SITE CHARACTERIZATION AND SVE PILOT TEST REPORT

Former Plaid Pantry Store #324
10645 16th Avenue SW
Seattle, Washington

Ecology Site UST ID No. 97464

Prepared for:

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1 INTRODUCTION

This report documents the results of site characterization and soil vapor extraction (SVE) pilot test activities conducted at the former Plaid Pantry #324 retail gasoline station, located at 10645 16th Avenue SW in Seattle, Washington (Figure 1). This report was prepared by PNG Environmental, Inc. (PNG), on behalf of Plaid Pantries, Inc. (Plaid). Work was performed in accordance with PNG's scope of work dated January 31, 2008.

The site characterization activities included drilling and soil sampling and analysis, conducted to provide further data regarding the extent of hydrocarbons exceeding Model Toxics Control Act (MTCA) Method A cleanup standards at the site. Soil Vapor Extraction (SVE) test wells were installed based on soil analytical data and the follow-up pilot test was conducted to evaluate the effectiveness of SVE as a remediation technology for soils exceeding MTCA Method A standards.

1.1 FACILITY BACKGROUND

The site is located at the northwest corner of SW 107th Street and 16th Avenue SW in Seattle, Washington. The site is occupied by a convenience store and restaurant (Figure 2). Site operations formerly included a retail gasoline station which was decommissioned in 2006.

Plaid operated its Store #324 retail gasoline station at the site between September 1986 and November 30, 1990, at which time it sub-leased the store building and sold the fueling system and equipment to Young Kil Kim and Chae Yop Kim. Plaid remained the primary lessee of the property until August 31, 2006. Fuel storage at the Plaid facility was provided by three underground storage tanks (USTs), as follows:

- Two 12,000-gallon capacity USTs formerly containing gasoline.
- One 10,000-gallon capacity UST formerly containing gasoline.

During Plaid's operations (and that of the sub-tenants), only gasoline is known to have been stored and dispensed at the site. Leaded gasoline may have been dispensed at the site during phase-out of that product in the 1980s. PNG understands that neither Plaid nor their sub-tenants stored or dispensed other hydrocarbons such as diesel fuel, bulk motor oil, or other bulk solvents at any time during site operations.

Plaid operated a leak detection system in accordance with Ecology requirements and no known system leaks were identified or reported to Plaid during Plaid's lease. Tank decommissioning data provided to Plaid in 2007 by the property owner indicate that gasoline constituents were identified in soil near the Plaid system, as summarized below.

1.1.1 UST Decommissioning Report (KEE, 2007)

UST decommissioning activities were conducted on behalf of the current property owner, as documented in an UST Closure Action Report dated January 10, 2007. That report was prepared by KEE Environmental, LLC, Redmond, WA (KEE). Information pertaining to UST closure activities is published in that report and summarized below.

- The service station was reportedly closed in March 2006 and UST decommissioning and removal activities were conducted in May 2006. Figure 2 illustrates the general site layout; including the locations of the UST closure soil samples designated S-1 through S-10.

- Groundwater was not encountered at maximum excavation depths of 16 feet below ground surface (bgs).
- Soil samples were collected from below each of the three former gasoline UST locations (16 feet depth), from each UST cavity sidewall (eight feet depth), and from the pump island area (four feet depth). One additional soil sample (S-10) was collected from the northeastern cavity margin at a depth of four feet, where "discolored and odorous" soil was encountered during excavation. Soil samples were analyzed for benzene, toluene, ethylbenzene, and xylenes (BTEX) by EPA Method 8021B and for gasoline-range hydrocarbons by method NWTPH-Gx.
- Laboratory analytical results indicated that gasoline-range hydrocarbons and BTEX constituents were not detected in nine of the ten confirmatory soil samples. Gasoline-range hydrocarbons (310 milligrams per kilogram [mg/Kg]), benzene (0.23 mg/Kg), and other BTEX compounds were present in sample S-10, where residual fuel impacts were observed during excavation. Sampling results are summarized on Table 1 and illustrated on Figure 3. Both gasoline-range hydrocarbons and benzene concentrations at the S-10 location exceeded Ecology's MTCA Method A Cleanup Levels for Soil (30 and 0.03 mg/Kg, respectively).

1.1.2 Site Assessment Report (PNG, 2008)

Based on the UST decommissioning results, Plaid requested that PNG conduct a site assessment to provide preliminary evaluation of the apparent gasoline release. PNG's field activities included soil sampling at four boring locations in November 2007, and a Site Assessment Report was issued on January 25, 2008. Findings and analytical results are illustrated on Figure 3 and summarized below.

- The site surface is asphalt-paved in the former UST area with perimeter landscaping. Shallow stratigraphy in the areas explored included an approximately ten to 17-foot thickness of silty sand and sandy silt with gravel, underlain by a dense gravel unit extending to maximum drilling depths of 29 feet. Groundwater was not encountered within 29 feet of the ground surface.
- Soil samples were collected from various depths in each of the four boreholes (designated B-1 through B-4).
- Gasoline-range hydrocarbons were detected in five of the seven soil samples submitted, ranging where detected from 2.0 to 1,400 mg/Kg. Three of the samples exceeded the MTCA Method A soil cleanup level of 30 mg/Kg, including samples collected from B-1 at five feet (1,400 mg/Kg) and B-3 at eight feet bgs (390 mg/Kg). A sample collected from the gravel unit at 23 feet bgs in B-1 yielded 50 mg/kg but this sample may have been cross-contaminated by surface debris and is not likely representative of gravel zone conditions (see Section 3.2).
- The same seven soil samples were also submitted for gasoline constituent volatile organic compounds (VOC) analysis. Similarly, VOCs were detected in five of the seven samples. BTEX compounds exceeded MTCA Method A soil cleanup levels in each of the same three samples which also exceeded MTCA criteria for gasoline. In particular, benzene in the shallowest samples

from B-1 (4.8 mg/kg at five feet bgs) and B-3 (0.86 mg/kg at eight feet bgs), exceeded the MTCA Method A soil cleanup level of 0.03 mg/Kg.

- Total lead was detected in five of the seven soil samples at concentrations (where detected) ranging between 2.4 and 8.0 mg/Kg. These site-specific lead concentrations are below representative natural background concentrations and are not indicative of a leaded gasoline release.

Based on the initial site assessment results, Plaid requested that PNG conduct additional delineation and testing to characterize the nature and extent of gasoline impacts, and for use in evaluating site cleanup options. These supplemental investigation tasks were conducted in July 2008 as detailed in Sections 2 and 3.

1.2 LOCAL HYDROGEOLOGIC CONDITIONS

PNG reviewed a geologic map of the site vicinity: *The Geologic Map of Seattle, USGS Open File Report 2005-1252* (Troost and others, 2005). The subject property is located in an area mapped as Quaternary-aged Vashon Till. The Vashon Till is composed of silt, sand, and sub-rounded to well rounded gravel that was glacially transported and deposited. The effective porosity for the Vashon Till is reportedly between 0.3 and 0.4. The silty till unit is underlain by dense sandy gravel.

Subsurface conditions observed at the site are relatively consistent with this regional description. Beneath surface pavement, up to two feet of compacted sandy gravel base was encountered, while at other locations the base material was very thin or absent. Below the asphalt and base layer, silty sand and sandy silts with occasional gravels (Vashon Till) were encountered to depths ranging between approximately ten to 17 feet bgs. Beneath the shallow silt material, gravels with varying sand content were encountered to a depth of 40 feet bgs, the total depth explored. Groundwater was not encountered among any site borings up to a depth of 40 feet bgs.

PNG performed a review of local well logs and received information from the drillers (Boart Longyear) who had recently installed wells in the site area. The results indicate that the water table is typically encountered at depths of 80 feet or greater in the site vicinity.

1.3 PURPOSE AND SCOPE OF WORK

At Plaid's request, PNG prepared a work plan including the following elements: (1) conduct characterization of the shallow silt and deeper gravel soil units; (2) determine whether groundwater is present within 40 feet of ground surface; and (3) test the suitability of vadose-zone soils for application of SVE as a potential remedial measure for vadose-zone soils. PNG's work plan (January 25, 2008) included tasks required by Washington Department of Ecology (Ecology) in its published Guidance for Site Checks and Site Assessments document (April 2003). Additional investigation may be required to fully address areas of concern.

Specific Work Scope Tasks included:

- Prepare a Health and Safety Plan to guide field safety protocols, in accordance with rules established by the Occupational Safety and Health Administration (OSHA).
- Prepare a simple Site Sampling Plan as required by Ecology.

- Coordinate with Ecology and other jurisdictions to obtain a permit (if necessary) to operate the proposed SVE pilot test.
- Request utility identification through the public Utility Notification Service.
- Review any site plans and as-built maps provided to PNG by Plaid.
- Contract with a qualified local firm to attempt to identify underground utility trenches and conduits located at each planned drilling location.
- Advance eight silt-zone soil borings up to approximately ten feet below ground surface (bgs) and three gravel-zone soil borings to depths of 40 feet bgs.
- Collect and submit soil samples for laboratory analysis for gasoline and related constituents consistent with Ecology guidance.
- Install a network of eight SVE wells and three vacuum monitoring points and conduct a short term SVE Pilot Test.
- Prepare a written Site Characterization and SVE Pilot Test report summarizing the results and findings of the work performed, and recommendations for additional work (if warranted).

2 SITE CHARACTERIZTION AND SVE PILOT TEST

PNG conducted Site Characterization and SVE Pilot Test fieldwork in July 2008. Related tasks and observations are summarized in the sections below. PNG's Standard Operating Procedure (SOP) for sonic drilling is included in Appendix A. Soil boring logs are presented in Appendix B.

PNG observed drilling operations and collected soil samples from eleven boring locations as illustrated on Figure 4. Boart Longyear, Inc. (Seattle, Washington), operated the sonic drilling and sampling equipment. In general, sonic rig soil samples are recovered using a ten-foot long, four-inch diameter core barrel advanced during drilling to yield a continuous core. The sample core may be extruded directly from the core barrel into a dedicated plastic sleeve, or onto a sampling table for observation. Each ten-foot long core section will typically be subdivided into shorter sections placed in new clear plastic bags, and laid out in sequence for logging. Soils were observed and classified in the field by an experienced geologist. Field volatile organic screening was performed using a photoionization detector (PID).

2.1 SONIC DRILLING, SOIL SAMPLING, AND LABORATORY ANALYSIS

From July 15 through July 18, 2008, eleven soil borings, B-5 through B-14 and VM-1, were drilled northeast of the former UST excavation where gasoline impacts were previously identified (Figure 3). Soil samples were collected on a continuous basis and observed for soil type, discoloration, odor, and the presence of organic vapors using a PID.

Seven borings (designated B-6, B-8, B-9, B-11, B-12, B-13, and B-14) were advanced to total depths between eight and 15 feet bgs to evaluate the distribution of gasoline impacts within shallow fine-grained soils. An additional shallow boring (VM-1) was drilled to approximately one foot bgs such that a vacuum monitoring point could be installed to monitor vacuum influence directly beneath the asphalt during the SVE pilot test.

Three borings (B-5, B-7, and B-10) were advanced to total depths of 40 feet bgs to characterize the deeper gravel unit and to determine whether groundwater was present within this zone. Consistent with the regional water table (suspected at depths of approximately 80 ft bgs) groundwater was not encountered during drilling to maximum depths of 40 feet bgs.

Soil samples were collected and observed on a continuous basis during drilling. Within the silt layer, soil samples were collected for laboratory analysis where field observations and PID readings indicated relatively high concentrations of petroleum hydrocarbons. Although field observations and PID measurements did not suggest significant impacts among soil samples collected from the deeper gravel in borings B-5, B-7 and B-10; soil samples from the deeper gravel unit were also submitted for laboratory analysis.

Soil samples were collected for laboratory analysis consistent with USEPA Method 5035A (for volatiles) and NWTPH-Gx (for gasoline range organics). All samples were labeled and immediately placed in a cooler with ice after collection. The samples were delivered under chain-of-custody protocol to Friedman & Bruya, Inc. in Seattle, Washington for chemical analyses.

Based on known site usage and the prior data consistent with gasoline-range hydrocarbon impacts, soil samples from each boring were submitted for analysis for

gasoline range organics using NWTPH-Gx, and for BTEX constituents using EPA Method 8021B.

2.2 SVE WELL INSTALLATION

During drilling activities borings B-6 and B-8 through B-14 were completed as SVE test wells. The SVE wells were constructed using 20-slot (0.020-inch) PVC screen and sand filter pack placed in the target extraction (or monitoring) zone for each well as determined by field observations and laboratory data. The borehole at each location was sealed above and below the screened interval using bentonite and/or concrete. Each SVE well was completed with a flush-mounted well monument. Logs are presented in Appendix B.

Based on field and lab data, measured gas impacts were limited to the fine-grained shallow soil zone, where SVE wells were therefore installed. Impacts within the deeper gravel unit were not identified and SVE wells were not installed in that zone.

The SVE well screen depth intervals were specified according to identified impacts as follows:

- B-6 from four to eight feet bgs.
- B-8 from five to nine feet bgs.
- B-9 from seven to 12 feet bgs.
- B-11 from 7.5 to ten feet bgs.
- B-12 from four to 6.5 feet bgs.
- B-13 from eight to 12 feet bgs.
- B-14 from four to eight feet bgs.

Three one-foot deep vacuum monitoring points (VM-1, VM-2 [formerly B-7], and VM-3 [formerly B-5]) were installed for use in monitoring vacuum beneath the asphalt pavement, and were constructed using six inches of 20-slot (0.020-inch) PVC screen and six inches of PVC pipe. As noted above, VM-2 and VM-3 were converted from deeper boreholes B-7 and B-5 respectively. VM-1 was installed in a one foot deep boring drilled specifically for the vacuum monitoring point. The vacuum monitoring points were also completed with flush-mounted well monuments.

2.3 SVE PILOT TEST

On July 30 and July 31, 2008, PNG performed a SVE pilot test at the site. The pilot test evaluated vapor extraction at five separate SVE wells while vacuum influence monitoring was performed on the other site wells. For the pilot test, Wells B-9, B-11, B-13, B-14, and VM-1 were used as extraction wells.

A one-horsepower Rotron DR404 blower was used to apply vacuum to each extraction well. The extraction wellhead was connected to the blower using piping and quick-connect hoses plumbed to a vapor/water separator (condensate tank) equipped with a vacuum gauge and dilution inlet valve. The extracted vapors were routed from the blower to a TSU-55 carbon canister filled with vapor phase granular activated carbon prior to discharge to the atmosphere via a ten foot length of PVC pipe. The system was equipped with two monitoring ports located upstream of the blower and downstream from the carbon treatment canister.

During the pilot test, vacuum was measured at approximately 15-minute intervals using a set of magnehelic gauges with vacuum ranges capable of measuring from 0.01 to 50 inches of water. A PID was used to measure volatile organic vapor concentrations in the blower exhaust air stream, both pre- and post-carbon treatment. Exhaust velocity through the SVE system was measured with an anemometer. Approximate airflow for selected wellheads was estimated by attaching a full one-liter tedlar bag to the wellheads and measuring the time to evacuate the known volume of air from the bag. For wellheads where the tedlar bags were not fully evacuated, the remaining air volume in the tedlar bag was estimated.

PNG collected SVE soil gas samples from the pre-blower sampling port during the pilot tests performed on B-9, B-11, B-13, and B-14 using laboratory evacuated and cleaned six-liter Summa canisters. The SVE soil gas samples were delivered to Air Toxics (Folsom, California) and analyzed for TPH as gasoline and volatile organic compounds (VOCs) by EPA Methods TO-3 and TO-14A, respectively.

3 RESULTS

The following sections discuss the results of the site characterization and SVE pilot test

3.1 SITE HYDROGEOLOGY

The soil boring logs are presented in Appendix B.

Beneath the site asphalt and sandy gravel fill, fine-grained sands and silts were encountered to maximum depths of 17 feet bgs. Beneath the shallow silty till material, gravels with varying sand content were encountered to a depth of 40 feet bgs, the total depth explored.

Groundwater was not encountered in any of the eleven borings and is not anticipated within approximately 80 feet of ground surface at the site.

3.2 ANALYTICAL RESULTS FOR SOIL

3.2.1 Field Screening Results

The PID measurements are included on the soil boring logs presented in Appendix B. Discolored soils and mild to strong organic odors were noted at varying depths from approximately three to 12 feet bgs in all borings except B-11 (within former UST cavity backfill). Review of the logs indicates field volatile headspace concentrations in soil ranged up to 800 parts per million by volume (ppmV) (B-6 at four feet bgs). PID measurements were near or below detection (1 ppmV) among all gravel-zone soils.

3.2.2 Laboratory Analytical Results

Laboratory analytical results for recent soil samples are summarized in Table 2, illustrated on Figure 5, and described below. Laboratory reports are presented in Appendix C.

- Gasoline-Range Hydrocarbons: TPH in the gasoline-range was detected in 16 of the 35 soil samples, ranging from 3.0 to 2,100 mg/Kg. Review of Table 2 indicates nine of the samples exceeded the MTCA Method A soil cleanup level of 30 mg/Kg all within the fine-grained till unit generally located within approximately ten feet of the ground surface. The highest gasoline-range TPH concentration was detected in boring B-9 in the sample collected from ten feet bgs, although gasoline and BTEX were not detected at 12 feet bgs in this boring.
- VOCs: BTEX compounds were detected in 18 of the 35 samples. One or more BTEX compounds exceeded MTCA Method A soil cleanup levels in ten of the samples. Benzene concentrations in samples from soil borings B-6 through B-10 and soil boring B-13 ranged between 0.05 and 9.9 mg/Kg, exceeding the MTCA Method A soil cleanup level of 0.03 mg/Kg. Consistent with the TPH analytical results, MTCA Method A exceedances were limited to soils within approximately ten feet of the ground surface.

3.3 SVE PILOT TEST RESULTS

Airflow, vacuum measurements, and PID readings collected during the pilot test are presented in Table 3.

Extraction wells B-9, B-13, and B-14 were all installed within the silty till layer where petroleum concentrations exceed MTCA Method A standards. Both wells B-9 and B-13 are installed with screen intervals near the base of the silt (i.e., between seven and 12 feet bgs) while well B-14 is screened in the upper silt-zone (i.e., four to eight feet). Calculated flow rates for these extraction wells installed in the silty soil are relatively low, ranging from 2.39 cubic feet per minute (cfm) at B-14 to 3.37 cfm at B-9.

In contrast to the low flow rates for extraction wells installed within the till, a relatively higher extraction flow rate was calculated for extraction well B-11 (43.63 cfm), installed within the sand backfill of the former UST excavation. However, the results from B-11 are not representative of native soil conditions within the silt where gasoline impacts are located, and the SVE results for this well suggest both vertical and horizontal leakage (short circuiting) within the more permeable sandy fill.

Conditions conducive to short circuiting at extraction well B-11 include communication between the former UST and pump island excavations (sand backfill) and fill beneath the asphalt pavement extending laterally to the planter area. In addition, the UST excavation extended to a depth of 16 ft bgs. Review of the boring logs also indicates the potential for vertical leakage from the underlying gravel in some areas.

Underground utilities beneath the site asphalt also are likely to influence shallow soil vapor flow patterns and include storm and sanitary sewers, an electric line (which extends east from the building and crosses over the former UST excavation to the planter), and a telephone line.

Based on a reported effective porosity for the Vashon Till of between 0.3 and 0.4, the calculated capture radii for B-14 ranged from 1.13 to 1.60 feet. The calculated capture radii assume that the applied vacuum would induce a pore-gas velocity of 0.1 feet per minute based on the observed volumetric flow rates at each SVE well location. This pore-gas velocity is arbitrarily defined as the minimum pore-gas velocity necessary to produce timely remediation at the site based on ranges presented in an EPA SVE design document (DiGiulio and Varadhan 2001).

3.3.1 Soil Vapor Laboratory Analytical Results

Soil gas analytical results are summarized in Table 4. Review of the table indicates gasoline and related volatile constituents were detected in each soil gas sample.

Gasoline-range TPH concentrations ranged from 6,000 ug/m^3 (micrograms per cubic meter of air) in B-11 to 10,000,000 ug/m^3 in B-9. The relative concentrations of gasoline-range hydrocarbons detected in soil gas samples are consistent with the soil analytical results discussed in Section 3.2 above.

Primary VOCs detected in the analyzed samples include each of the following BTEX compounds: hexane, 1,2,4-trimethylbenzene, and 1,3,5-trimethylbenzene.

Benzene concentrations were detected in B-9, B-13, and B-14 ranging from 23,000 to 58,000 ug/m^3. The distribution of detected gasoline constituent VOCs is consistent with soil analytical results for these borings.

Consistent with UST system decommissioning results and recent pilot test data indicating significant vertical and horizontal short circuiting in the former UST

excavation, Sample B-11 contained the lowest gasoline-range TPH concentrations, and did not contain a detectable concentration of benzene.

3.3.2 Effectiveness of SVE for Site Remediation

The SVE pilot test results indicate an effective radius of influence (ROI) of approximately 1.5 feet within the silty till material where the target hydrocarbons are located. This relatively small ROI suggests a short spacing between SVE wells of approximately three feet would be necessary to achieve adequate remedial coverage. Based on the distribution of silty soils exceeding MTCA Method A standards, both shallow (four to seven feet bgs) and deeper (eight to 12 feet bgs) arrays of SVE wells would be necessary in some areas of the site. Nested wells (i.e., shallow and deeper wells installed in the same vault box) are not appropriate due to interference between shallow and deep well screens caused by lack of vertical separation. Therefore, individual shallow and deep SVE wells would need to be installed and displaced laterally from each other.

Considering that the pilot test results indicate the need for a close-spaced well array (approximately three feet) within the silty till, and that nested wells would negatively effect performance of an SVE system, the pilot test results indicate that in the areas of the site where deeper SVE wells were installed, the combined shallow and deeper SVE well spacing should be no greater than approximately 1.5 ft.

In addition, the shallow and deeper SVE arrays could not be operated simultaneously due to the formation of stagnation zones, and would therefore need to be pulsed, further adding to the likely remediation time. Even if the shallow and deeper arrays were operated alternately, stagnation zones would likely also form within the shallow and deep zones and require alternating SVE operations on wells within the same array, again adding additional remediation time.

While the percent saturation of moisture in the silt is unknown, the relative permeability of the silt would improve over time as moisture was removed from the pore spaces, however, the removal of moisture also depends on the rate of air flow through the soil which indicates that drying of the silty till could also require a relatively long period of time.

Although SVE could be used at the site, pilot testing results indicate this approach would be difficult and complex to implement. Conclusions are provided in Section 4.

4 CONCLUSIONS AND RECOMMENDATIONS

4.1 SITE CHARACTERIZATION

Analytical results indicate that gasoline-range hydrocarbons and related constituents exceed MTCA Method A soil cleanup levels in an area that extends from the northeastern corner of the former UST cavity toward the north and northeast property boundaries. The greatest relative contaminant concentrations were measured at depths between four and ten feet bgs, which is generally consistent with prior investigations at the site by KEE (2007) and PNG (2008). Among 35 soil samples collected during the most recent phase of work, 19 were collected from depths between 11 and 40 feet. None of the samples from the deeper gravel unit exceeded MTCA Method A cleanup levels for gasoline or constituents.

The vertical extent of the gasoline impact has been determined for the subject site and is limited to the fine-grained till unit. However, the lateral extent of impacted soils north and northeast of the former tank cavity to the northeast has not been fully delineated (see Figure 6). Further site characterization may be required by Ecology to determine if offsite soils are affected and such evaluation would need to consider various utilities beneath the sidewalk along 16th Avenue. The gasoline impacts at the site appear generally to be limited to within the upper ten feet of ground surface soil. Due to the suspected depth to groundwater at the site (80 feet bgs), the release is unlikely to have impacted groundwater. PNG recommends that Plaid consult with Ecology to determine the scope of required subsurface characterization tasks before developing final cleanup options.

4.2 SVE PILOT TEST

The SVE pilot test was limited to the impacted shallow subsurface silt unit based on laboratory analytical results. SVE pilot test results indicated the following:

- Gasoline and volatile constituents can be removed from these silts but at low rates of efficiency.
- SVE well spacing and infrastructure logistics could be difficult and costly to implement with substantial disruption to site business operations.
- SVE remediation schedules will primarily be time-limited by the contaminant diffusion rate through fine-grained soils and are likely to be prolonged.

Based on these findings, SVE is not recommended at this time to address the identified soil impacts. PNG recommends Plaid consider other remedial technologies including excavation and removal of the impacted soil.

5 LIMITATIONS

PNG has prepared this report for use by Plaid Pantries, Inc. and its agents. This report may be made available to the property owner and to regulatory agencies at the discretion of Plaid Pantries, Inc. This report is not intended for use by others and the information contained herein is not applicable to other sites.

Our interpretation of subsurface conditions is based on field observations and chemical analytical data within the areas explored. Areas with contamination may exist in portions of the site that were not explored or analyzed.

Within the limitations of scope, schedule, and budget, our services have been executed in accordance with generally accepted practices and laws, rules, and regulations at the time that the report was prepared. No other conditions, expressed or implied, should be understood.

PNG ENVIRONMENTAL, INC.

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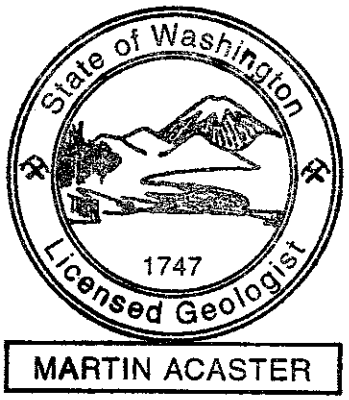
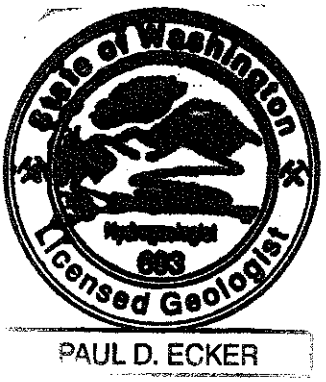




TABLES

Table 1
Soil Summary - Historical Site Data
KEE Environmental
(mg/Kg)
Plaid Pantry #324
Seattle, Washington

Sample Identification[a]	S-1	S-2	S-3	S-4	S-5	S-6	S-7	S-8	S-9	S-10	MTCA[b]
KEE Sample Designation	(EX2-16)	(TANK BT2)	(TANK BT3)	(NW-8)	(WW-8)	(EW-8)	(SW-8)	(S Isld)	(N Isld)	(EX1-4)	Method A
Sample Depth (feet bgs)	16	16	16	8	8	8	8	4	4	4	Cleanup Level
PARAMETERS Date Sampled	38841	38842	38842	38841	38842	38842	38842	38842	38842	38841	
Benzene	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	**0.23**	0.03
Toluene	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.85	7
Ethylbenzene	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	2.0	6
Total Xylenes	0.06 U	0.06 U	0.06 U	0.06 U	0.06 U	0.06 U	0.06 U	0.06 U	0.06 U	**16**	9
Gasoline Range Organics (GRO)	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U	**310**	30[c]

Notes:

[a] Initial sample designations shown in parentheses

[b] Model Toxics Control Act (MTCA) Method A Soil Cleanup Levels for Ground Water (WDOE, February 12, 2001)

[c] Gasoline cleanup level of 30 mg/Kg based on constituent concentrations greater than 1% gasoline concentrations

BTEX by EPA Method 8021B

Gasoline Range Organics by Method NWTPH-Gx

mg/Kg = Milligrams per kilogram (parts per million)

bgs = below ground surface

U = Not detected at method reporting limit shown

Values in **bold** indicate the compound concentration exceeds the MTCA Method A Cleanup Level

Table 2
Soil Analytical Results (mg/Kg)
Plaid Pantry #324
Seattle, Washington

Sample Identification	Sample Depth (feet bgs)	Date Sampled	Gasoline Range Organics (GRO)	Benzene	Toluene	Ethylbenzene	Total Xylenes	Methyl t-butyl ether (MTBE)	1,2-Dichloroethane (EDC)	1,2-Dibromoethane (EDB)	Naphthalene	Total Lead
B1-5	5	11/12/2007	**1,400**	**4.8**	**92**	**55**	**580**	0.05 U	0.05 U	0.05 U	**13**	7.95
B1-8	8	11/12/2007	11	0.03 U	0.05 U	0.05 U	0.21	0.05 U	0.05 U	0.05 U	0.05 U	2.38
B1-23	23	11/12/2007	**50**	**0.29**	6.2	3.8	**60**	0.05 U	0.05 U	0.05 U	3.2	-
B2-9	9	11/12/2007	2 U	0.03 U	0.05 U	0.05 U	0.15 U	0.05 U	0.05 U	0.05 U	0.05 U	2.46
B3-8	8	11/12/2007	**390**	**0.86**	**28**	**21**	**136**	0.05 U	0.05 U	0.05 U	5 U	4.11
B4-5	5	11/12/2007	2	0.03 U	0.065	0.059	0.303	0.05 U	0.05 U	0.05 U	0.057	2.61
B4-8	8	11/12/2007	2 U	0.03 U	0.05 U	0.05 U	0.15 U	0.05 U	0.05 U	0.05 U	0.05 U	-
B-5@4	4	07/16/2008	**1,300**	0.8 U	4.2	**12**	**120**	-	-	-	-	-
B-5@7	7	07/16/2008	2 U	0.02 U	0.02 U	0.02 U	0.06 U	-	-	-	-	-
B-5@12	12	07/16/2008	2 U	0.02 U	0.02 U	0.02 U	0.06 U	-	-	-	-	-
B-5@17	17	07/16/2008	2 U	-	-	-	-	-	-	-	-	-
B-5@22	22	07/16/2008	2 U	0.02 U	0.02 U	0.02 U	0.06 U	-	-	-	-	-
B-5@28	28	07/16/2008	2 U	-	-	-	-	-	-	-	-	-
B-5@34	34	07/16/2008	2 U	0.02 U	0.02 U	0.02 U	0.06 U	-	-	-	-	-
B-5@39	39	07/16/2008	2 U	-	-	-	-	-	-	-	-	-
B6@4	4	07/17/2008	**1,500**	**1.5**	**65**	**12**	**250**	-	-	-	-	-
B6@9	4	07/17/2008	2 U	0.02 U	0.02 U	0.02 U	0.06 U	-	-	-	-	-
B7@4	4	07/16/2008	2 U	0.02 U	0.02 U	0.02 U	0.06 U	-	-	-	-	-
B-7@8	8	07/16/2008	**580** U	**0.05**	6.1	**9.2**	**38**	-	-	-	-	-
B-7@11	11	07/16/2008	2 U	0.02 U	0.02 U	0.02 U	0.06 U	-	-	-	-	-
B-7@19	19	07/16/2008	2 U	-	-	-	-	-	-	-	-	-
B-7@21	21	07/16/2008	2 U	0.02 U	0.02 U	0.02 U	0.06 U	-	-	-	-	-
B-7@26	26	07/16/2008	2 U	0.02 U	0.02 U	0.02 U	0.06 U	-	-	-	-	-
B-7@34	34	07/16/2008	2 U	0.02 U	0.02 U	0.02 U	0.06 U	-	-	-	-	-
B-7@39	39	07/16/2008	2 U	-	-	-	-	-	-	-	-	-
B-8@6	6	07/17/2008	**1,200**	**0.73**	**16**	**17**	**150**	-	-	-	-	-
B-8@9	9	07/17/2008	18	**0.03**	1	0.5	0.78	-	-	-	-	-
B-9@5	5	07/17/2008	**950**	**1.5**	**42**	**14**	**120**	-	-	-	-	-
B-9@10	10	07/17/2008	**2,100**	**9.9**	**99**	**31**	**200**	-	-	-	-	-
B-9@12	12	07/17/2008	2 U	0.02 U	0.03	0.02 U	0.06 U	-	-	-	-	-
B-10@4	4	07/15/2008	8	**0.06**	0.22	0.17	0.92	-	-	-	-	-
B10@6	6	07/15/2008	6	**0.07**	0.4	0.24	0.74	-	-	-	-	-
B-10@10	10	07/15/2008	**76**	0.02 U	0.45	0.57	3.9	-	-	-	-	-
B-10@14.5	14.5	07/15/2008	19	0.02 U	0.17	0.15	0.97	-	-	-	-	-
B-10@19	19	07/15/2008	2 U	0.02 U	0.02 U	0.02 U	0.06 U	-	-	-	-	-
B-10@20-30	20-30	07/15/2008	2 U	0.02 U	0.02 U	0.02 U	0.06 U	-	-	-	-	-
B-10@31	31	07/16/2008	2 U	0.02 U	0.02 U	0.02 U	0.06 U	-	-	-	-	-
B-10@39.5	39.5	07/16/2008	2 U	-	-	-	-	-	-	-	-	-
B-12@4	4	07/17/2008	**150**	0.02 U	0.27	0.02 U	3.6	-	-	-	-	-
B-12@8	8	07/17/2008	2 U	0.02 U	0.02 U	0.02 U	0.06 U	-	-	-	-	-
B-13@5	5	07/17/2008	**140**	0.02 U	1.8	1.6	**11**	-	-	-	-	-
B-13@12	12	07/17/2008	3	0.12	0.26	0.06	0.3	-	-	-	-	-
MTCA[a] Method A Cleanup Level			**30**	**0.03**	**7**	**6**	**9**	**0.1**	**NA**	**0.005**	**5**	**250**

Notes:
[a] Model Toxics Control Act (MTCA) Method A Soil Cleanup Levels for Ground Water (WDOE, February 12, 2001)
Volatile Organics by EPA Method 8260B
Gasoline Range Organics by Method NWTPH-Gx
Total lead by EPA Method 6010
mg/Kg = Milligrams per kilogram (parts per million)
bgs = below ground surface
U = Not detected at method reporting limit shown
- = Not measured
NA = Not applicable
Values in **bold** indicate the compound concentration exceeds the MTCA Method A Cleanup Level

Table 3
SVE Vacuum Test Results
Plaid Pantry #324
Seattle, Washington

B-14 Soil Vapor Extraction Test

Well	Radial Distance (feet)	Vacuum Influence at Running Time; Inches of water									1 Liter Air Consumption
		0 minutes	5 minutes	20 minutes	35 minutes	55 minutes	70 minutes	85 minutes	120 minutes	140 minutes	
B-6	16	0.00	0.01	0.02	0.02	0.02	0.01	0.00	0.00	0.00	NM
B-8	10	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00	NM
B-9	10	0.00	0.07	0.08	0.08	0.08	0.08	0.08	0.08	0.09	92 Minutes
B-10	23	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	NM
B-11	31	0.17	0.17	0.16	0.17	0.17	0.14	0.16	0.15	0.16	76 Minutes
B-12	22	0.04	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	100 Minutes/0.75L
B-13	10	0.00	0.02	0.01	0.02	0.02	0.02	0.03	0.02	0.02	NM
B-14	0	48.00	48.00	46.00	46.00	46.00	46.00	46.00	46.00	45.00	NA
VM-1	7	0.00	0.02	0.03	0.03	0.03	0.02	0.02	0.02	0.02	NM
VM-2	12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	NM
VM-3	12	0.00	0.00	0.01	0.01	0.01	0.00	0.01	0.00	0.00	NM
Discharge PID Readings		NM	75.2	258	359	375	297	333	276	321	NA

Notes:
NA = Not applicable
Airflow = 110-120 feet / minute
NM = Not measured

Air Temp = 65.4 - 74.2 Deg. F
No water in KO Drum, Bleeder valve shut

B-9 Soil Vapor Extraction Test

Well	Radial Distance (feet)	Vacuum Influence at Running Time; Inches of water							1 Liter Air Consumption
		0 minutes	5 minutes	30 minutes	45 minutes	70 minutes	90 minutes	110 minutes	
B-6	9	0.00	0.01	0.02	0.02	0.02	0.02	0.02	NM
B-8	16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	90 Minutes
B-9	0	48.00	47.00	47.00	47.00	47.00	47.00	47.00	NA
B-10	17.5	0.00	0.01	0.01	0.01	0.01	0.01	0.01	NM
B-11	22	0.00	0.16	0.17	0.16	0.16	0.14	0.14	93 Seconds
B-12	20	0.00	0.05	0.06	0.06	0.06	0.06	0.06	90 Minutes/0.5 L
B-13	12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	NM
B-14	8	0.00	0.28	0.30	0.29	0.30	0.30	0.30	387 seconds
VM-1	2.5	0.00	0.10	0.11	0.11	0.11	0.10	0.10	NM
VM-2	19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	NM
VM-3	8.5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	NM
Discharge PID Readings		NM	465	406	369	382	312	326	NA

Notes:
NA = Not applicable
Airflow = 130-150 feet / minute
NM = Not measured

Air Temp = 68.8 - 79.1 Deg. F
No water in KO Drum, Bleeder valve shut

Table 3
SVE Vacuum Test Results
Plaid Pantry #324
Seattle, Washington

VM-1 Soil Vapor Extraction Test

Well	Radial Distance (feet)	Vacuum Influence at Running Time; Inches of water						1 Liter Air Consumption
		0 minutes	1 minute	15 minutes	25 minutes	55 minutes	65 minutes	
B-6	10	0.00	0.06	0.07	0.06	0.06	0.07	NM
B-8	19	0.00	0.00	0.00	0.00	0.00	0.00	NM
B-9	3	0.00	0.51	0.50	0.50	0.50	0.50	312 seconds
B-10	20	0.00	0.00	0.00	0.00	0.00	0.00	NM
B-11	24	0.00	0.10	0.10	0.09	0.09	0.12	1880 seconds
B-12	20	0.00	0.01	0.03	0.01	0.01	0.02	NM
B-13	10.5	0.00	0.00	0.00	0.00	0.00	0.00	NM
B-14	7	0.00	0.29	0.27	0.26	0.26	0.26	735 seconds
VM-1	0	47.00	47.00	47.00	45.00	45.00	45.00	NA
VM-2	22	0.00	0.00	0.01	0.00	0.00	0.00	NM
VM-3	8.5	0.00	0.11	0.11	0.10	0.10	0.11	2023 seconds
Discharge PID Readings		NM	64.6	13.7	11.5	8.8	7.6	NA

Notes:
NA = Not applicable
Airflow = 160 - 350 feet / minute
NM = Not measured
Air Temp = 81.1 - 86.0 Deg. F
No water in KO Drum, Bleeder valve shut

B-11 Soil Vapor Extraction Test

Well	Radial Distance (feet)	Vacuum Influence at Running Time; Inches of water						1 Liter Air Consumption
		0 minutes	15 minutes	25 minutes	40 minutes	70 minutes	100 minutes	
B-6	16	0.13	0.12	0.13	0.14	0.14	0.14	67 minutes/0 L
B-8	41.5	0.00	0.00	0.00	0.00	0.00	0.00	NM
B-9	23	0.02	0.02	0.02	0.02	0.02	0.02	NM
B-10	23	0.00	0.00	0.00	0.00	0.00	0.00	NM
B-11	0	34.00	34.00	34.00	34.00	34.00	34.00	NA
B-12	21.5	0.38	0.39	0.40	0.40	0.40	0.40	521 seconds
B-13	33.5	0.00	0.00	0.00	0.00	0.00	0.00	NM
B-14	30.5	0.03	0.03	0.03	0.03	0.03	0.03	NM
VM-1	26	0.02	0.01	0.01	0.01	0.01	0.01	NM
VM-2	43.5	0.00	0.00	0.00	0.00	0.00	0.00	NM
VM-3	20	0.08	0.06	0.07	0.06	0.06	0.06	70 minutes/0 L
Discharge PID Readings		8.1	12.3	8.9	9.6	9.4	9.8	NA

Notes:
NA = Not applicable
Airflow = 2000 - 2100 feet / minute
NM = Not measured
Air Temp = 85.8 - 93.2 Deg. F
No water in KO Drum, Bleeder valve shut

Table 3
SVE Vacuum Test Results
Plaid Pantry #324
Seattle, Washington

B-13 Soil Vapor Extraction Test

Well	Radial Distance (feet)	Vacuum Influence at Running Time; Inches of water						1 Liter Air Consumption
		0 minutes	15 minutes	35 minutes	60 minutes	95 minutes	120 minutes	
B-6	20	0.00	0.00	0.00	0.00	0.00	0.00	NM
B-8	10	0.00	0.00	0.00	0.00	0.00	0.00	105 minutes/0 L
B-9	12	0.00	0.02	0.02	0.02	0.02	0.02	105 minutes/0 L
B-10	20	0.00	0.00	0.00	0.00	0.00	0.00	NM
B-11	34	0.11	0.12	0.11	0.11	0.12	0.12	NM
B-12	32	0.03	0.04	0.03	0.03	0.04	0.04	NM
B-13	0	54.00	49.00	47.00	47.00	47.00	47.00	NA
B-14	9.5	0.04	0.07	0.07	0.07	0.07	0.07	65 minutes
VM-1	10.5	0.00	0.00	0.01	0.01	0.00	0.00	NM
VM-2	13	0.00	0.00	0.00	0.00	0.00	0.00	NM
VM-3	19	0.00	0.00	0.00	0.00	0.00	0.00	NM
Discharge PID Readings		252	217	222.0	232.0	240.0	228.0	NA

Notes:
NA = Not applicable
Airflow = 140 feet / minute
NM = Not measured
Air Temp = 56.8 - 67.2 Deg. F
No water in KO Drum, Bleeder valve shut

Table 4

SVE Vapor Analytical Results (ug/m^3)

Plaid Pantry #324

Seattle, Washington

Sample Identification	Date Sampled	Benzene	Toluene	Ethylbenzene	Total Xylenes	Hexane	1,3,5-Trimethyl-benzene	1,2,4-Trimethyl-benzene	Gasoline Range Organics
B-9	07/30/2008	58,000	200,000	44,000	219,000	320,000	13,000	34,000	10,000
B-11	07/30/2008	24 U	200	140	870	67	93	280	6.0
B-13	07/31/2008	28,000	120,000	36,000	156,000	130,000	8,700	20,000	4,800
B-14	07/30/2008	23,000	73,000	36,000	168,000	320,000	7,100	13,000	9,700

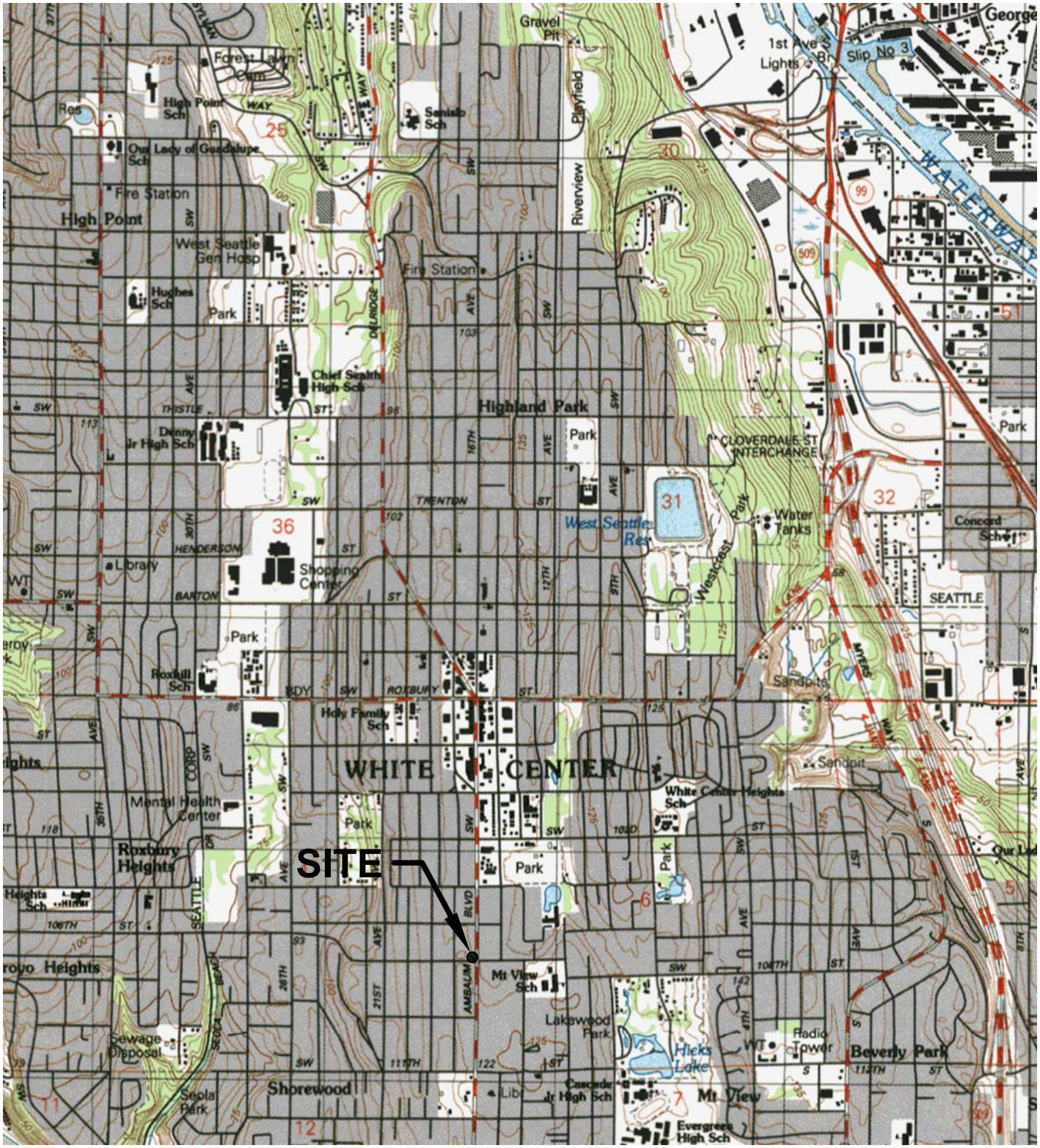
Notes:

Volatiles by EPA Method TO-14A (modified)

Gasoline Range Organics by EPA Method TO-3 (modified)

ug/m^3 = Micrograms per cubic meter of air

FIGURES

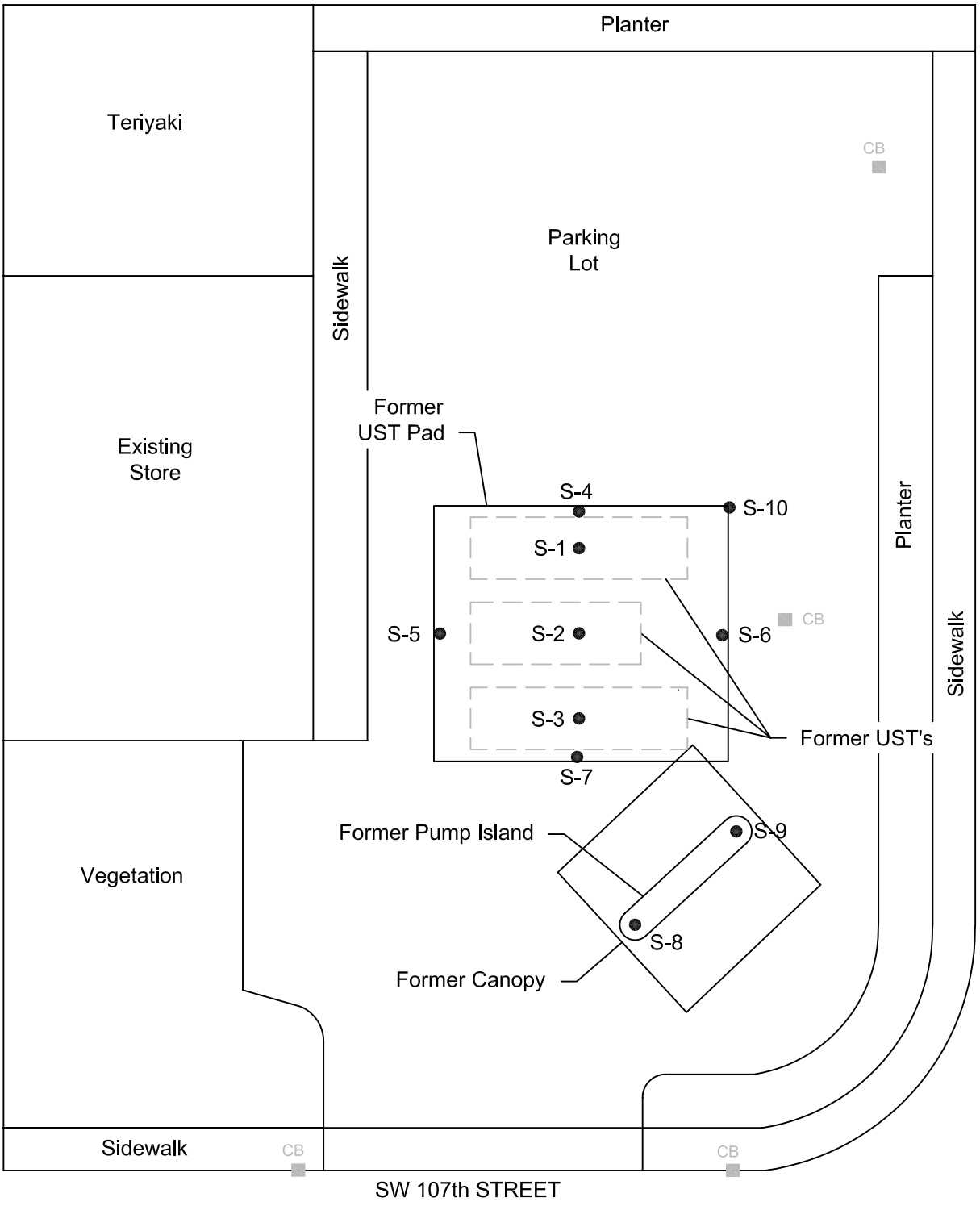


APPROXIMATE SCALE IN FEET

0 1000 2000 4000

NOTE: USGS, Seattle South Quadrangle
Washington - Snohomish Co.
7.5 x 15 Minute Quadrangle, 1983.
Base map provided by MapTech.

PNG ENVIRONMENTAL, INC. 6665 SW Hampton St., Ste. 101 TEL (503) 620-2387 Tigard, OR 97223 FAX (503) 620-2977	DATE: 9-24-08 FILE NAME: 1133-01 DRAWN BY: JJT APPROVED BY:	PLAID PANTRY #324 10645 16TH AVE. SW SEATTLE, WASHINGTON	SITE LOCATION MAP	Project No. 1133-01 Figure No. 1



LEGEND

- Existing Structures
- Former UST's (Removed May 2006)
- CB — Catch Basin
- S-6 — Soil Sample Location (KEE, May 2006)

APPROXIMATE SCALE IN FEET

0 20 40

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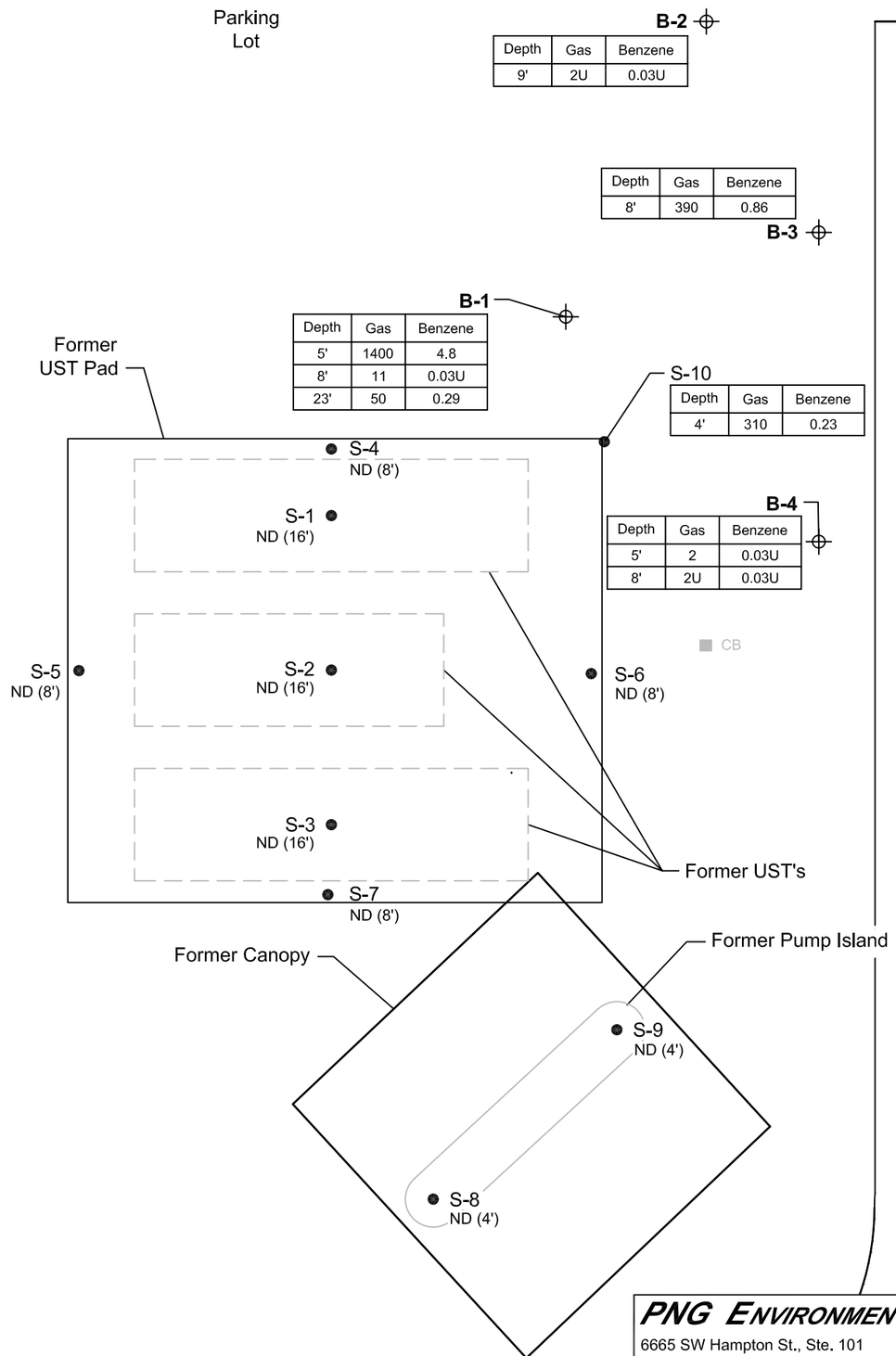
DATE:	9-24-08
FILE NAME:	1133-01
DRAWN BY:	JJT
APPROVED BY:	

PLAID PANTRY #324
10645 16TH AVE. SW
SEATTLE, WASHINGTON

SITE FEATURES

Project No. 1133-01
Figure No. 2



LEGEND

- Existing Structures
- Former UST's (Removed May 2006)
- CB — Catch Basin
- S-6 — Soil Sample Location (KEE, May 2006)
- B-1 — Boring Locations (PNG, Nov. 2007)
- Gx= — Gasoline Range Hydrocarbons
- B= — Benzene Concentration
- U= — Undetected at Laboratory Reporting Limit Shown
- 0.03U= — Constituents Not Detected above Laboratory Reporting Limit Shown
- ND= — Gasoline, Benzene and other constituents Not Detected

Results in milligrams per kilogram (mg/Kg)

N

APPROXIMATE SCALE IN FEET

0 10 20

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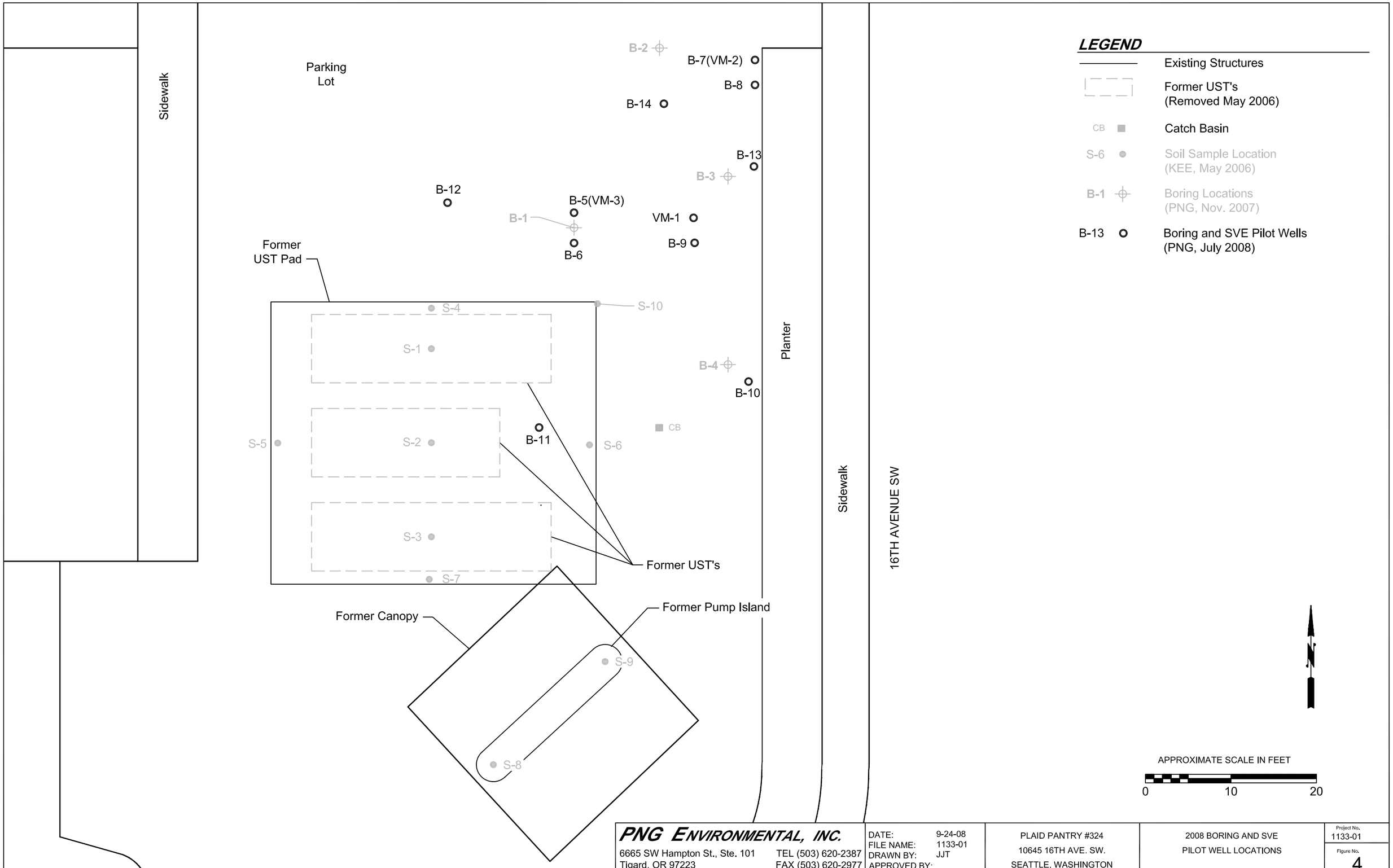
SEATTLE, WASHINGTON

GASOLINE AND CONSTITUENTS IN SOIL
(2006 - 2007)

Project No. 1133-01

Figure No. 3



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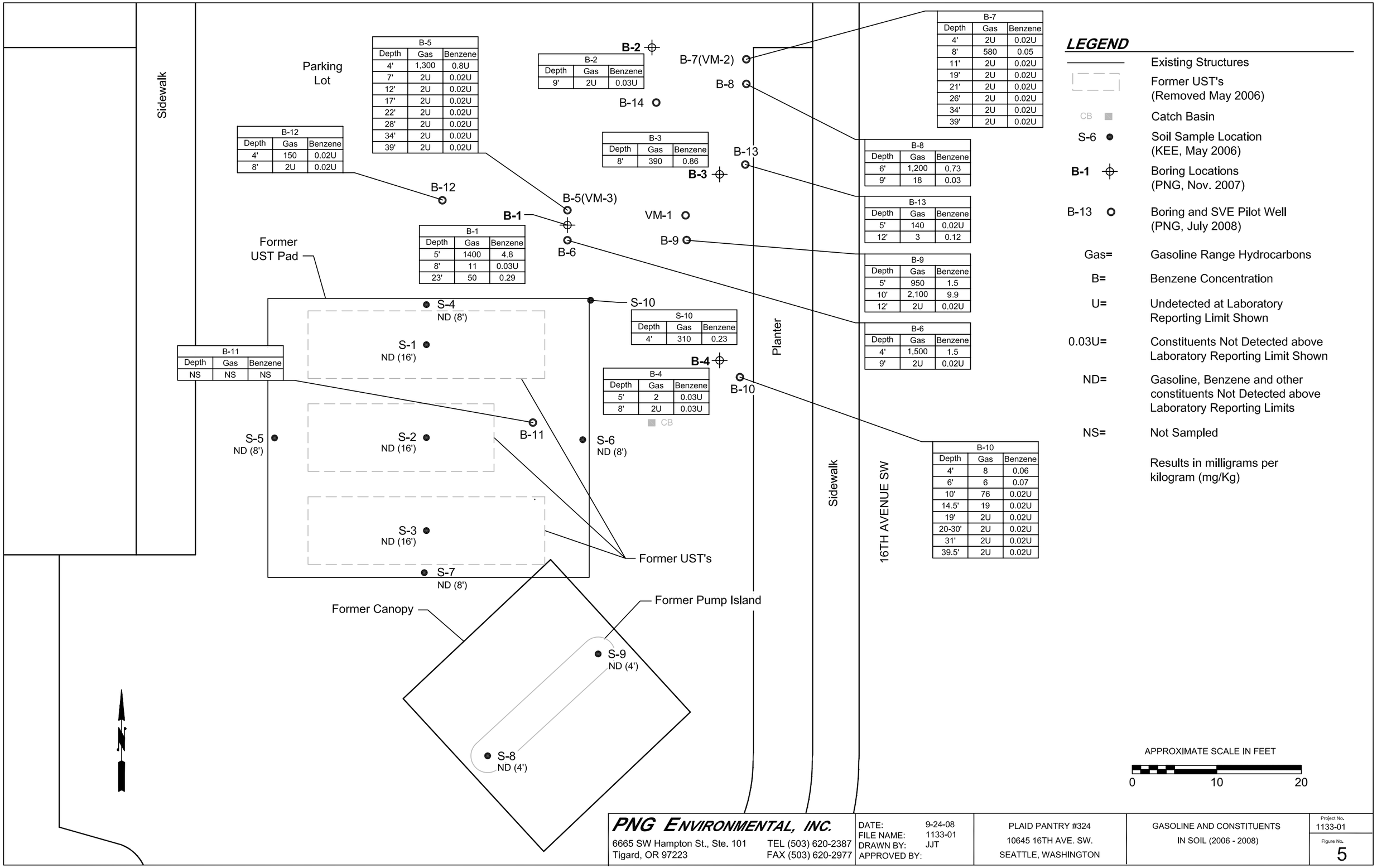
10645 16TH AVE. SW.
SEATTLE, WASHINGTON

2008 BORING AND SVE
PILOT WELL LOCATIONS

Project No. 1133-01

Figure No. 4



B-5		
Depth	Gas	Benzene
4'	1,300	0.8U
7'	2U	0.02U
12'	2U	0.02U
17'	2U	0.02U
22'	2U	0.02U
28'	2U	0.02U
34'	2U	0.02U
39'	2U	0.02U

B-2		
Depth	Gas	Benzene
9'	2U	0.03U

B-12		
Depth	Gas	Benzene
4'	150	0.02U
8'	2U	0.02U

B-3		
Depth	Gas	Benzene
8'	390	0.86

B-1		
Depth	Gas	Benzene
5'	1400	4.8
8'	11	0.03U
23'	50	0.29

B-11		
Depth	Gas	Benzene
NS	NS	NS

S-10		
Depth	Gas	Benzene
4'	310	0.23

B-4		
Depth	Gas	Benzene
5'	2	0.03U
8'	2U	0.03U

B-7		
Depth	Gas	Benzene
4'	2U	0.02U
8'	580	0.05
11'	2U	0.02U
19'	2U	0.02U
21'	2U	0.02U
26'	2U	0.02U
34'	2U	0.02U
39'	2U	0.02U

B-8		
Depth	Gas	Benzene
6'	1,200	0.73
9'	18	0.03

B-13		
Depth	Gas	Benzene
5'	140	0.02U
12'	3	0.12

B-9		
Depth	Gas	Benzene
5'	950	1.5
10'	2,100	9.9
12'	2U	0.02U

B-6		
Depth	Gas	Benzene
4'	1,500	1.5
9'	2U	0.02U

B-10		
Depth	Gas	Benzene
4'	8	0.06
6'	6	0.07
10'	76	0.02U
14.5'	19	0.02U
19'	2U	0.02U
20-30'	2U	0.02U
31'	2U	0.02U
39.5'	2U	0.02U

LEGEND

- Existing Structures
- Former UST's (Removed May 2006)
- CB — Catch Basin
- S-6 — Soil Sample Location (KEE, May 2006)
- B-1 — Boring Locations (PNG, Nov. 2007)
- B-13 — Boring and SVE Pilot Well (PNG, July 2008)
- Gas= Gasoline Range Hydrocarbons
- B= Benzene Concentration
- U= Undetected at Laboratory Reporting Limit Shown
- 0.03U= Constituents Not Detected above Laboratory Reporting Limit Shown
- ND= Gasoline, Benzene and other constituents Not Detected above Laboratory Reporting Limits
- NS= Not Sampled

Results in milligrams per kilogram (mg/Kg)

PNG ENVIRONMENTAL, INC.
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Tigard, OR 97223
TEL (503) 620-2387
FAX (503) 620-2977

DATE: 9-24-08
FILE NAME: 1133-01
DRAWN BY: JJT
APPROVED BY:

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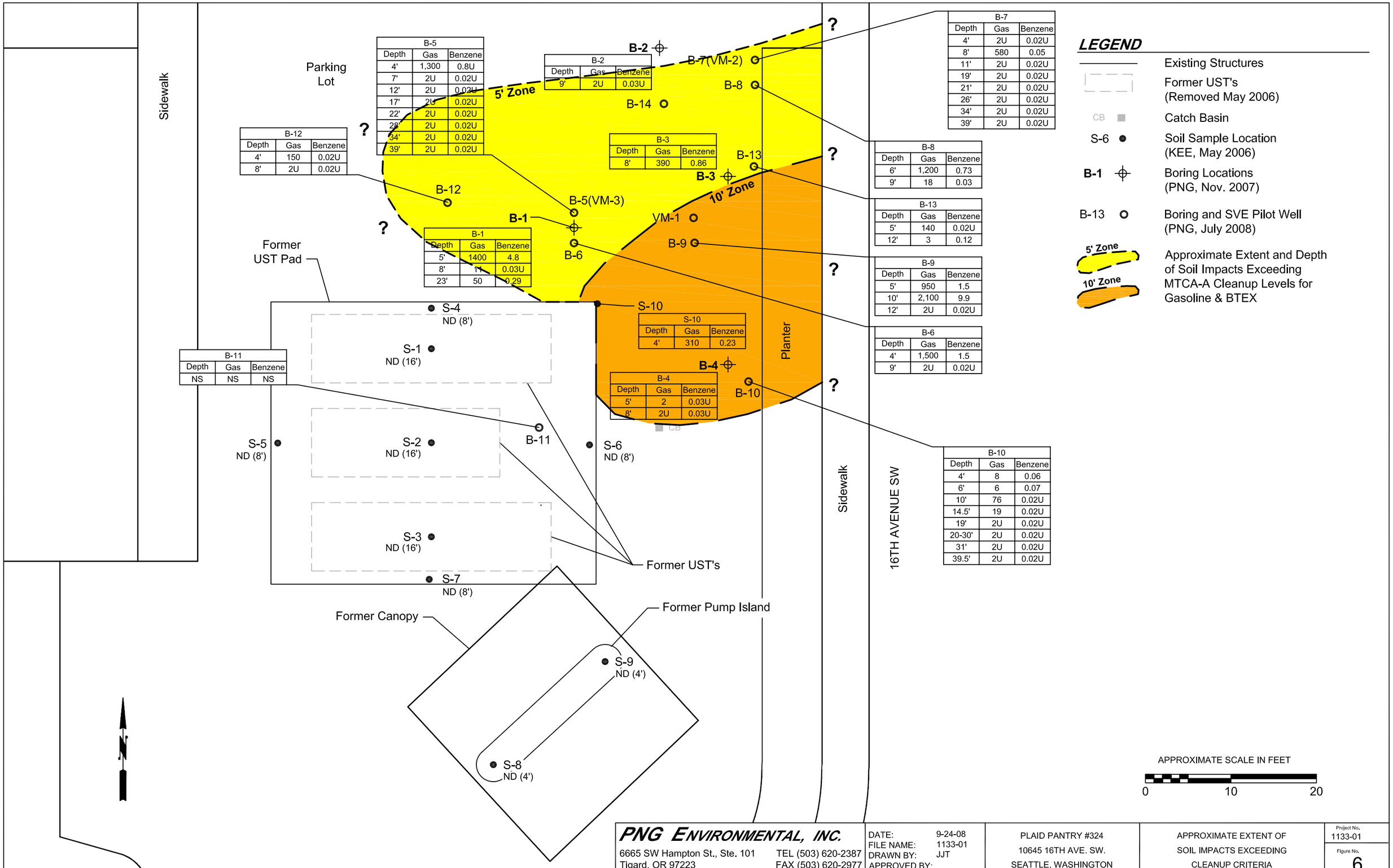
SEATTLE, WASHINGTON

GASOLINE AND CONSTITUENTS IN SOIL (2006 - 2008)

Project No. 1133-01

Figure No. 5



B-5		
Depth	Gas	Benzene
4'	1,300	0.8U
7'	2U	0.02U
12'	2U	0.02U
17'	2U	0.02U
22'	2U	0.02U
28'	2U	0.02U
34'	2U	0.02U
39'	2U	0.02U

B-2		
Depth	Gas	Benzene
9'	2U	0.03U

B-12		
Depth	Gas	Benzene
4'	150	0.02U
8'	2U	0.02U

B-3		
Depth	Gas	Benzene
8'	390	0.86

B-1		
Depth	Gas	Benzene
5'	1400	4.8
8'	11	0.03U
23'	50	0.29

B-11		
Depth	Gas	Benzene
NS	NS	NS

S-10		
Depth	Gas	Benzene
4'	310	0.23

B-4		
Depth	Gas	Benzene
5'	2	0.03U
8'	2U	0.03U

B-7		
Depth	Gas	Benzene
4'	2U	0.02U
8'	580	0.05
11'	2U	0.02U
19'	2U	0.02U
21'	2U	0.02U
26'	2U	0.02U
34'	2U	0.02U
39'	2U	0.02U

B-8		
Depth	Gas	Benzene
6'	1,200	0.73
9'	18	0.03

B-13		
Depth	Gas	Benzene
5'	140	0.02U
12'	3	0.12

B-9		
Depth	Gas	Benzene
5'	950	1.5
10'	2,100	9.9
12'	2U	0.02U

B-6		
Depth	Gas	Benzene
4'	1,500	1.5
9'	2U	0.02U

B-10		
Depth	Gas	Benzene
4'	8	0.06
6'	6	0.07
10'	76	0.02U
14.5'	19	0.02U
19'	2U	0.02U
20-30'	2U	0.02U
31'	2U	0.02U
39.5'	2U	0.02U

LEGEND

- Existing Structures
- Former UST's (Removed May 2006)
- CB — Catch Basin
- S-6 — Soil Sample Location (KEE, May 2006)
- B-1 — Boring Locations (PNG, Nov. 2007)
- B-13 — Boring and SVE Pilot Well (PNG, July 2008)
- 5' Zone / 10' Zone — Approximate Extent and Depth of Soil Impacts Exceeding MTCA-A Cleanup Levels for Gasoline & BTEX

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APPROXIMATE EXTENT OF SOIL IMPACTS EXCEEDING CLEANUP CRITERIA

Project No. 1133-01

Figure No. 6

APPENDIX A

PNG ENVIRONMENTAL SOPS

STANDARD OPERATING PROCEDURE
LOGGING OF SOIL BOREHOLES
SOP 1

The following procedures are used for completing the Soil Boring Log Form (Figure 1-1). These procedures, which must be used for PNG projects where soil boring techniques are performed during field exploration, establish the minimum information that must be recorded in the field to adequately characterize soil boreholes.

These procedures are adapted from ASTM D-2488-84 (attached). Field staff is encouraged to examine ASTM D-2488-84 in its entirety. This standard operating procedure (SOP) has made minor modifications to emphasize environmental investigations as opposed to geotechnical investigations (for which the standards were written). Because environmental projects are each unique and because job requirements can vary widely, the minimum standards presented may need to be supplemented with additional technical descriptions or field test results. However, all soil boring field logs, regardless of special project circumstances, must include information addressed in this SOP to achieve the minimum acceptable standards required by PNG.

HEADING INFORMATION

- Project Number: Use the standard contract number.
- Client: Identify the name of the client and the project site location.
- Location: If stationing, coordinates, mileposts, or similar are applicable identify the location of the project. If this information is not available, identify the facility (i.e., 20 ft NE of Retort #1).
- Drilling Method: Identify the bit size and type, drilling fluid (if used), and method of drilling (e.g., rotary, hollow-stem auger, cable tool) and the name of the drill rig (e.g., Mobil B 61, CME 55).
- Diameter: Provide the diameter of the borehole. If the borehole has variable diameters, provide the depth interval for each diameter.
- Sampling Method: Identify the type of sampler(s) used (e.g., standard split spoon, Dames & Moore sampler, grab).
- Drilling Contractor: Provide the name of the drilling contractor.
- PNG Staff: Enter the name(s) of PNG staff performing logging and sampling activities.
- Water Level Information: Provide the date, time, depth to static water, and casing depth. Generally, water levels should be taken each day before resuming drilling and at the completion of drilling. If water is not encountered in the boring, this information should be recorded.
- Boring Number: Provide the boring number. A numbering system should be developed prior to drilling that does not conflict with other site information, such as previous drilling or other sampling activities.
- Sheet: Number the sheets consecutively for each boring and continue the consecutive depth numbering.
- Drilling Start and Finish: Provide the drilling start and finish dates and times.

For consecutive sheets provide, at a minimum, the job number, the boring number, and the sheet number.

TECHNICAL DATA

- Sampler Type: Provide the sampler type (e.g., SS = split spoon, DM = Dames & Moore split spoon, G = grab).
- Depth of Casing: Enter the depth of the casing below ground surface immediately prior to sampling.
- Driven/Recovery: Provide the length that the sampler was driven and the length of sample recovered in the sampler. This column would not apply to grab samples.
- Sample Number/Sample Depth: Provide the sample number. The sample numbering scheme should be established prior to drilling. One method is to use the boring number and consecutive alphabetical letters. For instance, the first sample obtained from boring MW-4 would be identified as 4A and the second would be identified as 4B, and so on. Another method for sample identification is naming the boring number with the depth. For example, the sample from Boring 1 at 10 ft would be labeled B1-10'. The depth of the sample is the depth of the casing plus the length to the middle of the recovered sample to the nearest 0.1 ft. Typically, split spoon samplers are 18 in. long. Samples should be obtained from the middle of the recovered sample. The depth of the sample with the casing at 10 ft would then be 10.7 ft.
- Number of Blows: For standard split spoon samplers, record the number of blows for each 6 in. of sampler penetration. A typical blow count of 6, 12, and 14 is recorded as 6/12/14. Refusal is a penetration of less than 6 in. with a blow count of 50. A partial penetration of 50 blows for 4 in. is recorded as 50/4". For nonstandard split spoons (e.g., 5-ft tube used for continuous sampling), total blows will be recorded.
- Blank Columns: Two blank columns are provided. Project managers are encouraged to use these columns for site-specific information, usually related to the contaminants of concern. Examples for a hydrocarbon site would be sheen and PID readings of the samples.
- Depth: Use a depth scale that is appropriate for the complexity of the subsurface conditions. The boxes located to the right of the scale should be used to graphically indicate sample locations as shown in the example.
- Surface Conditions: Describe the surface conditions (e.g., paved, 4-in. concrete slab, grass, natural vegetation and surface soil, oil-stained gravel).
- Soil Description: The soil classification and definition of soil contacts should follow the format described in SOP-2, *Field Classification of Soil.*
- Comments: Include all pertinent observations. Drilling observations might include drilling chatter, rod-bounce (boulder), sudden differences in drilling speed, damaged samplers, and malfunctioning equipment. Information provided by the driller should be attributed to the driller. Information on contaminants might include odor, staining, color, and presence or absence of some indicator of contamination. Describe what it is that indicates contamination (e.g., fuel-like odor, oily sheen in drill cuttings, yellow water in drill cuttings).

Designation: D 2488 – 06

Standard Practice for Description and Identification of Soils (Visual-Manual Procedure)[1]

This standard is issued under the fixed designation D 2488; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

This standard has been approved for use by agencies of the Department of Defense.

1. Scope*

1.1 This practice covers procedures for the description of soils for engineering purposes.

1.2 This practice also describes a procedure for identifying soils, at the option of the user, based on the classification system described in Test Method D 2487. The identification is based on visual examination and manual tests. It must be clearly stated in reporting an identification that it is based on visual-manual procedures.

1.2.1 When precise classification of soils for engineering purposes is required, the procedures prescribed in Test Method D 2487 shall be used.

1.2.2 In this practice, the identification portion assigning a group symbol and name is limited to soil particles smaller than 3 in. (75 mm).

1.2.3 The identification portion of this practice is limited to naturally occurring soils (disturbed and undisturbed).

NOTE 1—This practice may be used as a descriptive system applied to such materials as shale, claystone, shells, crushed rock, etc. (see Appendix X2).

1.3 The descriptive information in this practice may be used with other soil classification systems or for materials other than naturally occurring soils.

1.4 The values stated in inch-pound units are to be regarded as the standard.

1.5 *This standard does not purport to address all of the safety problems, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.* For specific precautionary statements see Section 8.

1.6 *This practice offers a set of instructions for performing one or more specific operations. This document cannot replace education or experience and should be used in conjunction with professional judgment. Not all aspects of this practice may be applicable in all circumstances. This ASTM standard is not intended to represent or replace the standard of care by which the adequacy of a given professional service must be judged, nor should this document be applied without consideration of a project's many unique aspects. The word "Standard" in the title of this document means only that the document has been approved through the ASTM consensus process.*

2. Referenced Documents

2.1 *ASTM Standards:* [2]

D 653 Terminology Relating to Soil, Rock, and Contained Fluids

D 1452 Practice for Soil Investigation and Sampling by Auger Borings

D 1586 Test Method for Penetration Test and Split-Barrel Sampling of Soils

D 1587 Practice for Thin-Walled Tube Sampling of Soils for Geotechnical Purposes

D 2113 Practice for Rock Core Drilling and Sampling of Rock for Site Investigation

D 2487 Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)

D 3740 Practice for Minimum Requirements for Agencies Engaged in the Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction

D 4083 Practice for Description of Frozen Soils (Visual-Manual Procedure)

3. Terminology

3.1 *Definitions*—Except as listed below, all definitions are in accordance with Terminology D 653.

NOTE 2—For particles retained on a 3-in. (75-mm) US standard sieve, the following definitions are suggested:
Cobbles—particles of rock that will pass a 12-in. (300-mm) square opening and be retained on a 3-in. (75-mm) sieve, and
Boulders—particles of rock that will not pass a 12-in. (300-mm) square opening.

[1] This practice is under the jurisdiction of ASTM Committee D18 on Soil and Rock and is the direct responsibility of Subcommittee D18.07 on Identification and Classification of Soils.

Current edition approved Nov. 1, 2006. Published November 2006. Originally approved in 1966. Last previous edition approved in 2000 as D 2488 – 00.

[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

***A Summary of Changes section appears at the end of this standard.**

3.1.1 *clay*—soil passing a No. 200 (75-μm) sieve that can be made to exhibit plasticity (putty-like properties) within a range of water contents, and that exhibits considerable strength when air-dry. For classification, a clay is a fine-grained soil, or the fine-grained portion of a soil, with a plasticity index equal to or greater than 4, and the plot of plasticity index versus liquid limit falls on or above the "A" line (see Fig. 3 of Test Method D 2487).

3.1.2 *gravel*—particles of rock that will pass a 3-in. (75-mm) sieve and be retained on a No. 4 (4.75-mm) sieve with the following subdivisions:

coarse—passes a 3-in. (75-mm) sieve and is retained on a ¾-in. (19-mm) sieve.

fine—passes a ¾-in. (19-mm) sieve and is retained on a No. 4 (4.75-mm) sieve.

3.1.3 *organic clay*—a clay with sufficient organic content to influence the soil properties. For classification, an organic clay is a soil that would be classified as a clay, except that its liquid limit value after oven drying is less than 75 % of its liquid limit value before oven drying.

3.1.4 *organic silt*—a silt with sufficient organic content to influence the soil properties. For classification, an organic silt is a soil that would be classified as a silt except that its liquid limit value after oven drying is less than 75 % of its liquid limit value before oven drying.

3.1.5 *peat*—a soil composed primarily of vegetable tissue in various stages of decomposition usually with an organic odor, a dark brown to black color, a spongy consistency, and a texture ranging from fibrous to amorphous.

3.1.6 *sand*—particles of rock that will pass a No. 4 (4.75-mm) sieve and be retained on a No. 200 (75-μm) sieve with the following subdivisions:

coarse—passes a No. 4 (4.75-mm) sieve and is retained on a No. 10 (2.00-mm) sieve.

medium—passes a No. 10 (2.00-mm) sieve and is retained on a No. 40 (425-μm) sieve.

fine—passes a No. 40 (425-μm) sieve and is retained on a No. 200 (75-μm) sieve.

3.1.7 *silt*—soil passing a No. 200 (75-μm) sieve that is nonplastic or very slightly plastic and that exhibits little or no strength when air dry. For classification, a silt is a fine-grained soil, or the fine-grained portion of a soil, with a plasticity index less than 4, or the plot of plasticity index versus liquid limit falls below the "A" line (see Fig. 3 of Test Method D 2487).

4. Summary of Practice

4.1 Using visual examination and simple manual tests, this practice gives standardized criteria and procedures for describing and identifying soils.

4.2 The soil can be given an identification by assigning a group symbol(s) and name. The flow charts, Fig. 1a and Fig. 1b for fine-grained soils, and Fig. 2, for coarse-grained soils, can be used to assign the appropriate group symbol(s) and name. If the soil has properties which do not distinctly place it into a specific group, borderline symbols may be used, see Appendix X3.

NOTE 3—It is suggested that a distinction be made between *dual symbols* and *borderline symbols*.

Dual Symbol—A dual symbol is two symbols separated by a hyphen, for example, GP-GM, SW-SC, CL-ML used to indicate that the soil has been identified as having the properties of a classification in accordance with Test Method D 2487 where two symbols are required. Two symbols are required when the soil has between 5 and 12 % fines or when the liquid limit and plasticity index values plot in the CL-ML area of the plasticity chart.

Borderline Symbol—A borderline symbol is two symbols separated by a slash, for example, CL/CH, GM/SM, CL/ML. A borderline symbol should be used to indicate that the soil has been identified as having properties that do not distinctly place the soil into a specific group (see Appendix X3).

5. Significance and Use

5.1 The descriptive information required in this practice can be used to describe a soil to aid in the evaluation of its significant properties for engineering use.

5.2 The descriptive information required in this practice should be used to supplement the classification of a soil as determined by Test Method D 2487.

5.3 This practice may be used in identifying soils using the classification group symbols and names as prescribed in Test Method D 2487. Since the names and symbols used in this practice to identify the soils are the same as those used in Test Method D 2487, it shall be clearly stated in reports and all other appropriate documents, that the classification symbol and name are based on visual-manual procedures.

5.4 This practice is to be used not only for identification of soils in the field, but also in the office, laboratory, or wherever soil samples are inspected and described.

5.5 This practice has particular value in grouping similar soil samples so that only a minimum number of laboratory tests need be run for positive soil classification.

NOTE 4—The ability to describe and identify soils correctly is learned more readily under the guidance of experienced personnel, but it may also be acquired systematically by comparing numerical laboratory test results for typical soils of each type with their visual and manual characteristics.

5.6 When describing and identifying soil samples from a given boring, test pit, or group of borings or pits, it is not necessary to follow all of the procedures in this practice for every sample. Soils which appear to be similar can be grouped together; one sample completely described and identified with the others referred to as similar based on performing only a few of the descriptive and identification procedures described in this practice.

5.7 This practice may be used in combination with Practice D 4083 when working with frozen soils.

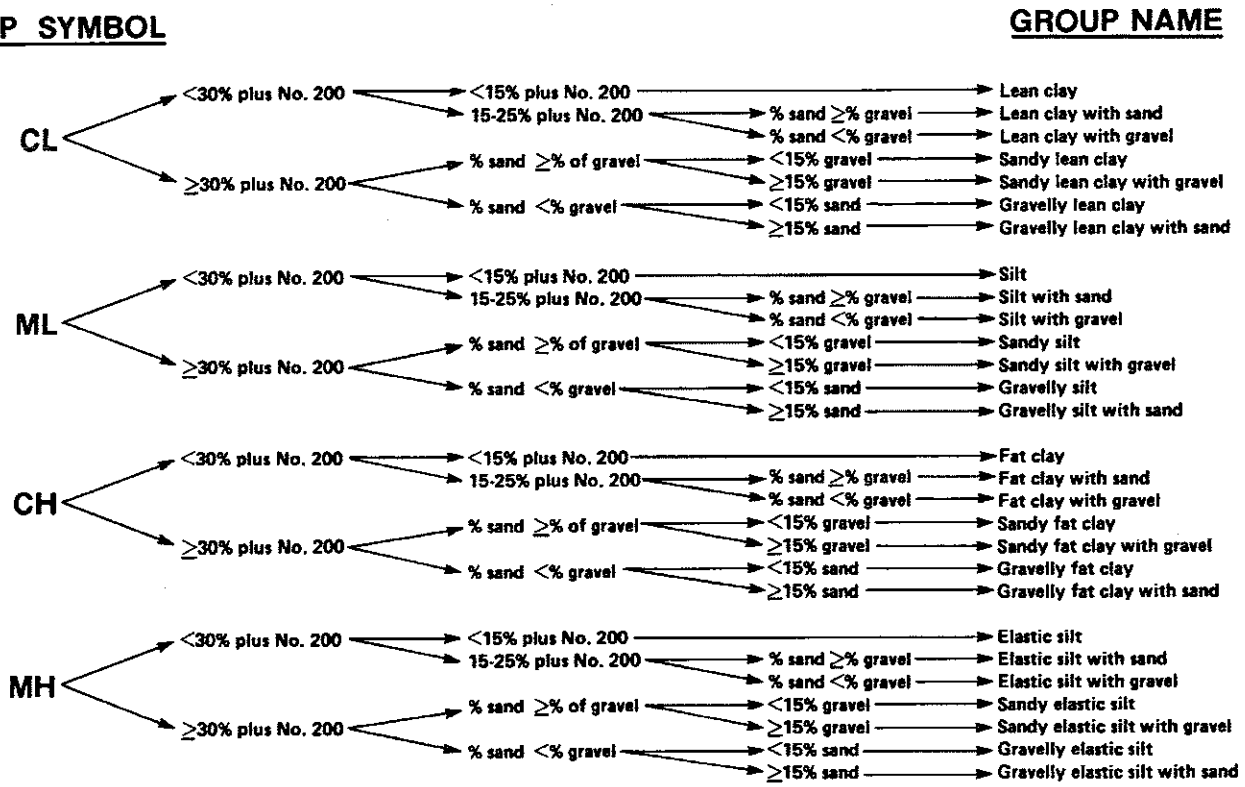
NOTE 5—Notwithstanding the statements on precision and bias contained in this standard: The precision of this test method is dependent on the competence of the personnel performing it and the suitability of the equipment and facilities used. Agencies that meet the criteria of Practice D 3740 are generally considered capable of competent and objective testing. Users of this test method are cautioned that compliance with Practice D 3740 does not in itself assure reliable testing. Reliable testing depends on several factors; Practice D 3740 provides a means for evaluating some of those factors.

6. Apparatus

6.1 *Required Apparatus*:

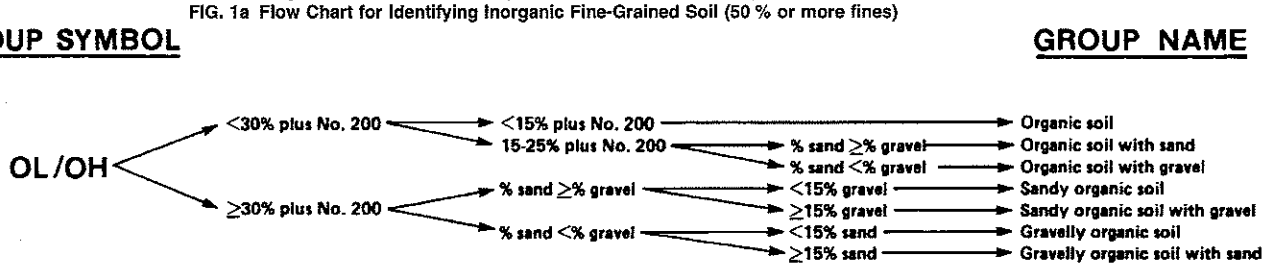
6.1.1 *Pocket Knife or Small Spatula.*

6.2 *Useful Auxiliary Apparatus*:



NOTE 1—Percentages are based on estimating amounts of fines, sand, and gravel to the nearest 5 %.

FIG. 1a Flow Chart for Identifying Inorganic Fine-Grained Soil (50 % or more fines)



NOTE 1—Percentages are based on estimating amounts of fines, sand, and gravel to the nearest 5 %.

FIG. 1 b Flow Chart for Identifying Organic Fine-Grained Soil (50 % or more fines)

6.2.1 *Small Test Tube and Stopper* (or jar with a lid).

6.2.2 *Small Hand Lens.*

7. Reagents

7.1 *Purity of Water*—Unless otherwise indicated, references to water shall be understood to mean water from a city water supply or natural source, including non-potable water.

7.2 *Hydrochloric Acid*—A small bottle of dilute hydrochloric acid, HCl, one part HCl (10 *N*) to three parts water (This reagent is optional for use with this practice). See Section 8.

8. Safety Precautions

8.1 When preparing the dilute HCl solution of one part concentrated hydrochloric acid (10 *N*) to three parts of distilled water, slowly add acid into water following necessary safety precautions. Handle with caution and store safely. If solution comes into contact with the skin, rinse thoroughly with water.

8.2 **Caution**—Do not add water to acid.

9. Sampling

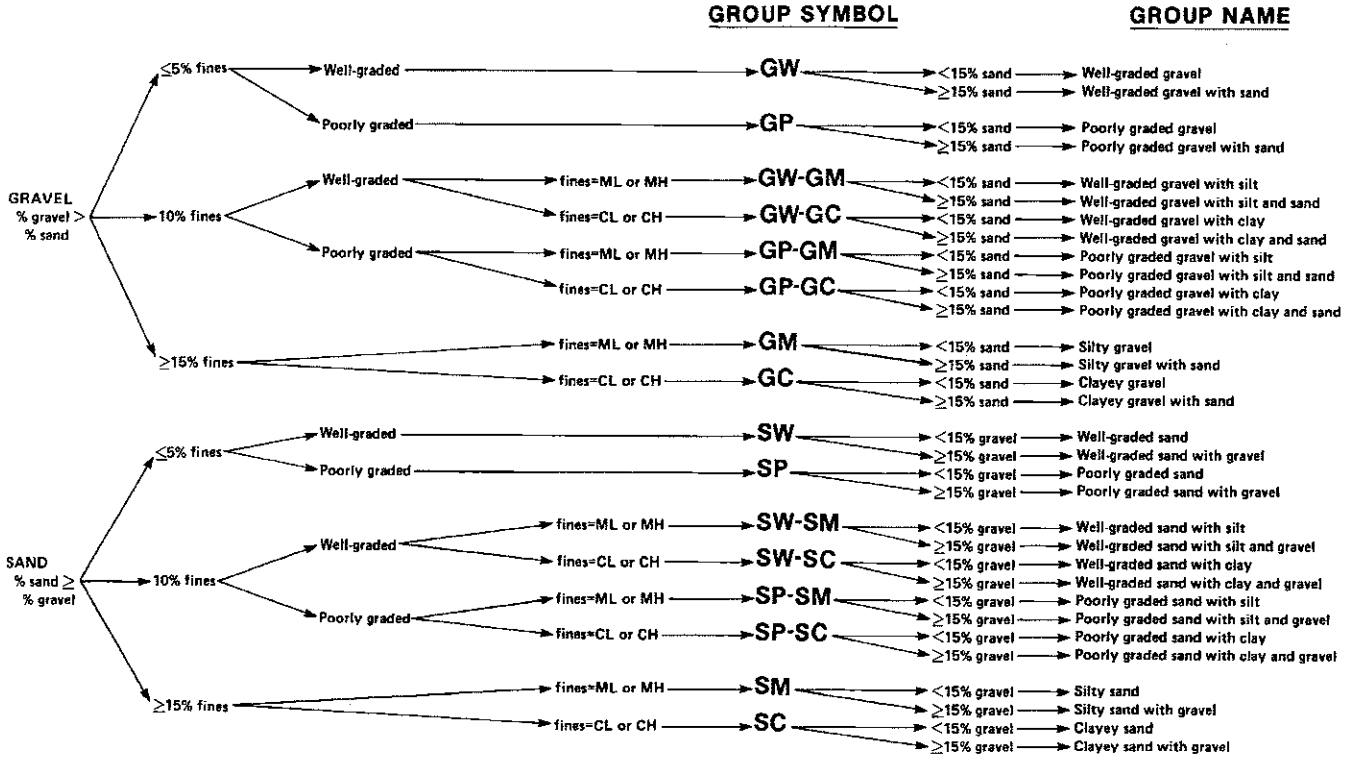
9.1 The sample shall be considered to be representative of the stratum from which it was obtained by an appropriate, accepted, or standard procedure.

NOTE 6—Preferably, the sampling procedure should be identified as having been conducted in accordance with Practices D 1452, D 1587, or D 2113, or Test Method D 1586.

9.2 The sample shall be carefully identified as to origin.

NOTE 7—Remarks as to the origin may take the form of a boring number and sample number in conjunction with a job number, a geologic stratum, a pedologic horizon or a location description with respect to a permanent monument, a grid system or a station number and offset with respect to a stated centerline and a depth or elevation.

9.3 For accurate description and identification, the minimum amount of the specimen to be examined shall be in accordance with the following schedule:



NOTE 1—Percentages are based on estimating amounts of fines, sand, and gravel to the nearest 5 %.

FIG. 2 Flow Chart for Identifying Coarse-Grained Soils (less than 50 % fines)

Maximum Particle Size, Sieve Opening	Minimum Specimen Size, Dry Weight
4.75 mm (No. 4)	100 g (0.25 lb)
9.5 mm (⅜ in.)	200 g (0.5 lb)
19.0 mm (¾ in.)	1.0 kg (2.2 lb)
38.1 mm (1½ in.)	8.0 kg (18 lb)
75.0 mm (3 in.)	60.0 kg (132 lb)

NOTE 8—If random isolated particles are encountered that are significantly larger than the particles in the soil matrix, the soil matrix can be accurately described and identified in accordance with the preceeding schedule.

9.4 If the field sample or specimen being examined is smaller than the minimum recommended amount, the report shall include an appropriate remark.

10. Descriptive Information for Soils

10.1 *Angularity*—Describe the angularity of the sand (coarse sizes only), gravel, cobbles, and boulders, as angular, subangular, subrounded, or rounded in accordance with the criteria in Table 1 and Fig. 3. A range of angularity may be stated, such as: subrounded to rounded.

10.2 *Shape*—Describe the shape of the gravel, cobbles, and boulders as flat, elongated, or flat and elongated if they meet the criteria in Table 2 and Fig. 4. Otherwise, do not mention the shape. Indicate the fraction of the particles that have the shape, such as: one-third of the gravel particles are flat.

10.3 *Color*—Describe the color. Color is an important property in identifying organic soils, and within a given locality it may also be useful in identifying materials of similar geologic origin. If the sample contains layers or patches of varying colors, this shall be noted and all representative colors shall be described. The color shall be described for moist samples. If the color represents a dry condition, this shall be stated in the report.

TABLE 1 Criteria for Describing Angularity of Coarse-Grained Particles (see Fig. 3)

Description	Criteria
Angular	Particles have sharp edges and relatively plane sides with unpolished surfaces
Subangular	Particles are similar to angular description but have rounded edges
Subrounded	Particles have nearly plane sides but have well-rounded corners and edges
Rounded	Particles have smoothly curved sides and no edges

10.4 *Odor*—Describe the odor if organic or unusual. Soils containing a significant amount of organic material usually have a distinctive odor of decaying vegetation. This is especially apparent in fresh samples, but if the samples are dried, the odor may often be revived by heating a moistened sample. If the odor is unusual (petroleum product, chemical, and the like), it shall be described.

10.5 *Moisture Condition*—Describe the moisture condition as dry, moist, or wet, in accordance with the criteria in Table 3.

10.6 *HCl Reaction*—Describe the reaction with HCl as none, weak, or strong, in accordance with the critera in Table 4. Since calcium carbonate is a common cementing agent, a report of its presence on the basis of the reaction with dilute hydrochloric acid is important.

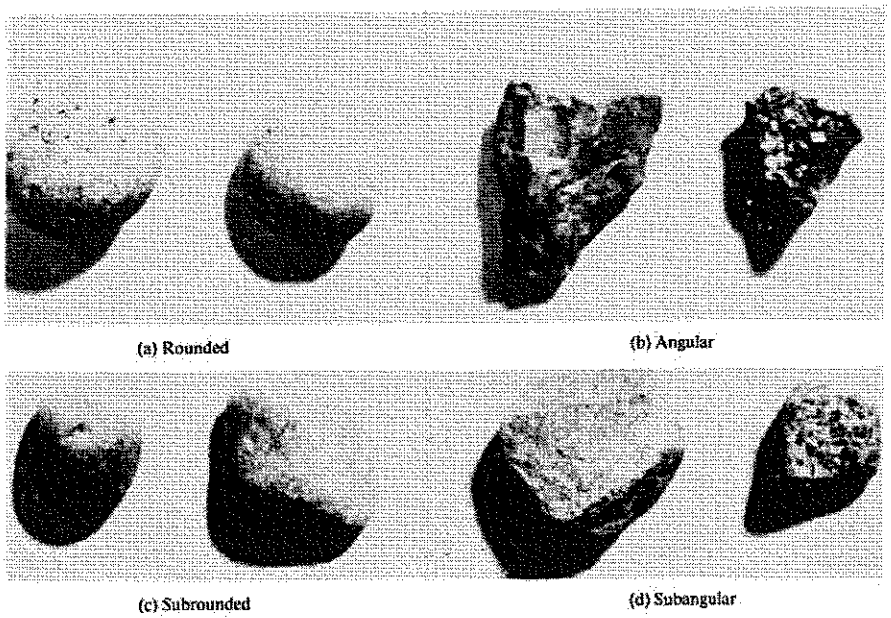


FIG. 3 Typical Angularity of Bulky Grains

TABLE 2 Criteria for Describing Particle Shape (see Fig. 4)

The particle shape shall be described as follows where length, width, and thickness refer to the greatest, intermediate, and least dimensions of a particle, respectively.	
Flat	Particles with width/thickness > 3
Elongated	Particles with length/width > 3
Flat and elongated	Particles meet criteria for both flat and elongated

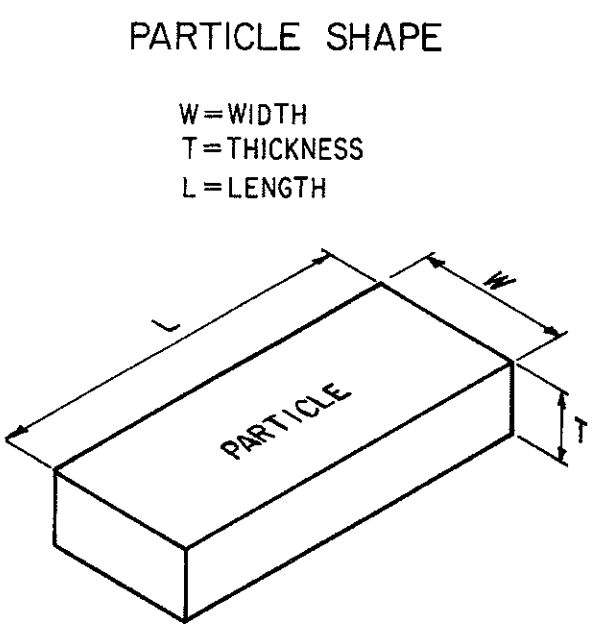


FIG. 4 Criteria for Particle Shape

10.7 *Consistency*—For intact fine-grained soil, describe the consistency as very soft, soft, firm, hard, or very hard, in accordance with the criteria in Table 5. This observation is inappropriate for soils with significant amounts of gravel.

10.8 *Cementation*—Describe the cementation of intact coarse-grained soils as weak, moderate, or strong, in accordance with the criteria in Table 6.

10.9 *Structure*—Describe the structure of intact soils in accordance with the criteria in Table 7.

10.10 *Range of Particle Sizes*—For gravel and sand components, describe the range of particle sizes within each component as defined in 3.1.2 and 3.1.6. For example, about 20 % fine to coarse gravel, about 40 % fine to coarse sand.

10.11 *Maximum Particle Size*—Describe the maximum particle size found in the sample in accordance with the following information:

10.11.1 *Sand Size*—If the maximum particle size is a sand size, describe as fine, medium, or coarse as defined in 3.1.6. For example: maximum particle size, medium sand.

10.11.2 *Gravel Size*—If the maximum particle size is a gravel size, describe the maximum particle size as the smallest sieve opening that the particle will pass. For example, maximum particle size, 1½ in. (will pass a 1½-in. square opening but not a ¾-in. square opening).

TABLE 3 Criteria for Describing Moisture Condition

Description	Criteria
Dry	Absence of moisture, dusty, dry to the touch
Moist	Damp but no visible water
Wet	Visible free water, usually soil is below water table

TABLE 4 Criteria for Describing the Reaction With HCl

Description	Criteria
None	No visible reaction
Weak	Some reaction, with bubbles forming slowly
Strong	Violent reaction, with bubbles forming immediately

TABLE 5 Criteria for Describing Consistency

Description	Criteria
Very soft	Thumb will penetrate soil more than 1 in. (25 mm)
Soft	Thumb will penetrate soil about 1 in. (25 mm)
Firm	Thumb will indent soil about ¼ in. (6 mm)
Hard	Thumb will not indent soil but readily indented with thumbnail
Very hard	Thumbnail will not indent soil

TABLE 6 Criteria for Describing Cementation

Description	Criteria
Weak	Crumbles or breaks with handling or little finger pressure
Moderate	Crumbles or breaks with considerable finger pressure
Strong	Will not crumble or break with finger pressure

TABLE 7 Criteria for Describing Structure

Description	Criteria
Stratified	Alternating layers of varying material or color with layers at least 6 mm thick; note thickness
Laminated	Alternating layers of varying material or color with the layers less than 6 mm thick; note thickness
Fissured	Breaks along definite planes of fracture with little resistance to fracturing
Slickensided	Fracture planes appear polished or glossy, sometimes striated
Blocky	Cohesive soil that can be broken down into small angular lumps which resist further breakdown
Lensed	Inclusion of small pockets of different soils, such as small lenses of sand scattered through a mass of clay; note thickness
Homogeneous	Same color and appearance throughout

10.11.3 *Cobble or Boulder Size*—If the maximum particle size is a cobble or boulder size, describe the maximum dimension of the largest particle. For example: maximum dimension, 18 in. (450 mm).

10.12 *Hardness*—Describe the hardness of coarse sand and larger particles as hard, or state what happens when the particles are hit by a hammer, for example, gravel-size particles fracture with considerable hammer blow, some gravel-size particles crumble with hammer blow. "Hard" means particles do not crack, fracture, or crumble under a hammer blow.

10.13 Additional comments shall be noted, such as the presence of roots or root holes, difficulty in drilling or augering hole, caving of trench or hole, or the presence of mica.

10.14 A local or commercial name or a geologic interpretation of the soil, or both, may be added if identified as such.

10.15 A classification or identification of the soil in accordance with other classification systems may be added if identified as such.

11. Identification of Peat

11.1 A sample composed primarily of vegetable tissue in various stages of decomposition that has a fibrous to amorphous texture, usually a dark brown to black color, and an organic odor, shall be designated as a highly organic soil and shall be identified as peat, PT, and not subjected to the identification procedures described hereafter.

12. Preparation for Identification

12.1 The soil identification portion of this practice is based on the portion of the soil sample that will pass a 3-in. (75-mm) sieve. The larger than 3-in. (75-mm) particles must be removed, manually, for a loose sample, or mentally, for an intact sample before classifying the soil.

12.2 Estimate and note the percentage of cobbles and the percentage of boulders. Performed visually, these estimates will be on the basis of volume percentage.

NOTE 9—Since the percentages of the particle-size distribution in Test Method D 2487 are by dry weight, and the estimates of percentages for gravel, sand, and fines in this practice are by dry weight, it is recommended that the report state that the percentages of cobbles and boulders are by volume.

12.3 Of the fraction of the soil smaller than 3 in. (75 mm), estimate and note the percentage, by dry weight, of the gravel, sand, and fines (see Appendix X4 for suggested procedures).

NOTE 10—Since the particle-size components appear visually on the basis of volume, considerable experience is required to estimate the percentages on the basis of dry weight. Frequent comparisons with laboratory particle-size analyses should be made.

12.3.1 The percentages shall be estimated to the closest 5 %. The percentages of gravel, sand, and fines must add up to 100 %.

12.3.2 If one of the components is present but not in sufficient quantity to be considered 5 % of the smaller than 3-in. (75-mm) portion, indicate its presence by the term *trace*, for example, trace of fines. A trace is not to be considered in the total of 100 % for the components.

13. Preliminary Identification

13.1 The soil is *fine grained* if it contains 50 % or more fines. Follow the procedures for identifying fine-grained soils of Section 14.

13.2 The soil is *coarse grained* if it contains less than 50 % fines. Follow the procedures for identifying coarse-grained soils of Section 15.

14. Procedure for Identifying Fine-Grained Soils

14.1 Select a representative sample of the material for examination. Remove particles larger than the No. 40 sieve (medium sand and larger) until a specimen equivalent to about a handful of material is available. Use this specimen for performing the dry strength, dilatancy, and toughness tests.

14.2 *Dry Strength*:

14.2.1 From the specimen, select enough material to mold into a ball about 1 in. (25 mm) in diameter. Mold the material until it has the consistency of putty, adding water if necessary.

14.2.2 From the molded material, make at least three test specimens. A test specimen shall be a ball of material about ½ in. (12 mm) in diameter. Allow the test specimens to dry in air, or sun, or by artificial means, as long as the temperature does not exceed 60°C.

14.2.3 If the test specimen contains natural dry lumps, those that are about ½ in. (12 mm) in diameter may be used in place of the molded balls.

NOTE 11—The process of molding and drying usually produces higher strengths than are found in natural dry lumps of soil.

14.2.4 Test the strength of the dry balls or lumps by crushing between the fingers. Note the strength as none, low, medium, high, or very high in accorance with the criteria in Table 8. If natural dry lumps are used, do not use the results of any of the lumps that are found to contain particles of coarse sand.

14.2.5 The presence of high-strength water-soluble cementing materials, such as calcium carbonate, may cause exceptionally high dry strengths. The presence of calcium carbonate can usually be detected from the intensity of the reaction with dilute hydrochloric acid (see 10.6).

14.3 *Dilatancy*:

14.3.1 From the specimen, select enough material to mold into a ball about ½ in. (12 mm) in diameter. Mold the material, adding water if necessary, until it has a soft, but not sticky, consistency.

14.3.2 Smooth the soil ball in the palm of one hand with the blade of a knife or small spatula. Shake horizontally, striking the side of the hand vigorously against the other hand several times. Note the reaction of water appearing on the surface of the soil. Squeeze the sample by closing the hand or pinching the soil between the fingers, and note the reaction as none, slow, or rapid in accordance with the criteria in Table 9. The reaction is the speed with which water appears while shaking, and disappears while squeezing.

14.4 *Toughness*:

14.4.1 Following the completion of the dilatancy test, the test specimen is shaped into an elongated pat and rolled by hand on a smooth surface or between the palms into a thread about ⅛ in. (3 mm) in diameter. (If the sample is too wet to roll easily, it should be spread into a thin layer and allowed to lose some water by evaporation.) Fold the sample threads and reroll repeatedly until the thread crumbles at a diameter of about ⅛ in. The thread will crumble at a diameter of ⅛ in. when the soil is near the plastic limit. Note the pressure required to roll the thread near the plastic limit. Also, note the strength of the thread. After the thread crumbles, the pieces should be lumped together and kneaded until the lump crumbles. Note the toughness of the material during kneading.

14.4.2 Describe the toughness of the thread and lump as low, medium, or high in accordance with the criteria in Table 10.

14.5 *Plasticity*—On the basis of observations made during the toughness test, describe the plasticity of the material in accordance with the criteria given in Table 11.

14.6 Decide whether the soil is an *inorganic* or an *organic* fine-grained soil (see 14.8). If inorganic, follow the steps given in 14.7.

14.7 *Identification of Inorganic Fine-Grained Soils*:

14.7.1 Identify the soil as a *lean clay*, CL, if the soil has medium to high dry strength, no or slow dilatancy, and medium toughness and plasticity (see Table 12).

14.7.2 Identify the soil as a *fat clay*, CH, if the soil has high to very high dry strength, no dilatancy, and high toughness and plasticity (see Table 12).

14.7.3 Identify the soil as a *silt*, ML, if the soil has no to low dry strength, slow to rapid dilatancy, and low toughness and plasticity, or is nonplastic (see Table 12).

14.7.4 Identify the soil as an *elastic silt*, MH, if the soil has low to medium dry strength, no to slow dilatancy, and low to medium toughness and plasticity (see Table 12).

NOTE 12—These properties are similar to those for a lean clay. However, the silt will dry quickly on the hand and have a smooth, silky feel when dry. Some soils that would classify as MH in accordance with the criteria in Test Method D 2487 are visually difficult to distinguish from lean clays, CL. It may be necessary to perform laboratory testing for proper identification.

14.8 *Identification of Organic Fine-Grained Soils*:

14.8.1 Identify the soil as an *organic soil*, OL/OH, if the soil contains enough organic particles to influence the soil properties. Organic soils usually have a dark brown to black color and may have an organic odor. Often, organic soils will change

TABLE 8 Criteria for Describing Dry Strength

Description	Criteria
None	The dry specimen crumbles into powder with mere pressure of handling
Low	The dry specimen crumbles into powder with some finger pressure
Medium	The dry specimen breaks into pieces or crumbles with considerable finger pressure
High	The dry specimen cannot be broken with finger pressure. Specimen will break into pieces between thumb and a hard surface
Very high	The dry specimen cannot be broken between the thumb and a hard surface

TABLE 9 Criteria for Describing Dilatancy

Description	Criteria
None	No visible change in the specimen
Slow	Water appears slowly on the surface of the specimen during shaking and does not disappear or disappears slowly upon squeezing
Rapid	Water appears quickly on the surface of the specimen during shaking and disappears quickly upon squeezing

TABLE 10 Criteria for Describing Toughness

Description	Criteria
Low	Only slight pressure is required to roll the thread near the plastic limit. The thread and the lump are weak and soft
Medium	Medium pressure is required to roll the thread to near the plastic limit. The thread and the lump have medium stiffness
High	Considerable pressure is required to roll the thread to near the plastic limit. The thread and the lump have very high stiffness

TABLE 11 Criteria for Describing Plasticity

Description	Criteria
Nonplastic	A ⅛-in. (3-mm) thread cannot be rolled at any water content
Low	The thread can barely be rolled and the lump cannot be formed when drier than the plastic limit
Medium	The thread is easy to roll and not much time is required to reach the plastic limit. The thread cannot be rerolled after reaching the plastic limit. The lump crumbles when drier than the plastic limit
High	It takes considerable time rolling and kneading to reach the plastic limit. The thread can be rerolled several times after reaching the plastic limit. The lump can be formed without crumbling when drier than the plastic limit

TABLE 12 Identification of Inorganic Fine-Grained Soils from Manual Tests

Soil Symbol	Dry Strength	Dilatancy	Toughness
ML	None to low	Slow to rapid	Low or thread cannot be formed
CL	Medium to high	None to slow	Medium
MH	Low to medium	None to slow	Low to medium
CH	High to very high	None	High

color, for example, black to brown, when exposed to the air. Some organic soils will lighten in color significantly when air dried. Organic soils normally will not have a high toughness or plasticity. The thread for the toughness test will be spongy.

NOTE 13—In some cases, through practice and experience, it may be possible to further identify the organic soils as organic silts or organic clays, OL or OH. Correlations between the dilatancy, dry strength, toughness tests, and laboratory tests can be made to identify organic soils in certain deposits of similar materials of known geologic origin.

14.9 If the soil is estimated to have 15 to 25 % sand or gravel, or both, the words "with sand" or "with gravel" (whichever is more predominant) shall be added to the group name. For example: "lean clay with sand, CL" or "silt with gravel, ML" (see Fig. 1a and Fig. 1b). If the percentage of sand is equal to the percentage of gravel, use "with sand."

14.10 If the soil is estimated to have 30 % or more sand or gravel, or both, the words "sandy" or "gravelly" shall be added to the group name. Add the word "sandy" if there appears to be more sand than gravel. Add the word "gravelly" if there appears to be more gravel than sand. For example: "sandy lean clay, CL", "gravelly fat clay, CH", or "sandy silt, ML" (see Fig. 1a and Fig. 1b). If the percentage of sand is equal to the percent of gravel, use "sandy."

15. Procedure for Identifying Coarse-Grained Soils

(Contains less than 50 % fines)

15.1 The soil is a *gravel* if the percentage of gravel is estimated to be more than the percentage of sand.

15.2 The soil is a *sand* if the percentage of gravel is estimated to be equal to or less than the percentage of sand.

15.3 The soil is a *clean gravel* or *clean sand* if the percentage of fines is estimated to be 5 % or less.

15.3.1 Identify the soil as a *well-graded gravel*, GW, or as a *well-graded sand*, SW, if it has a wide range of particle sizes and substantial amounts of the intermediate particle sizes.

15.3.2 Identify the soil as a *poorly graded gravel*, GP, or as a *poorly graded sand*, SP, if it consists predominantly of one size (uniformly graded), or it has a wide range of sizes with some intermediate sizes obviously missing (gap or skip graded).

15.4 The soil is either a *gravel with fines* or a *sand with fines* if the percentage of fines is estimated to be 15 % or more.

15.4.1 Identify the soil as a *clayey gravel*, GC, or a *clayey sand*, SC, if the fines are clayey as determined by the procedures in Section 14.

15.4.2 Identify the soil as a *silty gravel*, GM, or a *silty sand*, SM, if the fines are silty as determined by the procedures in Section 14.

15.5 If the soil is estimated to contain 10 % fines, give the soil a dual identification using two group symbols.

15.5.1 The first group symbol shall correspond to a clean gravel or sand (GW, GP, SW, SP) and the second symbol shall correspond to a gravel or sand with fines (GC, GM, SC, SM).

15.5.2 The group name shall correspond to the first group symbol plus the words "with clay" or "with silt" to indicate the plasticity characteristics of the fines. For example: "well-graded gravel with clay, GW-GC" or "poorly graded sand with silt, SP-SM" (see Fig. 2).

15.6 If the specimen is predominantly sand or gravel but contains an estimated 15 % or more of the other coarse-grained constituent, the words "with gravel" or "with sand" shall be added to the group name. For example: "poorly graded gravel with sand, GP" or "clayey sand with gravel, SC" (see Fig. 2).

15.7 If the field sample contains any cobbles or boulders, or both, the words "with cobbles" or "with cobbles and boulders" shall be added to the group name. For example: "silty gravel with cobbles, GM."

16. Report

16.1 The report shall include the information as to origin, and the items indicated in Table 13.

NOTE 14—*Example: Clayey Gravel with Sand and Cobbles, GC*—About 50 % fine to coarse, subrounded to subangular gravel; about 30 % fine to coarse, subrounded sand; about 20 % fines with medium plasticity, high dry strength, no dilatancy, medium toughness; weak reaction with HCl; original field sample had about 5 % (by volume) subrounded cobbles, maximum dimension, 150 mm.

In-Place Conditions—Firm, homogeneous, dry, brown

Geologic Interpretation—Alluvial fan

NOTE 15—Other examples of soil descriptions and identification are given in Appendix X1 and Appendix X2.

NOTE 16—If desired, the percentages of gravel, sand, and fines may be stated in terms indicating a range of percentages, as follows:

Trace—Particles are present but estimated to be less than 5 %

Few—5 to 10 %

Little—15 to 25 %

Some—30 to 45 %

Mostly—50 to 100 %

16.2 If, in the soil description, the soil is identified using a classification group symbol and name as described in Test Method D 2487, it must be distinctly and clearly stated in log forms, summary tables, reports, and the like, that the symbol and name are based on visual-manual procedures.

17. Precision and Bias

17.1 This practice provides qualitative information only, therefore, a precision and bias statement is not applicable.

TABLE 13 Checklist for Description of Soils

1. Group name
2. Group symbol
3. Percent of cobbles or boulders, or both (by volume)
4. Percent of gravel, sand, or fines, or all three (by dry weight)
5. Particle-size range:
   Gravel—fine, coarse
   Sand—fine, medium, coarse
6. Particle angularity: angular, subangular, subrounded, rounded
7. Particle shape: (if appropriate) flat, elongated, flat and elongated
8. Maximum particle size or dimension
9. Hardness of coarse sand and larger particles
10. Plasticity of fines: nonplastic, low, medium, high
11. Dry strength: none, low, medium, high, very high
12. Dilatancy: none, slow, rapid
13. Toughness: low, medium, high
14. Color (in moist condition)
15. Odor (mention only if organic or unusual)
16. Moisture: dry, moist, wet
17. Reaction with HCl: none, weak, strong

For intact samples:

18. Consistency (fine-grained soils only): very soft, soft, firm, hard, very hard
19. Structure: stratified, laminated, fissured, slickensided, lensed, homogeneous
20. Cementation: weak, moderate, strong
21. Local name
22. Geologic interpretation
23. Additional comments: presence of roots or root holes, presence of mica, gypsum, etc., surface coatings on coarse-grained particles, caving or sloughing of auger hole or trench sides, difficulty in augering or excavating, etc.

18. Keywords

18.1 classification; clay; gravel; organic soils; sand; silt; soil classification; soil description; visual classification

APPENDIXES

(Nonmandatory Information)

X1. EXAMPLES OF VISUAL SOIL DESCRIPTIONS

X1.1 The following examples show how the information required in 16.1 can be reported. The information that is included in descriptions should be based on individual circumstances and need.

X1.1.1 *Well-Graded Gravel with Sand (GW)*—About 75 % fine to coarse, hard, subangular gravel; about 25 % fine to coarse, hard, subangular sand; trace of fines; maximum size, 75 mm, brown, dry; no reaction with HCl.

X1.1.2 *Silty Sand with Gravel (SM)*—About 60 % predominantly fine sand; about 25 % silty fines with low plasticity, low dry strength, rapid dilatancy, and low toughness; about 15 % fine, hard, subrounded gravel, a few gravel-size particles fractured with hammer blow; maximum size, 25 mm; no reaction with HCl (Note—Field sample size smaller than recommended).

In-Place Conditions—Firm, stratified and contains lenses of silt 1 to 2 in. (25 to 50 mm) thick, moist, brown to gray; in-place density 106 lb/ft^3; in-place moisture 9 %.

X1.1.3 *Organic Soil (OL/OH)*—About 100 % fines with low plasticity, slow dilatancy, low dry strength, and low toughness; wet, dark brown, organic odor; weak reaction with HCl.

X1.1.4 *Silty Sand with Organic Fines (SM)*—About 75 % fine to coarse, hard, subangular reddish sand; about 25 % organic and silty dark brown nonplastic fines with no dry strength and slow dilatancy; wet; maximum size, coarse sand; weak reaction with HCl.

X1.1.5 *Poorly Graded Gravel with Silt, Sand, Cobbles and Boulders (GP-GM)*—About 75 % fine to coarse, hard, subrounded to subangular gravel; about 15 % fine, hard, subrounded to subangular sand; about 10 % silty nonplastic fines; moist, brown; no reaction with HCl; original field sample had about 5 % (by volume) hard, subrounded cobbles and a trace of hard, subrounded boulders, with a maximum dimension of 18 in. (450 mm).

X2. USING THE IDENTIFICATION PROCEDURE AS A DESCRIPTIVE SYSTEM FOR SHALE, CLAYSTONE, SHELLS, SLAG, CRUSHED ROCK, AND THE LIKE

X2.1 The identification procedure may be used as a descriptive system applied to materials that exist in-situ as shale, claystone, sandstone, siltstone, mudstone, etc., but convert to soils after field or laboratory processing (crushing, slaking, and the like).

X2.2 Materials such as shells, crushed rock, slag, and the like, should be identified as such. However, the procedures used in this practice for describing the particle size and plasticity characteristics may be used in the description of the material. If desired, an identification using a group name and symbol according to this practice may be assigned to aid in describing the material.

X2.3 The group symbol(s) and group names should be placed in quotation marks or noted with some type of distinguishing symbol. See examples.

X2.4 Examples of how group names and symbols can be incororated into a descriptive system for materials that are not naturally occurring soils are as follows:

X2.4.1 *Shale Chunks*—Retrieved as 2 to 4-in. (50 to 100-mm) pieces of shale from power auger hole, dry, brown, no reaction with HCl. After slaking in water for 24 h, material identified as "Sandy Lean Clay (CL)"; about 60 % fines with medium plasticity, high dry strength, no dilatancy, and medium toughness; about 35 % fine to medium, hard sand; about 5 % gravel-size pieces of shale.

X2.4.2 *Crushed Sandstone*—Product of commercial crushing operation; "Poorly Graded Sand with Silt (SP-SM)"; about 90 % fine to medium sand; about 10 % nonplastic fines; dry, reddish-brown.

X2.4.3 *Broken Shells*—About 60 % uniformly graded gravel-size broken shells; about 30 % sand and sand-size shell pieces; about 10 % nonplastic fines; "Poorly Graded Gravel with Silt and Sand (GP-GM)."

X2.4.4 *Crushed Rock*—Processed from gravel and cobbles in Pit No. 7; "Poorly Graded Gravel (GP)"; about 90 % fine, hard, angular gravel-size particles; about 10 % coarse, hard, angular sand-size particles; dry, tan; no reaction with HCl.

X3. SUGGESTED PROCEDURE FOR USING A BORDERLINE SYMBOL FOR SOILS WITH TWO POSSIBLE IDENTIFICATIONS.

X3.1 Since this practice is based on estimates of particle size distribution and plasticity characteristics, it may be difficult to clearly identify the soil as belonging to one category. To indicate that the soil may fall into one of two possible basic groups, a borderline symbol may be used with the two symbols separated by a slash. For example: SC/CL or CL/CH.

X3.1.1 A borderline symbol may be used when the percentage of fines is estimated to be between 45 and 55 %. One symbol should be for a coarse-grained soil with fines and the other for a fine-grained soil. For example: GM/ML or CL/SC.

X3.1.2 A borderline symbol may be used when the percentage of sand and the percentage of gravel are estimated to be about the same. For example: GP/SP, SC/GC, GM/SM. It is practically impossible to have a soil that would have a borderline symbol of GW/SW.

X3.1.3 A borderline symbol may be used when the soil could be either well graded or poorly graded. For example: GW/GP, SW/SP.

X3.1.4 A borderline symbol may be used when the soil could either be a silt or a clay. For example: CL/ML, CH/MH, SC/SM.

X3.1.5 A borderline symbol may be used when a fine-grained soil has properties that indicate that it is at the boundary between a soil of low compressibility and a soil of high compressibility. For example: CL/CH, MH/ML.

X3.2 The order of the borderline symbols should reflect similarity to surrounding or adjacent soils. For example: soils in a borrow area have been identified as CH. One sample is considered to have a borderline symbol of CL and CH. To show similarity, the borderline symbol should be CH/CL.

X3.3 The group name for a soil with a borderline symbol should be the group name for the first symbol, except for:

CL/CH lean to fat clay
ML/CL clayey silt
CL/ML silty clay

X3.4 The use of a borderline symbol should not be used indiscriminately. Every effort shall be made to first place the soil into a single group.

X4. SUGGESTED PROCEDURES FOR ESTIMATING THE PERCENTAGES OF GRAVEL, SAND, AND FINES IN A SOIL SAMPLE

X4.1 *Jar Method*—The relative percentage of coarse- and fine-grained material may be estimated by thoroughly shaking a mixture of soil and water in a test tube or jar, and then allowing the mixture to settle. The coarse particles will fall to the bottom and successively finer particles will be deposited with increasing time; the sand sizes will fall out of suspension in 20 to 30 s. The relative proportions can be estimated from the relative volume of each size separate. This method should be correlated to particle-size laboratory determinations.

X4.2 *Visual Method*—Mentally visualize the gravel size particles placed in a sack (or other container) or sacks. Then, do the same with the sand size particles and the fines. Then, mentally compare the number of sacks to estimate the percentage of plus No. 4 sieve size and minus No. 4 sieve size present. The percentages of sand and fines in the minus sieve size No. 4 material can then be estimated from the wash test (X4.3).

X4.3 *Wash Test (for relative percentages of sand and fines)*—Select and moisten enough minus No. 4 sieve size material to form a 1-in (25-mm) cube of soil. Cut the cube in half, set one-half to the side, and place the other half in a small dish. Wash and decant the fines out of the material in the dish until the wash water is clear and then compare the two samples and estimate the percentage of sand and fines. Remember that the percentage is based on weight, not volume. However, the volume comparison will provide a reasonable indication of grain size percentages.

X4.3.1 While washing, it may be necessary to break down lumps of fines with the finger to get the correct percentages.

X5. ABBREVIATED SOIL CLASSIFICATION SYMBOLS

X5.1 In some cases, because of lack of space, an abbreviated system may be useful to indicate the soil classification symbol and name. Examples of such cases would be graphical logs, databases, tables, etc.

X5.2 This abbreviated system is not a substitute for the full name and descriptive information but can be used in supplementary presentations when the complete description is referenced.

X5.3 The abbreviated system should consist of the soil classification symbol based on this standard with appropriate lower case letter prefixes and suffixes as:

Prefix:	Suffix:
s = sandy	s = with sand
g = gravelly	g = with gravel
	c = with cobbles
	b = with boulders

X5.4 The soil classification symbol is to be enclosed in parenthesis. Some examples would be:

Group Symbol and Full Name	Abbreviated
CL, Sandy lean clay	s(CL)
SP-SM, Poorly graded sand with silt and gravel	(SP-SM)g
GP, poorly graded gravel with sand, cobbles, and boulders	(GP)scb
ML, gravelly silt with sand and cobbles	g(ML)sc

SUMMARY OF CHANGES

In accordance with Committee D18 policy, this section identifies the location of changes to this standard since the last edition (2000) that may impact the use of this standard.

(1) Revised footnote numbering in Reference Section.

(2) Revised classification example in X2.4.2 and X2.4.3.

STANDARD OPERATING PROCEDURE
SONIC DRILLING
SOP 7

This standard operating procedure (SOP) describes procedures for sonic drilling soil borings, soil sampling, and monitoring well installation. Because each site is unique, these procedures should be viewed as guidelines and will likely require modification based on site and subsurface conditions present.

This SOP is intended as an overview and description of techniques for field personnel overseeing sonic drilling projects, and is not intended to guide subcontract drilling personnel in specific drilling techniques.

SONIC DRILLING OVERVIEW

Sonic drilling consists of a dual-cased system that uses high frequency mechanical vibration to collect intact, minimally disturbed continuous core soil samples, and to advance drill casing into the ground for well construction. The sonic drilling system may also utilize low speed rotational motion along with down-pressure to advance the drill bit. Sonic drilling is also referred to as Rotasonic, Rotosonic, Sonicore, Vibratory, and Resonantsonic drilling.

Advantage of using sonic drilling are that it provides a unique combination of low disturbance, large diameter continuous cores, high soil sample quality, and relatively fast drilling rates in deep gravel conditions. The outer casing prevents cross-contamination when drilling through contaminated zones or multiple aquifers. Sonic drilling also generates as much as 50% less investigation-derived waste soil cuttings compared to other common drilling methods.

The core barrel and drill rods are equipped with right hand threads and are rotated in a clockwise direction. The outer casing is equipped with left hand threads and is rotated in a counter-clockwise direction during drilling. In this manner, the core barrel and drill rods are not unscrewed as the outer casing is advanced.

Sonic Drilling Procedures

Down-hole drill tools and samplers will be steam-cleaned prior to arrival onsite and between each borehole location to minimize the potential for cross-contamination between borehole. Either a temporary decontamination pad will be constructed or a self-contained steam cleaning trailer will be used for steam cleaning the drilling tools and downhole equipment. All IDW generated during drilling, sampling, and decontamination will be containerized until characterized for disposal.

During drilling, the inner drill rods and core barrel may be advanced ahead of the outer casing to obtain a relatively undisturbed core sample. While drilling fluids (air or water) are occasionally used with sonic drilling, for environmental applications it is generally preferable not to add drilling fluids to the formation.

Soil samples are be collected and logged on a continuous basis during drilling as described below. Drill cuttings will be observed by the field geologist and each borehole will be logged in general accordance with ASTM D 2488, as described in the soil logging SOP (SOP 1).

In general, soil samples are recovered if possible using a ten-foot long, four-inch diameter core barrel advanced during drilling to yield a continuous core. The sample core may be extruded directly from the core barrel into a plastic sleeve, or onto a sampling table for observation. Samples may be collected with clear plastic or stainless steel liners placed inside the core barrel. Each ten-foot long core section will typically be

subdivided into shorter sections placed in new clear plastic bags, and laid out in sequence for logging. A geologist will visually inspect all recovered samples, and perform any required field screening and sample collection.

Upon drilling completion, the boring will be abandoned by pumping full of bentonite grout, with an asphalt or concrete surface patch placed at the surface. Refer to the sampling and analysis plan (SAP) and Work Plan for details of the soil boring, including sample depth, boring total depth, and media analytical testing.

Telescoped Drilling

In order to isolate any potentially contaminated shallow groundwater, an oversized steel transmission casing can be installed from the ground surface, penetrating five to ten feet (or another appropriate distance) into the water table. A bentonite seal can be placed inside the base of the casing, and drilling continued using smaller-diameter steel casing. The temporary steel transmission casings can then be removed during monitoring well construction. This "telescoping" method is an industry standard protection for drilling through contaminated or potentially-contaminated aquifers. Once drilling reaches the desired depth, the drill bit is removed from the boring, the conductor casing backed out of the hole approximately two feet, and high density bentonite grout is placed in the bottom of the borehole and mechanically pushed into the borehole, forcing it laterally into the surrounding soil formation and outside the conductor casing annulus. Then a smaller diameter drill casing is used to drill the deeper borehole. As the monitoring well is constructed, the drill string is backed out of the hole and sealed above the well's screened interval using pressurized bentonite grout below the water table. If no monitoring well is to be installed in the boring, the boring will be pumped full of bentonite grout as describe above.

Typical Well Installation Procedures

Wells are typically constructed as described below:

- Depending on the well location and depth, the sand filter pack will be installed by manually pouring sand from the ground surface as described below. The sand level will be measured with a stainless steel weighted tape during placement to detect bridging.
- The well casing will be surged and/or bailed with a clean surge block, stainless steel bailer, or submersible pump during placement of the sand pack and prior to the placement of bentonite in order to settle the sand pack. Sand pack settlement will be monitored by sounding until no further settlement is observed. Sand will be placed to one foot above the screen to prevent bentonite migration into the screen.
- After surging and confirming that the top of the sand pack reaches one foot above the top of the screen, bentonite will be installed to a depth of approximately one-foot below ground surface (bgs).
- The top of the well casing will be cut uniform and flat such that it is at a depth just below grade. A file will be used to cut a "reference mark" on the outside of the well casing.
- A protective monument will be installed flush to grade and the well casing will be furnished with a locking cap.
- Upon completion, the total depth of the well will be sounded such that construction details can be recorded to 0.01-foot accuracy. Total depth (length) of well, sump interval, screen intervals, and top of well below grade will be calculated and recorded. The top of the flush monument will represent ground datum unless a monument is set next to the well completion.

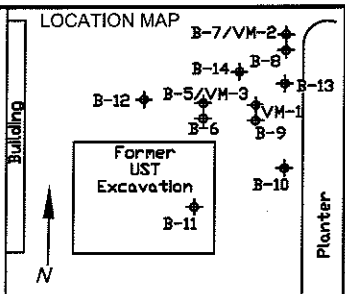
- Well logs and drilling reports will be furnished to the appropriate regulatory agency as required under state law.
- All information regarding soil conditions encountered in the boreholes and well construction details will be recorded on the Soil Borehole Log Form as described in SOP 1 (Logging of Soil Boreholes).

APPENDIX B

BORING AND SVE WELL CONSTRUCTION LOGS

PNG ENVIRONMENTAL, INC.
6665 SW Hampton, Suite 101
Tigard, Oregon 97223
TEL (503) 620-2387
FAX (503) 620-2977

LOCATION MAP



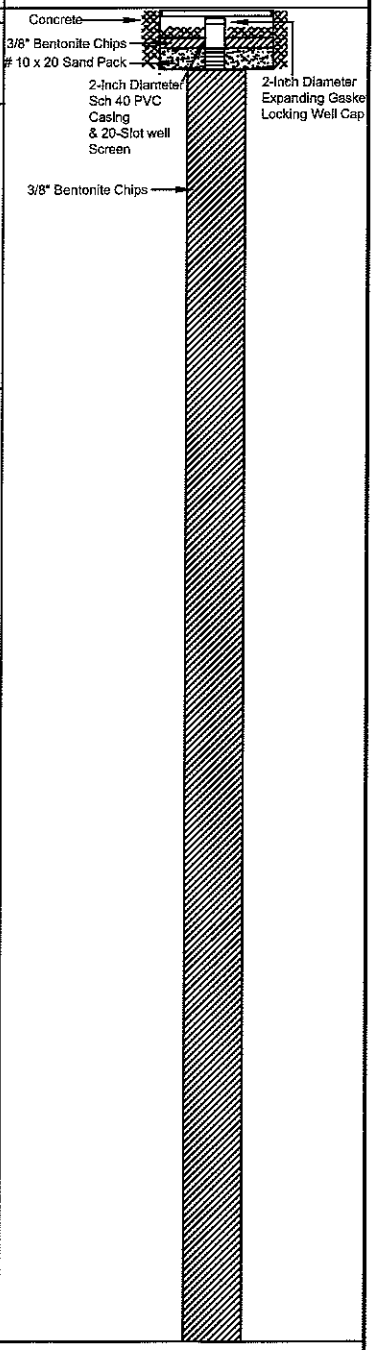
WELL/BORING NUMBER **B-5/VM-3**

PROJECT NAME: Plaid # 324
PROJECT NUMBER: 1133
LOCATION: West Seattle, Washington
LOGGED BY: Dan Becraft
REVIEWED BY: Paul Ecker
DATE: 7/16/08

SAMPLE INFORMATION

SAMPLE TYPE	BLOW COUNTS	PID (ppm)	First Water	LAB SAMPLE I.D.	DEPTH bgs (ft)	STRATA	SOIL TYPE	DESCRIPTION (USCS Classification, Depth Interval, Color, Grain Size, Plasticity, Shapes, Mineral Size, Density or Consistency, Moisture, Odor, Geological Interpretation)
								Asphalt
							GP	SANDY GRAVEL (GP), brown, subrounded to 2-inch diameter, fine and medium grained sand, occasional cobble, some fines, dry.
		452					SM	SILTY SAND (SM), gray, fine grained,dry, staining and hydrocarbon odor.
G		479		B-5@4'	5		SM-ML	Increasing silt content (SM-ML), moist.
G		159		B-5@7'				@ 7.5 ft: color change to brown.
		6.1			10		GP	SANDY GRAVEL (GP), brown, gravel subrounded to 2-inch diameter, fine-medium grained sand, dry.
		16						
G				B-5@12'				Between 12 and 15 ft: higher sand content (GP-SP).
		13.8			15			
		13						
G				B-5@17'				
		2.1					SP	SAND (SP), brown, medium grained, moist-damp.
					20		GP	As Above.
		9.2						Between 20 and 25 ft: high coarse grained sand content.
G				B-5@22'				
		2.8			25			Between 25 and 27 ft: high medium sand content .
		0.5						
G				B-5@28'				
		6.0			30			
		8.5						
G				B-5@34'	35			Between 34 and 36 ft: high medium sand content .

BOREHOLE/WELL CONSTRUCTION DETAIL



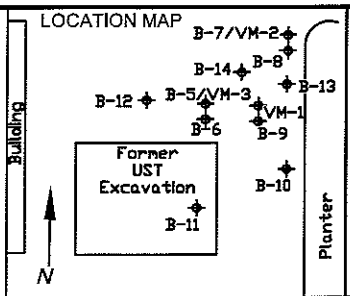
DRILLING CONTRACTOR: Boart-Longyear
DRILLING METHOD: Sonic
SAMPLING METHOD: Continuous Core
DRILLING START TIME: 2:45
DRILLING END TIME: 4:30

WELL I.D.: BAJ208

TIME	DATE	DTW

PNG ENVIRONMENTAL, INC.
6665 SW Hampton, Suite 101
Tigard, Oregon 97223
TEL (503) 620-2387
FAX (503) 620-2977

LOCATION MAP



WELL/BORING NUMBER **B-5/VM-3**

PROJECT NAME: Plaid # 324
PROJECT NUMBER: 1133
LOCATION: West Seattle, Washington
LOGGED BY: Dan Becraft
REVIEWED BY: Paul Ecker
DATE: 7/16/08

SAMPLE INFORMATION									STRATA	SOIL TYPE	DESCRIPTION (USCS Classification, Depth Interval, Color, Grain Size, Plasticity, Shapes, Mineral Size, Density or Consistency, Moisture, Odor, Geological Interpretation)	BOREHOLE/WELL CONSTRUCTION DETAIL
SAMPLE TYPE	BLOW COUNTS	PID (ppm)		First Water	LAB SAMPLE I.D.	DEPTH bgs (ft)	SAMPLE LOCATION	SAMPLE INTERVAL / REC %				
		3.8								GP	SANDY GRAVEL (GP), continued	
											Between 37 ft and 40 ft:cemented sand clasts, friable, dry.	3/8" Bentonite Chips
G		3.8			B-5@39'							
						40					Total Boring Depth - 40'	
						45						
						50						
						55						
						60						
						65						
						70						

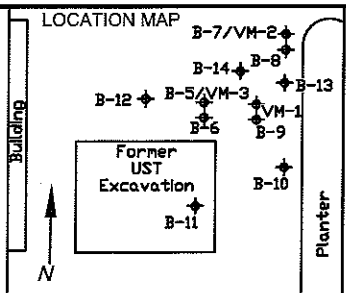
DRILLING CONTRACTOR: Boart-Longyear
DRILLING METHOD: Sonic
SAMPLING METHOD: Continuous Core
DRILLING START TIME: 2:45
DRILLING END TIME: 4:30

WELL I.D.: BAJ208

TIME	DATE	DTW

PNG ENVIRONMENTAL, INC.
6665 SW Hampton, Suite 101
Tigard, Oregon 97223
TEL (503) 620-2387
FAX (503) 620-2977

LOCATION MAP



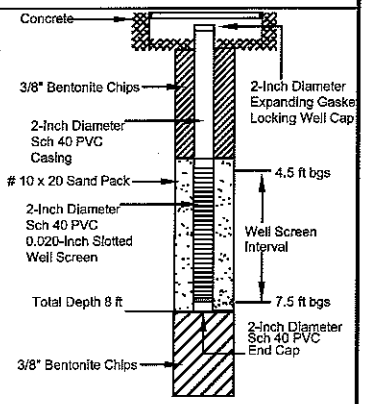
WELL/BORING NUMBER **B-6**
Page 1 of 1

PROJECT NAME: Plaid # 324
PROJECT NUMBER: 1133
LOCATION: West Seattle, Washington
LOGGED BY: Dan Becraft
REVIEWED BY: Paul Ecker
DATE: 7/17/08

SAMPLE INFORMATION

SAMPLE TYPE	BLOW COUNTS	PID (ppm)	First Water	LAB SAMPLE I.D.	DEPTH bgs (ft)	SAMPLE LOCATION	SAMPLE INTERVAL	REC %	STRATA	SOIL TYPE	DESCRIPTION (USCS Classification, Depth Interval, Color, Grain Size, Plasticity, Shapes, Mineral Size, Density or Consistency, Moisture, Odor, Geological Interpretation)
											Asphalt
		193								GP	SANDY GRAVEL (GP), brown, subrounded to 2-inch diameter, fine and medium grained sand, occasional cobble, some fines, dry.
											SILTY SAND (SM) brown, medium grained, moist.
G		800		B-6@4'	5						Between 3ft and 5ft: gray staining/discoloration, hydrocarbon odor.
		505									
G		53		B-6@9'							
					10					GP	GRAVEL (GP)
											Total Boring Depth 10 ft
					15						
					20						
					25						
					30						
					35						

BOREHOLE/WELL CONSTRUCTION DETAIL



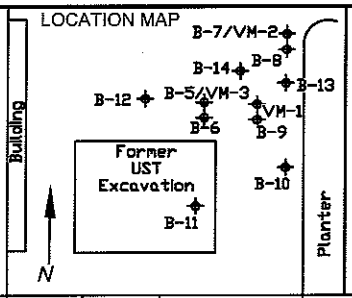
DRILLING CONTRACTOR: Boart-Longyear
DRILLING METHOD: Sonic
SAMPLING METHOD: Continuous Core
DRILLING START TIME: 11:10
DRILLING END TIME: 12:15

WELL I.D.: BAJ211

TIME	DATE	DTW

PNG ENVIRONMENTAL, INC.
6665 SW Hampton, Suite 101
Tigard, Oregon 97223
TEL (503) 620-2387
FAX (503) 620-2977

LOCATION MAP



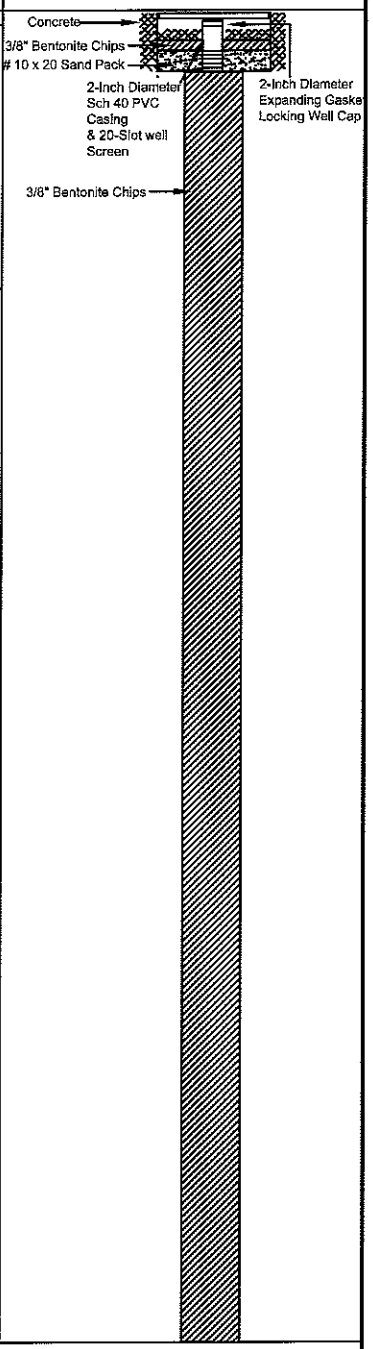
WELL/BORING NUMBER **B-7/VM-2**
Page 1 of 1

PROJECT NAME: Plaid # 324
PROJECT NUMBER: 1133
LOCATION: West Seattle, Washington
LOGGED BY: Dan Becraft
REVIEWED BY: Paul Ecker
DATE: 7/16/08

SAMPLE INFORMATION

SAMPLE TYPE	BLOW COUNTS	PID (ppm)	First Water	LAB SAMPLE I.D.	DEPTH bgs (ft)	SAMPLE LOCATION	SAMPLE INTERVAL	REC %	STRATA	SOIL TYPE	DESCRIPTION (USCS Classification, Depth Interval, Color, Grain Size, Plasticity, Shapes, Mineral Size, Density or Consistency, Moisture, Odor, Geological Interpretation)
											Asphalt
										SM-ML	SILTY SAND-SANDY SILT (SM-ML), brown, fine to medium grained,occasional gravel, dry,
		5.3									@2.5 ft: moist.
G		5.6		B-7@4'	5						@5 ft: gray, hydrocarbon odor.
		427									Between 6 and 7 ft: staining
G				B-7@8'						ML-SM	Increasing silt content: (ML-SM).
		493									
G		33.7		B-7@11'	10						@11 ft: dry.
		4.5								SP	SAND (SP), brown, medium grained some coarse sand, moist.
		0.9			15					GP	SANDY GRAVEL (GP), brown, gravel subangular to subrounded to 3-inch diameter, fine-medium grained sand, occational cobble, moist.
G		0		B-7@19'							As Above.
G		8.1		B-7@21'	20						Between 20 and 25 ft: high coarse grained sand content.
		3.0									
G		12		B-7@26'	25						Between 25 and 27 ft: high medium sand content .
		3.4									
		2.5			30						
		3.9									
G				B-7@34'	35						Between 34 and 36 ft: high medium sand content .

BOREHOLE/WELL CONSTRUCTION DETAIL



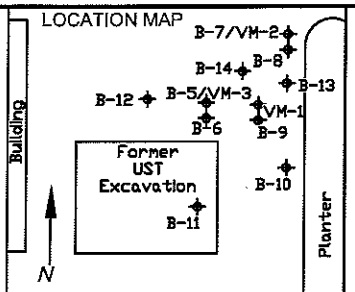
DRILLING CONTRACTOR: Boart-Longyear
DRILLING METHOD: Sonic
SAMPLING METHOD: Continuous Core
DRILLING START TIME: 11:20
DRILLING END TIME:1:00

WELL I.D.: BAJ207

TIME	DATE	DTW

PNG ENVIRONMENTAL, INC.
6665 SW Hampton, Suite 101
Tigard, Oregon 97223
TEL (503) 620-2387
FAX (503) 620-2977

LOCATION MAP



WELL/BORING NUMBER **B-7/VM-2**

PROJECT NAME: Plaid # 324
PROJECT NUMBER: 1133
LOCATION: West Seattle, Washington
LOGGED BY: Dan Becraft
REVIEWED BY: Paul Ecker
DATE: 7/16/08

SAMPLE INFORMATION								STRATA	SOIL TYPE	DESCRIPTION (USCS Classification, Depth Interval, Color, Grain Size, Plasticity, Shapes, Mineral Size, Density or Consistency, Moisture, Odor, Geological Interpretation)	BOREHOLE/WELL CONSTRUCTION DETAIL
SAMPLE TYPE	BLOW COUNTS	PID (ppm)	First Water	LAB SAMPLE I.D.	DEPTH bgs (ft)	SAMPLE LOCATION / SAMPLE INTERVAL	REC %				
		3.9							GP	SANDY GRAVEL (GP), continued	3/8" Bentonite Chips
G		2.7		B-7@39'						@ 39 ft:cemented sand clasts, friable, dry.	
					40					Total Boring Depth - 40'	
					45						
					50						
					55						
					60						
					65						
					70						

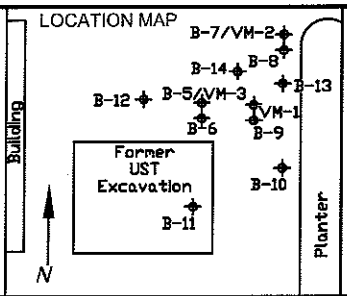
DRILLING CONTRACTOR: Boart-Longyear
DRILLING METHOD: Sonic
SAMPLING METHOD: Continuous Core
DRILLING START TIME: 11:20
DRILLING END TIME: 1:00

WELL I.D.: BAJ207

TIME	DATE	DTW

PNG ENVIRONMENTAL, INC.
6665 SW Hampton, Suite 101
Tigard, Oregon 97223
TEL (503) 620-2387
FAX (503) 620-2977

LOCATION MAP



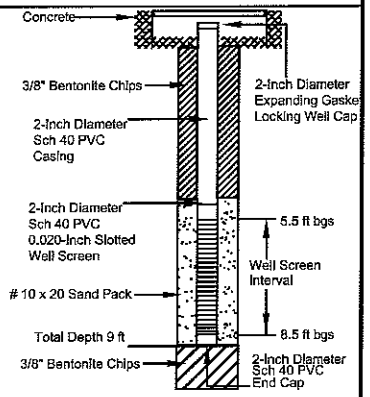
WELL/BORING NUMBER **B-8**
Page 1 of 1

PROJECT NAME: Plaid # 324
PROJECT NUMBER: 1133
LOCATION: West Seattle, Washington
LOGGED BY: Dan Becraft
REVIEWED BY: Paul Ecker
DATE: 7/17/08

SAMPLE INFORMATION

SAMPLE TYPE	BLOW COUNTS	PID (ppm)	First Water	LAB SAMPLE I.D.	DEPTH bgs (ft)	SAMPLE LOCATION	SAMPLE INTERVAL	REC %	STRATA	SOIL TYPE	DESCRIPTION (USCS Classification, Depth Interval, Color, Grain Size, Plasticity, Shapes, Mineral Size, Density or Consistency, Moisture, Odor, Geological Interpretation)
											Asphalt
		4.5								GP	SANDY GRAVEL (GP), brown, subrounded to 2-inch diameter, fine and medium grained sand, occasional cobble, some fines, dry.
		4			5						SILTY SAND to SANDY SILT (SM-ML) brown, fine to medium grained, gravels subrounded to 1-inch diameter, moist.
G		369		B-8@6'							@ 6 ft: color change to gray, some staining, hydrocarbon odor.
		391									
G				B-8@9'	10						
											Total Boring Depth 10 ft
					15						
					20						
					25						
					30						
					35						

BOREHOLE/WELL CONSTRUCTION DETAIL



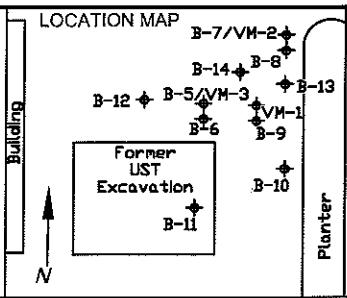
DRILLING CONTRACTOR: Boart-Longyear
DRILLING METHOD: Sonic
SAMPLING METHOD: Continuous Core
DRILLING START TIME: 2:00
DRILLING END TIME: 2:40

WELL I.D.: BAJ212

TIME	DATE	DTW

PNG ENVIRONMENTAL, INC.
6665 SW Hampton, Suite 101
Tigard, Oregon 97223
TEL (503) 620-2387
FAX (503) 620-2977

LOCATION MAP



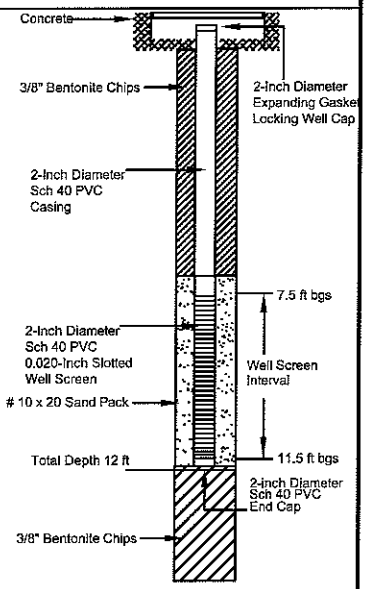
WELL/BORING NUMBER **B-9**
Page 1 of 1

PROJECT NAME: Plaid # 324
PROJECT NUMBER: 1133
LOCATION: West Seattle, Washington
LOGGED BY: Dan Becraft
REVIEWED BY: Paul Ecker
DATE: 7/17/08

SAMPLE INFORMATION

SAMPLE TYPE	BLOW COUNTS	PID (ppm)	First Water	LAB SAMPLE I.D.	DEPTH bgs (ft)	SAMPLE LOCATION	SAMPLE INTERVAL	REC %	STRATA	SOIL TYPE	DESCRIPTION (USCS Classification, Depth Interval, Color, Grain Size, Plasticity, Shapes, Mineral Size, Density or Consistency, Moisture, Odor, Geological Interpretation)
											Asphalt
										GP	SANDY GRAVEL (GP), brown, subrounded to 2-inch diameter, fine and medium grained sand, occasional cobble, some fines, dry.
		351									SILTY SAND to SANDY SILT (SM-ML) brown, fine to medium grained, gravels subrounded to 1-inch diameter, moist.
		519									@ 4 ft: hydrocarbon odor.
G				B-9@5'	5						
		130									
G		650		B-9@10'	10						
		509									
G		85		B-9@12'							
G		3.5		B-9@14'	15						SAND (SP), brown, fine to medium grained, some gravel, no odor, dry.
											Total Boring Depth 15 ft
					20						
					25						
					30						
					35						

BOREHOLE/WELL CONSTRUCTION DETAIL



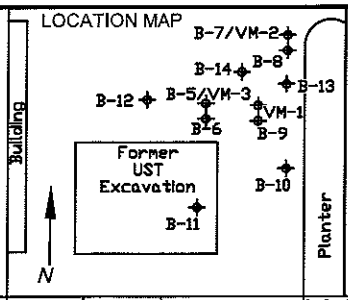
DRILLING CONTRACTOR: Boart-Longyear
DRILLING METHOD: Sonic
SAMPLING METHOD: Continuous Core
DRILLING START TIME: 5:00
DRILLING END TIME: 5:50

WELL I.D.: BAJ214

TIME	DATE	DTW

PNG ENVIRONMENTAL, INC.
6665 SW Hampton, Suite 101
Tigard, Oregon 97223
TEL (503) 620-2387
FAX (503) 620-2977

LOCATION MAP

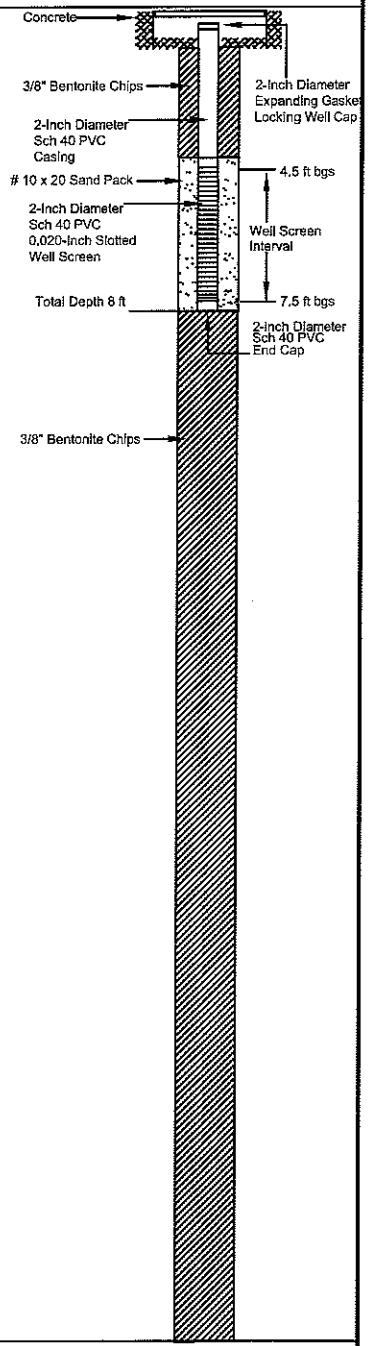


WELL/BORING NUMBER **B-10**
Page 1 of 2

PROJECT NAME: Plaid # 324
PROJECT NUMBER: 1133
LOCATION: West Seattle, Washington
LOGGED BY: Dan Becraft
REVIEWED BY: Paul Ecker
DATE: 7/15/08 - 7/16/08

SAMPLE TYPE	BLOW COUNTS	PID (ppm)	First Water	LAB SAMPLE I.D.	DEPTH bgs (ft)	STRATA	SOIL TYPE	DESCRIPTION (USCS Classification, Depth Interval, Color, Grain Size, Plasticity, Shapes, Mineral Size, Density or Consistency, Moisture, Odor, Geological Interpretation)
								Asphalt
							ML-SM	SANDY SILT to SILTY SAND (ML-SM),gray, fine to fine, medium and coarse grained sand,occasional gravel, moist.
								@4 ft: color change to brown.
G				B-10@4'	5			
G				B-10@6'				
G				B-10@10'	10			As Above
G				B-10@14.5'	15			As Above.
							GP	GRAVEL (GP)
							SP	SAND (SP), brown, medium grained some coarse sand, moist.
G				B-10@19'	20		GP-GM	SANDY GRAVEL (GP), brown, gravel subangular to subrounded to 3-inch diameter, fine-medium grained sand, some silt, occasional cobble, moist. @20 ft: no fines, dry.
G								As Above.
				B-10@ 20'-30'	25			Casing bound up in boring, only 3 ft of core removed from between 20 ft and 30ft. Location of sample from within 10 ft interval is unknown. Stopped drilling for day, resumed drilling on July 16, 2008.
G				B-10@31'	30			As Above.
					35			

BOREHOLE/WELL CONSTRUCTION DETAIL



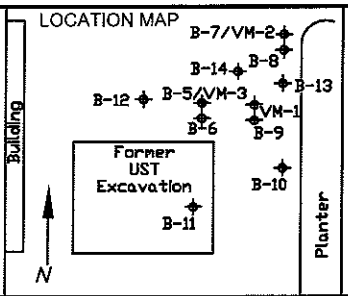
DRILLING CONTRACTOR: Boart-Longyear
DRILLING METHOD: Sonic
SAMPLING METHOD: Continuous Core
DRILLING START TIME: 9:20
DRILLING END TIME: 1:00

WELL I.D.: BAJ206

TIME	DATE	DTW

PNG ENVIRONMENTAL, INC.
6665 SW Hampton, Suite 101
Tigard, Oregon 97223
TEL (503) 620-2387
FAX (503) 620-2977

LOCATION MAP



WELL/BORING NUMBER **B-10**
Page 2 of 2

PROJECT NAME: Plaid # 324
PROJECT NUMBER: 1133
LOCATION: West Seattle, Washington
LOGGED BY: Dan Becraft
REVIEWED BY: Paul Ecker
DATE: 7/15/08 and 7/16/08

SAMPLE INFORMATION								STRATA	SOIL TYPE	DESCRIPTION (USCS Classification, Depth Interval, Color, Grain Size, Plasticity, Shapes, Mineral Size, Density or Consistency, Moisture, Odor, Geological Interpretation)	BOREHOLE/WELL CONSTRUCTION DETAIL
SAMPLE TYPE	BLOW COUNTS	PID (ppm)	First Water	LAB SAMPLE I.D.	DEPTH bgs (ft)	SAMPLE LOCATION	SAMPLE INTERVAL REC %				
		3.8							GP	SANDY GRAVEL (GP), continued	3/8" Bentonite Chips
G		3.8		B-10@39.5	40					Between 38.5 ft and 40 ft:cemented sand clasts, friable, dry.	
										Total Boring Depth - 40'	
					45						
					50						
					55						
					60						
					65						
					70						

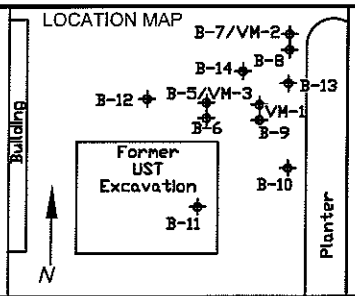
DRILLING CONTRACTOR: Boart-Longyear
DRILLING METHOD: Sonic
SAMPLING METHOD: Continuous Core
DRILLING START TIME: 2:45
DRILLING END TIME: 4:30

WELL I.D.: BAJ208

TIME	DATE	DTW

PNG ENVIRONMENTAL, INC.
6665 SW Hampton, Suite 101
Tigard, Oregon 97223
TEL (503) 620-2387
FAX (503) 620-2977

LOCATION MAP



WELL/BORING NUMBER **B-11**
Page 1 of 1

PROJECT NAME: Plaid # 324
PROJECT NUMBER: 1133
LOCATION: West Seattle, Washington
LOGGED BY: Dan Becraft
REVIEWED BY: Paul Ecker
DATE: 7/17/08

SAMPLE INFORMATION

SAMPLE TYPE	BLOW COUNTS	PID (ppm)	First Water	LAB SAMPLE I.D.	DEPTH bgs (ft)	SAMPLE LOCATION / SAMPLE INTERVAL / REC %	STRATA	SOIL TYPE
		0.2			5			GP
		0.4						
		0.6			10			
		0.8			15			
					20			
					25			
					30			
					35			

DESCRIPTION

(USCS Classification, Depth Interval, Color, Grain Size, Plasticity, Shapes, Mineral Size, Density or Consistency, Moisture, Odor, Geological Interpretation)

Asphalt

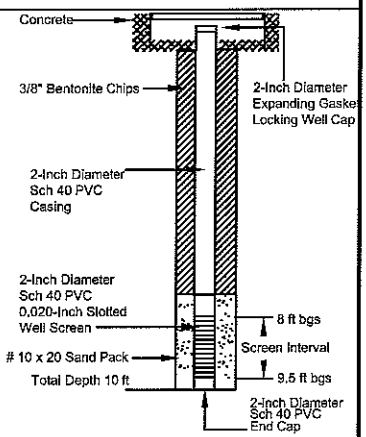
SANDY GRAVEL (GP), brown, subrounded to 2-inch diameter, fine and medium grained sand, occasional cobble, some fines, dry.

SAND (BACKFILL) (SP), brown, fine to medium grained, some gravel, no odor, dry.

@ 4 ft; hydrocarbon odor.

Total Boring Depth 10 ft

BOREHOLE/WELL CONSTRUCTION DETAIL



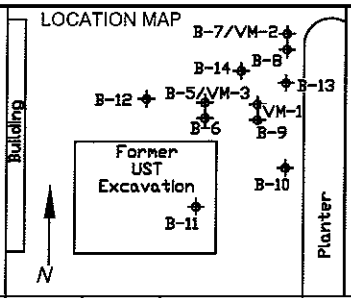
DRILLING CONTRACTOR: Boart-Longyear
DRILLING METHOD: Sonic
SAMPLING METHOD: Continuous Core
DRILLING START TIME: 9:30
DRILLING END TIME: 10:40

WELL I.D.: BAJ210

TIME	DATE	DTW

PNG ENVIRONMENTAL, INC.
6665 SW Hampton, Suite 101
Tigard, Oregon 97223
TEL (503) 620-2387
FAX (503) 620-2977

LOCATION MAP



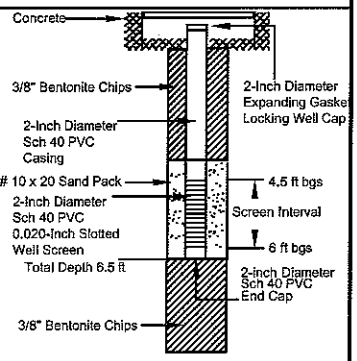
WELL/BORING NUMBER **B-12**
Page 1 of 1

PROJECT NAME: Plaid # 324
PROJECT NUMBER: 1133
LOCATION: West Seattle, Washington
LOGGED BY: Dan Becraft
REVIEWED BY: Paul Ecker
DATE: 7/17/08

SAMPLE INFORMATION

SAMPLE TYPE	BLOW COUNTS	PID (ppm)	First Water	LAB SAMPLE I.D.	DEPTH bgs (ft)	SAMPLE LOCATION	SAMPLE INTERVAL	REC %	STRATA	SOIL TYPE	DESCRIPTION (USCS Classification, Depth Interval, Color, Grain Size, Plasticity, Shapes, Mineral Size, Density or Consistency, Moisture, Odor, Geological Interpretation)
											Asphalt
										GP	SANDY GRAVEL (GP), brown, subrounded to 2-inch diameter, fine and medium grained sand, occasional cobble, some fines, dry.
		11.9									
G		775		B-12@4'	5					SM	SILTY SAND to SANDY SILT (SM-ML), gray, fine to medium grained, gravel subangular to subrounded to 1-inch diameter, hydrocarbon odor, discoloration, moist.
		10.1								GP	SANDY GRAVEL (GP), As Above
										SM	SILTY SAND (SM), As Above
G				B-12@8'						GP	SANDY GRAVEL (GP), As Above
		9.5			10						Total Boring Depth 9 ft
					15						
					20						
					25						
					30						
					35						

BOREHOLE/WELL CONSTRUCTION DETAIL



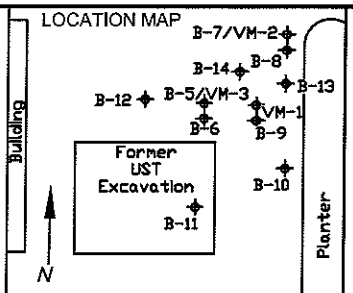
DRILLING CONTRACTOR: Boart-Longyear
DRILLING METHOD: Sonic
SAMPLING METHOD: Continuous Core
DRILLING START TIME: 8:40
DRILLING END TIME: 9:20

WELL I.D.: BAJ209

TIME	DATE	DTW

PNG ENVIRONMENTAL, INC.
6665 SW Hampton, Suite 101
Tigard, Oregon 97223
TEL (503) 620-2387
FAX (503) 620-2977

LOCATION MAP



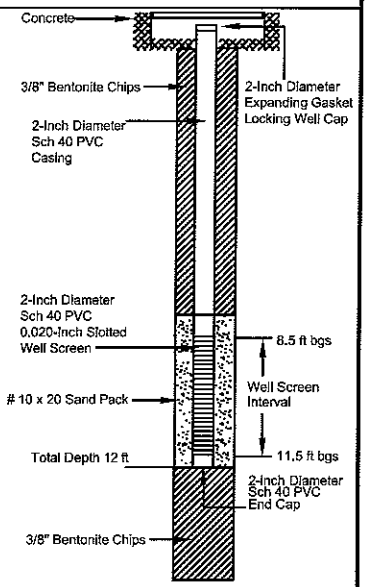
WELL/BORING NUMBER **B-13**
Page 1 of 1

PROJECT NAME: Plaid # 324
PROJECT NUMBER: 1133
LOCATION: West Seattle, Washington
LOGGED BY: Dan Becraft
REVIEWED BY: Paul Ecker
DATE: 7/17/08

SAMPLE INFORMATION

SAMPLE TYPE	BLOW COUNTS	PID (ppm)	First Water	LAB SAMPLE I.D.	DEPTH bgs (ft)	STRATA	SOIL TYPE	DESCRIPTION (USCS Classification, Depth Interval, Color, Grain Size, Plasticity, Shapes, Mineral Size, Density or Consistency, Moisture, Odor, Geological Interpretation)
								Asphalt
		21					GP	SANDY GRAVEL (GP), brown, subrounded to 2-inch diameter, fine and medium grained sand, occasional cobble, some fines, dry.
		148					SM	SILTY SAND to SANDY SILT (SM-ML), gray, medium grained, some gravel, moist.
		503						
G				B-13@5'	5			@ 4ft: discoloration, hydrocarbon odor.
		540						Between 5 ft and 7.5 ft: high gravel content.
		359						
								As Above.
		559						
		209			10			
		679						As Above.
G		22		B-13@12'				
		12.5						
		3.5						
					15			SAND(SP), brown, medium grained, no ODS, moist.
								Total Boring Depth 15 ft
					20			
					25			
					30			
					35			

BOREHOLE/WELL CONSTRUCTION DETAIL



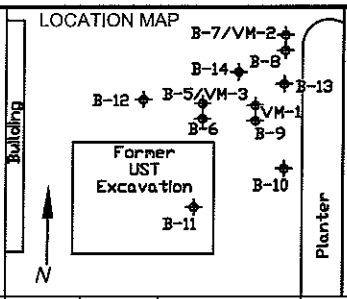
DRILLING CONTRACTOR: Boart-Longyear
DRILLING METHOD: Sonic
SAMPLING METHOD: Continuous Core
DRILLING START TIME: 3:05
DRILLING END TIME: 4:30

WELL I.D.: BAJ213

TIME	DATE	DTW

PNG ENVIRONMENTAL, INC.
6665 SW Hampton, Suite 101
Tigard, Oregon 97223
TEL (503) 620-2387
FAX (503) 620-2977

LOCATION MAP



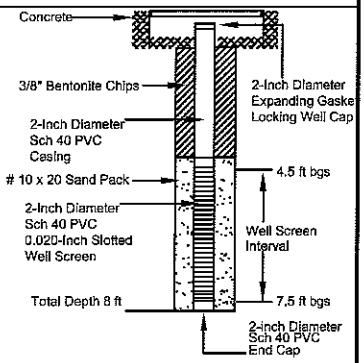
WELL/BORING NUMBER **B-14**
Page 1 of 1

PROJECT NAME: Plaid # 324
PROJECT NUMBER: 1133
LOCATION: West Seattle, Washington
LOGGED BY: Dan Becraft
REVIEWED BY: Paul Ecker
DATE: 7/18/08

SAMPLE INFORMATION

SAMPLE TYPE	BLOW COUNTS	PID (ppm)	First Water	LAB SAMPLE I.D.	DEPTH bgs (ft)	SAMPLE LOCATION	SAMPLE INTERVAL	REC %	STRATA	SOIL TYPE	DESCRIPTION (USCS Classification, Depth Interval, Color, Grain Size, Plasticity, Shapes, Mineral Size, Density or Consistency, Moisture, Odor, Geological Interpretation)
											Asphalt
		193								GP	SANDY GRAVEL (GP), brown, subrounded to 2-inch diameter, fine and medium grained sand, occasional cobble, some fines, dry.
		645			5						SILTY SAND (SM) brown, medium grained, moist. Between 3ft and 5ft: gray staining/discoloration, hydrocarbon odor.
		315									
					10						Total Boring Depth 8 ft
					15						
					20						
					25						
					30						
					35						

BOREHOLE/WELL CONSTRUCTION DETAIL



DRILLING CONTRACTOR: Boart-Longyear
DRILLING METHOD: Sonic
SAMPLING METHOD: Continuous Core
DRILLING START TIME: 8:00
DRILLING END TIME: 8:30

WELL I.D.: BAJ215

TIME	DATE	DTW

APPENDIX C

LABORATORY ANALYTICAL REPORTS AND

CHAIN OF CUSTODY DOCUMENTATION

AN ENVIRONMENTAL ANALYTICAL LABORATORY

Air Toxics Ltd. Introduces the Electronic Report

Thank you for choosing Air Toxics Ltd. To better serve our customers, we are providing your report by e-mail. This document is provided in Portable Document Format which can be viewed with Acrobat Reader by Adobe.

This electronic report includes the following:

- Work order Summary;
- Laboratory Narrative;
- Results; and
- Chain of Custody (copy).

180 BLUE RAVINE ROAD, SUITE B FOLSOM, CA - 95630

(916) 985-1000 .FAX (916) 985-1020
Hours 8:00 A.M to 6:00 P.M. Pacific

Air Toxics LTD.

AN ENVIRONMENTAL ANALYTICAL LABORATORY

WORK ORDER #: 0808064B

Work Order Summary

CLIENT:	Mr. Jay Greifer PNG Environmental 7130 SW Elmhurst Tigard, OR 97223	**BILL TO:**	Mr. Jay Greifer PNG Environmental 7130 SW Elmhurst Tigard, OR 97223
PHONE:	503-620-2387	**P.O. #**	1133-01
FAX:	503-620-2977	**PROJECT #**	1133-01 Plaid Pantry #324
DATE RECEIVED:	08/04/2008	**CONTACT:**	Kelly Buettner
DATE COMPLETED:	08/13/2008		

FRACTION #	NAME	TEST	RECEIPT VAC./PRES.	FINAL PRESSURE
01A	B-14	Modified TO-3	3.0 "Hg	5 psi
02A	B-9	Modified TO-3	3.5 "Hg	5 psi
02AA	B-9 Lab Duplicate	Modified TO-3	3.5 "Hg	5 psi
03A	B-11	Modified TO-3	3.5 "Hg	5 psi
04A	B-13	Modified TO-3	4.0 "Hg	5 psi
05A	Lab Blank	Modified TO-3	NA	NA
06A	LCS	Modified TO-3	NA	NA

CERTIFIED BY: Linda J. Fruman DATE: 08/13/08

Laboratory Director

Certfication numbers: CA NELAP - 02110CA, LA NELAP/LELAP- AI 30763, NJ NELAP - CA004
NY NELAP - 11291, UT NELAP - 9166389892, AZ Licensure AZ0719
Name of Accrediting Agency: NELAP/Florida Department of Health, Scope of Application: Clean Air Act,
Accreditation number: E87680, Effective date: 07/01/07, Expiration date: 06/30/08
Air Toxics Ltd. certifies that the test results contained in this report meet all requirements of the NELAC standards

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LABORATORY NARRATIVE
Modified TO-3
PNG Environmental
Workorder# 0808064B

Four 6 Liter Summa Canister samples were received on August 04, 2008. The laboratory performed analysis for volatile organic compounds in air via modified EPA Method TO-3 using gas chromatography with flame ionization detection. The method involves concentrating up to 200 mL of sample. The concentrated aliquot is then dry purged to remove water vapor prior to entering the chromatographic system. The TPH (Gasoline Range) results are calculated using the response factor of Gasoline. A molecular weight of 100 is used to convert the TPH (Gasoline Range) ppmv result to ug/L.

Method modifications taken to run these samples are summarized in the table below. Specific project requirements may over-ride the ATL modifications.

Requirement	*TO-3*	*ATL Modifications*
Daily Calibration Standard Frequency	Prior to sample analysis and every 4 - 6 hrs	Prior to sample analysis and after the analytical batch </= 20 samples
Initial Calibration Calculation	4-point calibration using a linear regression model	5-point calibration using average Response Factor
Initial Calibration Frequency	Weekly	When daily calibration standard recovery is outside 75 - 125 %, or upon significant changes to procedure or instrumentation
Moisture Control	Nafion system	Sorbent system
Minimum Detection Limit (MDL)	Calculated using the equation DL = A+3.3S, where A is intercept of calibration line and S is the standard deviation of at least 3 reps of low level standard	40 CFR Pt. 136 App. B
Preparation of Standards	Levels achieved through dilution of gas mixture	Levels achieved through loading various volumes of the gas mixture

Receiving Notes

There were no receiving discrepancies.

Analytical Notes

The recovery of surrogate Fluorobenzene in samples B-14, B-9 and B-9 Lab Duplicate was outside control limits due to high level hydrocarbon matrix interference. Data is reported as qualified.

Definition of Data Qualifying Flags

Seven qualifiers may have been used on the data analysis sheets and indicate as follows:

B - Compound present in laboratory blank greater than reporting limit.
J - Estimated value.
E - Exceeds instrument calibration range.
S - Saturated peak.
Q - Exceeds quality control limits.
U - Compound analyzed for but not detected above the detection limit.
M - Reported value may be biased due to apparent matrix interferences.

File extensions may have been used on the data analysis sheets and indicates as follows:
a-File was requantified
b-File was quantified by a second column and detector
r1-File was requantified for the purpose of reissue

AN ENVIRONMENTAL ANALYTICAL LABORATORY

Summary of Detected Compounds
MODIFIED EPA METHOD TO-3 GC/FID

Client Sample ID: B-14

Lab ID#: 0808064B-01A

Compound	Rpt. Limit (ppmv)	Rpt. Limit (uG/L)	Amount (ppmv)	Amount (uG/L)
TPH (Gasoline Range)	15	61	2400	9700

Client Sample ID: B-9

Lab ID#: 0808064B-02A

Compound	Rpt. Limit (ppmv)	Rpt. Limit (uG/L)	Amount (ppmv)	Amount (uG/L)
TPH (Gasoline Range)	3.8	16	2400	10000

Client Sample ID: B-9 Lab Duplicate

Lab ID#: 0808064B-02AA

Compound	Rpt. Limit (ppmv)	Rpt. Limit (uG/L)	Amount (ppmv)	Amount (uG/L)
TPH (Gasoline Range)	3.8	16	2400	9900

Client Sample ID: B-11

Lab ID#: 0808064B-03A

Compound	Rpt. Limit (ppmv)	Rpt. Limit (uG/L)	Amount (ppmv)	Amount (uG/L)
TPH (Gasoline Range)	0.038	0.16	1.5	6.0

Client Sample ID: B-13

Lab ID#: 0808064B-04A

Compound	Rpt. Limit (ppmv)	Rpt. Limit (uG/L)	Amount (ppmv)	Amount (uG/L)
TPH (Gasoline Range)	16	63	1200	4800

AN ENVIRONMENTAL ANALYTICAL LABORATORY

Client Sample ID: B-14

Lab ID#: 0808064B-01A

MODIFIED EPA METHOD TO-3 GC/FID

File Name:	**6081107**	**Date of Collection: 7/30/08**	
Dil. Factor:	**596**	**Date of Analysis: 8/11/08 11:15 AM**	

Compound	Rpt. Limit (ppmv)	Rpt. Limit (uG/L)	Amount (ppmv)	Amount (uG/L)
TPH (Gasoline Range)	15	61	2400	9700

Q = Exceeds Quality Control limits, due to matrix effects. Matrix effects confirmed by re-analysis.

Container Type: 6 Liter Summa Canister

Surrogates	%Recovery	Method Limits
Fluorobenzene (FID)	153 Q	75-150

AN ENVIRONMENTAL ANALYTICAL LABORATORY

Client Sample ID: B-9

Lab ID#: 0808064B-02A

MODIFIED EPA METHOD TO-3 GC/FID

File Name:	**6081109**	**Date of Collection: 7/30/08**	
Dil. Factor:	**152**	**Date of Analysis: 8/11/08 12:32 PM**	

Compound	Rpt. Limit (ppmv)	Rpt. Limit (uG/L)	Amount (ppmv)	Amount (uG/L)
TPH (Gasoline Range)	3.8	16	2400	10000

Q = Exceeds Quality Control limits, due to matrix effects. Matrix effects confirmed by re-analysis.

Container Type: 6 Liter Summa Canister

Surrogates	%Recovery	Method Limits
Fluorobenzene (FID)	230 Q	75-150

AN ENVIRONMENTAL ANALYTICAL LABORATORY

Client Sample ID: B-9 Lab Duplicate

Lab ID#: 0808064B-02AA

MODIFIED EPA METHOD TO-3 GC/FID

File Name:	**6081113**	**Date of Collection: 7/30/08**	
Dil. Factor:	**152**	**Date of Analysis: 8/11/08 02:59 PM**	

Compound	Rpt. Limit (ppmv)	Rpt. Limit (uG/L)	Amount (ppmv)	Amount (uG/L)
TPH (Gasoline Range)	3.8	16	2400	9900

Q = Exceeds Quality Control limits, due to matrix effects. Matrix effects confirmed by re-analysis.

Container Type: 6 Liter Summa Canister

Surrogates	%Recovery	Method Limits
Fluorobenzene (FID)	227 Q	75-150

AN ENVIRONMENTAL ANALYTICAL LABORATORY

Client Sample ID: B-11

Lab ID#: 0808064B-03A

MODIFIED EPA METHOD TO-3 GC/FID

File Name:	6081110	Date of Collection:	7/30/08
Dil. Factor:	1.52	Date of Analysis:	8/11/08 01:18 PM

Compound	Rpt. Limit (ppmv)	Rpt. Limit (uG/L)	Amount (ppmv)	Amount (uG/L)
TPH (Gasoline Range)	0.038	0.16	1.5	6.0

Container Type: 6 Liter Summa Canister

Surrogates	%Recovery	Method Limits
Fluorobenzene (FID)	111	75-150

Air Toxics LTD.

AN ENVIRONMENTAL ANALYTICAL LABORATORY

Client Sample ID: B-13

Lab ID#: 0808064B-04A

MODIFIED EPA METHOD TO-3 GC/FID

File Name:	6081111	Date of Collection:	7/31/08
Dil. Factor:	620	Date of Analysis:	8/11/08 01:52 PM

Compound	Rpt. Limit (ppmv)	Rpt. Limit (uG/L)	Amount (ppmv)	Amount (uG/L)
TPH (Gasoline Range)	16	63	1200	4800

Container Type: 6 Liter Summa Canister

Surrogates	%Recovery	Method Limits
Fluorobenzene (FID)	141	75-150

AN ENVIRONMENTAL ANALYTICAL LABORATORY

Client Sample ID: Lab Blank

Lab ID#: 0808064B-05A

MODIFIED EPA METHOD TO-3 GC/FID

File Name:	6081105	Date of Collection: NA	
Dil. Factor:	1.00	Date of Analysis: 8/11/08 10:01 AM	

Compound	Rpt. Limit (ppmv)	Rpt. Limit (uG/L)	Amount (ppmv)	Amount (uG/L)
TPH (Gasoline Range)	0.025	0.10	Not Detected	Not Detected

Container Type: NA - Not Applicable

Surrogates	%Recovery	Method Limits
Fluorobenzene (FID)	90	75-150

AN ENVIRONMENTAL ANALYTICAL LABORATORY

Client Sample ID: LCS

Lab ID#: 0808064B-06A

MODIFIED EPA METHOD TO-3 GC/FID

File Name:	**6081102**	**Date of Collection: NA**	
Dil. Factor:	**1.00**	**Date of Analysis: 8/11/08 08:01 AM**	

Compound	%Recovery
TPH (Gasoline Range)	87

Container Type: NA - Not Applicable

Surrogates	%Recovery	Method Limits
Fluorobenzene (FID)	118	75-150

AN ENVIRONMENTAL ANALYTICAL LABORATORY

Air Toxics Ltd. Introduces the Electronic Report

Thank you for choosing Air Toxics Ltd. To better serve our customers, we are providing your report by e-mail. This document is provided in Portable Document Format which can be viewed with Acrobat Reader by Adobe.

This electronic report includes the following:

- Work order Summary;
- Laboratory Narrative;
- Results; and
- Chain of Custody (copy).

180 BLUE RAVINE ROAD, SUITE B FOLSOM, CA - 95630

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Hours 8:00 A.M to 6:00 P.M. Pacific

Air Toxics LTD.

AN ENVIRONMENTAL ANALYTICAL LABORATORY

WORK ORDER #: 0808064B

Work Order Summary

CLIENT:	Mr. Jay Greifer PNG Environmental 7130 SW Elmhurst Tigard, OR 97223	**BILL TO:**	Mr. Jay Greifer PNG Environmental 7130 SW Elmhurst Tigard, OR 97223
PHONE:	503-620-2387	**P.O. #**	1133-01
FAX:	503-620-2977	**PROJECT #**	1133-01 Plaid Pantry #324
DATE RECEIVED:	08/04/2008	**CONTACT:**	Kelly Buettner
DATE COMPLETED:	08/13/2008		

FRACTION #	NAME	TEST	RECEIPT VAC./PRES.	FINAL PRESSURE
01A	B-14	Modified TO-3	3.0 "Hg	5 psi
02A	B-9	Modified TO-3	3.5 "Hg	5 psi
02AA	B-9 Lab Duplicate	Modified TO-3	3.5 "Hg	5 psi
03A	B-11	Modified TO-3	3.5 "Hg	5 psi
04A	B-13	Modified TO-3	4.0 "Hg	5 psi
05A	Lab Blank	Modified TO-3	NA	NA
06A	LCS	Modified TO-3	NA	NA

CERTIFIED BY: Linda J. Truman DATE: 08/13/08

Laboratory Director

Certfication numbers: CA NELAP - 02110CA, LA NELAP/LELAP- AI 30763, NJ NELAP - CA004
NY NELAP - 11291, UT NELAP - 9166389892, AZ Licensure AZ0719
Name of Accrediting Agency: NELAP/Florida Department of Health, Scope of Application: Clean Air Act,
Accreditation number: E87680, Effective date: 07/01/07, Expiration date: 06/30/08
Air Toxics Ltd. certifies that the test results contained in this report meet all requirements of the NELAC standards

180 BLUE RAVINE ROAD, SUITE B FOLSOM, CA - 95630
(916) 985-1000 . (800) 985-5955 . FAX (916) 985-1020

LABORATORY NARRATIVE
Modified TO-3
PNG Environmental
Workorder# 0808064B

Four 6 Liter Summa Canister samples were received on August 04, 2008. The laboratory performed analysis for volatile organic compounds in air via modified EPA Method TO-3 using gas chromatography with flame ionization detection. The method involves concentrating up to 200 mL of sample. The concentrated aliquot is then dry purged to remove water vapor prior to entering the chromatographic system. The TPH (Gasoline Range) results are calculated using the response factor of Gasoline. A molecular weight of 100 is used to convert the TPH (Gasoline Range) ppmv result to ug/L.

Method modifications taken to run these samples are summarized in the table below. Specific project requirements may over-ride the ATL modifications.

Requirement	*TO-3*	*ATL Modifications*
Daily Calibration Standard Frequency	Prior to sample analysis and every 4 - 6 hrs	Prior to sample analysis and after the analytical batch </= 20 samples
Initial Calibration Calculation	4-point calibration using a linear regression model	5-point calibration using average Response Factor
Initial Calibration Frequency	Weekly	When daily calibration standard recovery is outside 75 - 125 %, or upon significant changes to procedure or instrumentation
Moisture Control	Nafion system	Sorbent system
Minimum Detection Limit (MDL)	Calculated using the equation DL = A+3.3S, where A is intercept of calibration line and S is the standard deviation of at least 3 reps of low level standard	40 CFR Pt. 136 App. B
Preparation of Standards	Levels achieved through dilution of gas mixture	Levels achieved through loading various volumes of the gas mixture

Receiving Notes

There were no receiving discrepancies.

Analytical Notes

The recovery of surrogate Fluorobenzene in samples B-14, B-9 and B-9 Lab Duplicate was outside control limits due to high level hydrocarbon matrix interference. Data is reported as qualified.

Definition of Data Qualifying Flags

Seven qualifiers may have been used on the data analysis sheets and indicate as follows:

B - Compound present in laboratory blank greater than reporting limit.
J - Estimated value.
E - Exceeds instrument calibration range.
S - Saturated peak.
Q - Exceeds quality control limits.
U - Compound analyzed for but not detected above the detection limit.
M - Reported value may be biased due to apparent matrix interferences.

File extensions may have been used on the data analysis sheets and indicates as follows:
a-File was requantified
b-File was quantified by a second column and detector
r1-File was requantified for the purpose of reissue

Summary of Detected Compounds
MODIFIED EPA METHOD TO-3 GC/FID

Client Sample ID: B-14

Lab ID#: 0808064B-01A

Compound	Rpt. Limit (ppmv)	Rpt. Limit (uG/L)	Amount (ppmv)	Amount (uG/L)
TPH (Gasoline Range)	15	61	2400	9700

Client Sample ID: B-9

Lab ID#: 0808064B-02A

Compound	Rpt. Limit (ppmv)	Rpt. Limit (uG/L)	Amount (ppmv)	Amount (uG/L)
TPH (Gasoline Range)	3.8	16	2400	10000

Client Sample ID: B-9 Lab Duplicate

Lab ID#: 0808064B-02AA

Compound	Rpt. Limit (ppmv)	Rpt. Limit (uG/L)	Amount (ppmv)	Amount (uG/L)
TPH (Gasoline Range)	3.8	16	2400	9900

Client Sample ID: B-11

Lab ID#: 0808064B-03A

Compound	Rpt. Limit (ppmv)	Rpt. Limit (uG/L)	Amount (ppmv)	Amount (uG/L)
TPH (Gasoline Range)	0.038	0.16	1.5	6.0

Client Sample ID: B-13

Lab ID#: 0808064B-04A

Compound	Rpt. Limit (ppmv)	Rpt. Limit (uG/L)	Amount (ppmv)	Amount (uG/L)
TPH (Gasoline Range)	16	63	1200	4800

AN ENVIRONMENTAL ANALYTICAL LABORATORY

Client Sample ID: B-14

Lab ID#: 0808064B-01A

MODIFIED EPA METHOD TO-3 GC/FID

File Name:	**6081107**	**Date of Collection: 7/30/08**	
Dil. Factor:	**596**	**Date of Analysis: 8/11/08 11:15 AM**	

Compound	Rpt. Limit (ppmv)	Rpt. Limit (uG/L)	Amount (ppmv)	Amount (uG/L)
TPH (Gasoline Range)	15	61	2400	9700

Q = Exceeds Quality Control limits, due to matrix effects. Matrix effects confirmed by re-analysis.

Container Type: 6 Liter Summa Canister

Surrogates	%Recovery	Method Limits
Fluorobenzene (FID)	153 Q	75-150

Air Toxics LTD.

AN ENVIRONMENTAL ANALYTICAL LABORATORY

Client Sample ID: B-9

Lab ID#: 0808064B-02A

MODIFIED EPA METHOD TO-3 GC/FID

File Name:	**6081109**	**Date of Collection: 7/30/08**	
Dil. Factor:	**152**	**Date of Analysis: 8/11/08 12:32 PM**	

Compound	Rpt. Limit (ppmv)	Rpt. Limit (uG/L)	Amount (ppmv)	Amount (uG/L)
TPH (Gasoline Range)	3.8	16	2400	10000

Q = Exceeds Quality Control limits, due to matrix effects. Matrix effects confirmed by re-analysis.

Container Type: 6 Liter Summa Canister

Surrogates	%Recovery	Method Limits
Fluorobenzene (FID)	230 Q	75-150

AN ENVIRONMENTAL ANALYTICAL LABORATORY

Client Sample ID: B-9 Lab Duplicate

Lab ID#: 0808064B-02AA

MODIFIED EPA METHOD TO-3 GC/FID

File Name:	**6081113**	**Date of Collection: 7/30/08**	
Dil. Factor:	**152**	**Date of Analysis: 8/11/08 02:59 PM**	

Compound	Rpt. Limit (ppmv)	Rpt. Limit (uG/L)	Amount (ppmv)	Amount (uG/L)
TPH (Gasoline Range)	3.8	16	2400	9900

Q = Exceeds Quality Control limits, due to matrix effects. Matrix effects confirmed by re-analysis.

Container Type: 6 Liter Summa Canister

Surrogates	%Recovery	Method Limits
Fluorobenzene (FID)	227 Q	75-150

AN ENVIRONMENTAL ANALYTICAL LABORATORY

Client Sample ID: B-11

Lab ID#: 0808064B-03A

MODIFIED EPA METHOD TO-3 GC/FID

File Name:	**6081110**	**Date of Collection:**	**7/30/08**
Dil. Factor:	**1.52**	**Date of Analysis:**	**8/11/08 01:18 PM**

Compound	Rpt. Limit (ppmv)	Rpt. Limit (uG/L)	Amount (ppmv)	Amount (uG/L)
TPH (Gasoline Range)	0.038	0.16	1.5	6.0

Container Type: 6 Liter Summa Canister

Surrogates	%Recovery	Method Limits
Fluorobenzene (FID)	111	75-150

Air Toxics LTD.

AN ENVIRONMENTAL ANALYTICAL LABORATORY

Client Sample ID: B-13

Lab ID#: 0808064B-04A

MODIFIED EPA METHOD TO-3 GC/FID

File Name:	6081111	Date of Collection:	7/31/08
Dil. Factor:	620	Date of Analysis:	8/11/08 01:52 PM

Compound	Rpt. Limit (ppmv)	Rpt. Limit (uG/L)	Amount (ppmv)	Amount (uG/L)
TPH (Gasoline Range)	16	63	1200	4800

Container Type: 6 Liter Summa Canister

Surrogates	%Recovery	Method Limits
Fluorobenzene (FID)	141	75-150

AN ENVIRONMENTAL ANALYTICAL LABORATORY

Client Sample ID: Lab Blank

Lab ID#: 0808064B-05A

MODIFIED EPA METHOD TO-3 GC/FID

File Name:	**6081105**	**Date of Collection: NA**	
Dil. Factor:	**1.00**	**Date of Analysis: 8/11/08 10:01 AM**	

Compound	Rpt. Limit (ppmv)	Rpt. Limit (uG/L)	Amount (ppmv)	Amount (uG/L)
TPH (Gasoline Range)	0.025	0.10	Not Detected	Not Detected

Container Type: NA - Not Applicable

Surrogates	%Recovery	Method Limits
Fluorobenzene (FID)	90	75-150

AN ENVIRONMENTAL ANALYTICAL LABORATORY

Client Sample ID: LCS

Lab ID#: 0808064B-06A

MODIFIED EPA METHOD TO-3 GC/FID

File Name:	**6081102**	**Date of Collection: NA**	
Dil. Factor:	**1.00**	**Date of Analysis: 8/11/08 08:01 AM**	

Compound	%Recovery
TPH (Gasoline Range)	87

Container Type: NA - Not Applicable

Surrogates	%Recovery	Method Limits
Fluorobenzene (FID)	118	75-150

Air Toxics LTD.

CHAIN-OF-CUSTODY RECORD

Sample Transportation Notice
Relinquishing signature on this document indicates that sample is being shipped in compliance with all applicable local, State, Federal, national, and international laws, regulations and ordinances of any kind. Air Toxics Limited assumes no liability with respect to the collection, handling or shipping of these samples. Relinquishing signature also indicates agreement to hold harmless, defend, and indemnify Air Toxics Limited against any claim, demand, or action, of any kind, related to the collection, handling, or shipping of samples. D.O.T. Hotline (800) 467-4922

180 BLUE RAVINE ROAD, SUITE B
FOLSOM, CA 95630-4719
(916) 985-1000 FAX (916) 985-1020

Project Manager Paul Eener
Collected by: (Print and Sign) Jay Griker
Company PWG Environmental, Inc Email
Address 6665 SW Hampton City Tigard State OR Zip 97223
Phone 503-[illegible]-7387 Fax

Project Info:
P.O. # 1133-01
Project # 1133-01
Project Name Plaid Pantry # 334

Turn Around Time:
☒ Normal
☐ Rush
specify

Lab Use Only
Pressurized by:
Date:
Pressurization Gas: N_2 He

Lab I.D.	Field Sample I.D. (Location)	Can #	Date of Collection	Time of Collection	Analyses Requested	Canister Pressure/Vacuum Initial	Final	Receipt	Final (psi)
	B-14	3459	07-30-08	1202	TO3 + TO14A	-30	-5		
	B-9	4208	↓	1353	TO3 + TO14A	-30	-5		
	B-11	3490	↓	1711	TO3 + TO14A	-30	-5		
	B-13	3626	07-31-08	1000	TO3 + TO14A	-30	-5		

Relinquished by: (signature) Date/Time	Received by: (signature) Date/Time
[signature] 08-01-08 1100	
Relinquished by: (signature) Date/Time	Received by: (signature) Date/Time
Relinquished by: (signature) Date/Time	Received by: (signature) Date/Time

Notes:

Lab Use Only	Shipper Name	Air Bill #	Temp (°C)	Condition	Custody Seals Intact?	Work Order #
					Yes No None	

Form 1293 rev.11

FRIEDMAN & BRUYA, INC.

ENVIRONMENTAL CHEMISTS

James E. Bruya, Ph.D.
Charlene Morrow, M.S.
Yelena Aravkina, M.S.
Bradley T. Benson, B.S.
Kurt Johnson, B.S.

3012 16th Avenue West
Seattle, WA 98119-2029
TEL: (206) 285-8282
FAX: (206) 283-5044
e-mail: fbi@isomedia.com

July 21, 2008

Paul Ecker, Project Manager
PNG Environmental
6665 SW Hampton St, Suite101
Tigard, OR 97223

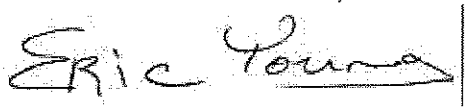
Dear Mr. Ecker:

Included are the results from the testing of material submitted on July 15, 2008 from the Plaid 324, F&BI 807158 project. There are 4 pages included in this report. Any samples that may remain are currently scheduled for disposal in 30 days. If you would like us to return your samples or arrange for long term storage at our offices, please contact us as soon as possible.

We appreciate this opportunity to be of service to you and hope you will call if you should have any questions.

Sincerely,

FRIEDMAN & BRUYA, INC.



Eric Young
Chemist

Enclosures
PNG0721R.DOC

FRIEDMAN & BRUYA, INC.

ENVIRONMENTAL CHEMISTS

CASE NARRATIVE

This case narrative encompasses samples received on July 15, 2008 by Friedman & Bruya, Inc. from the PNG Environmental Plaid 324, F&BI 807158 project. Samples were logged in under the laboratory ID's listed below.

Laboratory ID	PNG Environmental
807158-01	B-10@4'
807158-02	B-10@6'
807158-03	B-10@10'
807158-04	B-10@14.5'
807158-05	B-10@19'
807158-06	B-10/20'-30'

All quality control requirements were acceptable.

Date of Report: 07/21/08
Date Received: 07/15/08
Project: Plaid 324, F&BI 807158
Date Extracted: 07/16/08
Date Analyzed: 07/16/08

RESULTS FROM THE ANALYSIS OF THE SOIL SAMPLES FOR BENZENE, TOLUENE, ETHYLBENZENE, XYLENES AND TPH AS GASOLINE USING EPA METHOD 8021B AND NWTPH-Gx

Results Reported on a Dry Weight Basis
Results Reported as mg/kg (ppm)

Sample ID Laboratory ID	Benzene	Toluene	Ethyl Benzene	Total Xylenes	Gasoline Range	Surrogate (% Recovery) (Limit 50-139)
B-10@4' 807158-01	0.06	0.22	0.17	0.92	8	112
B-10@6' 807158-02	0.07	0.40	0.24	0.74	6	128
B-10@10' 807158-03	<0.02	0.45	0.57	3.9	76	138
B-10@14.5' 807158-04	<0.02	0.17	0.15	0.97	19	ip
B-10@19' 807158-05	<0.02	<0.02	<0.02	<0.06	<2	128
B-10/20'-30' 807158-06	<0.02	<0.02	<0.02	<0.06	<2	135
Method Blank	<0.02	<0.02	<0.02	<0.06	<2	82

Date of Report: 07/21/08
Date Received: 07/15/08
Project: Plaid 324, F&BI 807158

QUALITY ASSURANCE RESULTS FOR THE ANALYSIS OF SOIL SAMPLES FOR BENZENE, TOLUENE, ETHYLBENZENE, XYLENES, AND TPH AS GASOLINE USING EPA METHOD 8021B AND NWTPH-Gx

Laboratory Code: 807158-06 (Duplicate)

Analyte	Reporting Units	Sample Result	Duplicate Result	Relative Percent Difference (Limit 20)
Benzene	mg/kg (ppm)	<0.02	<0.02	nm
Toluene	mg/kg (ppm)	<0.02	<0.02	nm
Ethylbenzene	mg/kg (ppm)	<0.02	<0.02	nm
Xylenes	mg/kg (ppm)	<0.06	<0.06	nm
Gasoline	mg/kg (ppm)	<2	<2	nm

Laboratory Code: Laboratory Control Sample

Analyte	Reporting Units	Spike Level	Percent Recovery LCS	Acceptance Criteria
Benzene	mg/kg (ppm)	0.5	120	70-130
Toluene	mg/kg (ppm)	0.5	120	70-130
Ethylbenzene	mg/kg (ppm)	0.5	122	70-130
Xylenes	mg/kg (ppm)	1.5	119	70-130
Gasoline	mg/kg (ppm)	20	100	70-130

Data Qualifiers & Definitions

a - The analyte was detected at a level less than five times the reporting limit. The RPD results may not provide reliable information on the variability of the analysis.

A1 – More than one compound of similar molecule structure was identified with equal probablility.

b - The analyte was spiked at a level that was less than five times that present in the sample. Matrix spike recoveries may not be meaningful.

ca - The calibration results for this range fell outside of acceptance criteria. The value reported is an estimate.

c - The presence of the analyte indicated may be due to carryover from previous sample injections.

d - The sample was diluted. Detection limits may be raised due to dilution.

ds - The sample was diluted. Detection limits are raised due to dilution and surrogate recoveries may not be meaningful.

dv - Insufficient sample was available to achieve normal reporting limits and limits are raised accordingly.

fb - The analyte indicated was found in the method blank. The result should be considered an estimate.

fc – The compound is a common laboratory and field contaminant.

hr - The sample and duplicate were reextracted and reanalyzed. RPD results were still outside of control limits. The variability is attributed to sample inhomogeneity.

ht - The sample was extracted outside of holding time. Results should be considered estimates.

ip - Recovery fell outside of normal control limits. Compounds in the sample matrix interfered with the quantitation of the analyte.

j – The result is below normal reporting limits. The value reported is an estimate.

J - The internal standard associated with the analyte is out of control limits. The reported concentration is an estimate.

jl - The analyte result in the laboratory control sample is out of control limits. The reported concentration should be considered an estimate.

jr - The rpd result in laboratory control sample associated with the analyte is out of control limits. The reported concentration should be considered an estimate.

js - The surrogate associated with the analyte is out of control limits. The reported concentration should be considered an estimate.

lc - The presence of the compound indicated is likely due to laboratory contamination.

L - The reported concentration was generated from a library search.

nm - The analyte was not detected in one or more of the duplicate analyses. Therefore, calculation of the RPD is not applicable.

pc – The sample was received in a container not approved by the method. The value reported should be considered an estimate.

pr – The sample was received with incorrect preservation. The value reported should be considered an estimate.

ve - The value reported exceeded the calibration range established for the analyte. The reported concentration should be considered an estimate.

vo - The value reported fell outside the control limits established for this analyte.

x - The pattern of peaks present is not indicative of diesel.

y - The pattern of peaks present is not indicative of motor oil.

807158

SAMPLE CHAIN OF CUSTODY

ME 07-15-08 1582

Send Report To Paul Ecker
Company PNG Environmental
Address 6665 SW Hampton Suite 101
City, State, ZIP Tigard, OR 97223
Phone # 620-2387 Fax #

SAMPLERS (signature)
PROJECT NAME/NO. Plaid #324
PO #
REMARKS

Page # of
TURNAROUND TIME
☐ Standard (2 Weeks)
☒ RUSH
Rush charges authorized by:

SAMPLE DISPOSAL
☐ Dispose after 30 days
☐ Return samples
☐ Will call with instructions

Sample ID	Lab ID	Date Sampled	Time Sampled	Sample Type	# of containers	TPH-Diesel	TPH-Gasoline	BTEX by 8021B	VOCs by 8260	SVOCs by 8270	HFS								Notes
B-10 @ 4'	01A-C	7/15/08	9:40	S	3		X		X										
B-10 @ 6'	02A-C		10:10	S	3		X		X										
B-10 @ 10'	03A-C		10:15	S	3		X		X										
B-10 @ 14.5'	04A-C		11:40	S	3		X		X										
B-10 @ 19'	05A-C		11:45	S	3		X		X										
B-10/20'-30'	06A-C		1:20	S	3		X		X										

ANALYSES REQUESTED

Friedman & Bruya, Inc.
3012 16th Avenue West
Seattle, WA 98119-2029
Ph. (206) 285-8282
Fax (206) 283-5044

	SIGNATURE	PRINT NAME	COMPANY	DATE	TIME
Relinquished by:		Daniel Recraft	PNG	7/15/08	16:22
Received by:		HONG NGUYEN	FBI	7/15/08	16:22
Relinquished by:					
Received by:			Samples received at 21 °C		

FORMS\COC\COC.DOC

FRIEDMAN & BRUYA, INC.

ENVIRONMENTAL CHEMISTS

James E. Bruya, Ph.D.
Charlene Morrow, M.S.
Yelena Aravkina, M.S.
Bradley T. Benson, B.S.
Kurt Johnson, B.S.

3012 16th Avenue West
Seattle, WA 98119-2029
TEL: (206) 285-8282
FAX: (206) 283-5044
e-mail: fbi@isomedia.com

July 21, 2008

Paul Ecker, Project Manager
PNG Environmental
1339 Commerce Ave., Suite 313
Longview, WA 98632

Dear Mr. Ecker:

Included are the results from the testing of material submitted on July 16, 2008 from the Plaid 324, F&BI 807168 project. There are 6 pages included in this report. Any samples that may remain are currently scheduled for disposal in 30 days. If you would like us to return your samples or arrange for long term storage at our offices, please contact us as soon as possible.

We appreciate this opportunity to be of service to you and hope you will call if you should have any questions.

Sincerely,

FRIEDMAN & BRUYA, INC.

Eric Young
Chemist

Enclosures
PNG0721R.DOC

FRIEDMAN & BRUYA, INC.

ENVIRONMENTAL CHEMISTS

CASE NARRATIVE

This case narrative encompasses samples received on July 16, 2008 by Friedman & Bruya, Inc. from the PNG Environmental Plaid 324, F&BI 807168 project. Samples were logged in under the laboratory ID's listed below.

Laboratory ID	PNG Environmental
807168-01	B-7@4'
807168-02	B-7@8'
807168-03	B-7@11'
807168-04	B-7@19'
807168-05	B-7@21'
807168-06	B-7@26'
807168-07	B-7@34'
807168-08	B-7@39'
807168-09	B-10@31'
807168-10	B-10@39.5'
807168-11	B-5@4'
807168-12	B-5@7'
807168-13	B-5@12'
807168-14	B-5@17'
807168-15	B-5@22'
807168-16	B-5@28'
807168-17	B-5@34'
807168-18	B-5@39'

All quality control requirements were acceptable.

Date of Report: 07/21/08
Date Received: 07/16/08
Project: Plaid 324, F&BI 807168
Date Extracted: 07/17/08
Date Analyzed: 07/17/08 and 07/18/08

RESULTS FROM THE ANALYSIS OF THE SOIL SAMPLES FOR TOTAL PETROLEUM HYDROCARBONS AS GASOLINE USING METHOD NWTPH-Gx

Results Reported on a Dry Weight Basis
Results Reported as mg/kg (ppm)

Sample ID Laboratory ID	Gasoline Range	Surrogate (% Recovery) (Limit 50-150)
B-7@19' 807168-04	<2	92
B-7@39' 807168-08	<2	87
B-10@39.5' 807168-10	<2	92
B-5@17' 807168-14	<2	85
B-5@28' 807168-16	<2	90
B-5@39' 807168-18	<2	89
Method Blank	<2	92

FRIEDMAN & BRUYA, INC.

ENVIRONMENTAL CHEMISTS

Date of Report: 07/21/08
Date Received: 07/16/08
Project: Plaid 324, F&BI 807168
Date Extracted: 07/17/08
Date Analyzed: 07/18/08

RESULTS FROM THE ANALYSIS OF THE SOIL SAMPLES FOR BENZENE, TOLUENE, ETHYLBENZENE, XYLENES AND TPH AS GASOLINE USING EPA METHOD 8021B AND NWTPH-Gx

Results Reported on a Dry Weight Basis
Results Reported as mg/kg (ppm)

Sample ID Laboratory ID	Benzene	Toluene	Ethyl Benzene	Total Xylenes	Gasoline Range	Surrogate (% Recovery) (Limit 50-150)
B-7@4' 807168-01	<0.02	<0.02	<0.02	<0.06	<2	93
B-7@8' d 807168-02 1/10	0.50	6.1	9.2	38	580	100
B-7@11' 807168-03	<0.02	<0.02	<0.02	<0.06	<2	67
B-7@21' 807168-05	<0.02	<0.02	<0.02	<0.06	<2	89
B-7@26' 807168-06	<0.02	<0.02	<0.02	<0.06	<2	85
B-7@34' 807168-07	<0.02	<0.02	<0.02	<0.06	<2	69
B-10@31' 807168-09	<0.02	<0.02	<0.02	<0.06	<2	63
B-5@4' d 807168-11 1/40	<0.8	4.2	12	120	1,300	ip
B-5@7' 807168-12	<0.02	<0.02	<0.02	<0.06	<2	88
B-5@12' 807168-13	<0.02	<0.02	<0.02	<0.06	<2	64

FRIEDMAN & BRUYA, INC.

ENVIRONMENTAL CHEMISTS

Date of Report: 07/21/08
Date Received: 07/16/08
Project: Plaid 324, F&BI 807168
Date Extracted: 07/17/08
Date Analyzed: 07/18/08

RESULTS FROM THE ANALYSIS OF THE SOIL SAMPLES FOR BENZENE, TOLUENE, ETHYLBENZENE, XYLENES AND TPH AS GASOLINE USING EPA METHOD 8021B AND NWTPH-Gx

Results Reported on a Dry Weight Basis
Results Reported as mg/kg (ppm)

Sample ID Laboratory ID	Benzene	Toluene	Ethyl Benzene	Total Xylenes	Gasoline Range	Surrogate (% Recovery) (Limit 50-150)
B-5@22' 807168-15	<0.02	<0.02	<0.02	<0.06	<2	90
B-5@34' 807168-17	<0.02	<0.02	<0.02	<0.06	<2	88
Method Blank	<0.02	<0.02	<0.02	<0.06	<2	91

Date of Report: 07/21/08
Date Received: 07/16/08
Project: Plaid 324, F&BI 807168

QUALITY ASSURANCE RESULTS FOR THE ANALYSIS OF SOIL SAMPLES FOR BENZENE, TOLUENE, ETHYLBENZENE, XYLENES, AND TPH AS GASOLINE USING EPA METHOD 8021B AND NWTPH-Gx

Laboratory Code: 807168-01 (Duplicate)

Analyte	Reporting Units	Sample Result	Duplicate Result	Relative Percent Difference (Limit 20)
Benzene	mg/kg (ppm)	<0.02	<0.02	nm
Toluene	mg/kg (ppm)	<0.02	<0.02	nm
Ethylbenzene	mg/kg (ppm)	<0.02	<0.02	nm
Xylenes	mg/kg (ppm)	<0.06	<0.06	nm
Gasoline	mg/kg (ppm)	<2	<2	nm

Laboratory Code: Laboratory Control Sample

Analyte	Reporting Units	Spike Level	Percent Recovery LCS	Acceptance Criteria
Benzene	mg/kg (ppm)	0.5	96	70-130
Toluene	mg/kg (ppm)	0.5	90	70-130
Ethylbenzene	mg/kg (ppm)	0.5	84	70-130
Xylenes	mg/kg (ppm)	1.5	88	70-130
Gasoline	mg/kg (ppm)	20	106	70-130

Data Qualifiers & Definitions

a - The analyte was detected at a level less than five times the reporting limit. The RPD results may not provide reliable information on the variability of the analysis.

A1 – More than one compound of similar molecule structure was identified with equal probablility.

b - The analyte was spiked at a level that was less than five times that present in the sample. Matrix spike recoveries may not be meaningful.

ca - The calibration results for this range fell outside of acceptance criteria. The value reported is an estimate.

c - The presence of the analyte indicated may be due to carryover from previous sample injections.

d - The sample was diluted. Detection limits may be raised due to dilution.

ds - The sample was diluted. Detection limits are raised due to dilution and surrogate recoveries may not be meaningful.

dv - Insufficient sample was available to achieve normal reporting limits and limits are raised accordingly.

fb - The analyte indicated was found in the method blank. The result should be considered an estimate.

fc – The compound is a common laboratory and field contaminant.

hr - The sample and duplicate were reextracted and reanalyzed. RPD results were still outside of control limits. The variability is attributed to sample inhomogeneity.

ht - The sample was extracted outside of holding time. Results should be considered estimates.

ip - Recovery fell outside of normal control limits. Compounds in the sample matrix interfered with the quantitation of the analyte.

j – The result is below normal reporting limits. The value reported is an estimate.

J - The internal standard associated with the analyte is out of control limits. The reported concentration is an estimate.

jl - The analyte result in the laboratory control sample is out of control limits. The reported concentration should be considered an estimate.

jr - The rpd result in laboratory control sample associated with the analyte is out of control limits. The reported concentration should be considered an estimate.

js - The surrogate associated with the analyte is out of control limits. The reported concentration should be considered an estimate.

lc - The presence of the compound indicated is likely due to laboratory contamination.

L - The reported concentration was generated from a library search.

nm - The analyte was not detected in one or more of the duplicate analyses. Therefore, calculation of the RPD is not applicable.

pc – The sample was received in a container not approved by the method. The value reported should be considered an estimate.

pr – The sample was received with incorrect preservation. The value reported should be considered an estimate.

ve - The value reported exceeded the calibration range established for the analyte. The reported concentration should be considered an estimate.

vo - The value reported fell outside the control limits established for this analyte.

x - The pattern of peaks present is not indicative of diesel.

y - The pattern of peaks present is not indicative of motor oil.

807168

SAMPLE CHAIN OF CUSTODY

ME 07-16-08 VS2/CD3

Send Report To Paul Ecker
Company PNG Environmental
Address 6665 SW Hampton #101
City, State, ZIP Tigard, OR 97223
Phone # (503) 670-2387 Fax # (503) 620-7977

SAMPLERS (signature) [signature]
PROJECT NAME/NO. Plaid #324
PO #
REMARKS

Page # ____ of ____

TURNAROUND TIME
☐ Standard (2 Weeks)
☒ RUSH
Rush charges authorized by:

SAMPLE DISPOSAL
☐ Dispose after 30 days
☐ Return samples
☐ Will call with instructions

Sample ID	Lab ID	Date Sampled	Time Sampled	Sample Type	# of containers	ANALYSES REQUESTED: TPH-Diesel	TPH-Gasoline	BTEX by 8021B	VOCs by 8260	SVOCs by 8270	HFS	Notes (O-analyze per PE 7/17/08 MG)
B-7 @ 4'	01 A-D	7/16/08	11:30	S	4		X	X				Hold
B-7 @ 8'	02 A-C		11:35	S	3		X	X				Hold
B-7 @ 11'	03 A-C		11:50	S	4		X	X				Hold ***
B-7 @ 19'	04 A-D		12:00	S	4		X	X				Hold **
B-7 @ 21'	05 A-D		12:25	S	4		X	X				Hold
B-7 @ 26'	06 A-D		12:35	S	4		X	X				Hold
B-7 @ 34'	07 A-D		12:50	S	4		X	X				Hold
B-7 @ 39'	08 A-D		12:55	S	4		X	X				Hold
B-10 @ 31'	09 A-D		10:10	S	4		X	X				Hold
B-10 @ 39.5'	10 A-D	↓	10:20	S	4		X	X				Hold *

Friedman & Bruya, Inc.
3012 16th Avenue West
Seattle, WA 98119-2029
Ph. (206) 285-8282
Fax (206) 283-5044

FORMS\COC\COC.DOC

	SIGNATURE	PRINT NAME	COMPANY	DATE	TIME
Relinquished by:	[signature]	Daniel Jecrath	PNG	7/16/08	4:41
Received by:	[signature]	Michael Erdahl	FRB	1	1
Relinquished by:					
Received by:					

Samples received at 3 °C

FRIEDMAN & BRUYA, INC.

ENVIRONMENTAL CHEMISTS

James E. Bruya, Ph.D.
Charlene Morrow, M.S.
Yelena Aravkina, M.S.
Bradley T. Benson, B.S.
Kurt Johnson, B.S.

3012 16th Avenue West
Seattle, WA 98119-2029
TEL: (206) 285-8282
FAX: (206) 283-5044
e-mail: fbi@isomedia.com

July 30, 2008

Paul Ecker, Project Manager
PNG Environmental
6665 SW Hampton St, Suite101
Tigard, OR 97223

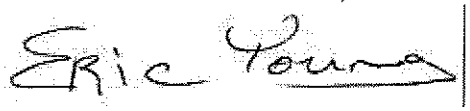
Dear Mr. Ecker:

Included are the results from the testing of material submitted on July 18, 2008 from the Plaid 324, F&BI 807189 project. There are 5 pages included in this report. Any samples that may remain are currently scheduled for disposal in 30 days. If you would like us to return your samples or arrange for long term storage at our offices, please contact us as soon as possible.

We appreciate this opportunity to be of service to you and hope you will call if you should have any questions.

Sincerely,

FRIEDMAN & BRUYA, INC.



Eric Young
Chemist

Enclosures
PNG0730R.DOC

FRIEDMAN & BRUYA, INC.

ENVIRONMENTAL CHEMISTS

CASE NARRATIVE

This case narrative encompasses samples received on July 18, 2008 by Friedman & Bruya, Inc. from the PNG Environmental Plaid 324, F&BI 807189 project. Samples were logged in under the laboratory ID's listed below.

Laboratory ID	PNG Environmental
807189-01	B-12@4'
807189-02	B-12@8'
807189-03	B-6@4'
807189-04	B-6@9'
807189-05	B-8@6'
807189-06	B-8@9'
807189-07	B-13@5'
807189-08	B-13@10'
807189-09	B-13@12'
807189-10	B-13@13.5'
807189-11	B-9@5'
807189-12	B-9@10'
807189-13	B-9@12'
807189-14	B-9@14'

All quality control requirements were acceptable.

Date of Report: 07/30/08
Date Received: 07/18/08
Project: Plaid 324, F&BI 807189
Date Extracted: 07/18/08
Date Analyzed: 07/18/08, 07/19/08, 07/21/08 and 07/23/08

RESULTS FROM THE ANALYSIS OF THE SOIL SAMPLES FOR BENZENE, TOLUENE, ETHYLBENZENE, XYLENES AND TPH AS GASOLINE USING EPA METHOD 8021B AND NWTPH-Gx

Results Reported on a Dry Weight Basis
Results Reported as mg/kg (ppm)

Sample ID Laboratory ID	Benzene	Toluene	Ethyl Benzene	Total Xylenes	Gasoline Range	Surrogate (% Recovery) (Limit 50-150)
B-12@4' 807189-01	<0.02	0.27	<0.02	3.6	150	133
B-12@8' 807189-02	<0.02	<0.02	<0.02	<0.06	<2	89
B-6@4' d 807189-03 1/20	1.5	65	12	250	1,500	ip
B-6@9' 807189-04	<0.02	<0.02	<0.02	<0.06	<2	89
B-8@6' d 807189-05 1/10	0.73	16	17	150	1,200	ip
B-8@9' 807189-06	0.03	1.0	0.50	0.78	18	104
B-13@5' d 807189-07 1/10	<0.2	1.8	1.6	11	140	110
B-13@12' 807189-09	0.12	0.26	0.06	0.30	3	92
B-9@5' d 807189-11 1/10	1.5	42	14	120	950	ip
B-9@10' d 807189-12 1/40	9.9	99	31	200	2,100	ip

Date of Report: 07/30/08
Date Received: 07/18/08
Project: Plaid 324, F&BI 807189
Date Extracted: 07/18/08
Date Analyzed: 07/18/08, 07/19/08, 07/21/08 and 07/23/08

RESULTS FROM THE ANALYSIS OF THE SOIL SAMPLES FOR BENZENE, TOLUENE, ETHYLBENZENE, XYLENES AND TPH AS GASOLINE USING EPA METHOD 8021B AND NWTPH-Gx

Results Reported on a Dry Weight Basis
Results Reported as mg/kg (ppm)

Sample ID Laboratory ID	Benzene	Toluene	Ethyl Benzene	Total Xylenes	Gasoline Range	Surrogate (% Recovery) (Limit 50-150)
B-9@12' 807189-13	<0.02	0.03	<0.02	<0.06	<2	97
Method Blank	<0.02	<0.02	<0.02	<0.06	<2	76

Date of Report: 07/30/08
Date Received: 07/18/08
Project: Plaid 324, F&BI 807189

QUALITY ASSURANCE RESULTS FOR THE ANALYSIS OF SOIL SAMPLES FOR BENZENE, TOLUENE, ETHYLBENZENE, XYLENES, AND TPH AS GASOLINE USING EPA METHOD 8021B AND NWTPH-Gx

Laboratory Code: 807189-13 (Duplicate)

Analyte	Reporting Units	Sample Result	Duplicate Result	Relative Percent Difference (Limit 20)
Benzene	mg/kg (ppm)	<0.02	<0.02	nm
Toluene	mg/kg (ppm)	0.03	0.05	50 a
Ethylbenzene	mg/kg (ppm)	<0.02	<0.02	nm
Xylenes	mg/kg (ppm)	<0.06	0.08	nm
Gasoline	mg/kg (ppm)	<2	<2	nm

Laboratory Code: Laboratory Control Sample

Analyte	Reporting Units	Spike Level	Percent Recovery LCS	Acceptance Criteria
Benzene	mg/kg (ppm)	0.5	120	70-130
Toluene	mg/kg (ppm)	0.5	112	70-130
Ethylbenzene	mg/kg (ppm)	0.5	106	70-130
Xylenes	mg/kg (ppm)	1.5	114	70-130
Gasoline	mg/kg (ppm)	20	115	70-130

Data Qualifiers & Definitions

a - The analyte was detected at a level less than five times the reporting limit. The RPD results may not provide reliable information on the variability of the analysis.

A1 – More than one compound of similar molecule structure was identified with equal probablility.

b - The analyte was spiked at a level that was less than five times that present in the sample. Matrix spike recoveries may not be meaningful.

ca - The calibration results for this range fell outside of acceptance criteria. The value reported is an estimate.

c - The presence of the analyte indicated may be due to carryover from previous sample injections.

d - The sample was diluted. Detection limits may be raised due to dilution.

ds - The sample was diluted. Detection limits are raised due to dilution and surrogate recoveries may not be meaningful.

dv - Insufficient sample was available to achieve normal reporting limits and limits are raised accordingly.

fb - The analyte indicated was found in the method blank. The result should be considered an estimate.

fc – The compound is a common laboratory and field contaminant.

hr - The sample and duplicate were reextracted and reanalyzed. RPD results were still outside of control limits. The variability is attributed to sample inhomogeneity.

ht - The sample was extracted outside of holding time. Results should be considered estimates.

ip - Recovery fell outside of normal control limits. Compounds in the sample matrix interfered with the quantitation of the analyte.

j – The result is below normal reporting limits. The value reported is an estimate.

J - The internal standard associated with the analyte is out of control limits. The reported concentration is an estimate.

jl - The analyte result in the laboratory control sample is out of control limits. The reported concentration should be considered an estimate.

jr - The rpd result in laboratory control sample associated with the analyte is out of control limits. The reported concentration should be considered an estimate.

js - The surrogate associated with the analyte is out of control limits. The reported concentration should be considered an estimate.

lc - The presence of the compound indicated is likely due to laboratory contamination.

L - The reported concentration was generated from a library search.

nm - The analyte was not detected in one or more of the duplicate analyses. Therefore, calculation of the RPD is not applicable.

pc – The sample was received in a container not approved by the method. The value reported should be considered an estimate.

pr – The sample was received with incorrect preservation. The value reported should be considered an estimate.

ve - The value reported exceeded the calibration range established for the analyte. The reported concentration should be considered an estimate.

vo - The value reported fell outside the control limits established for this analyte.

x - The pattern of peaks present is not indicative of diesel.

y - The pattern of peaks present is not indicative of motor oil.

807168

SAMPLE CHAIN OF CUSTODY

ME 07-16-08 VS2/CT3

Send Report To Paul Ecker
Company PNG Environmental
Address 6665 SW Hampton #101
City, State, ZIP Tigard, OR 97223
Phone # (503) 620-2387 Fax # (503) 620-2977

SAMPLERS (signature) [signature]
PROJECT NAME/NO. Plaid #324
PO #
REMARKS

Page # ____ of ____

TURNAROUND TIME
☐ Standard (2 Weeks)
☒ RUSH
Rush charges authorized by:

SAMPLE DISPOSAL
☐ Dispose after 30 days
☐ Return samples
☐ Will call with instructions

Sample ID	Lab ID	Date Sampled	Time Sampled	Sample Type	# of containers	TPH-Diesel	TPH-Gasoline	BTEX by 8021B	VOCs by 8260	SVOCs by 8270	HFS	Notes (* - analyze per PE 7/17/08 MG
B-7 @ 4'	01 A-D	7/16/08	11:30	S	4		⊗	⊗				Hold
B-7 @ 8'	02 A-C		11:35	S	3		⊗	⊗				Hold
B-7 @ 11'	03 A-C		11:50	S	4		⊗	⊗				Hold **
B-7 @ 19'	04 A-D		12:00	S	4		⊗	⊗				Hold **
B-7 @ 21'	05 A-D		12:25	S	4		⊗	⊗				Hold
B-7 @ 26'	06 A-D		12:35	S	4		⊗	⊗				Hold
B-7 @ 34'	07 A-D		12:50	S	4		⊗	⊗				Hold
B-7 @ 39'	08 A-D		12:55	S	4		⊗	⊗				Hold
B-10 @ 31'	09 A-D		10:10	S	4		⊗	⊗				Hold
B-10 @ 39.5'	10 A-D	↓	10:20	S	4		⊗	⊗				Hold *

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	SIGNATURE	PRINT NAME	COMPANY	DATE	TIME
Relinquished by:	[signature]	Daniel Secrist	PNG	7/16/08	4:41
Received by:	[signature]	Michael Erdahl	FB	1	1
Relinquished by:					
Received by:					

Samples received at 3 °C

807168

SAMPLE CHAIN OF CUSTODY

ME 07-16-08 VS2/CI3

Send Report To Paul Ecker
Company PNG Environmental
Address 6665 SW Hampton #101
City, State, ZIP Tigard, OR 97223
Phone # 620-2387 Fax # 620-2977

SAMPLERS (signature) Daniel Ecker
PROJECT NAME/NO. Plaid #324
PO #
REMARKS

Page # ____ of ____

TURNAROUND TIME
☐ Standard (2 Weeks)
☒ RUSH
Rush charges authorized by:

SAMPLE DISPOSAL
☐ Dispose after 30 days
☐ Return samples
☐ Will call with instructions

Sample ID	Lab ID	Date Sampled	Time Sampled	Sample Type	# of containers	ANALYSES REQUESTED: TPH-Diesel	TPH-Gasoline	BTEX by 8021B	VOCs by 8260	SVOCs by 8270	HFS							Notes
B-5 @ 4'	11 A-D	7/16/08	2:55	S	4		⊗	⊗										Hold
B-5 @ 7'	12 A-D		3:05	S	4		⊗	⊗										Hold *
B-5 @ 12'	13 A-D		3:10	S	4		⊗	⊗										Hold
B-5 @ 17'	14 A-D		3:30	S	4		⊗											Hold
B-5 @ 22'	15 A-D		3:40	S	4		⊗	⊗										Hold **
B-5 @ 28'	16 A-D		3:55	S	4		⊗											Hold
B-5 @ 34'	17 A-D		4:10	S	4		⊗	⊗										Hold
B-5 @ 39'	18 A-D	↓	4:20	S	4		⊗	⊗										Hold

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	SIGNATURE	PRINT NAME	COMPANY	DATE	TIME
Relinquished by:	Daniel Ecker	Daniel Ecker	PNG	7/16/08	4:41
Received by:		Michael Erdahl	FFB	1	1
Relinquished by:					
Received by:			Samples received at 3 °C		

SAMPLE CHAIN OF CUSTODY

Send Report To
Company Paul Echer - PNB Env.
Address 6665 SW Hampton #101
City, State, ZIP Tigard, OR 97223
Phone # 620-2387 Fax #

SAMPLERS (signature)
PROJECT NAME/NO. Plaid # 324
PO#
REMARKS

Page # _____ of _____
TURNAROUND TIME
(Standard (2 Weeks))
RUSH
Rush charges authorized by:

SAMPLE DISPOSAL
Dispose after 30 days
Return samples
Will call with instructions

Sample ID	Lab ID	Date Sampled	Time Sampled	Sample Type	# of containers	ANALYSES REQUESTED: TPH-Diesel	TPH-Gasoline	BTEX by 8021B	VOCs by 8260	SVOCs by 8270	HFS							Notes
B-12 @ 4'		7/17/08	8:50	S	4		X	X										
B-12 @ 8'			9:00	S	4		X	X										
B-6 @ 4'			11:40	S	4		X	X										
B-6 @ 9'			11:50	S	4		X	X										
B-8 @ 6'			2:15	S	4		X	X										
B-8 @ 9'			2:25	S	4		X	X										
B-13 @ 5'			3:20	S	4		X	X										
B-13 @ 10			3:30	S	4													Hold
B-13 @ 12'			4:10	S	4		X	X										
B-13 @ 13.5'		↓	4:20	S	4													Hold

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SIGNATURE	PRINT NAME	COMPANY	DATE	TIME
Relinquished by:				
Received by:				
Relinquished by:				
Received by:				

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SAMPLE CHAIN OF CUSTODY

Send Report To
Company Paul Ecker - PIUG Env
Address 6665 SW Hampton #101
City, State, ZIP Tigard, OR 97223
Phone # 620-2387 Fax #

SAMPLERS (signature)
PROJECT NAME/NO. Plaid #324
PO #
REMARKS

Page # ____ of ____
TURNAROUND TIME
Standard (2 Weeks)
RUSH
Rush charges authorized by:

SAMPLE DISPOSAL
Dispose after 30 days
Return samples
Will call with instructions

Sample ID	Lab ID	Date Sampled	Time Sampled	Sample Type	# of containers	TPH-Diesel	TPH-Gasoline	BTEX by 8021B	VOCs by 8260	SVOCs by 8270	HFS							Notes
						ANALYSES REQUESTED												
B-9 @ 5'		7/17/08	5:05	S	4		X	X										
B-9 @ 10'		"	5:15	S	4		X	X										~~Hold~~
B-9 @ 12'		"	5:30	S	4		X	X										
B-9 @ 14'		↓	5:40	S	4													Hold

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SIGNATURE	PRINT NAME	COMPANY	DATE	TIME
Relinquished by:				
Received by:				
Relinquished by:				
Received by:				

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SAMPLE CHAIN OF CUSTODY

Send Report To
Company Paul Echer - PNG Env.
Address 6665 SW Hampton #101
City, State, ZIP Tigard, OR 97223
Phone # 670-7387 Fax #

SAMPLERS (signature) Dan Echer
PROJECT NAME/NO. Plaid # 324
PO#
REMARKS

Page # 1 of 2

TURNAROUND TIME
(Standard (2 Weeks))
RUSH
Rush charges authorized by:

SAMPLE DISPOSAL
Dispose after 30 days
Return samples
Will call with instructions

Sample ID	Lab ID	Date Sampled	Time Sampled	Sample Type	# of containers	TPH-Diesel	TPH-Gasoline	BTEX by 8021B	VOCs by 8260	SVOCs by 8270	HFS								Notes
						ANALYSES REQUESTED													
B-12 @ 4'		7/17/08	8:50	S	4		X	X											
B-12 @ 8'			9:00	S	4		X	X											
B-6 @ 4'			11:40	S	4		X	X											
B-6 @ 9'			11:50	S	4		X	X											
B-8 @ 6'			2:15	S	4		X	X											
B-8 @ 9'			2:25	S	4		X	X											
B-13 @ 5'			3:20	S	4		X	X											
B-13 @ 10'			3:30	S	4														Hold
B-13 @ 12'			4:10	S	4		X	X											
B-13 @ 13.5'		V	4:20	S	4														Hold

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	SIGNATURE	PRINT NAME	COMPANY	DATE	TIME
Relinquished by:	Dan Echer	Dan Becraft	PNG	7/18/08	7:00
Received by:	Heather Rankin	H. Rankin	F&BI	7/18/08	7a.
Relinquished by:					
Received by:					

SAMPLE CHAIN OF CUSTODY

Page # 2 of 2

Send Report To
Company Paul Ecker - PWG Env
Address 6665 SW Hampton #101
City, State, ZIP Tigard, OR 97223
Phone # 620-2387 Fax #

SAMPLERS (signature) Dan Beeraft
PROJECT NAME/NO. Plaid #324
PO #
REMARKS

TURNAROUND TIME
✓ Standard (2 Weeks)
RUSH
Rush charges authorized by:

SAMPLE DISPOSAL
Dispose after 30 days
Return samples
Will call with instructions

Sample ID	Lab ID	Date Sampled	Time Sampled	Sample Type	# of containers	TPH-Diesel	TPH-Gasoline	BTEX by 8021B	VOCs by 8260	SVOCs by 8270	PAHs							Notes
B-9 @ 5'		7/17/08	5:05	S	4		X	X										
B-9 @ 10'			5:15	S	4		X	X										~~Hold~~
B-9 @ 12'			5:30	S	4		X	X										
B-9 @ 14'		↓	5:40	S	4													Hold

ANALYSES REQUESTED

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	SIGNATURE	PRINT NAME	COMPANY	DATE	TIME
Relinquished by:	Dan Beeraft	Dan Beeraft	PWG	7/18/08	7:00
Received by:	Heather Rankin	H. Rankin	F&B, I	7/18/08	7a.
Relinquished by:					
Received by:					

807158

SAMPLE CHAIN OF CUSTODY

ME 07-15-08 V82

Send Report To Paul Ecker
Company PNG Environmental
Address 6665 SW Hampton Suite 101
City, State, ZIP Tigard, OR 97223
Phone # 620-2387 Fax #

SAMPLERS (signature)
PROJECT NAME/NO. Plaid #324
PO #
REMARKS

Page # ____ of ____
TURNAROUND TIME
☐ Standard (2 Weeks)
☒ RUSH
Rush charges authorized by:

SAMPLE DISPOSAL
☐ Dispose after 30 days
☐ Return samples
☐ Will call with instructions

Sample ID	Lab ID	Date Sampled	Time Sampled	Sample Type	# of containers	TPH-Diesel	TPH-Gasoline	BTEX by 8021B	VOCs by 8260	SVOCs by 8270	HFS							Notes
						ANALYSES REQUESTED												
B-10 @ 4'	01A-C	7/15/08	9:40	S	3		X		X									
B-10 @ 6'	02A-C		10:10	S	3		X		X									
B-10 @ 10'	03A-C		10:15	S	3		X		X									
B-10 @ 14.5'	04A-C		11:40	S	3		X		X									
B-10 @ 19'	05A-C		11:45	S	3		X		X									
B-10/20'-30'	06A-C	✓	1:20	S	3		X		X									

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	SIGNATURE	PRINT NAME	COMPANY	DATE	TIME
Relinquished by:		Daniel Becraft	PNG	7/15/08	16:22
Received by:		HONG NGUYEN	FBI	7/15/08	16:22
Relinquished by:					
Received by:			Samples received at 20 °C		

SAMPLE CHAIN OF CUSTODY

Send Report To: Paul Echer
Company: PNG Environmental
Address: 6665 SW Hampton #101
City, State, ZIP: Tigard, OR 97773
Phone #: 620-2387 Fax #: 620-2977

SAMPLERS (signature):
PROJECT NAME/NO.: Plaid #324
PO #:
REMARKS: Analyses added 7/17/08 TE

Page # 1 of 2

TURNAROUND TIME
- ☐ Standard (2 Weeks)
- ☒ RUSH
- Rush charges authorized by:

SAMPLE DISPOSAL
- ☐ Dispose after 30 days
- ☐ Return samples
- ☐ Will call with instructions

Sample ID	Lab ID	Date Sampled	Time Sampled	Sample Type	# of containers	ANALYSES REQUESTED: TPH-Diesel	TPH-Gasoline	BTEX by 8021B	VOCs by 8260	SVOCs by 8270	HFS								Notes
B-5 @ 4'		7/16/08	2:55	S	4		X	X											Hold
B-5 @ 7'			3:05	S	4		X	X											Hold
B-5 @ 12'			3:10	S	4		X	X											Hold
B-5 @ 17'			3:30	S	4		X												Hold
ND/ND B-5 @ 22'			3:40	S	4		X	X											Hold
B-5 @ 28'			3:55	S	4		X												Hold
ND/ND B-5 @ 34'			4:10	S	4		X	X											Hold
B-5 @ 39'		↓	4:20	S	4		X												Hold

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Seattle, WA 98119-2029
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Fax (206) 283-5044

SIGNATURE	PRINT NAME	COMPANY	DATE	TIME
Relinquished by:	Daniel Berraft	PNG	7/16/08	4:41
Received by:	Michael Eadh	FBI	1	2
Relinquished by:				
Received by:				

FORMS\COC\COC.DOC

SAMPLE CHAIN OF CUSTODY

Page # 2 of 2

Send Report To: Paul Eckler
Company: PNG Environmental
Address: 6665 SW Hampton #101
City, State, ZIP: Tigard, OR 97223
Phone #: (503) 670-2337 Fax #: (503) 670-7972

SAMPLERS (signature): [signature]
PROJECT NAME/NO.: Plaid #324
PO #:
REMARKS: Analyses added 7/17/08 PE

TURNAROUND TIME
- ☐ Standard (2 Weeks)
- ☒ RUSH
- Rush charges authorized by:

SAMPLE DISPOSAL
- ☐ Dispose after 30 days
- ☐ Return samples
- ☐ Will call with instructions

Sample ID	Lab ID	Date Sampled	Time Sampled	Sample Type	# of containers	TPH-Diesel	TPH-Gasoline	BTEX by 8021B	VOCs by 8260	SVOCs by 8270	HFS								Notes
B-7 @ 4'		7/16/08	11:30	S	4		X	X											Hold
B-7 @ 8'			11:35	S	3		X	X											Hold
B-7 @ 11'			11:50	S	4		X	X											Hold
B-7 @ 19'			12:00	S	4		X												Hold
B-7 @ 21'			12:25	S	4		X	X											Hold
B-7 @ 26'			12:35	S	4		X	X											Hold
B-7 @ 34'			12:50	S	4		X	X											Hold
B-7 @ 39'			12:55	S	4		X												Hold
B-10 @ 31'			10:10	S	4		X	X											Hold
B-10 @ 39.5		↓	10:20	S	4		X												Hold

VD/ND
D/ND
80/ND
B/ND

SIGNATURE	PRINT NAME	COMPANY	DATE	TIME
Relinquished by: [signature]	Daniel Berrett	PNG	7/16/08	4:41
Received by: [signature]	Michael Eckler	FGB	1	1
Relinquished by:				
Received by:				

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