown froth appears via sheen test, (10-15 feet bgs)
							14			
							15			
							16			
							17			SAND - as above, wet, strong sheen and froth to depth of 17 feet bgs, no sheen from 17-18.5 feet bgs
							18			
	B25-04	12:35	92.7	-			19			SILT - olive gray, moist, no sheen (18-20 feet bgs)
							20		ML	

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: 12:05	Time: 12:45				
				DRILLING METHOD: 4 1/4-inch ID Hollow Stem Auger		Date: 10/2/95	Date: 10/2/95				
				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: 35.0 feet msl	
										TOP OF CASING ELEVATION: Not Applicable	
										SOIL DESCRIPTION	
3/4" Bentonite Chips	B25-05	12:40	191	0.45	↑	↑	21		ML	Sandy SILT - olive gray, wet, slightly stiff, slightly plastic, no sheen, (20-22 feet bgs)	
							22				
							23				
	B25-06	12:43	24.4	-	↓	↓	24		ML	SILT - olive gray with brown/orange spots, moist, stiff, plastic, no sheen, (22-25 feet bgs)	
							25				
							26				
							27				
							28				
							29				
							30			Drilled to 25 feet bgs Sampled to 24 feet bgs	
							31				
							32				
							33				
							34				
							35				
							36				
							37				
							38				
							39				
							40				

HAHN & ASSOCIATES, INC.

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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 DATA	
										BORING DIAMETER:	8-inch
3/4" Bentonite Clips	B26-01	8:15	753	9.3					SM	Silty SAND with Gravel - brown, moist, no hydrocarbon odor	
	B26-02	8:30	1191	-					SP	Lampblack - black, hydrophobic, slight sheen, slight hydrocarbon odor	
	B26-03	8:45	771	-					SP	SAND - olive gray, moist, loose, medium grained, strong hydrocarbon odor, sheen	
	B26-04	8:55	997	-							
B26-05	9:08	1611	-					SP	SAND - olive gray, wet, loose, poorly graded, medium grained, saturated with product, strong sheen on sampler		

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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	DRILL FINISH
Time: 8:20	Time: 10:20
Date: 10/4/95	Date: 10/4/95

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	B26-06	9:15		15,530			21		SP	8-inch	Not Applicable	34.9 feet MSL	Not Applicable	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								
								26		ML					
	B26-08	9:30		-			27							SILT - brown, moist, stiff, strong sheen on sampler, root zones present, black, oily product appears to be migrating through root zones	
			959				28								
							29								
	B26-09	9:45		-			30								
								31							Sandy SILT - olive gray to green, medium stiff, large amount of black staining appears to be migrating through root zones
							32			ML					
							33								
	B26-11	10:10		-			34								
							35								
								36							Sandy SILT - olive gray to green, medium stiff, sheen from 35-37 feet bgs, no sheen from 37-40 feet bgs
	B26-12	10:15		-			37								
							38			ML					
								39							Drilled to 40 feet bgs Sampled to 40 feet bgs
	B26-13	10:20		1.1			40								
			771											* Sample Number Prefix is 2708-951002-	

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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					

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 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
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

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: 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					
					2	100	23				
	B27-10	13:40		1,243	3	100	24		ML	SAND - black, wet, loose, saturated with oily substance, (22.5-23.5 feet bgs)	
				2500+	3	100				SILT - brown, wet, medium stiff, plastic, sheen via sheen test, (23.5-24 feet bgs)	
							25				
					2	100	26		SP	SAND with some Silt - black, wet, loose, sheen on sampler, (25-25.5 feet bgs)	
	B27-11	13:45			2	100				SILT with some Clay - brown, wet, soft, plastic, sheen via sheen test, (25.5-26.5 feet bgs)	
				392	2	50	27				
							28		ML		
	B27-12	13:55		125	4	100				Clayey SILT - brown, moist, medium stiff, plastic, no sheen via sheen test	
				120	5	70	29				
							30				
					3	100	31			Clayey SILT - as above, slight sheen via sheen test, (outside of core smeared with petroleum product from shallower depths)	
	B27-13	14:05			3	100					
				861	5	100	32				
							33				
	B27-14	14:15			3	100			ML	Clayey SILT - olive gray, moist, soft, sheen via sheen test, (outside of core smeared with petroleum product from shallower depths)	
				714	4	100	34				
				5	10						
						35					
B27-15	14:40		12.2	3	100	36			SILT - olive gray, moist, soft, no petroleum hydrocarbon odor, no sheen via sheen test		
			254	3	80						
				3	0	37					
						38					
						39			Drilled to 36.5 feet bgs Sampled to 36.5 feet bgs		
						40			* Sample Number Prefix is 2708-950920-		

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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)	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					
	B28-03	14:10	95.4	-				4						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)	
								5							
								6							
	B28-04	14:15	111	-				7						GRAVEL with Lampblack - black, dry, lampblack is hydrophobic, no hydrocarbon odor, no sheen via sheen test, (5-10 feet bgs)	
								8							
								9							
								10							
	B28-05	14:20	36.2	-				11						GRAVEL with Lampblack - sticky, tar-like pieces present, hard, with sheen on surface, strong hydrocarbon odor (10-12 feet bgs)	
								12							
	B28-06	14:25	71.4	-				13							
								14							
								15							SAND - olive gray, moist, loose, poorly graded, strong hydrocarbon odor, sheen via sheen test, (12-15 feet bgs)
								16							
	B28-07	14:30	372	612				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)
B28-08	14:35	53.7	-				20		SP						

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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: 14:00	Time: 15:00
DRILLING METHOD: 4 1/4-inch ID Hollow Stem Auger	Date: 10/2/95	Date: 10/2/95
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)
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-

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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 START	DRILL FINISH
SAMPLING METHOD: Split Spoon	Time: 14:15	Time: 9:30
DRILLING METHOD: 4 1/4-inch ID Hollow Stem Auger	Date: 9/22/95	Date: 9/25/95
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:	CASING DIAMETER:	SURFACE ELEVATION:	TOP OF CASING ELEVATION:	SOIL DESCRIPTION
3/4" Bentonite Chips	B29-01	14:08	-	230	-	-	1			8-inch	Not Applicable	31.1 feet msl	Not Applicable	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						
								6						
	B29-03	14:22			6	100	7							Sandy Silty GRAVEL - as above, no hydrocarbon odor, no sheen via sheen test
						9	0	8						
						5	0	9		GW				
	B29-04	14:26			11	100	10							
						5	60	11						
						11	0	12		GM				
	B29-05	14:30			3	100	13							Silty Sandy GRAVEL - brown, wet, dense, slightly plastic, well graded, no petroleum hydrocarbon odor, no sheen via sheen test
						13	20	14						
						20	0	15						
	B29-06	14:35			11	100	16							
						14	20	17						
						30	0	18						
								19						
	B29-07	15:05			5	100	16							
					8	100	17		ML					
					12	100	18							
							19							
B29-08	15:11			6	100	18								
					12	100	20							
					15	100								

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SOIL BORING NUMBER B-29

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

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			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	21				
					15	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			SILT - gray with red-brown mottling, non-plastic, slight hydrocarbon odor (22.75-23 feet bgs)	
			15:23			-	100			SAND - dark gray, moist to wet, poorly graded (23-24 feet bgs)	
	B29-10				-	100	24		SP		
							25				
	B29-11	15:30			3	100			tar	SILT and SAND - as above, tarry (25-25.25 feet bgs)	
					9	100	26		ML	SILT - gray, as above (25.25-26.25 feet bgs)	
					12	100			tar	SILT and SAND - black, tarry, hydrocarbon odor, sheen via sheen test (26.25-27 feet bgs)	
							27				
	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					
					6	100	29				
							30				
	B29-13	15:50			3	100				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			SM		
					5	100					
							32				
B29-14	16:00			9	100	33			SAND - black, wet, medium dense, poorly graded, entire core covered with brown product (32.5-34 feet bgs)		
				7	100						
				9	100	34					
						35		SP			
B29-15	16:08			4	100				SAND - as above, product saturated throughout core (35-36.5 feet bgs)		
			58,822	9	100	36					
				12	100				Drilling resumes at 8:40, 9/25/95		
				↑	↑	37					
						38					
B29-16	9:00								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)		
						39					
						40					

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SOIL BORING NUMBER

B-29

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

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

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: 31.1 feet msl
										TOP OF CASING ELEVATION: Not Applicable
SOIL DESCRIPTION										

3/4" Bentonite Chisps							41		
							42		
							43		
	B29-17	9:10		16.5			44		
			69.0				45		
							46		
	B29-18	9:25		0.18			47		
			28.1				48		
							49		
							50		
						51			
						52			
						53			
						54			
						55			
						56			
						57			
						58			
						59			
						60			

SP

SAND - olive-gray, wet, sheen via sheen test, strong sheen on drill stem (40-44 feet bgs)

SAND with some Silt - gray, moist, no sheen via sheen test, no sheen on drill stem (44-45 feet bgs)

SP

SAND with some Silt - moist to wet, poorly graded, fine to medium grained, no sheen via sheen test, no sheen on core (45-50 feet bgs)

Drilled to 50 feet bgs
 Sampled to 48 feet bgs

* Sample Number Prefix is 2708-950922-

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

PROJECT #: 2708

SOIL BORING NUMBER B-30

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	DRILL FINISH
Time: 10:15	Time: 12:40
Date: 9/22/95	Date: 9/22/95

BORING DIAMETER:	6-inch
CASING DIAMETER:	Not Applicable
SURFACE ELEVATION:	33.9 feet msl
TOP OF CASING ELEVATION:	Not Applicable

ABANDONMENT DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TPH-G/418.1 M (ppm)	CORE INTERVAL	SAMPLE RECOVERY	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	SOIL DESCRIPTION
							1			
							2			
							3		GM	
							4			
							5			
							6			
	B30-04	10:20	345	-			7			Silty GRAVEL with Sand - black, moist, some wet zones, plastic, hydrocarbon odor, sheen via sheen test
							8		GM	
							9			
	B30-05	10:25	28.4	-			10			Silty GRAVEL with Sand - as above, hydrocarbon odor, sheen via sheen test
							11			
	B30-06	10:35	52.4	6,776			12			Silty GRAVEL with Sand - black, wet, plastic, slight sheen
							13			
	B30-07	10:45	9.0	-			14			Silty GRAVEL with Sand - brown, wet, plastic, no sheen via sheen test
							15			
							16		GM	
							17			
	B30-08	10:55	17.6	-			18			Silty GRAVEL with Sand - brown, wet, stiff, plastic, hydrocarbon odor
							19			
	B30-09	11:20	24.2	-			20			Silty GRAVEL with Sand - as above, hydrocarbon odor

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SOIL BORING NUMBER

B-30

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	DRILL
START	FINISH
Time:	Time:
10:15	12:40
Date:	Date:
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:	CASING DIAMETER:	SURFACE ELEVATION:	TOP OF CASING ELEVATION:	SOIL DESCRIPTION	
3/4" Bentonite Chips	B30-10	11:30	35.1	-	21		21		GM	6-inch	Not Applicable	33.9 feet msl	Not Applicable	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								
					26		26			ML					
					27		27								SILT - gray, wet, stiff, slight plastic odor
					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								
B30-13	12:20	184	-	34		34			SM					Silty SAND - brown, wet, dense, slightly plastic, hydrocarbon odor, no sheen via sheen test	
				35		35									
				36		36								Boring terminated at 35 feet bgs Sample to 34 feet bgs	
				37		37									
				38		38									
				39		39									
				40		40									

* Sample Number Prefix is 2708-950922-

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SOIL BORING NUMBER

B-30-A

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

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	DRILL FINISH
Time: 9:00	Time: 9:40
Date: 9/22/95	Date: 9/22/95

PROJECT #: 2708

ABANDONMENT DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHS (ppm)	CORE INTERVAL	SAMPLE RECOVERY	DEPTH (feet)	GROUNDWATER	STRATA (USCS)
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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	B30-01	8:55	20.6	965			1		ML
							2		
							3		
						↑	↑	4	
		B30-02	9:20	304	-	↓	↓	5	
								6	
								7	
								8	
								9	
		B30-03	9:30	155	-	↓	↓	10	GP
								11	
								12	
								13	
								14	
						↓		15	
							16		
							17		
							18		
							19		
							20		

Surface sample

Sandy SILT - black, moist, tarry, hydrocarbon odor

Fill material, low recovery in sampler

Fill material - as above, little gravels, moist to wet, tarry, hydrocarbon odor

Boring terminated at 15 feet bgs due to lack of recovery in sample barrels.

* Sample Number Prefix is 2708-950922-

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

SOIL BORING NUMBER B-31

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	14:20	15:45
EQUIPMENT TYPE:	B-59 Mobile Drill	Date:	Date:
DRILLER:	Brad James	9/25/95	9/25/95
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	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							

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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
Time: 11:50	Time: 15:40
Date: 10/4/95	Date: 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	SM					Silty SAND with Gravel - olive-gray to black, moist, hydrocarbon odor (6.5-10 feet bgs)
	B32-02	12:08	296	-			9							
							10							
								11	GP					Sandy GRAVEL - brown, wet, no sheen via sheen test (10-11.5 feet bgs)
	B32-03	12:15	785	28,772			12							
		B32-04	12:18	-				13	GP					SAND and GRAVEL with some Silt - black, matrix is tar material, highly viscous, strong sheen via sheen test (11.5-15 feet bgs)
							14							
							15							
								16	GP					SAND and GRAVEL with some Silt - black, wet, matrix is tar material, highly viscous, strong sheen on sampling core (15-17 feet bgs)
		B32-05	12:25	-				17						
				809				18						
								19	GP					Gravelly SILT - brown, wet, little tar (17-17.5 feet bgs)
								20						

HAHN & ASSOCIATES, INC.

434 NW Sixth Avenue
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 (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										ML + tar	<p>SILT and TAR - black, moist, plastic, smooth texture, highly viscous (20-25 feet bgs)</p> <p>Sandy SILT - black, wet, poorly graded, matrix is tar material, highly viscous, roots present (25-26 feet bgs)</p> <p>Sandy SILT - olive-gray, moist, tar seams present - preferential in areas of roots, cracks (26-30 feet bgs)</p> <p>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)</p> <p>Sandy SILT - brown with orange pockets, saturated with oily, black product (35-37.5 feet bgs)</p> <p>SAND - black, wet, poorly graded, fine grained, saturated with product, sheen via sheen test (35-37.5 feet bgs)</p> <p>Sandy SILT - brown with orange pockets, saturated with oily, black product, sheen via sheen test (38-40 feet bgs)</p>
	B32-06	12:32	1072	-			21			ML + tar	
	B32-07	12:34					22			ML + tar	
							23			ML + tar	
							24			ML + tar	
							25			ML + tar	
							26			ML	
							27			ML	
	B32-08	12:46					28			ML	
				1321			29			ML	
							30			ML	
	B32-09	13:15					31			ML	
				1219			32			ML	
						33			ML		
B32-10	13:20					34			ML		
			1355			35			ML		
						36			ML		
B32-11	13:29					37			ML		
			499			38			SP		
B32-12	13:33					39			ML		
			745.0			40			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.
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PROJECT:
 Northwest Natural Gas Co.
 Gasco Facility
 Portland, Oregon

PROJECT #: 2708

SOIL BORING NUMBER B-33

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	
3/4" Bentonite Chips	B33-01	13:15	-	955			1		GM	8-inch	Not Applicable	34.8 feet msl	Not Applicable	Silty SAND with Gravel - brown, moist, no hydrocarbon odor, no sheen, no hydrocarbon odor (surface)	
							2								
	B33-02	14:00		38	3	100	3		SM + tar					Sandy SILT and GRAVEL - olive grey, moist, loose, no sheen	
				97	5	50	4								
					18	0	5								
	B33-03	14:03		8,238	15	100	6		SM + tar					Tarry Silty SAND with Gravel - black, wet, medium dense, viscous tar seeps from cracks	
				219	16	50	7								
							8	50/5"		5					Rock in end of sampler - no recovery
								9							
								10							
								11							
	B33-04	14:28		-	12	100	12		SM + tar					Tarry Silty SAND with Gravel - black, moist, medium dense	
				318	11	50	13								
								14							
	B33-05	14:30	624	-	5	50	15		SM + tar					Tarry Silty SAND with Gravel - as above, loose	
					7	0	16								
								17		GM + tar					Tarry Gravels with Sand and Silt - black, moist, viscous tar zone at 16.5 feet bgs
	B33-06	14:42		-			18								
				646			19								
							20								

Hahn & Associates, Inc.

434 NW Sixth Avenue
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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.

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

Time:

13:50

Date:

10/5/95

DRILL

FINISH

Time:

9:10

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)	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			

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434 NW Sixth Avenue
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SOIL BORING NUMBER

B-34

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

HAI LOGGER: Rob Ede
SAMPLING METHOD: 4" OD Core Barrel
DRILLING METHOD: 10 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: 9:45	Time: 13:15
Date: 9/26/95	Date: 9/26/95

PROJECT #: 2708

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
	B34-01	8:45	-	94					SM	CASING DIAMETER: Not Applicable
	B34-02 (dup)	8:50	-				1			SURFACE ELEVATION: 34.9 feet msl
							2			TOP OF CASING ELEVATION: Not Applicable
							3		GM	
							4			
							5			
	B34-03	10:00	-	-			6			
							7			
							8			
	B34-04	10:20					9		GP + tar	
			1344				10			
							11			
	B34-05	10:30		13,499			12			
			2,500+				13			
							14			
							15			
							16			
	B34-06	10:45		-			17			
			260				18		GP + tar	
							19			
							20			

3/4" Bentonite Chips

9/26/95

SOIL DESCRIPTION

Silty SAND with Gravel - brown, moist, no hydrocarbon odor (surface)

No Recovery-Gravels and Cobbles (0 to 5 feet bgs)

Silty Sandy GRAVEL with Cobbles, olive grey, moist, wood fragmernts, sheen

Silty Sandy GRAVEL with Cobbles, as above, brown, sheen, cobble fragment in end of sampler

Tarry Sandy GRAVEL - black, hard, sheen, large brick or slag at 9 feet bgs

Tarry Sandy GRAVEL - black, less hard than above, tar oozing from sand, large brick at 12.5 feet bgs

Tarry Sandy with GRAVEL - black, moist, tar content less than above, aluminum strips from 17 to 17.5 feet bgs.

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

PROJECT #: 2708

SOIL BORING NUMBER B-34

HAI LOGGER: Rob Ede	DRILL START	DRILL FINISH
SAMPLING METHOD: 4" OD Core Barrel	Time: 9:45	Time: 13:15
DRILLING METHOD: 10 1/4-inch ID Hollow Stem Auger	Date: 9/26/95	Date: 9/26/95
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)	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	1,107	-			23			
								24			
								25			
		B34-08	12:00	1,422	-			26		SP	SAND - black to olive gray, wet, loose, wood fragments, sheen throughout (25 - 27.5 feet bgs)
								27			
								28			
		B34-09	12:05	2,500+	-			29		ML	Sandy SILT - light brown, moist, organic matter and oxidized zones, thin tarry beds throughout core (27.5 - 30 feet bgs)
								30			
								31			
		B34-10	12:30	2,500+	-			32		SM	Silty SAND - olive gray, wet, fine to medium grained, wood fragments, patches of black oil throughout
								33			
		B34-11	12:35	2,500+	-			34			
								35			
								36		ML	SILT - green and gray mottled with brown oily pockets, sheen, product is more oil-like and less tar-like at this depth
		B34-12	13:00		-			37			
				2,500+				38			
								39			
								40			

Drilled to 37 feet bgs
 Sampled to 37 feet bgs
 * Sample Number Prefix is 2708-950926-

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

SOIL BORING NUMBER

B-35

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

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: 10:20	Time: 12:05
Date: 10/5/95	Date: 10/5/95

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: 33.8 feet msl
										TOP OF CASING ELEVATION: Not Applicable
SOIL DESCRIPTION										

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				Sandy GRAVEL with Silt, brown, wet, hardened tar in end of sampler, no sheen
						0		4			
								5			
						31	5	6			No Recovery - Rock blocking end of sampler
						34	0	7			
								8			
	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				
								11			Tarry SAND with Gravel and Silt, as above
								12			
								13			
								14			
								15			
								16			No Recovery - rock blocking end of sampler
								17			
								18		SP + tar	
								19			
							20				

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
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: 10:20	Time: 12:05
Date: 10/5/95	Date: 10/5/95

PROJECT #: 2708

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: 33.8 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)	SOIL DESCRIPTION
3/4" Bentonite Chips					4	100				GP+ oil SAND - black, wet, medium grained, saturated with black oily product (21.5 - 22.5 feet bgs) -- SILT - olive gray to green, upper 6-inches is tarry, no tar below (22.5-24 feet bgs) ML SILT - olive gray with orange oxidation spots, moist, medium stiff, some root zones present, no product, no sheen Drilled to 30 feet bgs Sampled to 30 feet bgs * Sample Number Prefix is 2708-951005-
	B35-05	11:10	936	-	6	100	21			
	B35-06	11:16		41,602	7	80	22			
				2,255			23			
	B35-07	11:20	499	-			24			
							25			
	B35-08	11:32	98	-			26			
	B35-09	11:56		-			27			
				335			28			
	B35-10	12:02		9.3			29			
			299			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 GT-1					
PROJECT: Northwest Natural - Gasco Facility 7900 NW St. Helens Road Portland, Oregon					HAI LOGGER: Rob Ede			DRILL START	DRILL FINISH	
PROJECT #: 2708					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

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			DRILL START	DRILL FINISH
SAMPLING METHOD: 2" OD Split Spoon					DRILLING METHOD: 4 1/4-inch OD Mud Rotary			Time: 14:30	Time: 16:00
EQUIPMENT TYPE: B-61 Mobile Drill					DRILLER: Jim Clark			Date: 11/17/97	Date: 11/17/97
DRILLING CONTRACTOR: Subterranean, Inc.					BORING DIAMETER: 4 1/4-inch				
CASING DIAMETER: Not Applicable					SURFACE ELEVATION: 20.68 feet MSL				
TOP OF CASING ELEVATION: Not Applicable					SOIL DESCRIPTION				
ABANDONMENT DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHS (ppm)	SPT (blows/0.5 feet)	RECOVERY (%)	DEPTH (feet)	GROUNDWATER	STRATA (USCS)
							1		GM
							2		
					3	100	3		
	012	1439	1.9	0.08	4	100	4		
					5	50	5		
					2	100	6		
	013	1442	2.7	-	3	100	6		
					4	50	7		SP
	014	1453	2.1	-	5	75	8		
					5	0	9		
					2	0	9		
							10		
					1	100	11		
	015	1500	2.5	-	0	100	11		
					1	100	12		
					0	100	13		
	016	1505		-	1	100	13		ML
			2.4		0	25	14		
							15		
					1	100	16		
	017	1510		ND	1	100	16		
			2.9		2	25	17		
							18		SP
							19		
							20		

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SOIL BORING NUMBER

GT-2

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:	Time:
DRILLING METHOD:	4 1/4-inch OD Mud Rotary	14:30	16:00
EQUIPMENT TYPE	B-61 Mobile Drill	Date:	Date:
DRILLER:	Jim Clark	11/17/97	11/17/97
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)	BORING DIAMETER: 4 1/4-inch
										CASING DIAMETER: Not Applicable
										SURFACE ELEVATION: 20.68 feet MSL
										TOP OF CASING ELEVATION: Not Applicable
SOIL DESCRIPTION										

Bentonite / Cement Grout					4	100				SP	SAND - as above, medium dense, no hydrocarbon odor, no sheen, slight organic decay odor.
	018	1515	3.6	-	5	100	21				
					6	50	22				
							23				
							24				
							25				
					4	100					
	019	1521	3.6	-	4	100	26				
					7	50	27				
							28				
							29				
							30				
		020	1529		-	2	100	31			
				2.2		7	25	32			
						7	100	33			
	021	1534		ND	8	100	34				
			2.6		9	25	35				
							36				
					5	100					
					10	100					
	022	1540	2.7	-	6	50					
							37				
							38				
							39				
							40				

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-

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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			
	023	847		43.1	3	100		4		SILT with fine Sand and Gravel - olive grey with some brown, moist, stiff, non-plastic, no hydrocarbon odor, no sheen, some wood fragments.	
				0		7	25	5			
	024	850	0	-	4	50		6		SILT with fine Sand and Gravel - as above, brown, no hydrocarbon, no sheen.	
						5	0	7	ML		
						16	0	8			
						3	100	9		SILT with fine Sand and Gravel - as above, no hydrocarbon odor, no sheen, some wood fragments.	
	025	859	0	-	8	100		10			
						11	50	11		SILT with fine sand and gravel - as above, no hydrocarbon odor, no sheen, some wood fragments.	
						3	20	12			
						2	0	13	SM	Silty SAND - grey with brown oxidation spots, moist, fine grained, very loose, no hydrocarbon odor, no sheen.	
	026	911	0	0.05	1	100		14		Sandy SILT - grey, moist, very soft, non-plastic, no hydrocarbon odor, no sheen.	
						1	10	15	ML		
						1	0	16			
						1	0	17			
						3	100	18		SAND - grey, moist, very loose, fine grained, non-plastic, no hydrocarbon odor, no sheen.	
	027	922	0	-	6	100		19			
						6	75	20	SP		

HAHN & ASSOCIATES, INC.
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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	DRILL
START	FINISH
Time:	Time:
8:20	12:00
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: 19.44 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							SAND - as above, moist to wet, no hydrocarbon odor, no sheen.									
							22															
					1	100								SAND - as above, grey, moist to wet, no hydrocarbon odor, no sheen, fine grained, some grey silt lenses with rootlets.								
					6	100																
	029	935	0	-	7	50									SAND - as above, many silt lenses, no hydrocarbon odor, no sheen, fine grained.							
							25															
					2	100										SP	SAND -as above, wet, no sheen, no hydrocarbon odor.					
					2	100																
	030	943	0	-	2	75												Drilled to 35.0 feet bgs Sampled to 36.5 feet bgs				
							26															
																			* Sample Number Prefix is 2708-971118-			
							27															
							28															
							29															
							30															
					2	100																
					1	100																
031	953		-	1	100																	
						31																
						32																
						33																
						34																
						35																
					8	100																
					10	100																
032	1000	0	ND	10	100																	
						36																
						37																
						38																
						39																
						40																

HAHN & ASSOCIATES, INC.

434 NW Sixth Avenue

Portland, Oregon

(503) 796-0717

SOIL BORING NUMBER

GT-4

HAI LOGGER:

Rob Ede

DRILL

DRILL

PROJECT:

SAMPLING METHOD:

2" OD Split Spoon

START

FINISH

Northwest Natural - Gasco Facility

DRILLING METHOD:

4 1/4-inch OD Mud Rotary

Time:

Time:

7900 NW St. Helens Road

EQUIPMENT TYPE

B-61 Mobile Drill

12:45

16:00

Portland, Oregon

DRILLER:

Jim Clark

Date:

Date:

PROJECT #: 2708

DRILLING CONTRACTOR:

Subterranean, Inc.

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)	SOIL DESCRIPTION
							1			
							2		GM	
					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			
					12	0	6			Silty GRAVEL with brick fragments - no hydrocarbon odor, no sheen.
					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	-	30	100	11			
					18	50	12			Driller indicates smoother drilling below 11.5 feet
							13			
					1	100	13			
					1	100	14			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			

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

SOIL BORING NUMBER **GT-4**

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: 12:45	Time: 16:00
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: 19.64 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					
						55					
						56					
						57					
						58					
						59					
						60					

Drilled to 50.0 feet bgs
 Sampled to 51.5 feet bgs

* Sample Number Prefix is 2708-971118-

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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.	
20 % Solids Bentonite Grout	M11-02	1330		-	18	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		27	100						
					21	70				GP	Sandy GRAVEL (5.0-6.5 feet bgs) - black (Lampblack), no sheen, pieces of brick, large pieces of slag looking material .	
					14	100						
					8	100						
					7	30						
					8	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.	
		M11-03	1335		-	5	100					
				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		-						SP		
			2500+									

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		ML	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					
							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				↑	66			SM		
				7.8			67			ML		
						↓	68			SM	SAND (67.5-68.5 feet bgs) - brown, wet, moderately dense, no sheen, fine grained.	
	M11-15	1030				↓	69			SP	SAND (68.5-70.0 feet bgs) - brown, wet, loose, poorly graded, no sheen, fine grained.	
			2.3		↓	70						
							71					
							72					
							73					
							74					
							75					
							76					
							77					
							78					
							79					
							80					

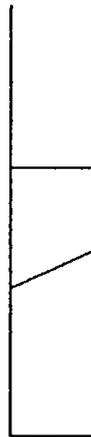
Boring terminated at 70.0 feet bgs.

*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

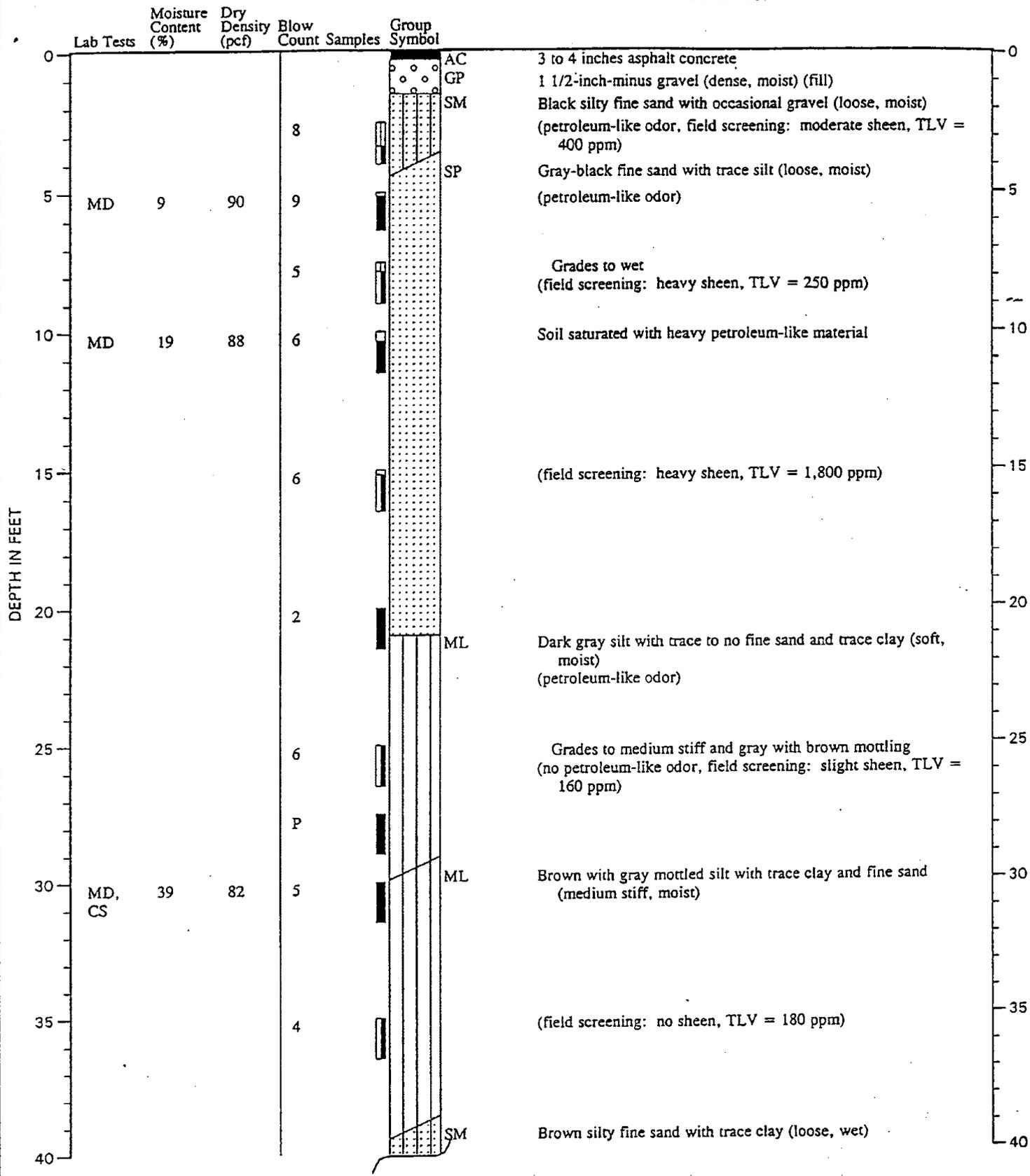
"P" indicates sampler pushed with weight of hammer or against weight of drill rig.

- 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



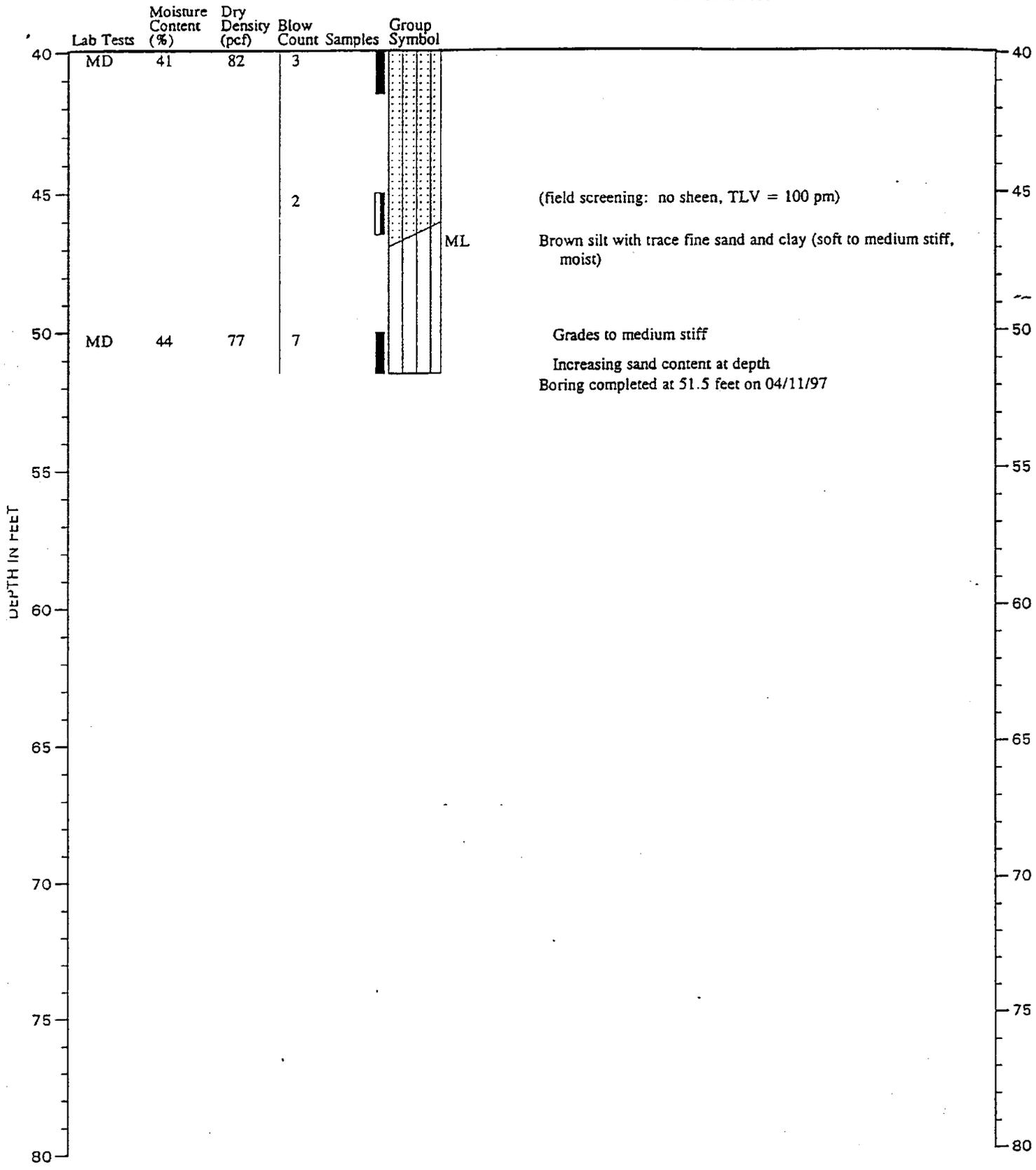
Note: See Figure 2 for explanation of symbols

58: -43-2 MB:V 16/97

TEST DATA

BORING G-1
(Continued)

DESCRIPTION



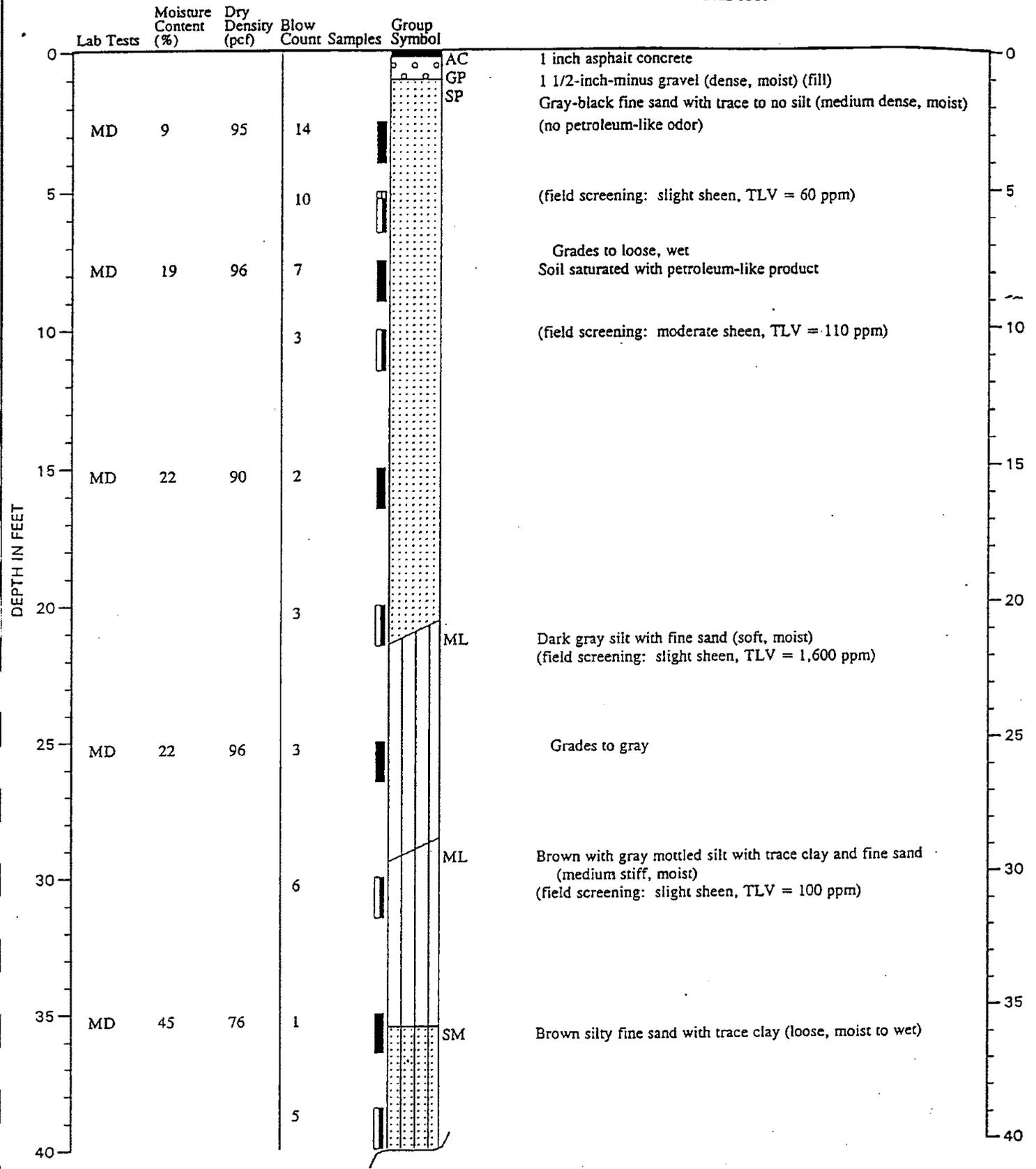
Note: See Figure 2 for explanation of symbols



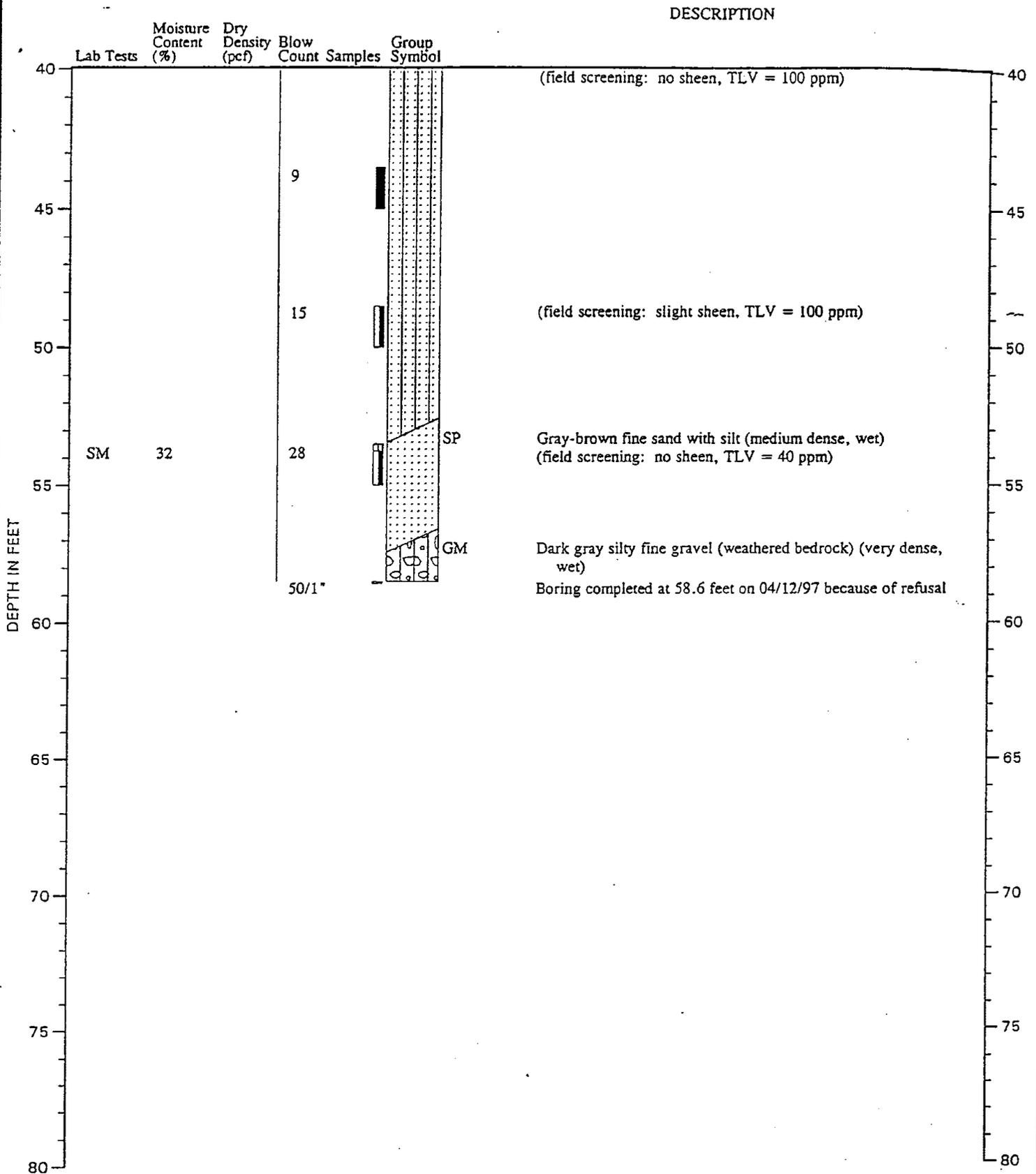
LOG OF BORING

FIGURE 5

DESCRIPTION



Note: See Figure 2 for explanation of symbols



Note: See Figure 2 for explanation of symbols

Vandehney Soil EX LLC

Operator : S.VAN/S.MES/W.MC CPT Date : 04-12-97 11:01 Sounding : SND433 Pg 1 / 1
 Location : P1/KOPPERS PORT Client : GEO ENGINEERS Job No. : 5827

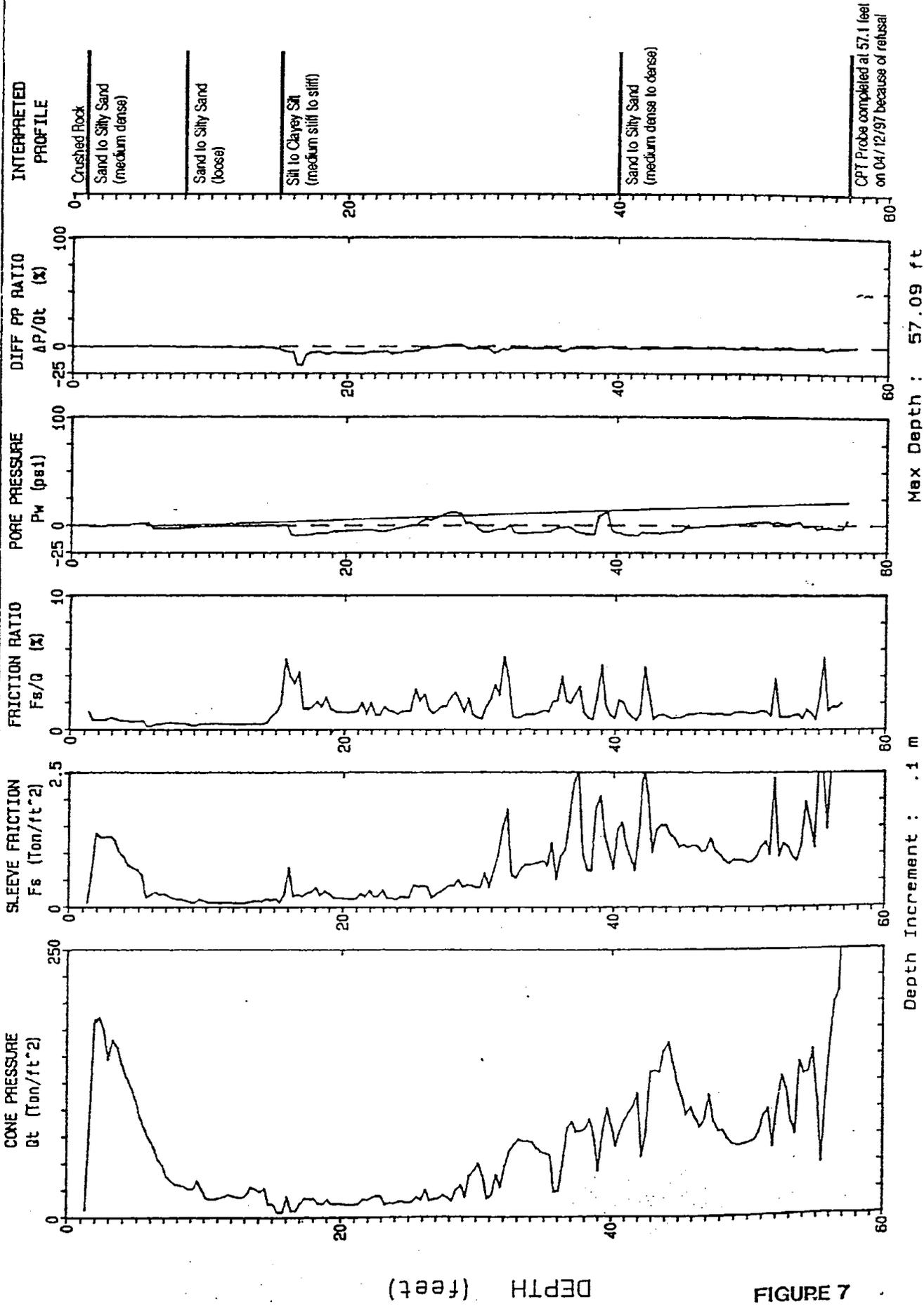
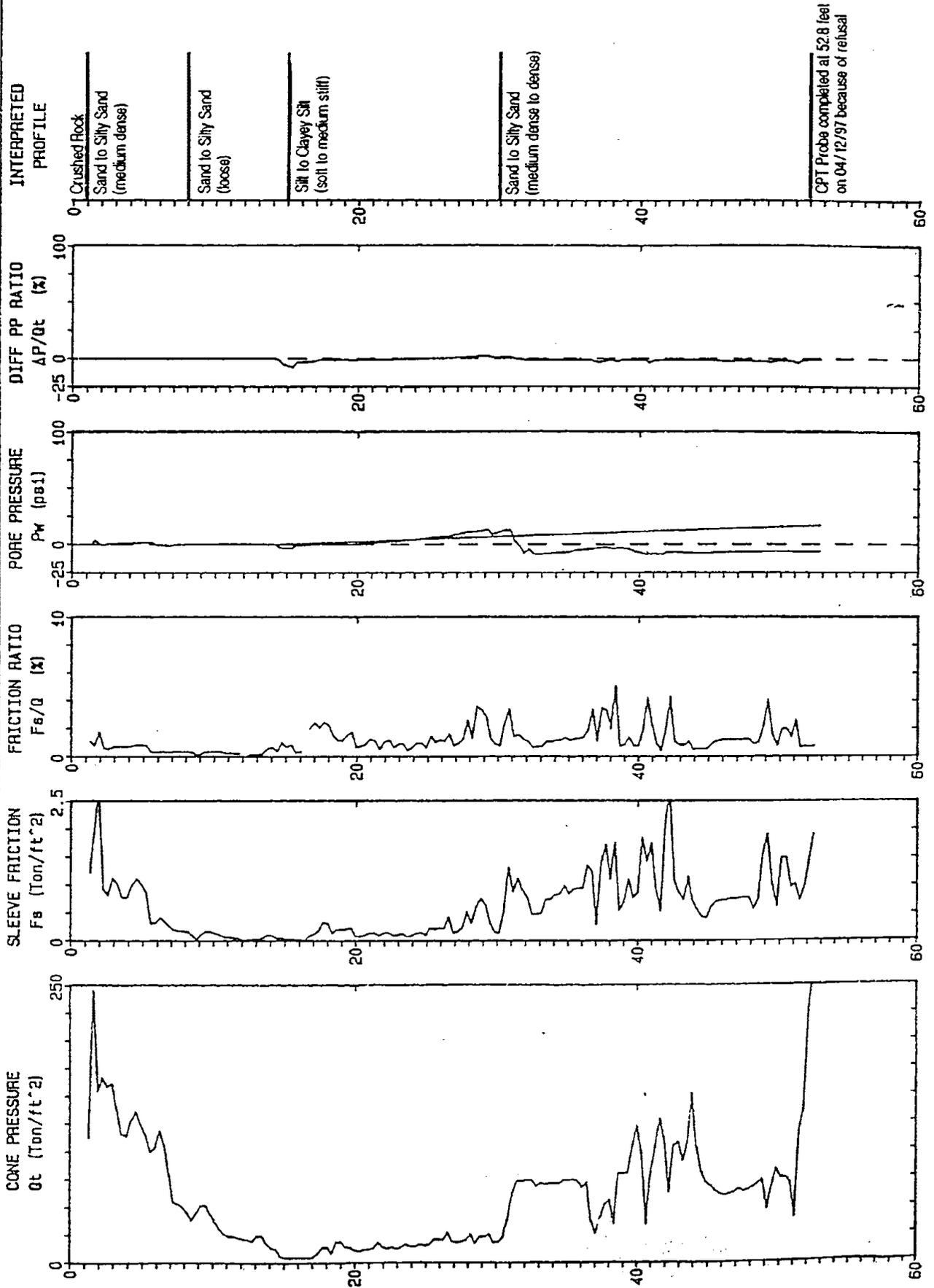


FIGURE 7

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

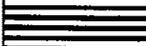
Note: bgs = below ground surface btc = below top of casing msl = mean sea level PVC = polyvinyl chloride

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	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
			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
		Sands With Over 12% Fines	SP		Poorly Graded Sands, Gravelly Sands
			SM		Silty Sands, Poorly Graded Sand-Silt Mixtures
			SC		Clayey Sands, Poorly Graded Sand-Clay Mixtures
FINE GRAINED SOILS	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	

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					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					SURFACE ELEVATION: 32.0 Feet MSL	
HAI LOGGER: Rob Ede					DRILLER: Brad James		DRILL START: 11:30		DRILL FINISH: 13:10	
PROJECT: Northwest Natural Gas Co. Gasco Facility Portland, Oregon					SAMPLING METHOD: Core Barrel		DRILLING METHOD: 6 1/4-inch ID Hollow Stem Auger		EQUIPMENT TYPE: B-59 Mobile Drill	
PROJECT: 2708					DRILLING CONTRACTOR: Geo-Tech Explorations		Date: 24-Oct-95		Date: 24-Oct-95	
									SOIL DESCRIPTION	
Steel Monument									Ground surface	
M1-01 1135 0.9 5.8									Surface: Sandy, Silty, GRAVEL - brown, moist, pieces of brick.	
M1-02 1150 1.1 12.8									Sandy GRAVEL (3.0-3.5 feet bgs) - brown, moist.	
M1-03 1158 4.1									Sandy GRAVEL with silt (3.5-5.0 feet bgs) - brown, moist, no hydrocarbon odor, no sheen, lamplblack at 4.0-4.5 feet bgs.	
M1-04 1205									Sandy GRAVEL with small cobbles and bricks (5.0-10.0 feet bgs) - olive grey, moist to wet, no hydrocarbon odor, no sheen, lamplblack from 5.0-5.4 feet bgs.	
M1-05 1220 1.4									Gravelly SAND with silt and pieces of brick (10.0-12.5 feet bgs) - moist, hydrocarbon odor, no sheen, wood fragments.	
									Gravelly SAND with silt and pieces of brick (10.0-12.5 feet bgs) - olive grey with blue staining, moist to wet, hydrocarbon odor, no sheen.	
									Silty SAND with gravel (15.0-16.0 feet bgs) - brown with turquoise blue staining, wet, strong hydrocarbon odor.	
									SAND (16.0-20.0 feet bgs) - olive grey, wet, fine grained, strong metallic sheen on core, black staining.	

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

MONITORING WELL NUMBER MW-1-22
OWRD #

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

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	DRILL FINISH
Time: 11:30	Time: 13:10
Date: 24-Oct-95	Date: 24-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: 32.0 Feet MSL	TOP OF CASING ELEVATION: 34.75 feet MSL
----------------------------------	-----------------------	-------------	------------------------	-------------------------------------	-----------------------------	---------------------	---------------------	--------------------	----------------------	---------------------------------	-----------------------------------	---	--

SOIL DESCRIPTION

10-20 Sand	Cap				21			SP	SAND (20.0-21.4 feet bgs) - black, wet, loose, poorly graded, fine grained, oily product coated, wood fragments.	
					9		21			SILT (21.4-21.5 feet bgs) - moist, slight sheen?, wood fragments.
3/8-inch Bentonite					20			ML	SILT (21.5-25.0 feet bgs) - olive grey, moist, slightly plastic, no sheen, mild hydrocarbon odor	
							22			
										23
	M1-06	1252		0.46			24			
			0.7				25			
							26		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	
							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

MONITORING WELL NUMBER

MW-2-32

OWRD # 84235

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

HAI LOGGER: Rob Ede
SAMPLING METHOD: 3-inch Split Spoon/4-inch 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 START	DRILL FINISH
Time: 11:20	Time: 13:00
Date: 6-Nov-95	Date: 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:	CASING DIAMETER:	SURFACE ELEVATION:	TOP OF CASING ELEVATION:
										10-inch	2-inch	35.8 feet MSL	34.46 feet MSL

SOIL DESCRIPTION

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

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
Concrete	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			SAND with 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.
					7	0	7			
	M2-03	1135					8			Sandy, Silty, GRAVEL (6.5-7.5 feet bgs) - lamplblack, pieces of brick, concrete.
			43.7				9			Driller notes large concrete pieces at 8.5 feet bgs.
							10		GM	
					7	50	11			Sandy, Silty, GRAVEL (10.0-11.5 feet bgs) - as above, some lamplblack, hydrocarbon odor, slight sheen.
					9	0	12			
					9	0	13			
					5	50	14			Sandy GRAVEL (12.5-14.0 feet bgs) - olive grey, moist, loose, hydrocarbon odor, sheen, brick in end of sampler.
					9	0	15			
					6	0	16		GP	
					9		17			Sandy GRAVEL (15.0-16.5 feet bgs) - large pieces of brick material, loose, hydrocarbon odor, sheen.
					50/5"		18			
	M2-04	1200	25.9		7	70	19		SP	Gravelly Sand (17.5-19.0 feet bgs) - yellow/brown, moist, poorly graded, fine grained, no hydrocarbon odor, no sheen, minor olive grey silt lenses.
					11	0	20			
					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			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)
Steel Monument							-3		
							-2		
							-1		
Concrete							1		
2-inch ID Blank PVC Casing							2		
							3		
							4		
							5		
Bentonite Chips							6		
							7		
							8		
2-inch ID Stainless Steel Casing							9		
							10		
							11		
							12		
							13		
							14		
							15		
Colorado 10-20 Sand Pack							16		
Stainless Steel Continuous Slot Filter							17		
							18		
							19		
							20		

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

Ground surface

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

11/2/95

Hahn & Associates, Inc. 434 NW Sixth Avenue Portland, Oregon (503) 796-0717				MONITORING WELL NUMBER				MW-3-26	
				OWRD # 84232					
PROJECT: Northwest Natural Gas Co. Gasco Facility Portland, Oregon				HAI LOGGER: Rob Ede			DRILL START	DRILL FINISH	
PROJECT: 2708				SAMPLING METHOD: Not Sampled			Time: 15:10	Time: 9:00	
				DRILLING METHOD: 6 1/4-inch ID Hollow Stem Auger			Date: 1-Nov-95	Date: 2-Nov-95	
				EQUIPMENT TYPE: B-59 Mobile 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)	
Colorado 10-20 Sand Pack 2-inch, 20 Slot Stainless Screen							21		
							22		
							23		
							24		
							25		
							26		
							27		
							28		
							29		
							30		
							31		
							32		
							33		
							34		
							35		
							36		
							37		
							38		
							39		
							40		
SOIL DESCRIPTION									
Boring terminated at 26.0 feet bgs Monitoring well installed to 26.0 feet bgs Materials: 15 feet 2-inch diameter, 0.010-inch stainless steel slotted screen 10 feet 2-inch diameter stainless steel blank casing 5 feet 2-inch diameter PVC blank casing 12 50# bags 10/20 sand 7 50# bags 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
 OWRD # 84231

MW-3-56

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

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	DRILL FINISH
Time: 8:00	Time: 11:00
Date: 1-Nov-95	Date: 1-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)
Bent. Bentonite Grout 2-inch ID Blank Stainless Steel Casing			7.9		20	100			
					8	20	21		ML
	M3-08	910					22		ML
				45.7				23	GP
								24	
								25	
								26	ML
								27	
	M3-09	915						28	
				5.8				29	
								30	
								31	
	M3-10	925						32	
				9.8				33	
								34	SP
	M3-11	930						35	
				2.8				36	
								37	
	M3-12	955						38	
				9.8				39	
	M3-13	1000						40	SM
				5.9					

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

SILT with some gravel (20.5-21.0 feet bgs) - brown, moist, stiff, slight hydrocarbon odor, sheen.

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.

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.

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.

SAND (34.0-35.0 feet bgs) - brown, wet, loose, fine grained, no hydrocarbon odor, no sheen, thin silt lenses present.

SAND (35.0-37.5 feet bgs) - olive grey, wet, loose, poorly graded, fine grained, no hydrocarbon odor, no sheen.

SAND (37.5-39.0 feet bgs) - brown, wet, medium dense, fine grained, no hydrocarbon odor, no sheen, silt layers

Silty SAND (39.0-40.0 feet bgs) - brown, moist to wet, dense, fine grained, no hydrocarbon odor, no sheen.

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
Bent. Chips		M3-14	1010	19.0				41			CASING DIAMETER:	2-inch ID
2-inch Blank Stainless Steel Casing								42			SURFACE ELEVATION:	31.20 feet MSL
								43			TOP OF CASING ELEVATION:	34.07 feet MSL
		M3-15	1015	3.1				44			SOIL DESCRIPTION	
								45		SP	SAND (40.0-41.5 feet bgs) - olive grey, wet, loose, medium grained, no hydrocarbon odor, no sheen.	
								46			SAND (41.5-45.0 feet bgs) - olive grey, wet, fine grained, silt layers.	
								47			SAND (45.0-49.0 feet bgs) - olive grey, wet, loose, poorly graded, medium grained, no hydrocarbon odor, no sheen.	
								48			SAND (49.0-50.0 feet bgs) - as above, silt layers, no hydrocarbon odor, no sheen.	
		M3-16	1025	6.7				49			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.	
								50			Boring terminated at 56.5 feet bgs Boring sampled to 56.5 feet Monitoring well installed to 55 feet bgs	
								51			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	
								52				
								53				
		M3-17	1048	-				54		SP		
		M3-18	1050	-				55				
Cap						3	100	56				
						5	100	57				
						16	100	58				
								59				
								60				

WELL CONSTRUCTION DETAILS		SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHs (ppm)	SPT (blows/0.5 feet)	RECOVERY (%)	DEPTH (feet)	GROUNDWATER	STRATA (USCS)
Bentonite / 2-inch ID Casing								21		
Blank Stainless Steel Casing								22		
								23		
								24		
								25		
Colorado 10-20 Sand Pack								26		
2-inch ID 0.020-inch Stainless Steel Continuous Slot Screen								27		
								28		
								29		
								30		
								31		
								32		
								33		
								34		
Cap								35		
								36		
								37		
								38		
								39		
								40		

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

MONITORING WELL NUMBER **MW-4-35**
OWRD # 84230

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: 10:30	Time: 13:17
Date: 31-Oct-95	Date: 31-Oct-95

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

PROJECT: 2708

BORING DIAMETER: 10-inch

CASING DIAMETER: 2-inch ID

SURFACE ELEVATION: 31.70 feet MSL

TOP OF CASING ELEVATION: 34.54 feet MSL

SOIL DESCRIPTION

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

* Sample Prefix Number is 2708-951031-

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: 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
START
 Time: 10:15
 Date: 30-Oct-95

PROJECT: 2708

DRILLING CONTRACTOR: Geo-Tech Explorations

FINISH
 Time: 13:15
 Date: 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: 10-inch	
										CASING DIAMETER: 2-inch ID	
										SURFACE ELEVATION: 31.7 feet MSL	
										TOP OF CASING ELEVATION: 34.53 feet MSL	
										SOIL DESCRIPTION	
Steel Monument											Ground surface
	M4-01	1005	1.9	195						SM	Surface: Silty SAND with gravel - brown, moist, pieces of brick, grass covered area, no hydrocarbon odor, no sheen.
					50/5.5"	60				GM	Silty Sandy GRAVEL (2.5 feet bgs) - brown, moist, well graded, no hydrocarbon odor, no sheen.
					23	70					
					27	0				GP	Sandy GRAVEL (5.0-6.5 feet bgs) - dry, loose, poorly graded, no hydrocarbon odor, no sheen.
					27	0					
	M4-02	1035			4	100				GM	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					
											Concrete (8.5-9.5 feet bgs)
					38	0				GM	
					7	0					No recovery (12.5-14.5 feet bgs)
					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					
	M4-04	1110								GM	Silty GRAVEL with sand (16.5-20 feet bgs) - as above, moist, hydrocarbon odor, slight sheen, pieces of brick, switch to core barrel sampler.
			10.2								

WELL CONSTRUCTION DETAILS				SPT (blows/0.5 feet)		RECOVERY (%)		DEPTH (feet)		GROUNDWATER		STRATA (USCS)		SOIL DESCRIPTION			
HAHN & ASSOCIATES, INC. 434 NW Sixth Avenue Portland, Oregon (503) 796-0717				MONITORING WELL NUMBER OWRD # 84229				MW-4-57				HAI LOGGER: Rob Ede		DRILL START: 10:15		DRILL FINISH: 13:15	
PROJECT: Northwest Natural Gas Co. Gasco Facility Portland, Oregon				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		DRILLING CONTRACTOR: Geo-Tech Explorations		Date: 30-Oct-95		Date: 30-Oct-95	
PROJECT: 2708				LAB RESULTS TOTAL PAHs (ppm)		HEADSPACE (ppm)		TIME		SAMPLE NUMBER*		WELL CONSTRUCTION DETAILS		BORING DIAMETER: 10-inch		CASING DIAMETER: 2-inch ID	
WELL CONSTRUCTION DETAILS				LAB RESULTS TOTAL PAHs (ppm)		HEADSPACE (ppm)		TIME		SAMPLE NUMBER*		WELL CONSTRUCTION DETAILS		SURFACE ELEVATION: 31.7 feet MSL		TOP OF CASING ELEVATION: 34.53 feet MSL	
SOIL DESCRIPTION																	
SILT with sand and gravel (20.0-25.0 feet bgs) - brown, moist, slightly plastic, no hydrocarbon odor, no sheen.																	
ML																	
Silty SAND (25.0-27.0 feet bgs) - olive grey, moist to wet, wood fragments, hydrocarbon odor, sheen.																	
SM																	
Sandy SILT (27.0-28.0 feet bgs) - olive grey with brown and orange oxidation spots, root zones, no hydrocarbon odor, no sheen.																	
ML																	
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.																	
SM																	
SAND (30.0-32.5 feet bgs) - olive grey, wet, loose, poorly graded, fine grained, root zones, hydrocarbon odor, sheen.																	
SP																	
SILT (32.5-33.0 feet bgs) - brown with orange oxidized zones, moist, slightly plastic, no hydrocarbon odor, no sheen.																	
ML																	
Silty SAND (33.0-33.5 feet bgs) - brown with bright orange oxidized zones, moist to wet, dense, fine grained.																	
SM																	
SILT (33.5-35.0 feet bgs) - olive grey, moist, stiff, no hydrocarbon odor, no sheen.																	
ML																	
SILT with fine sand (35.0-39.0 feet bgs) - olive grey, moist, stiff, root zones, no hydrocarbon odor, no sheen.																	
ML																	
SAND (39.0-40.0 feet bgs) - olive grey, wet, loose, medium grained, no hydrocarbon odor, no sheen.																	
SP																	

Bentonite Slurry
 2-inch ID Blank Stainless Steel Casing

WELL CONSTRUCTION DETAILS			SAMPLING METHOD			DRILL										
HAI LOGGER: Rob Ede			SAMPLING METHOD: 3-inch Split Spoon/Core Barrel			DRILL START										
PROJECT: Northwest Natural Gas Co. Gasco Facility Portland, Oregon			DRILLING METHOD: 6 1/4-inch ID Hollow Stem Auger			Time: 10:15										
PROJECT: 2708			EQUIPMENT TYPE: B-59 Mobile Drill			Time: 13:15										
			DRILLER: Brad James			Date: 30-Oct-95										
			DRILLING CONTRACTOR: Geo-Tech Explorations			Date: 30-Oct-95										
HEADSPACE (ppm)			LAB RESULTS TOTAL PAHs (ppm)		SPT (blows/0.5 feet)		RECOVERY (%)		DEPTH (feet)		GROUNDWATER		STRATA (USCS)		SOIL DESCRIPTION	
Bentonite Chip Seal									41				SP		SAND (40.0-44.0 feet bgs) - as above, no hydrocarbon odor, no sheen.	
20/40									42				SP			
2-inch ID Blank Stainless Steel Casing			M4-11 1220						43				SP			
			8.7						44				SP			
			M4-12 1225						45				ML		Sandy SILT (44.0-45.0 feet bgs) - olive grey, moist, stiff, slightly plastic, no hydrocarbon odor, no sheen.	
									46				SP		SAND (45.0-49.0 feet bgs) - olive grey, wet, loose, medium grained, no hydrocarbon odor, no sheen, thin silt layers from 49.0-50.0 feet bgs.	
									47				SP			
			M4-13 1238						48				SP			
			31.9						49				SP			
Colorado 10-20 Sand Pack									50				SP		SAND (50.0-55.0 feet bgs) - as above, no hydrocarbon odor, no sheen.	
2-inch ID 0.020-inch Stainless Steel Slotted Screen									51				SP			
									52				SP			
									53				SP			
									54				SP			
			M4-14 1245						55				SP		SAND (55.0-58.0 feet bgs) - as above, no hydrocarbon odor, no sheen.	
			178						56				SP			
									57				SP			
Ca P			M4-15 1312		0.26				58				SP			
			17.5						59				SP			
									60				SP			

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 # 84229	
HAI LOGGER:		Rob Ede		DRILL START	DRILL FINISH							
PROJECT:		Northwest Natural Gas Co.		Time:	Time:							
Gasco Facility		Portland, Oregon		10:15	13:15							
PROJECT: 2708		DRILLING CONTRACTOR:		Date:	Date:							
		Geo-Tech Explorations		30-Oct-95	30-Oct-95							
		BORING DIAMETER:		10-inch								
		CASING DIAMETER:		2-inch ID								
		SURFACE ELEVATION:		31.7 feet MSL								
		TOP OF CASING ELEVATION:		34.53 feet MSL								
SOIL DESCRIPTION												
<p>Boring terminated at 58.0 feet bgs Boring sampled to 58.0 feet Monitoring well installed to 58.0 feet bgs</p> <p>Materials: 10 feet 2-inch diameter, 0.010-inch stainless steel slotted screen 40.5 feet 2-inch diameter stainless steel blank casing 5.5 feet 2-inch diameter PVC blank casing 13 50# bags 10/20 sand 5 50# bags bentonite chips 1 end cap 1 locking cap above-grade steel monument 3 guard posts</p> <p>* Sample Prefix Number is 2708-951030-</p>												
								61				
								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-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

DRILL
DRILL
START
FINISH
Time:
Time:
13:03 15:00

PROJECT: 2708

DRILLING CONTRACTOR: Geo-Tech Explorations

Date:
Date:
27-Oct-95 27-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)
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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	Sandy SILT (20.0-22.0 feet bgs) - brown with orange mottling, moist, non-plastic, no hydrocarbon odor, no sheen, some root zones.			
			117									
	M5-07	1400	18.1	0.91	↓	↓	22					
	M5-08	1406		-	↑	↑	25			SP	Silty SAND (23.5-25.0 feet bgs) - brown with orange oxidation spots, wet, loose, no hydrocarbon odor, no sheen.	
			62.1									
Cap	M5-09	1425		-	↓	↓	29		SAND (22.5-23.5 feet bgs) - as above, no hydrocarbon odor, no sheen.			
			177									
					1	100			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.			
					3	100						
					4	100						
M5-10	1448		ND	4	70	32						
			29.4						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

PROJECT:

Northwest Natural Gas Co.

Gasco Facility

Portland, Oregon

PROJECT: 2708

MONITORING WELL NUMBER

MW-6-32

OWRD # 84239

HAI LOGGER:	Rob Ede	DRILL START	DRILL FINISH
SAMPLING METHOD:	Not Sampled	Time:	Time:
DRILLING METHOD:	6 1/4-inch ID Hollow Stem Auger	11:40	14:00
EQUIPMENT TYPE	B-59 Mobile Drill	Date:	Date:
DRILLER:	Brad James	9-Nov-95	9-Nov-95
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:	35.8 feet MSL
										TOP OF CASING ELEVATION:	35.51 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									See boring log for well MW-6-61 for soil 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-6-61

OWRD # 84236

(ABANDONED)

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

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

DRILL START:
 Time: 8:50
DRILL FINISH:
 Time: 11:45
Date:
 7-Nov-95

PROJECT: 2708

DRILLING CONTRACTOR: Geo-Tech Explorations

WELL CONSTRUCTION DETAILS	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

WELL CONSTRUCTION DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHs (ppm)	CORE INTERVAL	RECOVERY (%)	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	SOIL DESCRIPTION
Bentonite Slurry							41		ML	SILT (40.0-49.0 feet bgs) - olive grey, moist, medium stiff, fine grained sand lenses, no sheen.
							42			
Bentonite Chin Seal 2-inch ID Blank Stainless Steel Casing	M6-11	1050		0.06			43		ML	
				14.8			44			
20/40 Sand							45		ML	
							46			
Colorado 10-20 Sand Pack 2-inch ID 0.020-inch Stainless Steel Slotted Screen	M6-12	1100					49		SP	SAND (49.0-52.0 feet bgs) - olive grey, wet, loose, poorly graded, fine grained, no sheen.
				12.8			50			
							51		SP	
							52			
	M6-13	1120					53		SP	SAND (52.0-55.0 feet bgs) - as above, thin, brown silt layers, no sheen.
				8.4			54			
							55		SP	
							56			
	M6-14	1140					58		SP	SAND (55.0-60.0 feet bgs) - as above, thin olive grey silt layers, no sheen
				7.8			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
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

DRILL START	DRILL FINISH
Time: 8:50	Time: 11:45
Date: 7-Nov-95	Date: 7-Nov-95

PROJECT: 2708

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)
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)
							21		
							22		
							23		
							24		
							25		
							26		
							27		
							28		
							29		
							30		
							31		
							32		
							33		
							34		
							35		
							36		
							37		
							38		
							39		
							40		

BORING DIAMETER: 10-inch
CASING DIAMETER: 2-inch ID
SURFACE ELEVATION: 36.5 feet MSL
TOP OF CASING ELEVATION: 39.09 feet MSL

SOIL DESCRIPTION

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
 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
DRILLING CONTRACTOR: Geo-Tech Explorations

DRILL START: 905
DRILL FINISH: 1410
Date: 25-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: 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					↑	↑	21		GM	
	M8-06	1034			↓	↓	22			
				5.0		↓	↓		SP lampblack	
	M8-07	1044			9	100	23			
				13.3	50/3"	100		24		
						↑	↑	25		
						↑	↑	26		ML
	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			

Silty GRAVEL (20.0-22.0 feet bgs) - brown, wet, brick and wood fragments, no hydrocarbon odor, no sheen.

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.

Tarry SILT (25.0-27.5 feet bgs) - black, wet, stiff, mostly tar, strong sheen, vegetation throughout sample.

SILT (27.5-30.0 feet bgs) - olive grey, moist, stiff, vegetation, tar within root zones, sheen.

SILT (30.0-35.0 feet bgs) - olive grey, moist, stiff, semi-viscous tar within root zones.

Sandy SILT (35.0-40.0 feet bgs) - brown, orange-mottled, moist, stiff, tar within root zones.

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	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 Colorado 10-20 Sand Pack 2-inch ID 0.020-inch Stainless Steel Slotted Screen 2-inch ID 0.020-inch Stainless Steel Slotted Screen Cap							41		ML	Sandy SILT (40.0-42.0 feet bgs) - as above.
							42		SP	SAND (42-42.3 feet bgs) - olive grey, medium grained, black product saturated, less viscous than tar.
							43		ML	SILT (42.3-42.8 feet bgs) - olive grey, medium grained, black product saturated.
	M8-11	1202		112	8.1		44		SP	SAND (42.8-45 feet bgs) - olive grey, wet, loose, poorly graded, medium grained, no product, slight sheen.
							45			
							46			
	M8-12	1245		43.7			47			SAND (45.0-47.5 feet bgs) - olive grey, wet, loose, poorly graded, medium grained, no sheen.
							48			
	M8-13	1314					49			SAND (47.5-50.0 feet bgs) - olive grey, wet, loose, poorly graded, medium grained, some thin silt layers, no sheen.
							50			
							51			SAND (50.0-54.0 feet bgs) - as above, no hydrocarbon odor, no sheen.
							52			
	M8-14	1320					53			
							54			
							55		SP	SAND (54.0-56.0 feet bgs) - as above, no hydrocarbon odor, no sheen.
M8-15	1400			0.64		56				
						57				
						58				
						59				
						60				

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		
											MW-8-56		
HAIN & ASSOCIATES, INC.		434 NW Sixth Avenue		Portland, Oregon		(503) 796-0717		OWRD # 84226		HAI LOGGER: Rob Ede		DRILL START	DRILL FINISH
PROJECT: Northwest Natural Gas Co.		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		Time: 905	Time: 1410
PROJECT: 2708		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		
											Boring terminated at 56.0 feet bgs Boring sampled to 56.0 feet Monitoring well installed to 56.0 feet bgs		
											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		
											* Sample Prefix Number is 2708-951025-		
											61		
											62		
											63		
											64		
											65		
											66		
											67		
											68		
											69		
											70		
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											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:	CASING DIAMETER:	SURFACE ELEVATION:	TOP OF CASING ELEVATION:
										10-inch OD	2-inch	37.9 feet MSL	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		CONCRETE		
										9				
										10				
										11				
										12				
	M9-05	1045		0.52	13	100				13		Sandy SILT (11.5-13.0 feet bgs) - brown, moist to wet, slightly plastic, very fine sand, no hydrocarbon odor, no sheen.		
				6.7	8	30				14	ML	SILT (13.0-15.0 feet bgs) - brown, moist to wet, stiff, slightly plastic, no hydrocarbon odor, no sheen.		
					5	0				15				
	M9-06	1055		-	3	100				16		SILT (15.0-15.5 feet bgs) - as above, no hydrocarbon odor, no sheen.		
				8.8	4	100				17		Sandy SILT (15.5-16.0 feet bgs) - brown, moist to wet, slightly stiff, no hydrocarbon odor, no sheen.		
					8	50				18				
					2	0				19				
	M9-07	1120		-	3	100				20	SP	SAND with muscovite (16.0-17.0 feet bgs) - brown, wet, no hydrocarbon odor, no sheen.		
			20.9	6	100						SAND (17.0-18.5 feet bgs) - as above, no hydrocarbon odor, no sheen.			
				2	100									
				3	100									
				5	100									
				2	100									
				4	100					ML	SILT (18.5-20.0 feet bgs) - brown, moist to wet, stiff, no hydrocarbon odor, no sheen.			
				8	100									

WELL CONSTRUCTION DETAILS				HEADSPACE (ppm)	LAB RESULTS TOTAL PAHs (ppm)	SPT (blows/0.5 feet)	RECOVERY (%)	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	MONITORING WELL NUMBER		
SAMPLE NUMBER*	TIME	HAI LOGGER: Rob Ede									MW-9-29		
HAHN & ASSOCIATES, INC. 434 NW Sixth Avenue Portland, Oregon (503) 796-0717				OWRD # 84223				DRILL START DRILL FINISH					
PROJECT: Northwest Natural Gas Co. Gasco Facility Portland, Oregon				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				Time: 9:30 12:30					
PROJECT: 2708				DRILLING CONTRACTOR: Geo-Tech Explorations				Date: 23-Oct-95 23-Oct-95					
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						2	100				Cap 29 30 31 32 33 34 35 36 37 38 39 40	SP ML SP ML SP ML	<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>
	M9-08	1140		9.5		3	100	21					
						2	100	22					
						2	100						
						9	90	23					
						3	100						
	M9-09	1200				6	100	24					
						16	100						
						25	90	25					
						5	100						
						8	100	26					
						12	70						
	M9-10	1210				3	100	27					
						5	100						
				2.0		12	80	28					

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 Casing 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 soil 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
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MONITORING WELL NUMBER MW-10-61
 OWRD # 84237

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

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 START	DRILL FINISH
Time: 9:00	Time: 12:30
Date: 8-Nov-95	Date: 8-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)
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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

							21	
	M10-07	1005					22	SP
			2500+				23	
							24	
	M10-08	1010					25	ML
			1204				26	
							27	
							28	
	M10-09	1018		0.76			29	
			943				30	
							31	
	M10-10	1025					32	
							33	
							34	
							35	
							36	
	M10-11	1035	65.3				37	
	M10-12	1040	68.3				38	ML
							39	
							40	

SAND (20.0-23.5 feet bgs) - brown, wet, loose, poorly graded, medium grained, product saturated (oozes out of pore spaces)

SILT (23.5-25.0 feet bgs) - brown, moist, stiff, root zones, no product, no sheen.

SILT (25.0-30.0 feet bgs) - brown, moist, stiff, root zones, some black and brown spots (organic looking), no obvious product.

SILT (30.0-35.0 feet bgs) - olive grey with orange spots, root zones, no product, no sheen, poor sample recovery.

SILT (35.0-40.0 feet bgs) - olive grey to green, root zones, small piece of bark, no sheen.

2-inch ID Blank Stainless Steel Casing
 Bentonite Grout Slurry
 2-inch ID Blank Stainless Steel Casing
 Bentonite Grout Slurry

WELL CONSTRUCTION DETAILS			SPT (blows/0.5 feet)		RECOVERY (%)		DEPTH (feet)	GROUNDWATER	STRATA (USCS)	SOIL DESCRIPTION																											
HAHN & ASSOCIATES, INC. 434 NW Sixth Avenue Portland, Oregon (503) 796-0717			MONITORING WELL NUMBER OWRD # 84237					MW-10-61		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	DRILLING CONTRACTOR: Geo-Tech Explorations	Time: 9:00 Date: 8-Nov-95	Time: 12:30 Date: 8-Nov-95																										
PROJECT: 2708																																					
BORING DIAMETER: 10-inch CASING DIAMETER: 2-inch ID SURFACE ELEVATION: 36.5 feet MSL TOP OF CASING ELEVATION: 39.33 feet MSL																																					
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																					
Bentonite Grout Slurry Bentonite Chip Seal 2-inch ID Blank Stainless Steel Casing 20-40 Colorado 10-20 Sand Pack 2-inch ID 0.020-inch Stainless Steel Continuous Slotted Screen											41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60							
			M10-13		1050		220				44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	ML	ML	SP	ML	SM					
											44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	ML	SP	ML	SM	SILT (40.0-45.0 feet bgs) - olive grey to green (transition to green with depth), moist, stiff, non-plastic, slightly brittle from 44-45 feet bgs, root zones, bark, sandy silt from 43.5-44 feet bgs.	SILT (45.0-47.5 feet bgs) - olive green to 46.5 feet bgs, tan to 47.5 feet bgs, moist, hard/slightly brittle, no sheen.	SAND (47.5-53.0 feet bgs) - tan, wet, loose, poorly graded, fine grained, no sheen, some muscovite from 50-53 feet bgs.	Sandy SILT (53.0-57.5 feet bgs) - tan, moist, medium stiff, interbedded with fine grained sands from 55.0-57.5 feet bgs.	Tree trunk at 57.5 feet bgs surrounded by olive grey sands.	Silty SAND (57.5-60.0 feet bgs).
			M10-14		1115		61.3				48	49	50	51	52	53	54	55	56	57	58	59	60	ML	SP	ML	SM	ML	SP	ML	SM	SAND (47.5-53.0 feet bgs) - tan, wet, loose, poorly graded, fine grained, no sheen, some muscovite from 50-53 feet bgs.	Sandy SILT (53.0-57.5 feet bgs) - tan, moist, medium stiff, interbedded with fine grained sands from 55.0-57.5 feet bgs.	Tree trunk at 57.5 feet bgs surrounded by olive grey sands.	Silty SAND (57.5-60.0 feet bgs).		
			M10-15		1145		62.3				52	53	54	55	56	57	58	59	60	ML	SP	ML	SM	ML	SP	ML	SM	ML	SP	ML	SM	SAND (47.5-53.0 feet bgs) - tan, wet, loose, poorly graded, fine grained, no sheen, some muscovite from 50-53 feet bgs.	Sandy SILT (53.0-57.5 feet bgs) - tan, moist, medium stiff, interbedded with fine grained sands from 55.0-57.5 feet bgs.	Tree trunk at 57.5 feet bgs surrounded by olive grey sands.	Silty SAND (57.5-60.0 feet bgs).		
			M10-16		1200		47.6				56	57	58	59	60	ML	SP	ML	SM	ML	SP	ML	SM	ML	SP	ML	SM	ML	SP	ML	SM	SAND (47.5-53.0 feet bgs) - tan, wet, loose, poorly graded, fine grained, no sheen, some muscovite from 50-53 feet bgs.	Sandy SILT (53.0-57.5 feet bgs) - tan, moist, medium stiff, interbedded with fine grained sands from 55.0-57.5 feet bgs.	Tree trunk at 57.5 feet bgs surrounded by olive grey sands.	Silty SAND (57.5-60.0 feet bgs).		
			M10-17		1210						59	60	ML	SP	ML	SM	ML	SP	ML	SM	ML	SP	ML	SM	ML	SP	ML	SM	ML	SP	ML	SM	SAND (47.5-53.0 feet bgs) - tan, wet, loose, poorly graded, fine grained, no sheen, some muscovite from 50-53 feet bgs.	Sandy SILT (53.0-57.5 feet bgs) - tan, moist, medium stiff, interbedded with fine grained sands from 55.0-57.5 feet bgs.	Tree trunk at 57.5 feet bgs surrounded by olive grey sands.	Silty SAND (57.5-60.0 feet bgs).	

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			Boring terminated at 61.0 feet bgs Boring sampled to 60.0 feet Monitoring well installed to 61.0 feet bgs 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 * Sample Prefix Number is 2708-951108-
							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
SAMPLING METHOD: Not Sampled
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 START	DRILL FINISH
Time: 1350	Time: 1430
Date: 3-Nov-95	Date: 3-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: 35.4 feet MSL
										TOP OF CASING ELEVATION: 38.39 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			
							-2			
							-1			Ground surface
							1			See boring log for boring M-11 for soil description.
							2			
							3			
							4			
							5			
							6			
							7			
							8			
							9			
							10			
							11			
							12			
							13			
							14			
							15			
							16			
							17			
							18			
							19			
							20			

Concrete
 Bentonite Chips
 2-inch ID Blank PVC Casing
 Stainless Steel Casing
 Bentonite Chips

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)	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

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	
Steel Monument							-3			Ground surface	
							-2				
							-1				
2-inch ID Blank PVC Casing Bentonite Chips 2-inch ID Blank PVC Casing Bentonite Chips 2-inch ID Blank PVC Casing Bentonite Chips	M12-01	1415	0.1	116			1		GP	Surface: Sandy GRAVEL, (placed for ground cover) - moist, no hydrocarbon odor, no sheen.	
							2			SAND (2.0-4.5 feet bgs) - brown, moist, fine grained, loose, some thin silty zones present, no hydrocarbon odor, slight sheen.	
	M12-02	1420					3		SP		
				0.5				4			SILT (4.5-9.5 feet bgs) - moist to wet, olive grey, very soft, strong hydrocarbon odor, strong sheen.
							5				
	M12-03	1428	3.9	-			6		ML		
								7			SILT (9.5-14.5 feet bgs) - olive grey/green mottled with orange spots (oxidized zones), moist, stiff, strong hydrocarbon odor, sheen, brown oil-like substance in upper 2 feet of core.
							8				
							9				
							10				
								11			SILT (14.5-15 feet bgs) - olive grey, brown mottled, stiff, strong hydrocarbon odor, sheen via sheen test.
	M12-04	1440					12				
				46.3				13			SAND (15-16.5 feet bgs) - brown, wet, fine grained, poorly graded, strong hydrocarbon odor, sheen.
							14				
							15				
								16			SILT (16.5-19.5 feet bgs) - olive grey and brown mottled, stiff, strong hydrocarbon odor, sheen via sheen test, stained soil from 16.5-17.5 feet bgs.
	M12-05	1450					17		SP		
				69.6				18		ML	
								19			SILT (16.5-19.5 feet bgs) - olive grey and brown mottled, stiff, strong hydrocarbon odor, sheen via sheen test, stained soil from 16.5-17.5 feet bgs.
							20		SP		

Hahn & Associates, Inc.

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 (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
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:	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-

							41		
							42		
							43		
							44		
							45		
							46		
							47		
							48		
							49		
							50		
							51		
							52		
							53		
							54		
							55		
							56		
							57		
							58		
							59		
							60		

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-13-61

OWRD # 100684

PROJECT:
 Northwest Natural
 Gasco Facility
 Portland, Oregon

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 START:
 Time: 9:30
 Date: 18-Dec-97
DRILL FINISH:
 Time: 14:40
 Date: 18-Dec-97

PROJECT: 2708

WELL CONSTRUCTION DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHs (ppm)	CORE INTERVAL	RECOVERY (%)	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	BORING DIAMETER:	CASING DIAMETER:	SURFACE ELEVATION:	TOP OF CASING ELEVATION:
										10-inch	2-inch ID	35.23 feet MSL	34.78 feet MSL
SOIL DESCRIPTION													

WELL CONSTRUCTION DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHs (ppm)	CORE INTERVAL	RECOVERY (%)	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	SOIL DESCRIPTION
Flush Monument										Ground surface
Concrete							1			Surface: concrete.
							2			
							3			
	M13-01	10:04			↑	↓	4			SAND (3.5-5.5 feet bgs) - light brown, dry to slightly moist, fine grained, few rounded gravels, no hydrocarbon odor, no sheen (fill).
			6.4				5		SP	
							6			SAND (5.5-8.0 feet bgs) - light to rust brown, slightly moist, fine grained, poorly graded, no gravels, no hydrocarbon odor, no sheen (fill).
	M13-02	10:08		ND	↑	↓	7			
			5.0				8			SAND (8.0-11.5 feet bgs) - as above, no hydrocarbon odor, no sheen (fill).
							9			
							10			SAND (11.5-15.0 feet bgs) - as above, no hydrocarbon odor, no sheen (fill).
	M13-03	10:20		ND	↑	↓	11			
			5.5				12			SAND (15.0-19.0 feet bgs) - as above, wet below 18.0 feet bgs, no hydrocarbon odor, no sheen (fill).
							13			
							14			SAND (19.0-21.0 feet bgs) - as above, wet, dark grey with organic reducing (decay) odor below 20.5 feet bgs, no hydrocarbon odor, no sheen (fill).
	M13-04	10:27	5.2	ND	↑	↓	15			
							16			SAND (19.0-21.0 feet bgs) - as above, wet, dark grey with organic reducing (decay) odor below 20.5 feet bgs, no hydrocarbon odor, no sheen (fill).
							17			
							18		SP	SAND (19.0-21.0 feet bgs) - as above, wet, dark grey with organic reducing (decay) odor below 20.5 feet bgs, no hydrocarbon odor, no sheen (fill).
	M13-05	10:38	8.1	1.0	↑	↓	19			
							20			

HAHN & ASSOCIATES, INC.

434 NW Sixth Avenue

Portland, Oregon

(503) 796-0717

MONITORING WELL NUMBER

MW-13-61

OWRD # 100684

PROJECT: Northwest Natural

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 START
DRILL FINISH

Time: 9:30
Time: 14:40

Date: 18-Dec-97
Date: 18-Dec-97

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

WELL CONSTRUCTION DETAILS	SAMPLE NUMBER*	TIME	HEADSPACE (ppm)	LAB RESULTS TOTAL PAHs (ppm)	CORE INTERVAL	RECOVERY (%)	DEPTH (feet)	GROUNDWATER	STRATA (USCS)	SOIL DESCRIPTION
Bentonite Grout							41		SM	
							42			
Bentonite Chip Plug							43		SP	SAND (42.5-44.0 feet bgs) - dark grey, wet, fine grained, shell fragments, rootlets, no hydrocarbon odor, no sheen.
							44			
2-inch ID Blank Stainless Steel Casing							45		ML	Sandy SILT (44.0-47.5 feet bgs) - grey, slightly moist, few thin clayey silt lenses, shell fragments and rootlets, no hydrocarbon odor, no sheen.
	M13-14	12:27					46	18.3		
Colorado 10-20 Sand Pack							47			
							48		SM	Silty SAND (47.5-51.0 feet bgs) - with olive grey silt lenses and dark grey fine sand lenses throughout, wet, shell fragments and rootlets, no hydrocarbon odor, no sheen.
2-inch ID 0.020-inch Stainless Steel Slotted Screen							49			
							50			
2-inch ID 0.020-inch Stainless Steel Slotted Screen							51		SP	SAND (51.0-51.5 feet bgs) - grey, wet, fine grained, no hydrocarbon odor, no sheen.
	M13-15	13:45	4.4				52			
2-inch ID 0.020-inch Stainless Steel Slotted Screen							53		SM	Silty SAND (51.5-55.5 feet bgs) - dark grey, moist to wet, few silt lenses throughout and a 3-inch fine sand lens at 47.5 feet bgs, shell fragments, root fragments, no hydrocarbon odor, no sheen.
							54			
2-inch ID 0.020-inch Stainless Steel Slotted Screen							55			
	M13-16	14:00					56	12.4		
2-inch ID 0.020-inch Stainless Steel Slotted Screen							57		SP	SAND (55.5-61.0 feet bgs) - dark grey, wet, fine grained, few silt lenses, slight reducing odor within silt lenses, no hydrocarbon odor, no sheen.
	M13-17	14:18		ND			58	4.7		
2-inch ID 0.020-inch Stainless Steel Slotted Screen							59			
	M13-18	14:30					60			

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				HAI LOGGER: Rob Ede				DRILL	DRILL		
				SAMPLING METHOD: 4-inch Core Barrel				START	FINISH		
				DRILLING METHOD: 6 1/4-inch ID Hollow Stem Auger				Time:	Time:		
				EQUIPMENT TYPE: B-59 Mobil Drill				9:30	14:40		
PROJECT: 2708				DRILLER: Brad James				Date:	Date:		
				DRILLING CONTRACTOR: Geo-Tech Explorations				18-Dec-97	18-Dec-97		
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				
							70				
							71				
							72				
							73				
							74				
							75				
							76				
							77				
							78				
							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
			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

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)	DESCRIPTION
SD-4-01	12:25	2.3	165/ND	↑	↑		ML	SILT-brown, wet, very soft, roots, sheen, hydrocarbon odor (0"-6")
SD-4-02	12:30	4.0	-			1		Sandy SILT-grey, wet, soft, roots, sheen, hydrocarbon odor (6"-3')
SD-4-03	12:36	9.5	-			2		Sandy SILT with gravel and wood chips-brown, wet, sheen, hydrocarbon odor (3'-4')
SD-4-04	12:47	13.6	-			3		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-4-05	12:54	24.3	-			4		Silty SAND-grey, moist, fine grained, root fragments, no sheen, hydrocarbon odor (6'-7')
SD-4-06	13:00	23.4	-			5		Silty SAND-as above, many root fragments, no sheen, hydrocarbon odor (7'-9.5')
SD-4-07	13:30	16.7	-			6		
SD-4-08	13:32	15.6	-			7		
SD-4-09	13:36	13.9	-			8		
SD-4-10	13:38	12.3	-			9		
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:					Rob Ede		DRILL	DRILL
PROJECT:					SAMPLING METHOD:		START	FINISH
EQUIPMENT TYPE					VibraCore attached to barge		Time:	Time:
DRILLER:					Bill Jaworski		Date:	Date:
DRILLING CONTRACTOR:					Marine Sampling Systems		1/23/96	1/23/96
SD-5-01	14:30	4.7	118/ND	↑	↑			
SD-5-02	14:33	4.4	-				1	
SD-5-03	14:35	3.5	-				2	
SD-5-04	14:40	3.7	-				3	
SD-5-05	14:45	3.4	-				4	
SD-5-06	14:50	9.6	-				5	
SD-5-07	15:00	9.4	-				6	
SD-5-08	15:05	19.0	-				7	
SD-5-09	15:10	17.4	1,154/ND		↓		8	
							9	
							10	
							11	
							12	
							13	
							14	
							15	
							16	
							17	
							18	
							19	
							20	

SOIL BORING NUMBER SD-5

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

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 **DRILL**
START **FINISH**
 Time: Time:
 10:23 10:40
 Date: Date:
 1/23/96 1/23/96

BORING DIAMETER: 3.75-inch

CASING DIAMETER: 3.75-inch

SURFACE ELEVATION: Not Surveyed

TOP OF CASING ELEVATION: Not Applicable

SOIL DESCRIPTION

SM

ML

ML

Silty SAND-brown, wet, loose, very fine grained, sheen (0"-6")

SILT with silty sand lenses-brown, wet, medium stiff, roots, strong sheen (6"-2')

SILT-olive grey, wet, very soft, wood chips at 2', slight sheen (2'-3')

Sandy SILT-dark brown, moist, medium stiff, rootlets, many wood fragments and dark grey to black discoloration from 6' to 8', sheen (3'-8')

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

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	-				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	-				6
SD-8-08	10:23	30.4	-				7
SD-8-09	10:30	172.0	-				8
SD-8-10	10:32	59.7	3,254/2.6		↓		9
							10
							11
							12
							13
							14
							15
							16
							17
							18
							19
							20

SOIL BORING NUMBER SD-8

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

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

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')

ML

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')

SP

SAND-grey, moist, medium grained, loose, wood fragments, strong sheen (5'-7')

ML

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)	BORING DIAMETER: 3.75-inch	
SD-10-01	12:50	2.5	ND/283	↑	↑		ML	CASING DIAMETER: 3.75-inch	
SD-10-02	12:55	2.4	-			1		SURFACE ELEVATION: Not Surveyed	
SD-10-03	13:00	4.4	-			2	SP	TOP OF CASING ELEVATION: Not Applicable	
SD-10-04	13:05	7.1	-			3		SOIL DESCRIPTION	
SD-10-05	13:08	3.6	-			4		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')	
SD-10-06	13:25	3	-			5		SAND-wet, loose, medium grained, wood chips, no hydrocarbon odor or sheen (2'-3')	
SD-10-07	13:28	2.3	-			6		SAND-as above, some gravel, no hydrocarbon odor or sheen (3'-5')	
SD-10-08	13:22	0.6	-			7		SAND- dark brown, loose, medium grained, some silt, wood chips, slight hydrocarbon odor, no sheen (5'-7.5')	
SD-10-09	13:30	3.2	ND/9.6		↓	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-11				
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			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	-			2	ML	SILT-dark brown, stiff, medium grained sand lenses, strong hydrocarbon odor and sheen (1'-2')	
SD-11-03	14:00	13.3	569/ND			3		SAND-dark brown, loose, medium grained, some silt, wood chips, hydrocarbon odor and sheen (2'-3')	
SD-11-04	14:03	7.8	-			4	SP	SAND- as above, no wood chips, brick fragments from 5' to 5.5', slight hydrocarbon odor, no sheen, (3'-6')	
SD-11-05	14:11	6.3	-			5			
SD-11-06	14:14	12.6	-			6			
SD-11-07	14:16	6.3	-		↓	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		
SD-12-05	11:05	0.0	-			5		Clay, greenish gray, moist, some silt, plastic, no hydrocarbon odor, no sheen (4'-5.5')	
SD-12-06	11:08	0.0	-			6	ML		
SD-12-07	11:25	0.0	-			7		Sandy SILT- light brown, moist, no hydrocarbon odor, no sheen (5.5'-8')	
SD-12-08	11:28	0.3	-			8			
SD-12-09	11:41	0.6	-			9	SP		
SD-12-10	11:45	0.9	-			10		SAND, light brown, moist, fine grained, no hydrocarbon odor, no sheen, (8'-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

HAI LOGGER: Steve Johnson (FES)

DRILL

DRILL

PROJECT:

SAMPLING METHOD: 3.75"OD Disposable Core Barrel

START

FINISH

Northwest Natural Gas Co.

DRILLING METHOD: Vibration/Push

Time:

Time:

Gasco Facility

EQUIPMENT TYPE: VibraCore attached to barge

9:43

10:15

Portland, Oregon

DRILLER: Bill Jaworski

Date:

Date:

PROJECT #: 2708

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-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)
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:	Time:
12:16	12:25
Date:	Date:
1/24/96	1/24/96

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

SOIL DESCRIPTION

SAMPLE NUMBER*	TIME (1/25/96)	HEADSPACE (ppm)	LAB RESULTS total PAHs/total BTEX(ppm)	Core Interval	RECOVERY INTERVAL	DEPTH (feet)	STRATA (USCS)	SOIL 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		Silty SAND-fine grained, small wood chips, no hydrocarbon odor, no sheen (3.5'-4')
SD-14-05	9:35	-	-			5		
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		
SD-14-08	9:55	0.4	-			8		
SD-14-09	10:00	5.8	181/ND		↓	9	SP	SAND, light brown, moist, medium grained, no hydrocarbon odor, no sheen, (7.5'-8.5')
						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**

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	
Black rock	128 - 162
Grey rock	162 - 189
Black lava rock w/thin layer grey clay	189 - 199
Black rock, broken in places	199 - 212
Broken black rock-grey sandy clay	212 - 281
Black lava rock	281 - 305
Black lava rock/layers grey clay	305 - 344
Black rock-broken in places	344 - 350
	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 1/4 SW 1/4 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 Abandonment 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

(6) CASING INSTALLED:

Threaded Welded 12" Diam. from 0 ft. to 63 ft. Gage 8" 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.

(8) SCREENS:

Well screen installed? Yes No Manufacturer's Name Type Model No. 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.

Table with columns MATERIAL, FROM, TO. Rows: 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)

Drilling Machine Operator's License No. Date 19

6711 N. E. 58th Ave. Phone: 694-6242
Vancouver, Wash. 98661 834-3370

HANSEN DRILLING CO., Inc.

LOG

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

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

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.

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

Time:
 67 hrs...Drilling time
 7 hrs....Down time
 10 hrs...Set up & clean up
 6½ hrs...Circulate anodes, coke, etc..

Desmet Rotary

PERFOR. PFG. IN

6711 N. E. 58th Ave. Phone: 694-6242
Vancouver, Wash. 98661

HANSEN DRILLING CO., Inc.

LOG

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

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

DESCRIPTION:

- (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 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

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

PERFOR. PFG. IN

260/ Hansen over

NOV 17 1985

006108

12/11W-12

PLEASE TYPE or PRINT IN INK

(for official use only)

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 Irrigation 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
 Was a pump test made? Yes No If yes, by whom?
 Test 1: Rate gal./min. with ft. drawdown after hrs.
 Test 2: Rate gal./min. with drill stem at ft. hrs.
 Filter test: Rate 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 sack (lb) pounds
 How was cement grout placed?
 Was pump installed? Type HP Depth ft.
 Was 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
 Was 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