

## ***PNG ENVIRONMENTAL, INC.***

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April 22, 2011

1133-02

Mr. Terry Pyle  
Plaid Pantries, Inc.  
10025 SW Allen Boulevard  
Beaverton, Oregon 97005-4124

Subject: **Interim Remedial Action Work Plan**  
Former Plaid Pantries Store #324  
10645 16<sup>th</sup> Avenue SW  
Seattle, Washington  
Ecology Site ID #97464

Dear Mr. Pyle:

PNG Environmental, Inc. (PNG) is pleased to present this proposal to conduct interim remedial action tasks at the subject property. PNG's proposed work scope is intended to address onsite areas at the former Plaid Pantries, Inc. (Plaid) site where gasoline impacts exceed Washington Department of Ecology (Ecology) soil cleanup criteria. Maps illustrating the former fueling system location and other pertinent site features are provided as Figures 1 and 2.

The site's gasoline fueling system was removed in 2006. Extensive site characterization indicates gasoline contamination in soil extends north and northeast of the former underground storage tank (UST) cavity, but no free product or groundwater impacts related to the fueling operations are suspected. Site characterization reports prepared for Plaid have been submitted to Ecology.

Site characterization efforts to date, and the proposed future remedial actions, are being conducted along an "independent cleanup" pathway in accordance with Washington's Model Toxics Control Act (MTCA) environmental cleanup rules as published in WAC 173-340. The proposed remedy focuses on soil treatment but it is considered to be an interim action because implementation would occur prior to completion of a formal Remedial Investigation (RI). Please note that the interim remedy is consistent with the findings and recommendations presented in a focused feasibility study (PNG 2010).

### **BACKGROUND**

The site is located at the northwest corner of SW 107<sup>th</sup> Street and 16<sup>th</sup> Avenue SW in Seattle, Washington. The property is owned by Louise Piacentini and is occupied by a convenience store and restaurant. Former site operations included a retail gasoline station. The UST system was decommissioned by Plaid's subtenant in 2006.

Plaid operated the Store #324 retail gasoline station at the site between September 1986 and November 30, 1990. Plaid then sub-leased the store building and sold the UST system fixtures and equipment to Young Kil Kim and Chae Yop Kim. Fuel storage at the facility was provided by three gasoline USTs (two 12,000-gallon capacity USTs and one 10,000-gallon capacity UST) which were decommissioned by the sub-tenants in 2006. Plaid remained the primary lessee of the property until August 31, 2006.

During the operations of Plaid and its 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 and its sub-tenants operated a leak detection system in accordance with Ecology requirements and no known system leaks were identified or reported to Plaid during the term of Plaid's lease. Tank decommissioning data provided to Plaid in 2007 by the property owner and subsequent investigations by Plaid indicate that gasoline constituents were identified in soil near the former UST system. This information is summarized in the following reports: UST Decommissioning Report (KEE 2007-prepared for the subtenants), Site Assessment Report (PNG 2008a), Site Characterization and SVE Pilot Test Report (PNG 2008b).

### **Site Characterization**

Based on site characterization performed to date (PNG 2009), soils located north and northeast of the former UST cavity are contaminated with gasoline and benzene at concentrations exceeding Ecology's MTCA Method A cleanup levels (Table 1 and Figure 3). Gasoline impacts may extend offsite into the right-of-way immediately east of the property. Groundwater was not encountered at maximum drilling depths of 50 feet, which is consistent with records identifying the local water table at depths between approximately 60 and 100 feet below ground surface (bgs). Based on the limited vertical extent of identified soil contamination (approximately 12 feet bgs), groundwater is unlikely to be impacted by the release and PNG has not collected confirmatory groundwater samples at the site.

### **Remedial Action Objectives**

Remedial action objectives (RAOs) proposed in this work plan are to reduce gasoline range hydrocarbon and related constituents (e.g. benzene) to concentrations that are below their respective MTCA Method A Cleanup Levels (30 and 0.03 mg/Kg for gasoline and benzene, respectively).

### **Evaluation of Cleanup Action Alternatives**

Based on the identified lateral and vertical extent of the impacted soil, PNG evaluated a range of remedial action alternatives for addressing soil contamination at the site.

- PNG conducted pilot testing at the site in 2008 and 2009 to evaluate in-situ treatment of impacted soils using vapor extraction and/or air injection. Testing results indicated site soil conditions were unfavorable for these remedial technologies, with limited effectiveness even for very closely-spaced vacuum extraction/air injection points.
- Excavation was considered and was determined to be excessively complex and costly because property line shoring would be required to address deeper soil impacts and to stabilize the adjoining 16<sup>th</sup> Avenue right-of-way.
- PNG compiled and evaluated a broad range of remedial technology alternatives (PNG 2010). Many of the identified technologies were not recommended for further evaluation because of limited effectiveness and/or applicability at the site,

limited availability of the technology in the Pacific Northwest, cost, and potential risk to adjacent infrastructure.

## **SELECTED REMEDIAL APPROACH**

Based on the technology screening and discussions with Plaid, a phased remedial approach has been developed that will incorporate both In Situ Chemical Oxidation (ISCO) and focused excavation technologies. The components of this phased approach are presented below.

### **Focused Remedial Excavation**

Focused remedial excavation of gasoline impacted soil (excluding the property margins) is considered the most cost-effective remedial technology that could be applied at this site. Remedial excavation is best suited for impacted areas where the following conditions apply:

- Impacted soils are not obstructed by surface features.
- Impacted soil is present at a relatively shallow depth to minimize the amount of overburden that must be removed to access and excavate impacted soil.
- Impacted soil does not extend offsite.
- Impacted soil does not extend to great depths below the water table to minimize the need for dewatering activities.

Although site characterization data indicate that impacted soil may extend offsite beneath the adjacent right-of-way (ROW), the identified contamination at the site meets the other three criteria. No surface features are covering the impacted area, impacted soil extends from approximately four to twelve feet bgs, and depth to groundwater at the site is estimated to be approximately 60 to 100 feet bgs (approximately 50 feet or deeper below identified soil impacts).

Remedial excavation is not appropriate at this time at the site margins bordered by the ROW. Because impacted soil appears to extend offsite, the application of ISCO injection technology along the property boundary is an additional component of the remedial approach as discussed below.

### **ISCO Injection Technology and Media**

Based on site characterization and remedial technology screening performed to date, ISCO injection has been identified as a promising technology to reduce contaminant concentrations in place, without disturbance of the adjoining 16<sup>th</sup> Avenue ROW. If ISCO achieves remedial action objectives (RAOs) at the site perimeter near the ROW, then focused remedial excavation can proceed efficiently at other portions of the Plaid site.

In general terms, ISCO is well-suited to soil remediation in portions of this site where remedial excavation would not be advisable for several reasons including:

- ISCO injection represents an aggressive destruction technology for a range of organic contaminants including gasoline/constituents.

- ISCO injection is applied in situ in the property boundary area and therefore does not generate large volumes of external waste and will not disturb infrastructure in the ROW.
- ISCO injection does not generate toxic byproducts.
- Although multiple applications may be required, ISCO injection does not require ongoing operations and maintenance (O&M).
- ISCO injection media are widely available.
- ISCO injection technology is widely accepted by regulatory agencies.

Based on a review of available ISCO technologies, experience at other sites, and calculations of oxidant demand, PNG recommends one or more ISCO injection events using a catalyzed 15 percent sodium persulfate solution. Sodium persulfate is a stable, highly soluble crystalline material which, upon activation using sodium hydroxide, generates the sulfate radical, a very strong oxidant capable of destroying a broad range of organic contaminants. In addition to its oxidizing strength, persulfate and sulfate radical oxidation has several advantages over other oxidant systems. It is kinetically efficient and the sulfate radical is more stable relative to other oxidizers. Also, persulfate has less affinity for natural soil organics and is thus more efficient in high organic soils. The byproduct of persulfate reaction with gasoline is sodium monosulfate, which subsequently breaks down into sulfate ions. Sulfate ions are naturally occurring soil components and do not represent an environmental concern when present in excess concentrations. Sulfate ions are gradually consumed by sulfate reducing bacteria that are naturally present in the soil.

An important consideration with injected media relates to subsurface distribution, particularly in fine-grained soil matrices similar to those observed at the Plaid site. Compared to other more viscous blended chemical oxidant solutions, PNG has had good success injecting and distributing sodium persulfate in fine-grained soils.

These chemical and physical attributes combine to make persulfate a potentially viable option for the chemical oxidation of gasoline.

### **Recommended Oxidant Product**

Based on PNG's evaluation, we propose to use a common and commercially available ISCO product provided by FMC Corporation (FMC). The FMC "Klozur" sodium persulfate product will be activated using sodium hydroxide as described in Attachment A. The blended products are not hazardous and can be safely handled and injected. However, as with all oxidizing chemicals, these products require careful attention to all aspects of handling and use. Material safety data sheets are provided in Attachment B. A technical bulletin on safe handling is also included in Attachment B. The in-situ injection of this product achieves aggressive fast-acting contaminant mass reduction associated with chemical oxidation.

### **PROPOSED SCOPE OF WORK**

The interim remedial strategy will target on-site soils located north and northeast of the former UST cavity where gasoline and benzene concentrations exceed MTCA Method A Soil Cleanup Levels (30 and 0.03 mg/Kg, respectively). Two separate remedial technologies are proposed for application at contaminated site areas, including

(1) injection of sodium persulfate ISCO media extending along a portion the eastern property boundary adjacent to the 16<sup>th</sup> Avenue ROW where excavation is not feasible, and (2) remedial excavation of impacted soil up to a depth of 12 feet bgs to the west of the ISCO injection area. The approach is sequenced such that ISCO injection would be applied first, followed by a period of confirmatory performance monitoring, followed by excavation. The proposed treatment and excavation areas for the proposed actions discussed below are illustrated in Figure 4.

The initial phase of ISCO injection includes a pilot test that evaluates the implementability and effectiveness of sodium persulfate media to destroy gasoline contaminants in order to meet RAOs. Factors that may limit the effectiveness of sodium persulfate and that will be evaluated include: (1) ability to inject and distribute adequate volumes of the chemical oxidant solution within the subsurface such that adequate contact occurs between the persulfate and the contaminant, and (2) existing soil chemistry that could affect or interfere with desired ISCO performance. The likely limiting factor at the Plaid site will be the ability to inject adequate volumes of the treatment chemistry into the soil matrix due to the low permeability nature of the formation.

The interim action approach limits ISCO injection within the Plaid site property boundaries (Figure 4) and drilling activities will not extend into any portion of the ROW (including landscaping and sidewalk areas). Subject to confirmation and as verified by a boundary survey if appropriate, we assume this scenario would not require the acquisition of ROW permits. This approach would address impacted soil extending up to the ROW, including ISCO injection (approximately 720 square feet) and excavation (approximately 1,680 square feet). Remedial excavation at the Plaid site would generate approximately 200 to 300 cubic yards of impacted soil requiring off-site disposal.

### **Preliminary Coordination Tasks**

PNG will complete the following preliminary tasks prior to field implementation:

- Update the current Health and Safety Plan (HASP) to guide field safety protocols, in accordance with rules established by the Occupational Safety and Health Administration. Safe work practices will be incorporated into the HASP with tailgate safety meetings as appropriate to ensure workers are using proper personal protective equipment.
- Prepare and submit an Underground Injection Control (UIC) Permit application in accordance with Ecology guidelines for remediation sites.
- Request utility identification through the public utility notification service.
- Contract with a private utility locator to identify and locate utility lines in the proposed treatment and excavation area both onsite and within the adjacent ROW. Identified utilities will be marked and mapped. This approach does not guarantee that unidentified conduits will not be encountered during drilling, but greatly minimizes the risk of doing so at depths where underground utilities are commonly present.
- Contract with a licensed surveyor to identify and mark the property boundary in the proposed treatment and excavation area and record the marked locations of utilities identified by the public and private utility locators.

## **Baseline Soil Sampling for ISCO Treatability Testing and Geotechnical Engineering Excavation Design**

Prior to the ISCO injection phase of the project, PNG will collaborate with Earth Engineers Inc. (EEI) of Vancouver, Washington to perform simultaneous environmental and geotechnical evaluation of the proposed ISCO injection and remedial excavation treatment area. Assessment activities will include the following:

- Direct field operations using hollow-stem auger drilling techniques at two locations to collect standard penetration test disturbed split spoon soil samples at 2.5 foot intervals extending to 15 feet bgs.
- Collect soil samples for geotechnical analysis (soil moisture, particle size and Atterberg limits if cohesive soil is encountered) and bench scale soil titration testing (which is necessary to determine the amount of activator solution that will be required during the ISCO injection).
- Submit selected soil samples for baseline laboratory analysis for gasoline range petroleum hydrocarbons by Method NWTPH-Gx, benzene, toluene, ethylbenzene, and xylenes (BTEX) by EPA Method 8021, and soil pH by EPA Method 9045. These data will be compared with post-injection samples to evaluate ISCO effectiveness as discussed below.
- EEI will prepare a geotechnical engineering report for the proposed remedial excavation area. The report will include a discussion of subsurface conditions encountered including pertinent soil and groundwater conditions, recommendations for remedial excavation slopes, and recommendations for placing structural fill to replace excavated petroleum impacted soil.

## **Bench-Scale ISCO Evaluation**

For soil applications above the water table, the proposed ISCO media manufacturer (FMC) recommends blending sodium persulfate oxidant with a sodium hydroxide activator compound. Bench-scale titration analysis using soil collected from the planned treatment area is recommended by FMC to determine a site-specific oxidant/activator blending ratio for ISCO injection. Bench scale soil titration analysis will be performed by Apex Laboratories (Tigard, Oregon) in accordance with the methodology developed by FMC as described in Attachment A. Bench scale soil titration results will be used to verify the effectiveness of the ISCO chemistry for the site and to optimize the quantity of sodium hydroxide activator during ISCO injection as described below.

## **In-Situ Chemical Oxidation Implementability Evaluation (Pilot Scale)**

Based on subsurface soil conditions encountered during previous site investigation and SVE pilot testing activities, the possibility exists that the soil boring and ISCO injection methodology proposed for the treatment area may not be implementable due to low soil permeability and/or density. Low permeability would reduce the volume of oxidant and activator that could be injected at each injection point and limit the distribution and effectiveness of the ISCO technology. PNG will perform an ISCO implementability evaluation prior to performing the full-scale ISCO injection described below. The implementability evaluation would consist of a test application of the proposed ISCO media at selected locations within the proposed treatment area. The test application would be performed in accordance with the methodology described in the following



section but would be restricted to no more than six borings (approximately one field day). The suitability of direct-push drilling methods will also be evaluated during this pilot test. In the event the implementability evaluation is considered unsuccessful, the application of the ISCO technology proposed below will be reevaluated.

### **In-Situ Chemical Oxidant Injection (Full Scale)**

Based on the bench-scale testing and assuming the selected ISCO chemistry is confirmed as being suitable for application at the Plaid site, the following tasks will be completed as part of the remedial injection scope:

- Direct field operations using direct-push Geoprobe (or other) drilling techniques consisting of a grid-based array located at the eastern portion of the Plaid site (Figure 4). Alternative drilling technologies may be considered depending on the implementability of using direct-push methods as determined during the previous trial phase. The planned injection event will consist of 36 closely-spaced boring locations (approximately five feet on center). Boring locations will be modified as necessary based on obstructions and/or utility locations.
  - Advance each boring to completion depths of approximately 15 feet bgs, if possible, using small-diameter drive rods.
  - Pressure-inject (<100 psi) a solution containing Klozur persulfate and a sodium hydroxide activator within impacted portions of the unsaturated zone between approximately 15 and four feet bgs, if possible. Based on FMC recommendations (Attachment A), the mix design will include a 15 percent Klozur solution applied at a dose rate of approximately 14 pounds per foot, mixed with 11 gallons per foot tap water. The 25% sodium hydroxide activator solution will be injected at each boring location immediately following injection of the Klozur solution. As discussed above, the quantity of activator solution that will be required is dependent on the results of the bench scale soil titration test.
  - Following injection, each borehole will be filled and sealed with granular hydrated bentonite, and the pavement surface will be restored with concrete (and landscaping will be restored if affected).

### **Post-Injection Soil Sampling**

Approximately two to three months after injection activities, PNG will conduct a soil sampling event in the treatment area to characterize residual contamination and evaluate the progress of the ISCO treatment. Soil sampling activities will include:

- Direct field operations using direct-push Geoprobe (or other) drilling techniques to collect soil samples at approximately four boring locations within the treatment area. To the extent possible, the borings will duplicate prior sampling locations and sample depth intervals so that direct analytical comparison is possible. A minimum of eight soil samples are expected to be submitted for laboratory analysis.
- Submit soil samples for laboratory analysis for gasoline range petroleum hydrocarbons by Method NWTPH-Gx, BTEX by EPA Method 8021, and soil pH by EPA Method 9045.

Results from the post-injection soil sampling will be evaluated to determine ISCO treatment effectiveness. Based on contaminant reductions, if RAOs have not been achieved PNG will discuss the results with FMC to determine if supplemental ISCO injection would be appropriate. If additional treatment is necessary and assuming initial ISCO effectiveness was good, PNG would design and implement a second phase of ISCO injection in the treatment area (subject to approval by Plaid).

## **Remedial Excavation of Impacted Soil**

Following ISCO treatment near the eastern property boundary (assuming RAOs are achieved), PNG will direct excavation of gasoline impacted soil located immediately west of the treatment area (Figure 4). As discussed above, excavation sloping, backfill/pavement design, and civil/municipal permitting as necessary will be developed by a qualified geotechnical engineering firm (EEI). Final excavation planning, design, restoration, and related costs will be detailed in a supplemental work plan to be issued after the completion of ISCO activities.

Remedial excavation and contaminated soil management/transport will be performed by a qualified environmental remediation contractor (to be selected). At this time we estimate that approximately 200 to 300 cubic yards of regulated contaminated soil will be excavated and transported offsite for disposal at a permitted facility (landfill to be determined). Factors that will influence the excavation volume include:

- The geotechnical design of the remedial excavation which will affect slope angle at the excavation boundaries, particularly along the property boundary.
- Variability in the actual limits of gasoline impacted soil encountered during the remedial excavation.

Before the excavation cavity is filled, PNG will collect confirmatory soil samples from the walls and floor of the remedial excavation and obtain laboratory analytical results. We anticipate testing these confirmation samples on an expedited basis to minimize contractor standby time. Confirmatory soil samples will be analyzed for gasoline range petroleum hydrocarbons by Method NWTPH-Gx and for BTEX by EPA Method 8021.

Note that we anticipate approximately 250 cubic yards of non-contaminated "overburden" soils (the shallowest three to four feet of cover soil) will be removed before encountering contaminated material. PNG assumes that the overburden cannot be stockpiled or re-used on the Plaid site because of access limitations, and we therefore expect that soil will be transported offsite for disposal as "clean" fill material.

## **Reporting**

Anticipated project reporting is as follows:

- The findings and recommendations of geotechnical engineering tasks will be provided in a written report.
- Final excavation planning, design, restoration, and related costs will be detailed in a supplemental work plan to be issued after the completion of ISCO activities.
- Interim status reports will be issued at project milestones and/or as requested by Plaid. At a minimum, written status reports will cover (1) initial tasks and observations through ISCO pilot testing, (2) the results of ISCO testing, treatment, and performance evaluation, and (3) final project completion documentation as



described below. In the event that additional phase(s) of ISCO injection are recommended, PNG will describe the proposed supplemental tasks in writing and obtain Plaid's approval before proceeding with additional ISCO treatment.

- At the completion of excavation/restoration work and any other scoped remedial activities, PNG will prepare a written site remediation report to include a discussion of all field work, analytical testing, an evaluation of the effectiveness of the remediation, site maps depicting key features and sampling locations, tabulated analytical results, copies of all analytical reports, chain-of-custody and disposal documentation, and recommendations for additional work (if warranted).

## ASSUMPTIONS

The proposed work is recommended in accordance with Ecology's published environmental cleanup rules and PNG's experience at similar sites. Additional investigation or remedial actions may be required to fully address areas of concern, if identified.

Assumptions used to generate the work plan are as follows:

- Meetings, negotiations, and submittals to regulatory agencies are not included in the scope of work.
- This work plan was prepared in accordance with regulatory guidance as indicated, and PNG's proposed work is expected to proceed under Ecology's "Independent Cleanup" framework. To the extent that future technical consultation with Ecology results in work plan modifications, such modifications are not included or budgeted within this scope.
- Access to the subject property and negotiations with the property owner and/or tenants will be arranged by Plaid, and all fieldwork can be conducted during normal business hours.
- Unimpeded access to the work area(s) will be available, including no overhead or underground utility conflicts.
- PNG assumes pre-injection borehole logging and sampling can be accomplished under one mobilization and will not exceed one day. In addition to a one-day ISCO implementation test, the first phase of ISCO injection is assumed to be completed under a single mobilization over a period of approximately one week. If supplemental ISCO injection events are determined to be necessary, those tasks will require additional mobilizations and costs that are not included in this work scope.
- No unreasonably difficult subsurface conditions will be encountered requiring the use of alternative drilling/excavation equipment.
- All fieldwork can be performed using standard personal protective equipment and procedures (Level D).
- Other than Ecology drilling permits/start cards and underground injection control permitting (which are included in this scope), no other permits are specified or included. If necessary, such permits would be obtained at an additional time and materials cost basis.

- A public utility locate notification will be conducted and PNG will contract a private utility locator in an effort to identify subsurface utilities at each proposed drilling location. The use of these methods does not guarantee that unidentified conduits/structures will not be encountered during drilling, but greatly minimizes the risk of doing so. PNG will not be responsible for damage to subsurface utilities not identified to us prior to initiating work.
- Recommendations for additional analyses, if any, will be discussed prior to laboratory testing.
- Equipment decontamination rinsate, soil cuttings, and other debris will be generated as part of the proposed work. The investigation-derived wastes (IDW) will be contained in sealed and properly labeled 55-gallon steel drums (or in a covered steel drop box) and stored onsite. PNG will coordinate disposal of IDW. However, characterization and disposal costs for the IDW, if any, are not included under this proposal.

### GENERAL CONDITIONS

The scope of services will be performed in accordance with PNG's existing contract with Plaid, which is hereby made part of this agreement. Both parties must agree upon any changes to the scope, cost, or general conditions.

PNG appreciates this opportunity to present this proposal. If you have any questions, please call (503) 620-2387.

Sincerely,

**PNG ENVIRONMENTAL, INC.**



Martin Acaster, L.G.  
Senior Geologist



Paul Ecker, L.H.G.  
Project Manager

Attachments: Table 1 – Soil Analytical Results - Gasoline and Volatile Organic Compounds

Figure 1 – Site Location Map

Figure 2 – Site Features

Figure 3 – Approximate Extent of Petroleum Impacted Soils

Figure 4 – Proposed Remedial Excavation and ISCO Injection Treatment Areas

Attachment A – FMC Corporation Persulfate Demand Calculations

Attachment B – FMC Corporation Material Safety Data Sheets

## REFERENCES

- KEE. 2007 (January 10). *UST Closure Action Report, Zip Market & Gas*. KEE, LLC.
- PNG. 2008a (January 25). *Site Assessment Report*. PNG Environmental, Inc.
- PNG. 2008b (October 1). *Site Characterization and SVE Pilot Test Report*. PNG Environmental, Inc.
- PNG 2009 (May 18). *Supplemental Site Characterization - April 2009*. PNG Environmental, Inc.
- PNG. 2010 (July 15). *Site Status Report - Remedial Alternative Screening*. PNG Environmental, Inc.

## TABLES

Table 1  
Soil Analytical Results - Gasoline and Volatile Organic Compounds (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	1,2-Dibromoethane	1,2-Dichloroethane	Naphthalene	Total Lead
S-1	16	05/04/2006	2 U	0.02 U	0.02 U	0.02 U	0.06 U	-	-	-	-	-
S-2	16	05/04/2006	2 U	0.02 U	0.02 U	0.02 U	0.06 U	-	-	-	-	-
S-3	16	05/04/2006	2 U	0.02 U	0.02 U	0.02 U	0.06 U	-	-	-	-	-
S-4	8	05/04/2006	2 U	0.02 U	0.02 U	0.02 U	0.06 U	-	-	-	-	-
S-5	8	05/04/2006	2 U	0.02 U	0.02 U	0.02 U	0.06 U	-	-	-	-	-
S-6	8	05/04/2006	2 U	0.02 U	0.02 U	0.02 U	0.06 U	-	-	-	-	-
S-7	8	05/04/2006	2 U	0.02 U	0.02 U	0.02 U	0.06 U	-	-	-	-	-
S-8	4	05/04/2006	2 U	0.02 U	0.02 U	0.02 U	0.06 U	-	-	-	-	-
S-9	4	05/04/2006	2 U	0.02 U	0.02 U	0.02 U	0.06 U	-	-	-	-	-
S-10	4	05/04/2006	310	0.23	0.85	2.0	16	-	-	-	-	-
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	-	-	-	-	-
Plaid 324 Comp		07/16/2008	-	-	-	-	-	-	-	-	-	2.09
MTCA Method A Cleanup Level			30	0.03	7	6	9	0.1	0.005	NA	5	250

Table 1  
Soil Analytical Results - Gasoline and Volatile Organic Compounds (mg/Kg)  
Plaid Pantry #324  
Seattle, Washington

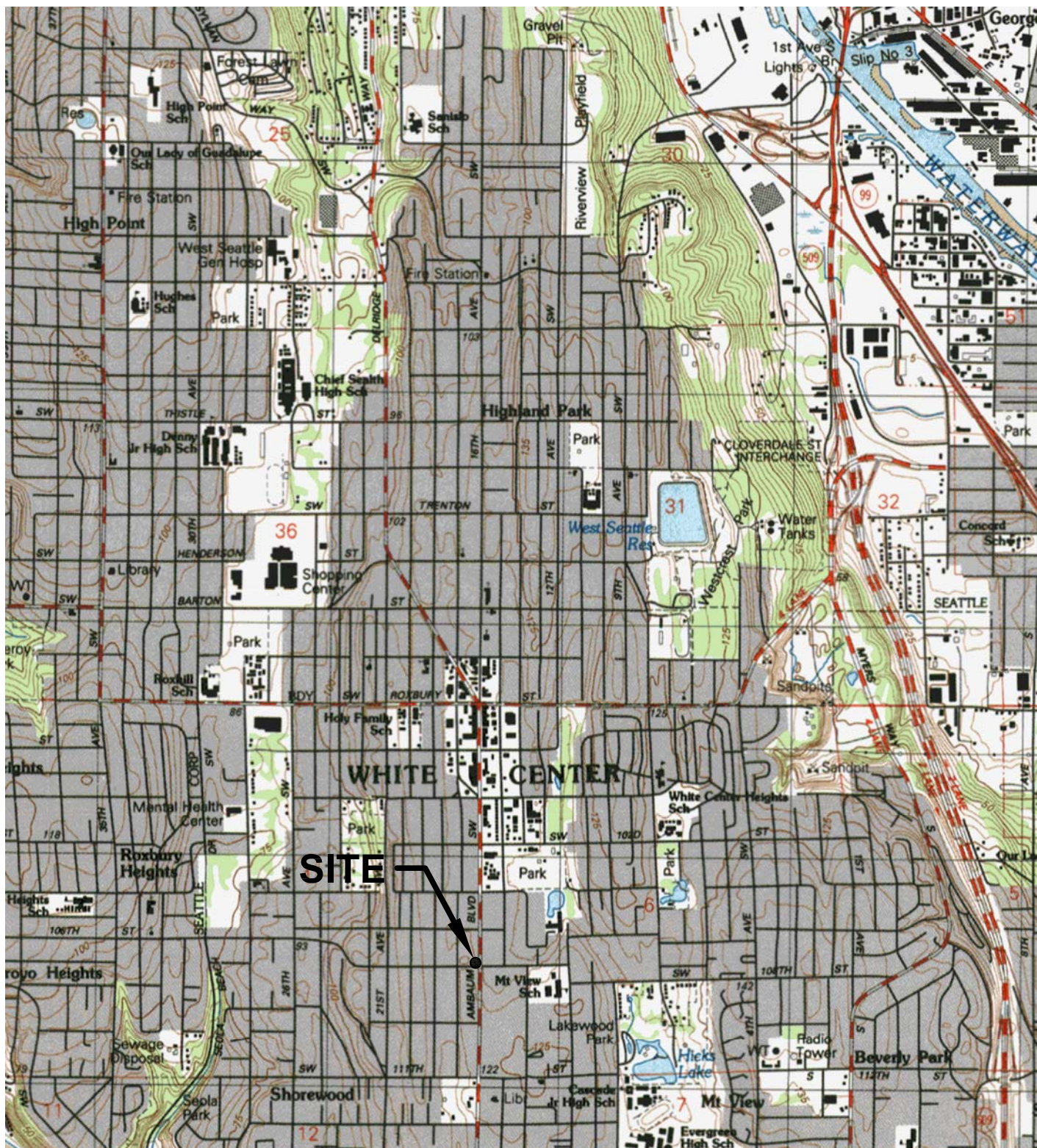
Sample Identification	Sample Depth (feet bgs)	Date Sampled	Gasoline Range Organics (GRO)	Benzene	Toluene	Ethylbenzene	Total Xylenes	Methyl t-butyl ether	1,2-Dibromoethane	1,2-Dichloroethane	Naphthalene	Total Lead
B-15/4	4	04/22/2009	2 U	0.03 U	0.05 U	0.05 U	0.15 U	0.05 U	0.05 U	0.05 U	0.05 U	-
B-15/8	8	04/22/2009	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-15/12	12	04/22/2009	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-16/4	4	04/22/2009	2 U	0.03 U	0.05 U	0.05 U	0.15 U	-	-	-	0.05 U	-
B-16/8	8	04/22/2009	120	0.03 U	0.05 U	0.33	0.98	-	-	-	1.0	-
B-16/11	11	04/22/2009	2 U	0.03 U	0.05 U	0.05 U	0.15 U	-	-	-	0.05 U	-
B-17/4	4	04/22/2009	2 U	0.03 U	0.05 U	0.05 U	0.15 U	-	-	-	0.05 U	-
B-17/7	7	04/22/2009	46	0.03 U	0.05 U	0.06	0.15 U	-	-	-	0.32	-
B-17/10	10	04/22/2009	90	0.03 U	0.05 U	0.05 U	0.15 U	-	-	-	0.05 U	-
B-17/13	13	04/22/2009	2 U	0.03 U	0.05 U	0.05 U	0.15 U	-	-	-	0.05 U	-
B-18/4	4	04/22/2009	54	0.03 U	0.05 U	0.05 U	0.15 U	0.05 U	0.005 U	0.05 U	0.092	-
B-18/8	8	04/22/2009	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-18/12	12	04/22/2009	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-19/4	4	04/22/2009	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-19/8	8	04/22/2009	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-19/12	12	04/22/2009	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-20/4	4	04/22/2009	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-20/6	6	04/22/2009	93	0.03 U	0.05 U	0.05 U	0.15 U	0.05 U	0.005 U	0.05 U	0.05 U	-
B-20/10	10	04/22/2009	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-21/4	4	04/22/2009	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-21/9	9	04/22/2009	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-22/4	4	04/22/2009	2 U	0.03 U	0.05 U	0.05 U	0.15 U	-	-	-	0.05 U	-
B-22/7	7	04/22/2009	93	0.03 U	0.05 U	0.12	0.1	-	-	-	0.32	-
B-23/5	5	04/22/2009	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-23/10	10	04/22/2009	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-24/4	4	11/10/2009	2	0.02 U	0.02	0.02 U	0.06 U	-	-	-	-	-
B-24/8	8	11/10/2009	990	0.5	15	17	96	-	-	-	-	-
B25/4	4	11/10/2009	2	0.02 U	0.02	0.02 U	0.06 U	-	-	-	-	-
B-25/8	8	11/10/2009	2 U	0.02 U	0.02 U	0.02 U	0.06 U	-	-	-	-	-
B-26/4	4	11/10/2009	27	0.23	0.15	0.76	3.8	-	-	-	-	-
B-26/8	8	11/10/2009	130	0.25	4.4	2.0	13	-	-	-	-	-
B-26/12	12	11/10/2009	17	0.60	0.99	0.37	2.0	-	-	-	-	-
B-27/4	4	11/11/2009	1,000	0.90	24	20	100	-	-	-	-	-
B-27/8	8	11/11/2009	12	0.02 U	0.21	0.17	1.1	-	-	-	-	-
B-27/12	12	11/11/2009	5.0	0.02 U	0.26	0.08	0.45	-	-	-	-	-
MTCA Method A Cleanup Level			30	0.03	7	6	9	0.1	0.005	NA	5	250

Notes:

MTCA = Model Toxics Control Act Method A Cleanup Levels for Soil (Washington Department of Ecology, February 12, 2001)  
Volatile organic compounds (VOCs) by EPA Method 8260B  
Gasoline range organics (GRO) 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



## FIGURES



APPROXIMATE SCALE IN FEET



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

**PNG ENVIRONMENTAL, INC.**

1339 Commerce Avenue, Suite 313  
Longview, Washington 98632

TEL (360) 414-0669  
FAX (360) 414-0663

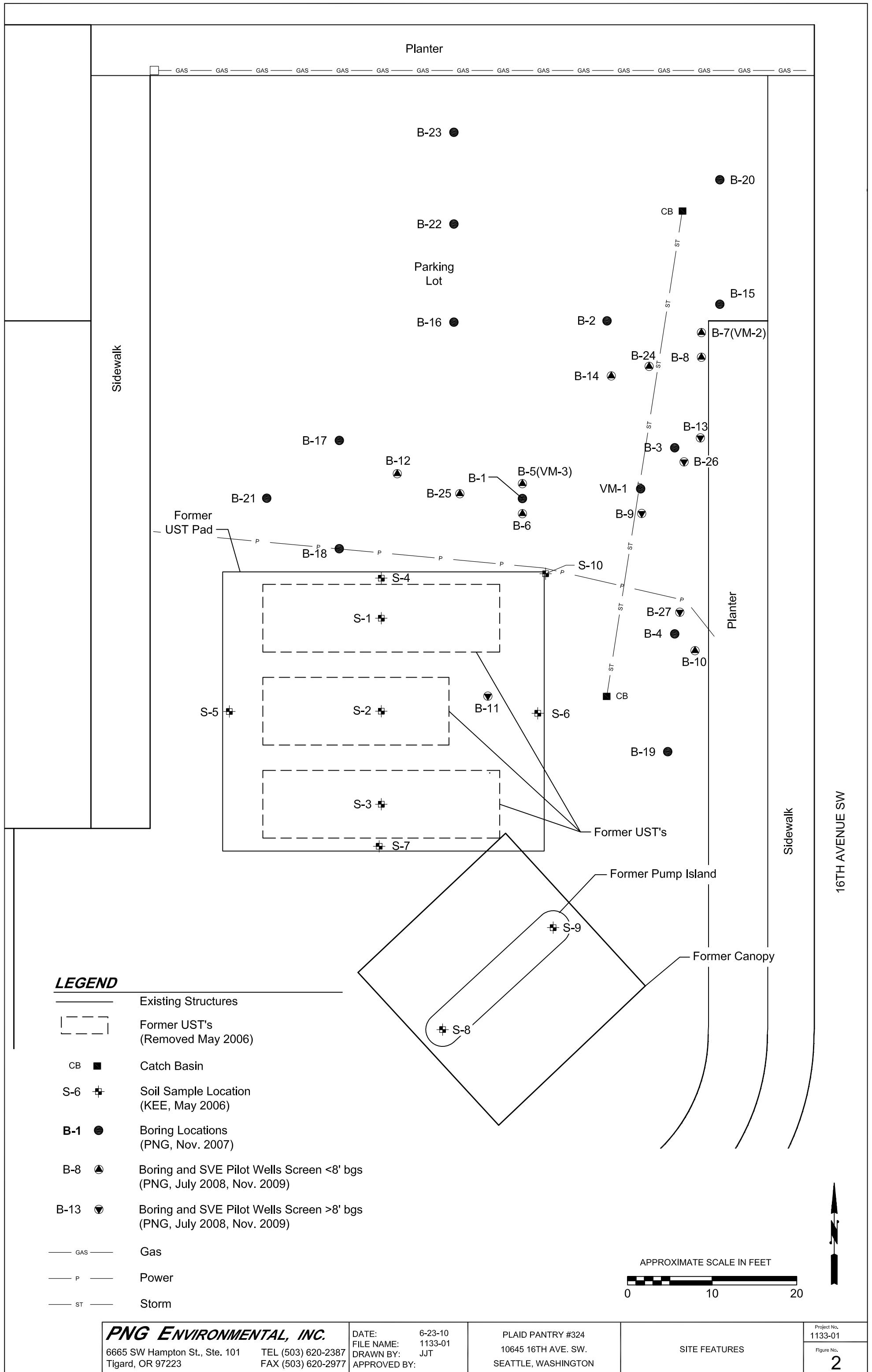
DATE: 10-5-07  
FILE NAME: 1133-01  
DRAWN BY: JJT  
APPROVED BY:

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

SITE LOCATION MAP

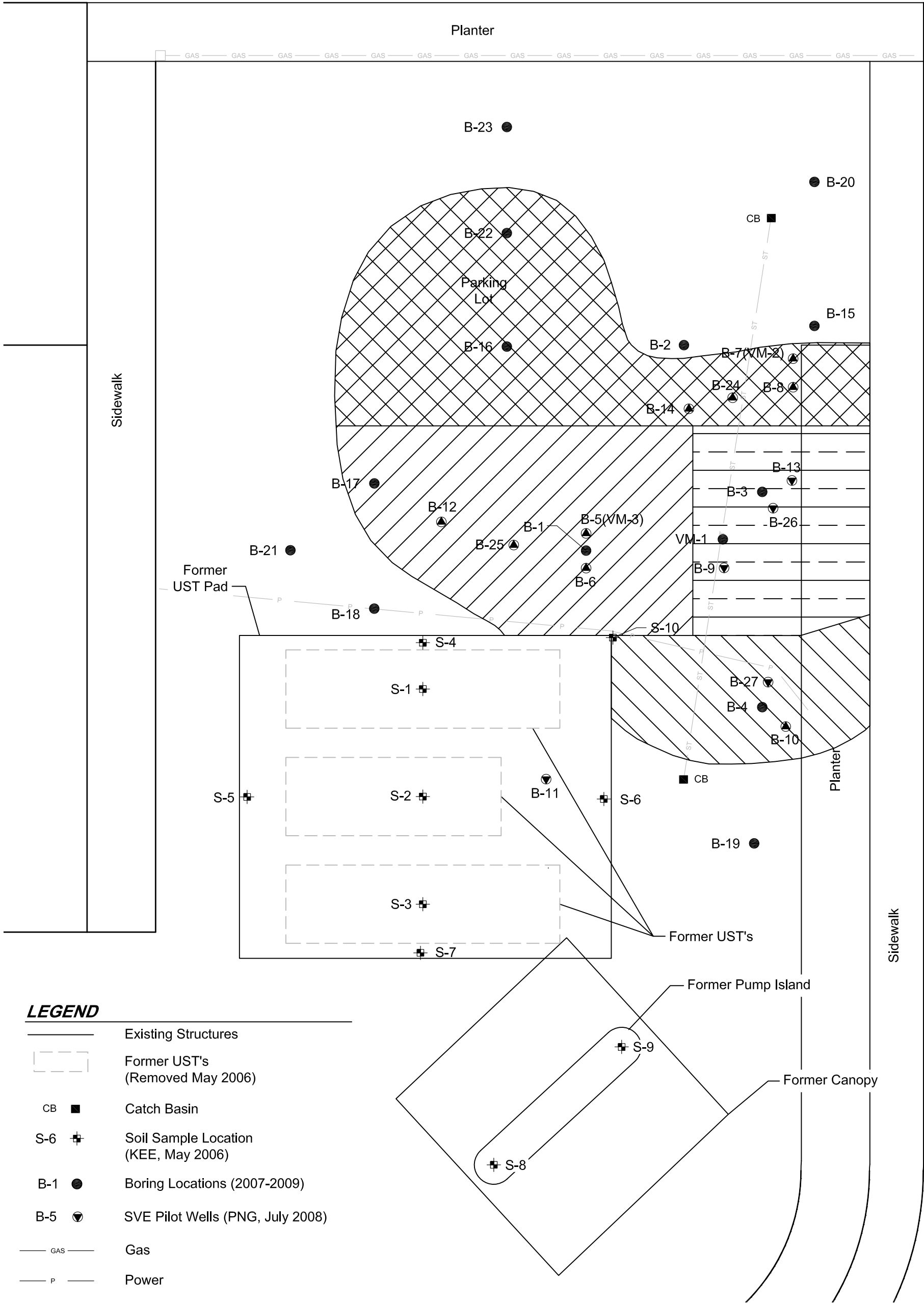
Project No. 1133-01  
Figure No.

1





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**LEGEND**

- Existing Structures
- Former UST's (Removed May 2006)
- CB Catch Basin
- S-6 Soil Sample Location (KEE, May 2006)
- B-1 Boring Locations (2007-2009)
- B-5 SVE Pilot Wells (PNG, July 2008)
- GAS Gas
- P Power
- ST Storm

Gasoline > MTCA Method A Soils Cleanup Level = 30 mg/Kg

- 3 - 6' Zone
- 3 - 10' Zone
- 5 - 10' Zone
- 4 - 12' Zone



16TH AVENUE SW

**PNG ENVIRONMENTAL, INC.**

6665 SW Hampton St., Ste. 101  
Tigard, OR 97223

TEL (503) 620-2387  
FAX (503) 620-2977

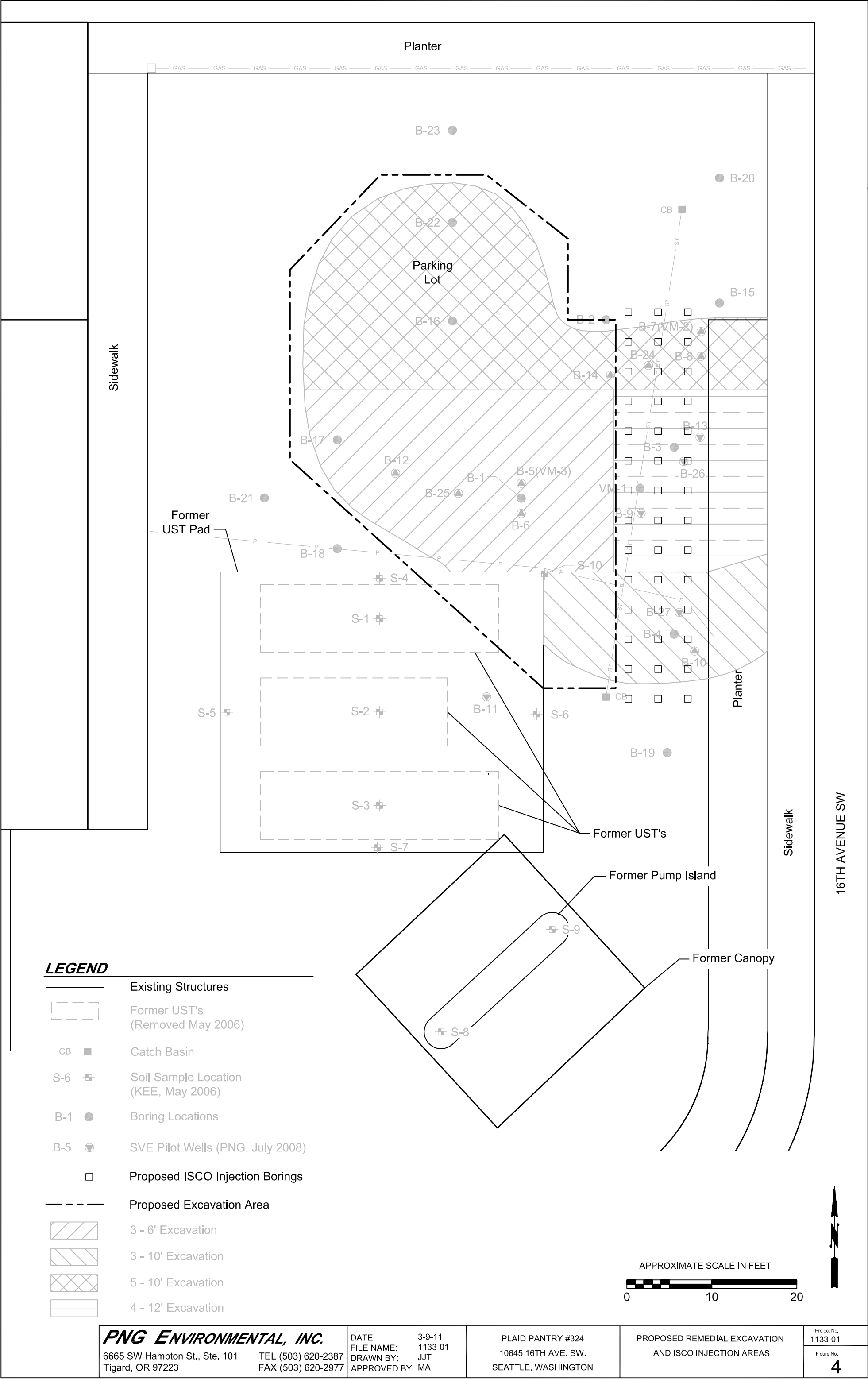
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FILE NAME: 1133-01  
DRAWN BY: JJT  
APPROVED BY:

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

APPROXIMATE EXTENT OF  
PETROLEUM IMPACTED SOILS

Project No.  
1133-01

Figure No.  
**3**



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**ATTACHMENT A**  
**FMC Corporation Persulfate Demand Calculations**





# Environmental Solutions

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## Procedure for Activating Klozur® Persulfate with a 25% Sodium Hydroxide Solution

### Background

For alkaline activation of Klozur Persulfate, the pH of the soil and groundwater will need to be maintained between 10.5 and 12. Sodium Hydroxide (NaOH, caustic soda) can be used to achieve the pH target range. The NaOH demand arises from two sources; 1) soil and groundwater acidity, and 2) the generation of acid formed during the decomposition of Klozur Persulfate. The amount of the NaOH needed to raise soil and groundwater pH must be determined experimentally (see procedure below). In addition, to address the persulfate generated acid, 2 moles of NaOH per mole of Klozur Persulfate must be added to neutralize the persulfate-generated acid.

**Total NaOH Demand = NaOH needed to raise soil and groundwater to target pH 10.5-12 +  
2 moles NaOH / mole Klozur persulfate**

### Safety and Handling

Sodium Hydroxide is a corrosive chemical and can cause severe chemical burns to body tissue if mishandled. Therefore, appropriate Personal Protective Equipment (PPE), including chemical goggles and face shield, is required when handling and transferring NaOH. **Review the MSDS with all workers prior to handling this chemical.**

Sodium Hydroxide is sold commercially in a variety of concentrations. Common concentrations include; 50%, 73%, and solid flakes or pellets (100%). These highly concentrated forms of NaOH may generate extreme exothermic reactions upon dilution. In certain circumstances, so much heat may be liberated that it can boil the solution causing steam eruptions, loss of product containment and damage to equipment. Use of concentrated NaOH require very long dilution times and/or heat exchange equipment with agitation or good mixing.

**FMC recommends NaOH solutions of no more than 25% by weight be used to activate Klozur persulfate.**

This will help to minimize the generation of heat upon mixing the NaOH with water. FMC does not permit use of NaOH concentrations greater than 25% in its Klozur mixing rental equipment.

**Use of NaOH solutions in excess of 25 wt% or in solid form may increase the risk of injury, loss of product containment and equipment damage.**



# Environmental Solutions

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## Activation Procedures

### **Part A: Soil Titration Method for 25% NaOH determination**

1. Take a 500 gram (1.1 lb) sample of the soil from an area that is representative of the contaminated site.
2. Take a 1500 gram (3.31 lb) sample of the ground water.
3. Place these samples in a clean glass or plastic container and mix thoroughly for 5 minutes.
4. Determine and record the pH of the water.
5. Take 100 ml aliquot of the mixed soil/ water slurry in a clean glass beaker. Insert a pH probe to measure the pH as NaOH is added.
6. Set up a burette with 25% NaOH solution.
7. Slowly dose 25% NaOH into the beaker until the pH reaches 10.5 and maintains 10.5 for 30 minutes. Add more 25% NaOH if the pH drops during the test.
8. Record the ml's of 25% NaOH required to neutralize 100 ml's of soil slurry.
9. Calculate and scale up the amount of NaOH to Field scale conditions based on total treatment soil volume.

Note: 3785 ml's (3.785 L) = 1 gallon.

### **Part B: Determine the amount of 25% NaOH to neutralize the Persulfate-Generated Acid**

1. Determine total Klozur® requirement in lbs
2. Multiply lbs of Klozur® by 0.1267 to determine gallons of 25% NaOH required

Note: 2 lb-moles NaOH required / lb-mole persulfate  
→ 1.344 lb of 25 wt% NaOH / lb of Klozur persulfate  
Density of 25 wt% NaOH = 10.61 lb / gal  
→ 126.67 gal 25 wt% NaOH / 1000 lb Klozur persulfate

<b>The total 25 wt% NaOH demand = amount from Part A + amount from Part B</b>
---

### **Applying Klozur solution and NaOH activator to a contaminated site**

1. 25% NaOH solution can be:
  - applied to a site prior to addition of the Klozur persulfate solution
  - applied to a site post addition of the Klozur persulfate solution



# Environmental Solutions

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- applied to a site simultaneous to the addition of the Klozur persulfate solution
2. It is recommended that if the Klozur persulfate and 25 wt% NaOH solution are added simultaneously
- No more than **0.2 gallons** of 25% NaOH should be added per gallon of 30% Klozur solution
  - No more than **0.4 gallons** of 25% NaOH should be added per gallon of 20% Klozur solution
  - No more than **0.6 gallons** of 25% NaOH should be added per gallon of 10% Klozur solution

Mixing of NaOH and persulfate solutions in ratios greater than mentioned above may lead to increases in solution temperature.

**ATTACHMENT B**  
**FMC Corporation Material Safety Data Sheets**

# MATERIAL SAFETY DATA SHEET

Klozür™



MSDS Ref. No.: 7775-27-1-12

Date Approved: 02/22/2005

Revision No.: 1

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This document has been prepared to meet the requirements of the U.S. OSHA Hazard Communication Standard, 29 CFR 1910.1200; the Canada's Workplace Hazardous Materials Information System (WHMIS) and, the EC Directive, 2001/58/EC.

---

## 1. PRODUCT AND COMPANY IDENTIFICATION

<b>PRODUCT NAME:</b>	Klozür™
<b>SYNONYMS:</b>	Sodium Persulfate, Sodium Peroxydisulfate; Disodium Peroxydisulfate
<b>GENERAL USE:</b>	In situ and ex situ chemical oxidation of contaminants and compounds of concern for environmental remediation applications.

### MANUFACTURER

FMC CORPORATION  
Active Oxidants Division  
1735 Market Street  
Philadelphia, PA 19103  
(215) 299-6000 (General Information)

### EMERGENCY TELEPHONE NUMBERS

(800) 424-9300 (CHEMTREC - U.S.)  
(303) 595-9048 (Medical - Call Collect)

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## 2. HAZARDS IDENTIFICATION

### EMERGENCY OVERVIEW:

- White, odorless, crystals
- Oxidizer.
- Decomposes in storage under conditions of moisture (water/water vapor) and/or excessive heat causing release of oxides of sulfur and oxygen that supports combustion. Decomposition could form a high temperature melt. See Section 10 ("Stability and Reactivity").

**POTENTIAL HEALTH EFFECTS:** Airborne persulfate dust may be irritating to eyes, nose, lungs, throat and skin upon contact. Exposure to high levels of persulfate dust may cause difficulty in breathing in sensitive persons.

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### 3. COMPOSITION / INFORMATION ON INGREDIENTS

Chemical Name	CAS#	Wt. %	EC No.	EC Class
Sodium Persulfate	7775-27-1	>99	231-892-1	Not classified as hazardous

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### 4. FIRST AID MEASURES

**EYES:** Flush with plenty of water. Get medical attention if irritation occurs and persists.

**SKIN:** Wash with plenty of soap and water. Get medical attention if irritation occurs and persists.

**INGESTION:** Rinse mouth with water. Dilute by giving 1 or 2 glasses of water. Do not induce vomiting. Never give anything by mouth to an unconscious person. See a medical doctor immediately.

**INHALATION:** Remove to fresh air. If breathing difficulty or discomfort occurs and persists, contact a medical doctor.

**NOTES TO MEDICAL DOCTOR:** This product has low oral toxicity and is not irritating to the eyes and skin. Flooding of exposed areas with water is suggested, but gastric lavage or emesis induction for ingestions must consider possible aggravation of esophageal injury and the expected absence of system effects. Treatment is controlled removal of exposure followed by symptomatic and supportive care.

---

### 5. FIRE FIGHTING MEASURES

**EXTINGUISHING MEDIA:** Deluge with water.

**FIRE / EXPLOSION HAZARDS:** Product is non-combustible. On decomposition releases oxygen which may intensify fire. Presence of water accelerates decomposition.

**FIRE FIGHTING PROCEDURES:** Do not use carbon dioxide or other gas filled fire extinguishers; they will have no effect on decomposing persulfates. Wear full protective clothing and self-contained breathing apparatus.

**FLAMMABLE LIMITS:** Non-combustible

**SENSITIVITY TO IMPACT:** No data available



**SENSITIVITY TO STATIC DISCHARGE:** Not available

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## 6. ACCIDENTAL RELEASE MEASURES

**RELEASE NOTES:** Spilled material should be collected and put in approved DOT container and isolated for disposal. Isolated material should be monitored for signs of decomposition (fuming/smoking). If spilled material is wet, dissolve with large quantity of water and dispose as a hazardous waste. All disposals should be carried out according to regulatory agencies procedures.

---

## 7. HANDLING AND STORAGE

**HANDLING:** Use adequate ventilation when transferring product from bags or drums. Wear respiratory protection if ventilation is inadequate or not available. Use eye and skin protection. Use clean plastic or stainless steel scoops only.

**STORAGE:** Store (unopened) in a cool, clean, dry place away from point sources of heat, e.g. radiant heaters or steam pipes. Use first in, first out storage system. Avoid contamination of opened product. In case of fire or decomposition (fuming/smoking) deluge with plenty of water to control decomposition. For storage, refer to NFPA Bulletin 430 on storage of liquid and solid oxidizing materials.

**COMMENTS:** VENTILATION: Provide mechanical general and/or local exhaust ventilation to prevent release of dust into work environment. Spills should be collected into suitable containers to prevent dispersion into the air.

---

## 8. EXPOSURE CONTROLS / PERSONAL PROTECTION

### EXPOSURE LIMITS

Chemical Name	ACGIH	OSHA	Supplier
Sodium Persulfate	0.1 mg/m <sup>3</sup> (TWA)		

**ENGINEERING CONTROLS:** Provide mechanical local general room ventilation to prevent release of dust into the work environment. Remove contaminated clothing immediately and wash before reuse.

### PERSONAL PROTECTIVE EQUIPMENT

**EYES AND FACE:** Use cup type chemical goggles. Full face shield may be used.

**RESPIRATORY:** Use approved dust respirator when airborne dust is expected.

**PROTECTIVE CLOTHING:** Normal work clothes. Rubber or neoprene footwear.

**GLOVES:** Rubber or neoprene gloves. Thoroughly wash the outside of gloves with soap and water prior to removal. Inspect regularly for leaks.

---

## 9. PHYSICAL AND CHEMICAL PROPERTIES

<b>ODOR:</b>	None
<b>APPEARANCE:</b>	White crystals
<b>AUTOIGNITION TEMPERATURE:</b>	Not applicable. No evidence of combustion up to 800°C. Decomposition will occur upon heating.
<b>BOILING POINT:</b>	Not applicable
<b>COEFFICIENT OF OIL / WATER:</b>	Not applicable
<b>DENSITY / WEIGHT PER VOLUME:</b>	Not available
<b>EVAPORATION RATE:</b>	Not applicable (Butyl Acetate = 1)
<b>FLASH POINT:</b>	Non-combustible
<b>MELTING POINT:</b>	Decomposes
<b>ODOR THRESHOLD:</b>	Not applicable
<b>OXIDIZING PROPERTIES:</b>	Oxidizer
<b>PERCENT VOLATILE:</b>	Not applicable
<b>pH:</b>	typically 5.0 - 7.0 @ 25 °C (1% solution)
<b>SOLUBILITY IN WATER:</b>	73 % @ 25 °C (by wt.)
<b>SPECIFIC GRAVITY:</b>	2.6 (H <sub>2</sub> O=1)
<b>VAPOR DENSITY:</b>	Not applicable (Air = 1)
<b>VAPOR PRESSURE:</b>	Not applicable

---

## 10. STABILITY AND REACTIVITY

<b>CONDITIONS TO AVOID:</b>	Heat, moisture and contamination.
<b>STABILITY:</b>	Stable (becomes unstable in presence of heat, moisture and/or contamination).
<b>POLYMERIZATION:</b>	Will not occur
<b>INCOMPATIBLE MATERIALS:</b>	Acids, alkalis, halides (fluorides, chlorides, bromides and iodides), combustible materials, most metals and heavy metals, oxidizable materials, other oxidizers, reducing agents, cleaners, and organic or carbon containing compounds. Contact

with incompatible materials can result in a material decomposition or other uncontrolled reactions.

**HAZARDOUS DECOMPOSITION PRODUCTS:** Oxygen that supports combustion and oxides of sulfur.

**COMMENTS:** PRECAUTIONARY STATEMENT: Pumping and transport of Klozür persulfate requires appropriate precautions and design considerations for pressure and thermal relief.

Decomposing persulfates will evolve large volumes of gas and/or vapor, can accelerate exponentially with heat generation, and create significant and hazardous pressures if contained and not properly controlled or mitigated.

Use with alcohols in the presence of water has been demonstrated to generate conditions that require rigorous adherence to process safety methods and standards to prevent escalation to an uncontrolled reaction.

---

## 11. TOXICOLOGICAL INFORMATION

**EYE EFFECTS:** Non-irritating (rabbit) [FMC Study Number: ICG/T-79.029]

**SKIN EFFECTS:** Non-irritating (rabbit) [FMC Study Number: ICG/T-79.029]

**DERMAL LD<sub>50</sub>:** > 10 g/kg [FMC Study Number: ICG/T-79.029]

**ORAL LD<sub>50</sub>:** 895 mg/kg (rat) [FMC Study Number: ICG/T-79.029]

**INHALATION LC<sub>50</sub>:** 5.1 mg/l (rat) [FMC I95-2017]

**SENSITIZATION:** May be sensitizing to allergic persons. [FMC Study Number: ICG/T-79.029]

**TARGET ORGANS:** Eyes, skin, respiratory passages

**ACUTE EFFECTS FROM OVEREXPOSURE:** Dust may be harmful and irritating. May be harmful if swallowed.

**CHRONIC EFFECTS FROM OVEREXPOSURE:** Sensitive persons may develop dermatitis and asthma [Respiration 38:144, 1979]. Groups of male and female rats were fed 0, 300 or 3000 ppm sodium persulfate in the diet for 13 weeks, followed by 5000 ppm for 5 weeks. Microscopic examination of tissues revealed some injury to the gastrointestinal tract at the high dose (3000 ppm) only. This effect is not unexpected for an oxidizer at high concentrations. [Ref. FMC I90-1151, Toxicologist 1:149, 1981].

**CARCINOGENICITY:**

<b>NTP:</b>	Not listed
<b>IARC:</b>	Not listed
<b>OSHA:</b>	Not listed
<b>OTHER:</b>	ACGIH: Not listed

---

## 12. ECOLOGICAL INFORMATION

**ECOTOXICOLOGICAL INFORMATION:**

Bluegill sunfish, 96-hour  $LC_{50}$  = 771 mg/L [FMC Study I92-1250]  
Rainbow trout, 96-hour  $LC_{50}$  = 163 mg/L [FMC Study I92-1251]  
Daphnia, 48-hour  $LC_{50}$  = 133 mg/L [FMC Study I92-1252]  
Grass shrimp, 96-hour  $LC_{50}$  = 519 mg/L [FMC Study I92-1253]

**CHEMICAL FATE INFORMATION:** Biodegradability does not apply to inorganic substances.

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## 13. DISPOSAL CONSIDERATIONS

**DISPOSAL METHOD:** Dispose as a hazardous waste in accordance with local, state and federal regulatory agencies.

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## 14. TRANSPORT INFORMATION

**U.S. DEPARTMENT OF TRANSPORTATION (DOT)**

<b>PROPER SHIPPING NAME:</b>	Sodium Persulfate
<b>PRIMARY HAZARD CLASS / DIVISION:</b>	5.1 (Oxidizer)
<b>UN/NA NUMBER:</b>	UN 1505
<b>PACKING GROUP:</b>	III
<b>LABEL(S):</b>	5.1 (Oxidizer)
<b>PLACARD(S):</b>	5.1 (Oxidizer)
<b>MARKING(S):</b>	Sodium Persulfate, UN 1505
<b>ADDITIONAL INFORMATION:</b>	Hazardous Substance/RQ: Not applicable

49 STCC Number: 4918733

This material is shipped in 225 lb. fiber drums, 55 lb. poly bags and 1000 - 2200 lb. IBC's (supersacks).

## **INTERNATIONAL MARITIME DANGEROUS GOODS (IMDG)**

**PROPER SHIPPING NAME:**

Sodium Persulfate

## **INTERNATIONAL CIVIL AVIATION ORGANIZATION (ICAO) / INTERNATIONAL AIR TRANSPORT ASSOCIATION (IATA)**

**PROPER SHIPPING NAME:**

Sodium Persulfate

### **OTHER INFORMATION:**

Protect from physical damage. Do not store near acids, moisture or heat.

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## **15. REGULATORY INFORMATION**

### **UNITED STATES**

#### **SARA TITLE III (SUPERFUND AMENDMENTS AND REAUTHORIZATION ACT)**

##### **SECTION 302 EXTREMELY HAZARDOUS SUBSTANCES (40 CFR 355, APPENDIX A):**

Not applicable

##### **SECTION 311 HAZARD CATEGORIES (40 CFR 370):**

Fire Hazard, Immediate (Acute) Health Hazard

##### **SECTION 312 THRESHOLD PLANNING QUANTITY (40 CFR 370):**

The Threshold Planning Quantity (TPQ) for this product, if treated as a mixture, is 10,000 lbs; however, this product contains the following ingredients with a TPQ of less than 10,000 lbs.:

None

##### **SECTION 313 REPORTABLE INGREDIENTS (40 CFR 372):**

Not listed

#### **CERCLA (COMPREHENSIVE ENVIRONMENTAL RESPONSE COMPENSATION AND LIABILITY ACT)**

##### **CERCLA DESIGNATION & REPORTABLE QUANTITIES (RQ) (40 CFR 302.4):**

Unlisted, RQ = 100 lbs., Ignitability

#### **TSCA (TOXIC SUBSTANCE CONTROL ACT)**

##### **TSCA INVENTORY STATUS (40 CFR 710):**

Listed

**RESOURCE CONSERVATION AND RECOVERY ACT (RCRA)**  
**RCRA IDENTIFICATION OF HAZARDOUS WASTE (40 CFR 261):**  
Waste Number: D001

## CANADA

**WHMIS (WORKPLACE HAZARDOUS MATERIALS INFORMATION SYSTEM):**

Product Identification Number: 1505  
Hazard Classification / Division: Class C (Oxidizer), Class D, Div. 2, Subdiv. B. (Toxic)  
Ingredient Disclosure List: Listed

## INTERNATIONAL LISTINGS

Sodium persulfate:  
Australia (AICS): Listed  
China: Listed  
Japan (ENCS): (1)-1131  
Korea: KE-12369  
Philippines (PICCS): Listed

## HAZARD, RISK AND SAFETY PHRASE DESCRIPTIONS:

EC Symbols: (Not classified as hazardous)  
EC Risk Phrases: (Not classified as hazardous)  
EC Safety Phrases: (Not classified as hazardous)

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## 16. OTHER INFORMATION

### HMIS

Health	1
Flammability	0
Physical Hazard	1
Personal Protection (PPE)	J

Protection = J (Safety goggles, gloves, apron & combination dust & vapor respirator)

HMIS = Hazardous Materials Identification System

Degree of Hazard Code:  
4 = Severe



3 = Serious  
2 = Moderate  
1 = Slight  
0 = Minimal

**NFPA**

Health	1
Flammability	0
Reactivity	1
Special	OX

SPECIAL = OX (Oxidizer)

NFPA = National Fire Protection Association

Degree of Hazard Code:

4 = Extreme  
3 = High  
2 = Moderate  
1 = Slight  
0 = Insignificant

**REVISION SUMMARY:**

New MSDS

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# MATERIAL SAFETY DATA SHEET

Klozur® Caustic



MSDS Ref. No.: 1310-73-2-1

Date Approved: 12/19/2008

Revision No.: 1

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This document has been prepared to meet the requirements of the U.S. OSHA Hazard Communication Standard, 29 CFR 1910.1200 and Canada's Workplace Hazardous Materials Information System (WHMIS) requirements.

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## 1. PRODUCT AND COMPANY IDENTIFICATION

**PRODUCT NAME:** Klozur® Caustic

**SYNONYMS:** Caustic Soda Solution; Lye Solution; Sodium Hydrate Solution, White Caustic Solution

**GENERAL USE:** Activating agent for Klozur® Persulfate.

### MANUFACTURER

FMC CORPORATION  
FMC Peroxygens  
1735 Market Street  
Philadelphia, PA 19103  
(215) 299-6000 (General Information)  
msdsinfo@fmc.com (Email - General Information)

### EMERGENCY TELEPHONE NUMBERS

(303) 595-9048 (Medical - U.S. - Call Collect)

For leak, fire, spill, or accident emergencies, call:  
(800) 424-9300 (CHEMTREC - U.S.A. & Canada)

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## 2. HAZARDS IDENTIFICATION

### EMERGENCY OVERVIEW:

- Clear, colorless, odorless liquid
- Solution is corrosive to body tissues and metallic materials.
- Product may react violently with acids.

**POTENTIAL HEALTH EFFECTS:** Solution is corrosive and severely irritating to the eyes and skin.

**MEDICAL CONDITIONS AGGRAVATED:** Skin and lung disorders may be affected adversely by this material; an individual's specific medical condition and circumstances of exposure determine the likelihood of an adverse effect.

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### 3. COMPOSITION / INFORMATION ON INGREDIENTS

Chemical Name	CAS#	Wt. %	EC No.	EC Class
Sodium Hydroxide	1310-73-2	25	215-185-5	C; R35
Water	7732-18-5	75	231-791-2	Not classified

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### 4. FIRST AID MEASURES

**EYES:** Immediately flush with water for at least 15 minutes, lifting the upper and lower eyelids intermittently. See a medical doctor or ophthalmologist immediately.

**SKIN:** Immediately flush with plenty of water while removing contaminated clothing and/or shoes, and thoroughly wash with soap and water. See a medical doctor immediately.

**INGESTION:** Rinse mouth with water. Dilute by giving 1 or 2 glasses of water. Do not induce vomiting. Never give anything by mouth to an unconscious person. See a medical doctor immediately.

**INHALATION:** Remove to fresh air. If breathing difficulty or discomfort occurs and persists, contact a medical doctor.

**NOTES TO MEDICAL DOCTOR:** Sodium hydroxide at this concentration is corrosive. Major burns to all surfaces may result. Prolonged dilution with water is required. Neutralization of eye burns is absolutely contraindicated; for skin, 2% acetic acid has been recommended, but washing with water is effective. Ingestion requires milk or water dilution, consideration of esphagoscopy and management for possible esophageal stricture.

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### 5. FIRE FIGHTING MEASURES

**EXTINGUISHING MEDIA:** Will not burn. Extinguish fire using agents suitable for nearby fires. Use water spray to keep fire exposed containers cool.

**FIRE / EXPLOSION HAZARDS:** Non-combustible.

**FIRE FIGHTING PROCEDURES:** Use water spray to keep fire exposed containers cool. Do not get water into container.

**FLAMMABLE LIMITS:** Not applicable

**HAZARDOUS COMBUSTION PRODUCTS:** None

**SENSITIVITY TO IMPACT:** Not Sensitive

**SENSITIVITY TO STATIC DISCHARGE:** Not Sensitive

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## 6. ACCIDENTAL RELEASE MEASURES

**RELEASE NOTES:** Wear personal protective equipment as recommended in Section 8, "Exposure Controls/Personal Protection" below.

Contain spill using absorbent material and place in an approved container.

Dispose of according to the method outlined in Section 13, "Disposal Considerations" below.

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## 7. HANDLING AND STORAGE

**HANDLING:** During handling of liquid, prevent contact with skin and eyes by using adequate personal protective equipment (see Section 8, "Exposure Controls/Personal Protection" below). If the release of airborne material is likely, exhaust ventilation and/or respiratory protection may also be necessary.

**STORAGE:** Store in closed containers away from sources of heat. Store in a cool dry area, away from acids.

**COMMENTS:** Use only in systems, processes and procedures in which effective ventilation has been provided to meet established exposure limits.

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## 8. EXPOSURE CONTROLS / PERSONAL PROTECTION

### EXPOSURE LIMITS

Chemical Name	ACGIH	OSHA	Supplier
Sodium Hydroxide	2 mg/m <sup>3</sup> (STEL) (ceiling)	2 mg/m <sup>3</sup> (TWA) 2 mg/m <sup>3</sup> (PEL) (ceiling)	

**ENGINEERING CONTROLS:** Adequate engineering controls and/or personal protective equipment must be used to prevent contact with skin and eyes. Engineering controls and/or respirators may be necessary when the generation of airborne mists or fogs are possible.

## PERSONAL PROTECTIVE EQUIPMENT

**EYES AND FACE:** Chemical goggles (and face shield if necessary) should be worn to prevent contact.

**RESPIRATORY:** When exposure above the established standard is likely, a respiratory protection program that complies with OSHA General Industry Standard 1910.134 should be implemented. Wear full face-piece respirators approved by MSHA / NIOSH if mists are expected.

**PROTECTIVE CLOTHING:** Rubber or vinyl apron. Rubber boots or rubber overshoes.

**GLOVES:** Impervious rubber or vinyl gloves with gauntlets. Thoroughly wash the outside of gloves with soap and water prior to removal. Inspect regularly for leaks.

## COMMENTS:

The information noted above provides general guidance for handling this product. Specific work environments and material handling practices will dictate the selection and use of personal protection equipment (PPE).

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## 9. PHYSICAL AND CHEMICAL PROPERTIES

<b>ODOR:</b>	Odorless
<b>APPEARANCE:</b>	Clear, colorless liquid
<b>AUTOIGNITION TEMPERATURE:</b>	Not applicable
<b>BOILING POINT:</b>	112 - 122 °C ( 234 - 252 °F)
<b>COEFFICIENT OF OIL / WATER:</b>	Not applicable
<b>EVAPORATION RATE:</b>	(butyl acetate = 1) Not available
<b>FLASH POINT:</b>	Non-combustible
<b>FREEZING POINT:</b>	-12 - 14 °C ( 10 - 57 °F)
<b>ODOR THRESHOLD:</b>	Not applicable
<b>OXIDIZING PROPERTIES:</b>	Not available
<b>PERCENT VOLATILE:</b>	65 - 75
<b>pH:</b>	14 (7.4% NaOH solution)
<b>SOLUBILITY IN WATER:</b>	100 %
<b>SPECIFIC GRAVITY:</b>	1.278 - 1.384 @ 15.5 °C
<b>VAPOR DENSITY:</b>	Not applicable
<b>VAPOR PRESSURE:</b>	10 - 18 hPa @ 30 °C (86 °F)

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## 10. STABILITY AND REACTIVITY

**CONDITIONS TO AVOID:**

Contact with acids, flammable liquids, organic halogen compounds, nitro compounds, and amphoteric metals, such as aluminum, magnesium and zinc.

**STABILITY:**

Slightly reactive

**POLYMERIZATION:**

Will not occur

**INCOMPATIBLE MATERIALS:**

Acids, flammable liquids, organic halogen compounds, nitro compounds, and amphoteric metals, such as aluminum, magnesium and zinc.

**HAZARDOUS DECOMPOSITION PRODUCTS:** None

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## 11. TOXICOLOGICAL INFORMATION

**EYE EFFECTS:** Severely irritating, corrosive

**SKIN EFFECTS:** Severely irritating, corrosive

**DERMAL LD<sub>50</sub>:** Corrosive

**ORAL LD<sub>50</sub>:** 37% Sodium hydroxide solution: 400 mg/kg (rabbit)

**INHALATION LC<sub>50</sub>:** Corrosive

**TARGET ORGANS:** Skin, eyes, mucous membranes

**ACUTE EFFECTS FROM OVEREXPOSURE:** Sodium hydroxide is corrosive and may produce severe eye, skin and respiratory tract irritation and upper gastrointestinal tract damage. Ingestion of concentrated solutions has caused death in animals and humans. [Gosselin, Smith & Hodge, 1984; PB 234-899 1974]

**CHRONIC EFFECTS FROM OVEREXPOSURE:** Sodium hydroxide may produce inflammation of the eyes, skin, and mucous membranes. Esophageal carcinoma at the site of a chronic lye stricture has been reported. [Gosselin, Smith & Hodge 1984]

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## 12. ECOLOGICAL INFORMATION

**ECOTOXICOLOGICAL INFORMATION:**

The damaging effects are mostly a consequence of the increase in pH. The upper pH limit tolerated by most freshwater fish is 8.4; the pH must generally be greater than 9 before the aqueous environment becomes lethal for fully developed fish. Freshwater algae are destroyed above pH 8.5. Concentrations of 20 to 100 mg/L have been reported to kill salmon, trout, carp and crayfish. [Ref. , Environment Canada, Environmental Protection Service, Sodium Hydroxide Environmental and Technical Information for Problem Spills. June 1984]

**CHEMICAL FATE INFORMATION:** The pH effect of sodium hydroxide in water is naturally reduced by the absorption of atmospheric carbon dioxide. This reduction is also effected by dilution with water and by the natural acidity of a given water body. There is no degradation of sodium hydroxide in waters, only loss by absorption or through chemical neutralization.

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## 13. DISPOSAL CONSIDERATIONS

**DISPOSAL METHOD:** Dispose of in accordance with all local, state and federal environmental rules and regulations. Check the pH of the waste to be disposed, if it is greater than 12.5 it must be handled as a RCRA hazardous waste.

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## 14. TRANSPORT INFORMATION

### U.S. DEPARTMENT OF TRANSPORTATION (DOT)

<b>PROPER SHIPPING NAME:</b>	Sodium Hydroxide Solution
<b>PRIMARY HAZARD CLASS / DIVISION:</b>	8 (Corrosive)
<b>UN/NA NUMBER:</b>	UN 1824
<b>PACKING GROUP:</b>	II
<b>LABEL(S):</b>	Corrosive
<b>PLACARD(S):</b>	Corrosive
<b>MARKING(S):</b>	Sodium Hydroxide Solution
<b>ADDITIONAL INFORMATION:</b>	Hazardous Substance/RQ = 1000 lbs. (454 kg) 49 STCC Number: 4935240

### INTERNATIONAL MARITIME DANGEROUS GOODS (IMDG)

<b>PROPER SHIPPING NAME:</b>	Sodium Hydroxide Solution
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**INTERNATIONAL CIVIL AVIATION ORGANIZATION (ICAO) /  
INTERNATIONAL AIR TRANSPORT ASSOCIATION (IATA)****PROPER SHIPPING NAME:**

Sodium Hydroxide Solution

**OTHER INFORMATION:**

Cool containers with water if exposed to fire or excessive heat conditions.

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**15. REGULATORY INFORMATION****UNITED STATES****SARA TITLE III (SUPERFUND AMENDMENTS AND REAUTHORIZATION ACT)****SECTION 302 EXTREMELY HAZARDOUS SUBSTANCES (40 CFR 355, APPENDIX A):**

Not listed

**SECTION 311 HAZARD CATEGORIES (40 CFR 370):**

Immediate (Acute) Health Hazard

**SECTION 312 THRESHOLD PLANNING QUANTITY (40 CFR 370):**

The Threshold Planning Quantity (TPQ) for this product, if treated as a mixture, is 10,000 lbs;  
however, this product contains the following ingredients with a TPQ of less than 10,000 lbs.:  
None

**SECTION 313 REPORTABLE INGREDIENTS (40 CFR 372):**

Not listed

**CERCLA (COMPREHENSIVE ENVIRONMENTAL RESPONSE COMPENSATION AND  
LIABILITY ACT)****CERCLA DESIGNATION & REPORTABLE QUANTITIES (RQ) (40 CFR 302.4):**

Listed

Chemical Name

Sodium Hydroxide

RQ

1,000 lb

Category C

**TSCA (TOXIC SUBSTANCE CONTROL ACT)****TSCA INVENTORY STATUS (40 CFR 710):**

Listed

**U.S. STATES****U.S. State Regulation:**

New Jersey - Special Health Hazard

Massachusetts - Substance List



**CANADA****WHMIS (WORKPLACE HAZARDOUS MATERIALS INFORMATION SYSTEM):**

Product Identification Number: Not available  
Hazard Classification / Division: Class D, Div. 2, Subdiv. B (Toxic), E (Corrosive)  
Ingredient Disclosure List: Listed

**EU EINECS NUMBERS:**

215-185-5 (sodium hydroxide)

**HAZARD AND RISK PHRASE DESCRIPTIONS:**

EC Symbols: C (Corrosive)

EC Risk Phrases: R35/34 (Causes severe burns / causes burns)

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**16. OTHER INFORMATION****HMIS**

Health	3
Flammability	0
Physical Hazard	1
Personal Protection (PPE)	J

Protection = J (Safety goggles, gloves, apron & combination dust & vapor respirator)

HMIS = Hazardous Materials Identification System

Degree of Hazard Code:

4 = Severe  
3 = Serious  
2 = Moderate  
1 = Slight  
0 = Minimal

**NFPA**

Health	3
Flammability	0
Reactivity	1
Special	None

No special requirements

NFPA (National Fire Protection Association)

Degree of Hazard Code:

4 = Extreme

3 = High

2 = Moderate

1 = Slight

0 = Insignificant

**REVISION SUMMARY:**

This MSDS replaces Revision #1, dated December 15, 2008.

Changes in information are as follows:

Section 11 (Toxicological Information)

Section 16 (Other Information)

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