PES Environmental, Inc.
Engineering & Environmental Services

A Report Prepared for:

Washington State Department of Ecology
Northwest Regional Office
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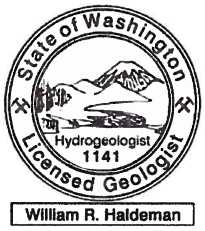
COMPLIANCE MONITORING PLAN
SHALLOW AQUIFER CLEANUP ACTION

BSB PROPERTY
KENT, WASHINGTON

DECEMBER 18, 2015

By:



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1.0 INTRODUCTION

1.1 Purpose

This compliance monitoring plan (CMP) describes the tasks and methods used to document the effectiveness of the cleanup action (CA) installed at the B.S.B. Diversified Company, Inc. (BSB) property located at 8202 South 200th Street, Kent, Washington (referred to as the Property; see Figure 1). This CMP has been prepared under Consent Decree No. 11-2-27288-5 (CD) between BSB and the State of Washington Department of Ecology (Ecology). This CMP has been prepared in accordance with the requirements of the Model Toxics Control Act (MTCA), Chapter 173-340-410 of the Washington Administrative Code (WAC).

MTCA defines three components of compliance monitoring:

- Protection monitoring, performed to confirm the protection of human health and the environment during implementation of the cleanup action [WAC 173-340-410(1)(a)];
- Performance monitoring, conducted to confirm that the cleanup action has attained performance criteria [WAC 173-340-410(1)(b)]; and
- Confirmational monitoring, performed to demonstrate the long-term effectiveness of the cleanup action [WAC 173-340-410(1)(c)].

This CMP replaces the Startup Plan (PES, 2011). It discusses all three components of compliance monitoring and (1) defines specific scopes of work and objectives, (2) provides guidance for field activities, and (3) defines the quality assurance project plan procedures used during monitoring, sampling, and laboratory analysis.

1.2 Document Organization

The CMP is organized into 14 sections. A brief description of each section is presented below:

- **Section 1 – Introduction.** Section 1 contains the purpose of the CMP and organization of the document;
- **Section 2 – Background Information.** Section 2 contains a description of the Property and a summary of the environmental conditions;
- **Section 3 – Summary of the Cleanup Action.** Section 3 provides a description of the containment system, reactor vault, and groundwater pretreatment system;
- **Section 4 – Monitoring Network.** Section 4 provides a summary of the monitoring network, including piezometer and well locations and completions;
- **Section 5 – Protection Monitoring.** Section 5 identifies the health and safety monitoring used for protection of human health and the environment during implementation of the cleanup action;

- **Section 6 – Performance Monitoring.** Section 6 discusses the monitoring conducted to confirm that the cleanup action has attained performance criteria;

- **Section 7 – Confirmational Monitoring.** Section 7 provides the monitoring conducted to demonstrate the long-term effectiveness of the cleanup action;

- **Section 8 – Sampling and Analysis Plan.** Section 8 provides the procedures used to conduct the compliance monitoring;

- **Section 9 – Monitoring Network Maintenance.** Section 9 provides the monitoring and maintenance used to maintain the integrity of the monitoring network;

- **Section 10 – Quality Assurance Project Plan.** Section 10 identifies quality assurance/quality control (QA/QC) procedures for monitoring and laboratory analysis;

- **Section 11 – Data Evaluation.** Section 11 provides the procedures for data validation review; evaluation of the groundwater extraction, groundwater level, and groundwater quality data; and periodic cleanup action;

- **Section 12 – Criteria for Meeting Performance and Compliance Standards.** Section 12 provides a description of the performance and compliance monitoring standards for groundwater monitoring of the CA;

- **Section 13 – Reporting.** Section 13 briefly discusses the progress and periodic review reports that will be submitted to Ecology; and

- **Section 14 – References.** Section 14 provides the references cited in the CMP.

2.0 BACKGROUND INFORMATION

2.1 Property Description

The Property is located in Township 22 North, Range 4 East, Section 1H at a latitude of 47 degrees 25' 22" North and a longitude of 122 degrees 13' 51" West. The 4.2-acre Property is currently a fenced, vacant lot that slopes gently to the north. The area surrounding the Property is topographically flat and is zoned "Limited Industrial." The Property is bounded on the north by South 200th Street and the Hexcel Corporation (Hexcel) industrial facility. Commercial and industrial park properties are located to the west and south of the Property, and the Carr industrial facility is immediately to the east of the Property.

2.2 Summary of Environmental Conditions

Following is a summary of the environmental conditions at the Property.

2.2.1 Hydrogeology

Figure 2 presents a sampling location map, and Figure 3 provides a typical cross section across the Property. Five hydrostratigraphic units (labeled by letter from shallowest to deepest) have been identified at the Property: two aquifers (referred to as Layers B and D) and three low-permeability zones (referred to as Layers A, C, and E/F). Layers A, C, E, and F are fine grained and exhibit low permeability. Layers B and D are composed of relatively high permeability sand.

Layer A. The uppermost portion of this unit is unsaturated or only seasonally saturated. The unit is laterally continuous and likely serves as a barrier to downward groundwater movement.

Layer B. The entire thickness of Layer B is saturated, and the Layer B sand forms the shallow aquifer at the Property. An intermediate silt largely divides Layer B into two subunits. For the purpose of assessing groundwater flow and the nature and extent of contamination, Layer B has historically been divided into two aquifer zones. The shallow aquifer zone is defined as the upper portion of Layer B, above the intermediate silt, and the intermediate aquifer zone is defined as the lower portion of Layer B, below the intermediate silt. Wells or piezometers at the Property monitor the shallow and/or intermediate aquifer zones.

Layer C. The silt of Layer C was encountered throughout the Property. The top of the unit has been found from approximately 27 to 44 feet below ground surface (bgs), with thicknesses ranging from approximately 3.7 to 21 feet. This unit serves as an aquitard to vertical groundwater flow and a restriction to the vertical transport of contaminants at the Property. No wells or piezometers at the Property are screened in Layer C.

Layer D. This unit forms the deeper aquifer at the Property and consists primarily of saturated fine to medium sand with interbeds of silty sand. Layer D contains occasional interbeds of sandy silt, silt, and organic soil and occasional accumulations of shell fragments and wood fragments.

Property monitoring wells or piezometers monitor both the upper and lower portions of the deep aquifer.

Layer E/F. Layer E/F, the deepest unit encountered during on- or off-property investigations, consists of laminated to massive, gray, moderate to high plasticity silt and clay. The unit contains trace fine sand and fine to coarse gravel, with occasional scattered shell fragments and wood fragments. The upper few feet of the unit can also include interbedded silty sand. Similar to the Layer C silt, the silt and clay of transitional Layer E and Layer F serve as an aquitard to vertical groundwater flow and a restriction to the vertical transport of contaminants at the Property.

Appendix A provides the boring logs for the monitoring wells completed at and adjacent to the Property.

2.2.2 Groundwater Flow

Depth to groundwater at the Property has varied from approximately 2 to 12 feet bgs, and groundwater elevations at the Property have varied from approximately 17.5 to 25 feet (relative to the North American Vertical Datum of 1988 [NAVD 88]) in wells screened in Layers A and B, and from approximately 18 to 28 feet in wells screened in Layers D and E. In well clusters, the Layer D potentiometric heads have generally been higher than the Layer B potentiometric heads. Downward vertical gradients across Layer C have occurred periodically during winter and spring recharge. Groundwater elevations have varied up to approximately 6.5 feet seasonally in wells completed in Layers A and B and up to approximately 5 feet seasonally in wells completed in Layers D and E. Groundwater elevations have been highest in winter to spring and lowest in the fall, lagging approximately 2 to 4 months behind precipitation. Groundwater flow in the shallow, intermediate, and deep aquifer zones is generally toward the northeast.

2.2.3 Nature and Distribution of Contamination

The cleanup action plan (CAP; Exhibit A of the CD) provides a summary of the nature and distribution of contamination at the Property, and a detailed presentation of contamination at the Property is presented in the FRI/FS report (PES, 2008) and the RI report addendum (PES, 2011). The primary contaminants of concern (indicator hazardous substances or IHSs) at the Property are halogenated volatile organic constituents (HVOCs), principally trichloroethene (TCE), cis-1,2-dichloroethene (cDCE), and vinyl chloride (VC). These three HVOCs were detected at the highest concentrations and were the most frequently detected compounds. The highest concentrations of these HVOCs (low mg/L) have been detected in HYCP-3i, located in a former drum storage area. The cleanup levels for TCE, cDCE, and VC are presented in Table 1.

In general, metals were either infrequently detected or detected at low concentrations in groundwater from Property wells. The results were low enough that only arsenic was considered in the development of IHSs. Dissolved arsenic concentrations in the shallow aquifer have ranged from below the method reporting limit (MRL) of 5 µg/L to 37 µg/L.

3.0 SUMMARY OF THE CLEANUP ACTION

The shallow aquifer cleanup action is being implemented under the Model Toxics Control Act (MTCA), Chapter 173-340-410 of the Washington Administrative Code (WAC). It consists of (1) a soil-bentonite cutoff wall (SBCW) keyed into the Layer C silt aquitard to contain shallow aquifer HVOCs within the Property, (2) a subsurface reactor vault (vault) from which groundwater is pumped from the containment area to provide gradient control, (3) a groundwater treatment system for pretreating groundwater prior to discharge to the sanitary sewer and subsequent treatment at King County wastewater treatment plan, and (4) an asphalt cap over all of the Property to reduce infiltration into the shallow aquifer inside the SBCW. Figure 4 provides a layout of the SBCW alignment, capped area, and location of the vault. A detailed description of the cleanup action is provided in the engineering design report (PES and Vista Consultants, LLC, 2011), the cleanup action construction report (PES, 2013a), and the accompanying O&M plan.

The SBCW generally follows the perimeter of the Property, and the vault is located within the northeast (i.e., downgradient) corner of the contained area. The SBCW prevents groundwater from passing into the contaminated area and contains groundwater within the Property boundary, the groundwater pretreatment system removes contaminants from the groundwater that is pumped from within the SBCW, and the cap minimizes surface water infiltration.

3.1 Containment System Description

The perimeter SBCW is approximately 27 inches thick, 1,600 feet long, with an average depth of approximately 40 feet bgs. The SBCW is embedded at least 1 foot into Layer C along its entire length, with measured hydraulic conductivities of the in-place SBCW between 8×10^{-9} and 8×10^{-8} cm/sec. The surface component of the containment system consists of an asphalt cap. The cap is constructed of at least 2 to 3 inches of hot-mix asphalt underlain by 4 to 9 inches of crushed rock subbase.

3.2 Vault Description

The vault is used to collect groundwater from the shallow aquifer containment cell and then pump the groundwater through the pretreatment system before discharge to the sanitary sewer. The concrete vault is located in the northeastern corner of the containment cell (Figure 4) and consists of a 29-foot-wide, 40-foot-long, 18-foot-deep, concrete vault divided into six internal cells. The vault collects water in perforated pipes around the outside of the vault, and the water then gravity flows into the first internal cell (Cell 1). The remaining 5 internal cells are not currently used. A dedicated, electrically-powered submersible pump transfers groundwater from Cell 1 to the pretreatment system. The pump is controlled by a programmable logic controller (PLC) with remote measurement and control capabilities. An in-line flow meter is used to document the volume of water pumped to the pretreatment system, and a pressure transducer in Cell 1 allows the automated measurement and recording of water levels on a regular interval.

3.3 Groundwater Pretreatment System Description

The groundwater pretreatment system (GWPS) consists of an air stripper, a chemical dosing system, a control panel, and an optional vapor treatment system. The GWPS equipment is installed inside a prefabricated equipment building located adjacent to the vault. The chemical dosing system, which consists of a manually adjustable metering pump mounted on top of a 55-gallon drum of anti-scalent, is used to reduce the amount of scale that forms in the air stripper trays. The low-profile, two-tray air stripper is constructed of perforated stainless steel, with a stainless steel mist eliminator above the top tray and view ports on the top tray and on the air stripper sump. A 3 horsepower 240 VAC Rotron Model EN656 regenerative blower provides the fresh air for stripping. The blower is mounted next to the air stripper so that the blower exhaust piping is plumbed directly into the air stripper sump. The air stripper sump includes a high water level alarm switch, a low air pressure switch, and a high air pressure switch to ensure that groundwater is pumped from the vault only when the air stripper is operating. Water from the vault is plumbed into the top of air stripper using 1.25-inch Schedule 80 PVC pipe, flexible hoses, and fittings, and water from the air stripper sump gravity drains through a 3-inch-diameter Schedule 40 PVC pipe to a 4-inch-diameter side sewer pipe. The air stripper discharge includes a siphon break to prevent discharge of water when the blower is shut-off.

4.0 COMPLIANCE MONITORING NETWORK

Monitoring of the containment system[1] will be conducted to document the hydraulic response within and around the containment system to pumping from the vault. Groundwater quality monitoring will also be conducted to document conditions inside and outside of the SBCW. Appendix A provides the boring logs for the monitoring wells and piezometers that are part of the compliance monitoring network.

4.1 Groundwater Level Monitoring Network

The groundwater level monitoring network will consist of shallow, intermediate, and deep monitoring wells, and shallow and intermediate piezometers (Figure 5, Table 2), including:

- Five shallow piezometers (P-1, P-5, P-7, P-9, and P-13) located inside the containment system, and three shallow piezometers (P-3, P-11, and P-15) and six shallow monitoring wells (Gs, Hs, HY-1s, HY-11s, HYCP-2, and HYCP-7s) located outside of the containment system;
- Five intermediate piezometers (P-2, P-6, P-8, P-10, and P-14) and three intermediate monitoring wells (HY-12i, HY-13i, and HYCP-3i) located inside the containment system, and three intermediate piezometers (P-4, P-12, and P-16) and six intermediate monitoring wells located outside the containment system (Gi, Hi, HY-1i, HY-11i, HYCP-2i, and HYCP-7i); and
- Four deep monitoring wells located within the footprint of the containment system (HY-108, HY-117, HY-122, and HY-125) and three deep monitoring wells located outside the containment system (HY-1d, HY-11d, and HYCP-7d).

The shallow and intermediate piezometer and monitoring well clusters positioned to monitor groundwater levels across the SBCW are located as follows:

- **Northeast Corner** – A shallow and intermediate piezometer pair (P-1 and P-2) located immediately inside the SBCW and a shallow and intermediate piezometer pair located just outside the SBCW (P-3 and P-4) opposite from the P-1/P-2 pair will be used to monitor groundwater levels at the downgradient edge of the containment system;
- **North-Central Boundary** – A shallow and intermediate piezometer pair (P-5 and P-6) located inside the SBCW opposite monitoring wells HY-7s and HY-7i will be used to monitor groundwater levels on the northern boundary of the containment system;
- **Northwest Corner** – A shallow and intermediate piezometer pair (P-7 and P-8) located inside the SBCW opposite monitoring wells HY-1s and HY-1i will be used to monitor groundwater levels in the northwestern corner of the containment system;

[1] For purposes of this plan, the term "containment system" will be used to refer to the combination of the SBCW, asphalt cap, and Layer C, which encloses the majority of the shallow aquifer on the Property.

- **Southwest Corner** – A shallow and intermediate piezometer pair located immediately inside the SBCW (P-9 and P-10) opposite a shallow and intermediate piezometer pair located just outside the SBCW (P-11 and P-12) will be used to monitor groundwater levels at the upgradient edge of the containment system; and
- **Eastern Boundary** – A shallow and intermediate piezometer pair located immediately inside the SBCW (P-13 and P-14) opposite a shallow and intermediate piezometer pair located just outside the SBCW (P-15 and P-16) will be used to monitor groundwater levels on the eastern boundary of the containment system.

4.2 Groundwater Quality Monitoring Network

The groundwater quality monitoring network will include all of the shallow and intermediate monitoring wells used for groundwater level monitoring, including the three intermediate monitoring wells (HY-12i, HY-13i, and HYCP-3i) located inside the SBCW, and six shallow monitoring wells (Gs, Hs, HY-1s, HY-11s, HYCP-2, and HYCP-7s) and six intermediate monitoring wells (Gi, Hi, HY-1i, HY-11i, HYCP-2i, and HYCP-7i) located outside the SBCW (Figure 5, Table 2).

As stated in Section 6.2 of the CAP, the point of compliance (POC) for the Property is a conditional POC (CPOC) located at the Property boundary, given the containment-based nature of the CA. CPOC wells will include the following shallow and intermediate well pairs that are located downgradient of the SBCW (Figure 5):

- **HYCP-2 and HYCP-2i.** This well pair is located along the Property boundary north of the northeastern corner of the SBCW. HYCP-2 has been monitored since 1985, and HYCP-2i has been monitored since April 2008;
- **HYCP-7s and HYCP-7i.** This well pair is located along the Property boundary north of the central portion of the northern SBCW. HYCP-7s and HYCP-7i have been monitored since December 2011;
- **Gs and Gi.** This well pair is located approximately 70 feet east of the northeastern Property corner, in a location downgradient of the northeastern corner of the SBCW. Gs and Gi have been monitored since 1987; and
- **Hs and Hi.** This well pair is located approximately 55 feet east of the eastern Property boundary, in a location downgradient of the southeastern portion of the SBCW. Hs and Hi have been monitored since 1987.

The HY-1s and HY-1i well pair located northwest of the northwest corner of the SBCW will not be used as CPOC wells due to (1) their location cross-gradient to the containment system and (2) the likely off-Property source of HVOCs upgradient of their location.

5.0 PROTECTION MONITORING

Protection monitoring will be conducted to confirm the protection of human health and the environment during implementation of the long-term monitoring component of the CA. Protection monitoring will consist of compliance with a site-specific health and safety plan (HASP) that is consistent with the requirements outlined in the Worker Health and Safety guidelines (WAC 173-340-810) and the Occupational Safety and Health Act (OSHA, 29 CFR 1900). Appendix B presents the HASP to be used during CA operation and maintenance and during compliance monitoring of the CA.

All personnel will maintain a high degree of awareness of moving vehicles and any other hazards associated with activities at the Property, on the adjacent roadways, and on the adjacent properties. Additionally, all personnel will comply with any health and safety requirements of the adjacent property owners when monitoring is being conducted on those properties.

6.0 PERFORMANCE MONITORING

The objective of performance monitoring is to confirm that the cleanup action has attained cleanup standards, remediation levels, or other performance standards (WAC 173-340-410(1)(b)). Performance monitoring will be conducted to document and evaluate two aspects of the cleanup action: (1) the groundwater levels within and around the containment system in response to pumping from the vault and (2) the groundwater quality inside and outside of the SBCW during CA implementation. Performance monitoring will be conducted using the compliance monitoring network discussed in Section 4 until the performance criteria outlined in Section 12 have been met. Tables 2 and 3 summarize the performance monitoring well network, well completion details, monitoring frequency, and monitored parameters. CMP well locations are shown on Figure 5. The following sections provide an overview of the two components of performance monitoring.

6.1 Groundwater Level Measurements

6.1.1 Monitoring Objectives

Performance groundwater level monitoring will be conducted in all network piezometers and monitoring wells (Table 2) to document the groundwater elevations across the SBCW and across Layer C in response to groundwater pumping from the containment system.

6.1.2 Monitoring Overview

Groundwater levels will be monitored monthly in all network piezometers and wells located within the containment system and in piezometer and monitoring well clusters positioned to monitor groundwater levels across the SBCW. Other network monitoring wells (Table 3) will be monitored quarterly to allow for the development of shallow aquifer groundwater contour maps, if needed. Groundwater level monitoring events will be conducted concurrent with the groundwater quality monitoring events, when applicable. In the future, BSB may seek approval from Ecology for a less comprehensive water level monitoring program if the data set indicates that the monitoring objectives could be met through less comprehensive monitoring.

6.2 Groundwater Sampling

6.2.1 Monitoring Objectives

The objective of groundwater quality monitoring will be to document the groundwater quality following implementation of the CA, including groundwater quality inside and outside of the containment system.

6.2.2 Monitoring Overview

BSB has monitored groundwater quality in the network monitoring wells quarterly since installation of containment system. Since the VOC concentrations outside of the containment

system have been relatively stable, especially downgradient of the Property, groundwater quality samples will be collected from the network sampling wells on a twice yearly basis. Monitoring at that frequency will provide sufficient data to identify long-term groundwater quality trends at the site. Network sampling wells will include shallow wells Gs, Hs, HY-1s, HY-11s, HYCP-2, and HYCP-7s and intermediate wells Gi, Hi, HY-1i, HY-11i, HY-12i, HY-13i, HYCP-2i, HYCP-3i, and HYCP-7i (Table 3). During groundwater sampling, the network wells will be monitored for the following field parameters:

- Temperature;
- pH;
- Specific conductance;
- Dissolved oxygen (DO); and
- Oxidation-reduction potential (ORP).

Groundwater samples collected from the network wells will be analyzed for HVOCs using EPA Method 8260.

Groundwater performance monitoring will be conducted on a twice yearly basis until the performance criteria (Section 12) have been obtained at the conditional points of compliance (CPOCs). Upon completion of the performance monitoring program, the confirmational monitoring program outlined below will be implemented.

7.0 CONFIRMATIONAL MONITORING

The objective of confirmational monitoring is to confirm the long-term effectiveness of the CA once cleanup standards, remediation levels, or performance standards have been met (WAC 173-340-410(1)(c)). Confirmational monitoring will consist of water level monitoring and groundwater sampling in the network piezometers and monitoring wells.

7.1 Groundwater Level Measurements

7.1.1 Monitoring Objectives

Similar to the performance monitoring, confirmational groundwater level monitoring will be conducted in all network piezometers and monitoring wells (Table 2) to document the groundwater elevations across the SBCW and across Layer C in response to groundwater pumping from the containment system.

7.1.2 Monitoring Overview

For the first year after cleanup levels have been met at the compliance wells, groundwater levels will be monitored monthly in all network piezometers and wells located within the containment system and in piezometer and monitoring well clusters positioned to monitor groundwater levels across the SBCW. Other network monitoring wells (Table 3) will be monitored quarterly to allow for the development of shallow aquifer groundwater contour maps, if needed. Groundwater level monitoring events will be conducted concurrent with the groundwater quality monitoring events, when applicable. After a year of monitoring, BSB will review the data set and seek approval from Ecology for a less comprehensive water level monitoring program if the objectives can be met through less comprehensive monitoring.

7.2 Groundwater Sampling

7.2.1 Monitoring Objectives

Confirmational groundwater quality monitoring will be conducted to confirm the long-term effectiveness of the cleanup action, including groundwater quality inside and outside of the containment system.

7.2.2 Monitoring Overview

Once cleanup levels have been met in the CPOC wells, BSB will confirm that status by conducting 1 year of quarterly confirmational monitoring in the network monitoring wells. If cleanup levels are met in the CPOC wells during the first year of confirmational monitoring, the sampling frequency will be reduced to twice yearly sampling for the second and third years after achieving cleanup levels in the CPOC wells. If cleanup levels are still met in the CPOC wells after the third year, the sampling frequency will be reduced to annual sampling.

Network sampling wells will include shallow wells Gs, Hs, HY-1s, HY-11s, HYCP-2, and HYCP-7s and intermediate wells Gi, Hi, HY-1i, HY-11i, HY-12i, HY-13i, HYCP-2i, HYCP-3i, and HYCP-7i (Table 3). During groundwater sampling, the network wells will be monitored for the following field parameters:

- Temperature;
- pH;
- Specific conductance;
- DO; and
- ORP.

Groundwater samples collected from the network wells will be analyzed for HVOCs using EPA Method 8260.

8.0 SAMPLING AND ANALYSIS PLAN

The sampling and analysis plan has been developed to collect high quality environmental data. The overall goal of the compliance monitoring plan is to generate data that are acceptable for use in evaluating groundwater elevations inside and outside the containment system, groundwater quality with respect to the Site cleanup levels, and long-term groundwater quality trends. To generate these data, groundwater levels will be measured and groundwater quality samples will be collected and analyzed. Procedures used during system start-up (PES, 2011b) have been reiterated and incorporated into this CMP, where applicable.

8.1 Groundwater Level Measurements

8.1.1 Monitoring Locations and Schedule

Groundwater levels will be measured per the frequency outlined in Sections 6.1.2 and 7.1.2 in each network piezometer and monitoring well (Table 3 and Figure 5) using an electronic groundwater probe. The water level monitoring events will be conducted on a monthly basis.

8.1.2 Equipment

Equipment used for groundwater level monitoring is listed in Table 4. An electronic water level meter (e-tape) will be used to measure depth-to-water within the piezometers monitoring wells. The meter consists of a permanently marked coaxial cable or plastic-coated flat wire with 0.01-foot calibrations, a detection probe, and electronic controls contained in a spool or reel. The water level meter/sounder registers a response when the probe attached to the cable contacts an electrically conductive medium, such as water, thereby completing the electrical circuit. The response is visible (e.g., red light), audible (e.g., alarm), or a combination of the two.

8.1.3 Groundwater Level Monitoring Methods

Groundwater levels will be measured using the following procedures:

1. Open the well monument, and remove any standing water and debris (i.e., sediment, vegetation, or refuse) prior to removing the well cap.
2. Open the well by carefully removing the well cap and allow the well to vent. Record the time at which the well is initially vented to the atmosphere (i.e., time of well cap removal). Document initial conditions (i.e., well over-pressurized or under-pressurized relative to the atmosphere) on the Water Level Form (Appendix C).
3. After opening and venting the well, measure the initial water level to the nearest 0.01 foot, using electronic water level probe.
4. Measure the water level at the surveyed measuring point (MP) on the north side of the top of the PVC casing.
5. Record all results (times, measured values, etc.) on the Water Level Form (Appendix C).

6. Rinse the probe tip with distilled water between each well to avoid cross contaminating monitoring wells.
7. Take at least two depth-to-water measurements from each well, spaced at least 30 minutes apart. If the difference between the two measurements is 0.05 feet or greater, take a third measurement spaced at least 30 minutes apart.
8. Replace and tightly seal the well cap and surface monument on each well upon completing the final water level measurement.

8.2 Groundwater Sampling

8.2.1 Monitoring Locations and Schedule

Groundwater samples will be collected per the frequency outlined in Sections 6.2.2 and 7.2.2 in each shallow and intermediate network monitoring well (Table 3 and Figure 5). To maintain consistency with historical sampling months, the groundwater sampling events will be conducted during the last month of the quarter: quarterly sampling will be conducted in March, June, September, and December, semiannual sampling will be conducted in March and September, and annual sampling will be conducted in September.

8.2.2 Groundwater Sampling Equipment and Methods

Groundwater samples will be collected using "low flow" sampling methods. The purge rate is designed to be low enough to simulate natural groundwater flow conditions and to pull groundwater from a discrete zone within the adjacent aquifer near the pump intake, rather than pulling stagnant groundwater from within the well or from a large area around the well. A low purge rate is also intended to reduce the possibility of stripping volatile constituents from groundwater and to reduce the likelihood of mobilizing colloids in the subsurface that are typically immobile under natural groundwater flow conditions. A summary of the sampling procedures is outlined below.

Sampling Preparation. Prior to the initiation of any sampling activities, all of the necessary field equipment and documentation materials (e.g. field notebook and sampling forms) will be prepared. A summary of the sampling tools and equipment to be used during the sampling activities are listed in Table 4. Prior to the commencement of purging and sampling, each of the field instruments will be calibrated with standard solutions at a minimum of once per day. Laboratory supplied sample bottles will be inspected for proper preservative (Table 5). The depth to water will be measured prior to sampling using the procedures outlined above.

Low-Flow Purging with Peristaltic Pump. New disposable polyethylene tubing or dedicated polyethylene tubing will be used to sample each monitoring well. The polyethylene tubing will be slowly lowered into the well until the tubing intake is at the midpoint of the well screen. Table 3 provides the well screen depths for each of the groundwater sampling monitoring wells. The monitoring well will be purged with the peristaltic pump fitted with new disposable silicon tubing in the pump head. The polyethylene tubing in the well will be connected to the silicon tubing in the pump head. The time will be recorded on a Groundwater Sampling Form

(Appendix C), and the pump will be started. Pumping rates will be measured with a stopwatch and graduated cylinder, graduated cup, or volatile organic analysis (VOA) 40 milliliter (mL) vial, depending on flow rate. Low flow purging will be conducted at a pumping rate between 80 and 500 mL per minute (mL/min).

During purging, the water level will be measured approximately every 3 to 5 minutes, until a steady water level is determined. If possible, a drawdown of 0.3 feet or less will be maintained in the well, with the pumping rate lowered to a minimum rate of 80 mL/min if necessary to maintain a drawdown of 0.3 feet or less. The water level in the well will be maintained above the tubing intake depth at all times. If the well yield is sufficiently poor that the water level drops to the tubing intake, the pump will be stopped until the water level recovers to near the pre-pumping level. The process will then be repeated until the field parameters have stabilized. The final purge volume will be at least as great as the submerged tubing volume plus the stabilized drawdown volume. All measured water levels and pumping rate changes will be recorded on a Groundwater Sampling Form (Appendix C).

Field Parameter Measurements. Field indicator parameters will be measured approximately every 3 to 5 minutes during purging. Field parameters will include pH, specific conductance, temperature, turbidity, dissolved oxygen (DO), and ORP. Measurements will be recorded to the following standards:

- pH to ±0.01 units;
- Specific conductance to ±1 microSiemens;
- Temperature to ±0.1^{o}C;
- Turbidity to ±1 units;
- DO to ±0.1 milligrams per liter (mg/L); and
- ORP to ±1millivolts (mV).

Samples will not be collected until these parameters have stabilized for three consecutive readings to the following criteria:

- pH to ±0.2 pH unit;
- Specific conductance to ±3 percent; and
- Temperature to ±3 percent.

Attempts to stabilize turbidity, DO, and ORP measurements should be made, but will not be used to determine stability. If field parameters do not stabilize after 1 hour of pumping, a sample will be collected. Well purging data will be recorded on a Groundwater Sampling Form. Field instruments will be calibrated using known, standard solutions, a minimum of once per day.

Sample Collection. Upon completion of purging, samples will be collected from the discharge end of the peristaltic pump tubing. The same pump rate used at the end of well purging will be used during sample collection. Samples will be collected by allowing the sample water to pour down the inside of the VOA vials and without splashing onto the base. All sample containers will be prepared and provided by the analytical laboratory (Table 5).

After collection of the sample from each well, the disposable polyethylene tubing will be removed from the well, the well cap will be replaced, and the well cap or monument locked. All

used tubing will be discarded appropriately. If dedicated tubing is used, it will either be secured in the well casing or removed from the well and placed in a dedicated storage bag.

Decontamination and purge water will be handled in accordance to the residuals management procedures outlined in Sections 8.6 and 8.7, respectively.

8.3 Laboratory Analytical Procedures

Groundwater samples will be submitted to a Washington State accredited laboratory for analysis of HVOCs by EPA Method 8260.

8.4 Sample Labeling, Shipping, and Chain-of-Custody

Sample labeling, shipping, and chain-of-custody will be performed consistent with the procedures described below.

8.4.1 Sample Labeling

Sample container labels will be completed immediately before or immediately following sample collection. Container labels will include the following information:

- Project name;
- Sample name labeled with a unique sample identification number. The sample number consists of the appropriate monitoring well designation followed by a date identification code. The date identification code consists of a four-digit number that represents the month and year that the sample was collected. For example, the sample number HYCP-7s-031216 denotes a sample collected on March 12, 2016 from monitoring well HYCP-7s;
- Date and time of collection;
- Initials of collector;
- Preservatives added to the sample; and
- Parameter(s) for which the sample to be analyzed.

Field duplicates and field blanks will be submitted blind to the analytical laboratory. Sample numbers associated with field duplicates and field blanks will include a generic (distinct from any wells that are being sampled) well number (e.g., D-100) and four digit date identification, as described above. The actual sample numbers and associated samples (for field duplicates) will be recorded in a field notebook and or Groundwater Sampling Form.

All trip blanks are provided by the analytical laboratory and are labeled as “Trip Blank” with a date identification code as described above. Distinctions among multiple field or trip blanks can be made by the associated dates.

8.4.2 Sample Shipping

Samples will be shipped to the analytical laboratory using the procedures outlined in the SOG Sample Packaging and Shipping. General guidelines are summarized below:

- Sample containers will be place in a sealed, iced cooler or other suitable shipping container after sample collection. This container will be used for transporting the samples to the analytical laboratory;
- In each shipping container, glass bottles will be separated by a shock absorbing material to prevent breakage and leakage;
- Ice sealed in separate plastic bags or "gel ice" packs, will be placed into each shipping container with the samples;
- All sample shipments will be accompanied by a chain-of-custody form (COC). The completed form will be sealed in a plastic bag, which will be taped to the inside lid of the shipping container;
- Signed and dated COC seals will be placed on all shipping containers; and
- The name and address of the analytical laboratory, along with the sampling company name and office (return) address, will be placed on each shipping container prior to shipping.

8.4.3 Chain-of-Custody

Once a sample is collected, it will remain in the custody of the sampler or other approved project personnel until shipment to the laboratory. Upon transfer of sample possession to subsequent custodians, a COC will be signed by the persons transferring custody of the sample container. A signed and dated COC seal will be placed on each shipping container prior to shipping. COC records will be included in the analytical report prepared by the laboratory.

8.5 Decontamination

Decontamination procedures will be performed consistent with the procedures described in this section. All non-disposable sampling equipment will be decontaminated prior to initial use, between sampling locations, and at the completion of the site-specific sampling.

The following decontamination procedure will be used for non-dedicated and non-disposable sampling equipment:

- Tap water rinse;
- Non-phosphatic detergent (e.g., Liquinox) and tap water wash;
- Tap water rinse; and
- Distilled water rinse.

Water level probes will be decontaminated by rinsing with distilled or de-ionized water. Decontamination of personnel involved in sampling activities will be accomplished as described in a site-specific health and safety plan.

8.6 Sampling Residuals

The following procedures will be used for the drilling and sampling residuals, including groundwater sampling purge water and decontamination water:

- Purge water and decontamination water generated during the investigation activities will be placed in labeled 55-gallon drums to settle. Water not containing detergent will be transferred to the reactor vault for pretreatment with the air stripper treatment system prior to discharge to the sanitary sewer. Water containing detergent will be profiled and disposed at an appropriate waste disposal facility; and
- Disposable clothing and equipment will be placed in plastic bags and disposed of as solid waste.

9.0 MONITORING NETWORK MAINTENANCE

This section describes a program to provide regular inspection, and if necessary, maintenance of the groundwater monitoring wells and associated equipment.

9.1 Well Inspection

Monitoring wells in the network will be inspected by the sampling team during routine monitoring to assess their integrity. The inspection will involve a visual inspection of the well to determine if the well has been damaged or tampered with. The well inspection will verify the physical condition of the well at the ground surface and the internal well casing. Monitoring wells will also be fully inspected after any major physical event that may affect the wells, such as an earthquake or heavy construction in the vicinity of a well.

Problems discovered during the inspection will be recorded on field forms and a well maintenance form, which will be provided by the field personnel to the Project Manager. Problems that require immediate attention will be reported to the Project Manager so as to remedy the condition prior to the next sampling event. If a significant problem, such as a broken wellhead, bent casing, or other damage that compromises well access is discovered, it may be necessary to remedy the problem as soon as possible and/or before sampling. A problem with the well integrity may require a modification of the sampling schedule or some other change in the sampling program. All decisions regarding such modifications will be reported immediately by the field personnel to the Project Manager.

9.2 Maintenance

Total depths in the 16 piezometers and 21 monitoring wells (Table 2) will be measured once per year to evaluate the well integrity. A weighted water level probe or tape will be used to perform the measurements. If more than 1 foot of sediment has built up in the bottom of a well, the well will be redeveloped by surging and pumping techniques to remove the sediment.

All sampling equipment used for groundwater monitoring will be maintained regularly by the sampling team members according to the manufacturer's equipment manuals.

9.3 Monitoring Well Replacement

If any piezometer or monitoring well in the network must be replaced, BSB will notify Ecology prior to replacement. The damaged piezometer or well will be decommissioned and the replacement well installed only after Ecology’s approval. Wells decommissioning will be consistent with WAC 173-160-460 (Abandonment of Resource Protection Wells). The CMP will be revised to reflect changes to the monitoring well network.

10.0 QUALITY ASSURANCE PROJECT PLAN

The QAPP describes the measures undertaken so that the data collected during the project are acceptable for their intended use(s) and includes the elements from Ecology's QAPP guidance document (Ecology, 2004). The specific requirements pertaining to this CMP are described in this section.

10.1 Quality Assurance Project Plan Objectives

The overall QAPP objective for measurement data is to provide data of known and acceptable quality. All measurements will be made to yield accurate and precise results representative of the media and conditions measured. Chemical analyses will be performed in accordance with the requirements of the analytical methods. All sample results will be calculated and reported in consistent units to allow comparison of the sample data with regulatory criteria and federal, state, and local databases. QAPP objectives for precision, accuracy, and completeness have been established for each measurement variable, where possible, and are discussed below.

10.2 Chemical Analyses

Analysis of environmental samples will be performed in accordance with the laboratory analytical methods summarized in Table 5. The laboratory will report the results to levels less than or equal to the cleanup levels, using method reporting limits (MRLs) or method detection limits (MDLs) as necessary to meet the cleanup levels. Any special analytical methods or modifications to methods will be determined with laboratory concurrence prior to beginning sample analysis.

10.3 Laboratory Quality Control

This section presents quality control (QC) requirements for the analytical laboratory. The purpose of this QC program is to produce data of known quality meeting project objectives and the requirements of the standard methods of analysis. Laboratory QC samples will include laboratory control samples (LCSs), matrix spike/matrix spike duplicate (MS/MSD) samples, laboratory duplicates, and method blanks. Laboratory QC samples (e.g., blanks and LCSs) will be included in the preparation batch with the field samples. An analytical batch is a number of samples (not to exceed 20, including the associated laboratory QC samples, MSs and MSDs) that are from a similar matrix and extracted or digested at the same time, analyzed sequentially, and with the same lot of reagents.

The identity of each analytical batch will be reported with the analyses so that a reviewer can identify the QC samples and the associated environmental samples. Samples that do not need separate extraction or digestion (e.g., volatile analyses by purge and trap) are included in each analytical batch.

All sample preparation and analysis will be completed within the method-required holding times. The holding time begins at the time of sample collection. If holding times are exceeded and the

analyses are performed, the data will be qualified during the data review, in accordance with USEPA Functional Guidelines (USEPA, 1999 and 2002).

10.4 Field Quality Assurance

Field QC samples will be collected during groundwater sampling and will include trip blanks and field duplicates. Field QC samples will be collected at the frequency specified in Table 6 and described below.

10.4.1 Trip Blanks

A trip blank consists of a set of VOA vials filled in the laboratory with reagent-grade water, transported to the sampling site, handled under the same conditions as an environmental sample, and returned to the laboratory for analysis. Trip blanks are not opened in the field. Trip blanks are prepared only when volatile samples are collected and are analyzed only for volatile analytes. Trip blanks are used to assess the potential introduction of contaminants from sample containers or during the transportation and storage procedures. One trip blank per sampling event will be included with the shipment of samples to the laboratory if HVOC analyses are requested and will be analyzed for HVOCs. If an analyte is detected in a trip blank, the data will be qualified during the data review per USEPA Functional Guidelines for Organics (USEPA, 1999).

10.4.2 Field Duplicates

A field duplicate sample is a second sample collected at the same location as the original sample. Duplicate samples are collected simultaneously or in immediate succession, using identical sampling techniques, and treated in an identical manner during storage, transportation, and analysis. The sample containers are assigned an identification number in the field so that they cannot be identified (blind duplicate) as duplicate samples by laboratory personnel performing the analysis. Duplicate sample results are used to assess precision of the sample collection process. One duplicate sample will be collected for approximately every 20 project samples.

10.5 Data Reporting and Review

The laboratory performing sample analyses will be required to submit summary data and QA information to permit independent determination of data quality. The determination of data quality will be performed using the USEPA Contract Laboratory Program National Functional Guidelines for Organic Data Review (USEPA, 1999) and USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review (USEPA, 2002) as guidelines for data review.

Laboratory deliverable requirements are outlined below and included in Table 7:

- Narrative cover letters for each sample batch will include a summary of any QC, sample, shipment, or analytical problems, and will document all internal decisions. Problems will be outlined and final solutions documented;

- A copy of the signed chain-of-custody form for each batch of samples will be included in the results packet;
- Sample concentrations will be reported on standard data sheets in proper units and to the appropriate number of significant figures. For undetected values, the lower limit of detection for each compound will be reported separately for each sample. Dates of sample extraction or preparation and analysis must be included;
- A method blank summary will be included;
- Surrogate percent recovery will be calculated and reported;
- LCS results will be included;
- MS/MSD percent recoveries, spike level, and relative percent difference will be included; and
- Laboratory duplicate results will be included.

11.0 DATA EVALUATION

11.1 Data Validation

All chemistry data will be validated per USEPA data review guidelines (USEPA, 1999 and 2002). Data validation will include a review of holding times, method blank results, surrogate recovery results, LCSs, MS/MSDs, field and laboratory duplicates, completeness, detection limits, and chain-of-custody forms. Data validation memos will be prepared summarizing the reviews and any assigned data qualifiers.

11.2 Data Evaluation

Data generated during compliance monitoring will be reviewed, tabulated, and evaluated. Updated data summaries will be submitted to Ecology as discussed in Section 13 below.

11.2.1 Groundwater Levels

The groundwater level data collected during compliance monitoring will be added to the existing water level database. Groundwater elevations piezometers and wells completed in the shallow and intermediate aquifer zones across the SBCW will be compared, and groundwater elevations in monitoring points completed above and below the basal aquitard (Layer C) will be compared. Additionally, the existing well hydrographs will be updated.

11.2.2 Groundwater Quality

The groundwater quality data collected during compliance monitoring will be added to the water quality database, and the existing time-trend plots will be updated. The data will be used in future evaluations of long-term water quality changes.

12.0 CRITERIA FOR MEETING PERFORMANCE AND COMPLIANCE STANDARDS

Groundwater elevations in network monitoring wells located inside and outside the containment system and the concentrations of IHSs in the CPOC wells outside the containment system will be evaluated to document the effectiveness of the on-going CA. As discussed in Section 2.2.3, the IHSs are TCE and its breakdown products cDCE and VC. Table 1 provides the cleanup levels for TCE, cDCE, and VC.

12.1 Performance Monitoring Standards

Per WAC 173-340-410(1)(b), the objective of performance monitoring is to confirm that the CA has attained cleanup standards, remediation levels, or other performance standards. Ultimately, the cleanup standard for the CA is that IHSs in the CPOC wells meet the cleanup levels. Until that occurs, the groundwater elevation and groundwater quality performance standards will be met during implementation of the CA, as discussed in the following sections.

12.1.1 Groundwater Elevations

To minimize the potential for IHS-containing groundwater to flow out of the containment system through the SBCW or Layer C, the water level performance standard will be to maintain lower groundwater elevations in most of the monitoring points inside the SBCW compared to the co-located monitoring points outside the SBCW (or beneath Layer C) most of the time. To achieve this standard, groundwater will be pumped from the containment system at a rate sufficient to maintain groundwater elevations in the containment system at a level that meets the performance standard. The groundwater extraction rate from the containment system will be adjusted as necessary to meet this standard.

To determine whether this performance standard has been met, groundwater elevations will be compared at paired monitoring points located across the SBCW and Layer C. The comparisons will be made in the following co-located monitoring points (inside location/outside location):

1. **Northeast Corner.** P-1/P-3 (shallow) and P-2/P-4 (intermediate).
2. **North Boundary.** P-5/HYCP-7s (shallow) and P-6/HYCP-7i (intermediate).
3. **Northwest Corner.** P-7/HY-1s (shallow) and P-8/HY-1i (intermediate).
4. **Southwest Corner.** P-9/P-11 (shallow) and P-10/P-12 (intermediate).
5. **East Boundary.** P-13/P-15 (shallow) and P-14/P-16 (intermediate).
6. **Center of the Property (across Layer C).** HYCP-3i/HY-117, HY-12i/HY-122, and HY-13i/HY-125.

12.1.2 Groundwater Quality

The water quality performance standard will be to maintain generally neutral to decreasing IHS concentration trends in the CPOC wells. That is, implementation and operation of the CA should not cause a sustained increase in IHS concentrations in the CPOC wells. Due to pre-existing concentrations of IHSs in the vicinity of these wells, an apparent source of cDCE and VC to the southwest of the Property, and relatively stagnant groundwater flow near the downgradient side of the SBCW, this performance standard will ensure that the SBCW is working to keep IHSs within the containment system.

To document that this performance standard has been met, the IHS concentration trends in the CPOC wells will be reviewed. When the IHS cleanup levels have been met in the CPOC wells for at least four consecutive sampling events, the confirmational monitoring program below will be implemented.

12.2 Confirmational Monitoring Standards

Per WAC 173-340-410(1)(c), the purpose of confirmational monitoring is to confirm the long-term effectiveness of the CA once cleanup standards, remediation levels, or other performance standards have been met. As discussed in Section 12.1.2, once the IHS cleanup levels have been met in the CPOC wells for at least four consecutive sampling events, the confirmational monitoring program below will be implemented and the confirmational groundwater elevation and groundwater quality performance standards will be met, as discussed in the following sections.

12.2.1 Groundwater Elevations

The water level standard applicable during the confirmational monitoring will be the same as during the performance-monitoring period: to maintain lower groundwater elevations in most of the monitoring points inside the SBCW compared to the co-located monitoring points outside the SBCW (or beneath Layer C) most of the time. Groundwater will continue to be pumped from the containment system at a rate sufficient to maintain groundwater elevations in the containment system at a level that meets the performance standard. The same groundwater elevation comparisons made during the performance-monitoring period will be made during confirmational monitoring, including the co-located points in the northeast corner, north boundary, northwest corner, southwest corner, east boundary, and center of the Property.

12.2.2 Groundwater Quality

The water quality standard applied during confirmational monitoring will be to maintain the concentrations of the IHSs at or below the cleanup levels in the CPOC wells. Due to the low VC cleanup level relative to the laboratory reporting limits, occasional exceedances of the VC cleanup level will not initiate an investigation into the VC source or change system operations. If an IHS increases in concentration so that it is consistently detected above the cleanup level in at least one CPOC well, an investigation into a potential source or change in system operations will be initiated.

13.0 REPORTING

13.1 Quarterly King County Self-Monitoring Reports

As discussed in the O&M plan, BSB will provide Ecology with a copy of the self-monitoring reports that are submitting to King County quarterly. These reports summarize the volume of water discharged to the sanitary sewer and the results of the required discharge monitoring.

13.2 Progress Reports

Per Consent Decree 11-2-27288-5, Section XI (Ecology, 2011), progress reports are to be submitted to Ecology on a quarterly basis, no later than 20 days after the end of the quarter. Each report includes:

- A list of activities that have taken place during the quarter;
- A detailed description of deviations from required tasks and the cleanup action plan;
- A schedule for recovering time lost due to deviations;
- Raw data generated during the quarter; and
- A list of deliverables in the upcoming month if different from the schedule.

BSB has submitted these progress reports since the cleanup action was implemented and will continue to submit these progress reports during the first year of CMP implementation. Progress reports documenting the second and fourth quarters of each year will also provide updates to the tables and graphs summarizing the monitoring data; these will include the reactor vault pumping and elevation data, the monitoring well hydrographs, the groundwater chemistry tables, and the groundwater chemistry time-trend plots.

After the first year of CMP data have been collected, BSB will review the data set, and if groundwater elevations continue to show consistent hydraulic control across the SBCW and groundwater quality data outside of the containment system continue to show stable concentration trends, BSB will consider submitting to Ecology a request to reduce the reporting frequency to twice yearly. If the data are not yet sufficiently robust to reduce the reporting frequency, BSB will review the data set annually in the future, submitting a reporting reduction request once the data are sufficiently robust.

13.3 Periodic Review

Per WAC 173-340-420, for sites under a consent decree with an institutional control, Ecology will conduct a review of the cleanup action at least every 5 years. The review will evaluate site conditions and monitoring data to assure continued protection of human health and the environment. If needed, BSB will provide information required by Ecology to support the periodic review.

14.0REFERENCES

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TABLES

Table 1

Indicator Hazardous Substance Cleanup Levels
Compliance Monitoring Plan
BSB Property, Kent, Washington

Indicator Hazardous Substance	Final Cleanup Levels (µg/L)
Cis-1,2-Dichloroethene (cDCE)	70
Trichloroethylene (TCE)	30
Vinyl Chloride (VC)	0.2

Notes:
µg/L = micrograms per liter

Table 2

Containment System Monitoring Nework Completion Details
Compliance Monitoring Plan
BSB Property, Kent, Washington

Well	Date Installed	Northing	Easting	Monitoring Point Elevation	Surface Casing Rim Elevation	Well Type	Monument	Boring Depth	Screen Depth	Filter Pack Depth	Seal Depth
Shallow Aquifer Zone Monitoring Wells											
Gs	7/9/87	157,364.02	1,294,758.01	26.90	27.32	2" SS, 0.010" slot size	Above	17.5	5.5 - 15.5	3.5 - 15.5	0 - 3.5
Hs	7/6/87	157,192.46	1,294,730.88	25.94	26.45	2" SS, 0.010" slot size	Flush	18	5 - 15	3 - 18	0 - 3
HY-1s	6/25/82	157,370.15	1,294,202.42	30.16	30.21	2" PVC	Above	20.5	14 - 19	10 - 20.5*	0 - 10
HY-11s	12/20/85	156,795.46	1,294,193.52	31.14	31.46	2" PVC, 0.010" slots	Flush	18	8 - 18	6 - 18	0 - 6
HYCP-2	12/3/84	157,370.41	1,294,617.54	26.42	27.52	2" Sch 80 PVC, 0.010" slots	Above	28	8 - 28	6 - 28	0 - 6
HYCP-7s	12/08/11	157,371.47	1,294,493.49	26.49	26.92	1.5" Schedule 40 pre-pack PVC, 0.010" slot size	Flush	16	9.9 - 14.9	8 - 15.2	0 - 8
Shallow Aquifer Zone Piezometers											
P-1	12/06/11	157,324.11	1,294,619.47	27.19	27.48	1.5" Schedule 40 pre-pack PVC, 0.010" slot size	Flush	15.2	9.9 - 14.9	8 - 15.2	0 - 8
P-3	12/06/11	157,336.05	1,294,639.01	26.49	26.78	1.5" Schedule 40 pre-pack PVC, 0.010" slot size	Flush	17	9.8 - 14.8	8 - 15.1	0 - 8
P-5	12/08/11	157,337.90	1,294,489.50	28.36	28.71	1.5" Schedule 40 pre-pack PVC, 0.010" slot size	Flush	16	9.7 - 14.7	8 - 15	0 - 8
P-7	12/09/11	157,339.12	1,294,230.94	29.64	30.01	1.5" Schedule 40 pre-pack PVC, 0.010" slot size	Flush	18.3	13 - 18	11 - 18.3	0 - 11
P-9	12/14/11	156,992.66	1,294,218.30	32.39	32.80	1.5" Schedule 40 pre-pack PVC, 0.010" slot size	Flush	19.8	14.5 - 19.5	12 - 19.8	0 - 12
P-11	12/08/11	156,973.90	1,294,198.97	32.60	32.98	1.5" Schedule 40 pre-pack PVC, 0.010" slot size	Flush	20	14.9 - 18.9	12 - 19.2	0 - 12
P-13	12/07/11	157,204.98	1,294,611.83	29.13	29.43	1.5" Schedule 40 pre-pack PVC, 0.010" slot size	Flush	19	13.7 - 18.7	12 - 19	0 - 12
P-15	12/07/11	157,184.84	1,294,612.59	29.25	29.79	1.5" Schedule 40 pre-pack PVC, 0.010" slot size	Flush	18	12.7 - 17.7	11 - 18	0 - 11
Intermediate Aquifer Zone Monitoring Wells											
Gi	7/9/87	157,365.03	1,294,748.17	27.28	27.36	2" SS, 0.010" slot size	Above	41	28 - 38	25 - 41	0 - 25
Hi	7/6/87	157,197.41	1,294,730.68	26.04	26.25	2" SS, 0.010" slot size	Flush	40	28 - 38	25 - 40	0 - 25
HY-1i	12/13/85	157364.46	1294202.31	30.76	31.01	2" Sch 80 PVC, 0.010" slots	Above	80	30 - 40	28 - 42	0 - 28, 42 - 52^
HY-11i	12/20/85	156,793.43	1,294,190.90	31.12	31.42	2" Sch 80 PVC, 0.010" slot size	Flush	38	26 - 36	24 - 38	0 - 24
HY-12i	1/26/11	157,239.44	1,294,502.80	29.90	30.26	2" Sch 40 pre-pack PVC, 0.010" slot size	Flush	38.7	28.5 - 38.4	26 - 38.4	0 - 26
HY-13i	1/26/11	157,196.73	1,294,550.87	29.59	30.07	2" Sch 40 pre-pack PVC, 0.010" slot size	Flush	38.7	28.5 - 38.4	26 - 38.4	0 - 26
HYCP-2i	1/8/08	157,369.07	1,294,637.04	26.06	26.51	2" Sch 40 pre-packed PVC, 0.010" slots	Flush	35.5	24.8 - 34.8	22 - 35.5	0 - 22
HYCP-3i	12/1/84	157,190.43	1,294,408.33	29.40	30.20	2" Schedule 80 PVC	Flush	33.0	22 - 32	20 - 33	0 - 20
HYCP-7i	1/7/08	157,375.07	1,294,498.73	25.75	26.10	2" Sch 40 pre-pack PVC, 0.010" slot size	Flush	35	23.8 - 33.8	21 - 35	0 - 21
Intermediate Aquifer Zone Piezometers											
P-2	12/06/11	157,318.23	1,294,624.62	26.98	27.42	1.5" Schedule 40 pre-pack PVC, 0.010" slot size	Flush	34.5	29.2 - 34.2	27 - 34.5	0 - 27
P-4	12/06/11	157,333.17	1,294,641.75	26.44	26.79	1.5" Schedule 40 pre-pack PVC, 0.010" slot size	Flush	34	28.7 - 33.7	27 - 34	0 - 27
P-6	12/08/11	157,337.32	1,294,497.12	28.25	28.66	1.5" Schedule 40 pre-pack PVC, 0.010" slot size	Flush	38	25.8 - 30.8	24 - 35	0 - 24
P-8	12/09/11	157,348.05	1,294,233.80	29.45	29.85	1.5" Schedule 40 pre-pack PVC, 0.010" slot size	Flush	38.3	28 - 38	26 - 38	0 - 26

Table 2

Containment System Monitoring Nework Completion Details
Compliance Monitoring Plan
BSB Property, Kent, Washington

Well	Date Installed	Northing	Easting	Monitoring Point Elevation	Surface Casing Rim Elevation	Well Type	Monument	Boring Depth	Screen Depth	Filter Pack Depth	Seal Depth
P-10	12/14/11	156,987.94	1,294,225.89	32.40	32.85	1.5" Schedule 40 pre-pack PVC, 0.010" slot size	Flush	37	30.2 - 35.2	28 - 35.5	0 - 28
P-12	12/09/11	156,969.51	1,294,204.89	32.74	33.09	1.5" Schedule 40 pre-pack PVC, 0.010" slot size	Flush	37	29.9 - 34.9	28 - 35.2	0 - 28
P-14	12/07/11	157,203.95	1,294,622.57	28.91	29.36	1.5" Schedule 40 pre-pack PVC, 0.010" slot size	Flush	31	25.1 - 30.1	23.5 - 30.4	0 - 23.5
P-16	12/07/11	157,183.97	1,294,621.27	29.25	29.78	1.5" Schedule 40 pre-pack PVC, 0.010" slot size	Flush	31	25.1 - 30.1	23.5 - 30.4	0 - 23.5
Deep Aquifer Zone Monitoring Wells											
HY-1d	12/18/85	157352.25	1294202.38	31.44	31.78	2" Sch 80 PVC, 0.010" slot size	Above	96	84 - 94	81 - 96	0 - 81
HY-11d	12/20/85	156,788.15	1,294,192.19	31.08	31.46	2" Sch 80 PVC, 0.010" slot size	Flush	94.5	82 - 92	80 - 94.5	0 - 80
HY-108	2/16/10	157,342.32	1,294,654.69	26.19	26.44	2" Sch 40 pre-pack PVC, 0.010" slot size	Flush	57	43.8 - 56.3	41.5 - 57	0 - 41.5
HY-117	5/13/10	157,198.62	1,294,438.32	30.11	30.58	2" Sch 40 pre-pack PVC, 0.010" slot size	Flush	56	47 - 54.6	45 - 55	0-45, 55-56
HY-122	1/17/11	157,253.78	1,294,501.19	29.71	30.18	2" Sch 40 pre-pack PVC, 0.010" slot size	Flush	63	49.4 - 61.9	48 - 63	0 - 48
HY-125	1/20/11	157,196.34	1,294,559.26	29.60	30.02	2" Sch 40 pre-pack PVC, 0.010" slot size	Flush	59	48.1 - 57.8	46 - 59	0 - 46
HYCP-7d	1/7/08	157,374.91	1,294,489.46	26.05	26.50	2" Sch 40 pre-pack PVC, 0.010" slot size	Flush	60	49.0 - 59.0	47 - 60	0 - 47

Notes:
1. Northing/Easting relative to the WA State Plane System North Zone (NAD 83); based on King County survey control monuments 5832 and 5692.
2. Elevations in feet relative to the North American Vertical Datum (NAVD) of 1988; based on city of Kent benchmark #939 (elevation 27.20 ft), located at the intersection of South 200th Street and 81st Avenue South.
3. All depths shown in feet below ground surface.
4. Abbreviations:
   a. SS = stainless steel.
   b. PVC = polyvinyl chloride.
   c. Sch = schedule.
   d. Pre-pack = PVC screen with pre-packed filter pack consisting of 20 x 40 Colorado Silica Sand.
   d. Above = above-grade completion.
   e. Flush = flush-with-grade completion.
5. Completion notes:
   a. * = lower portion of filter pack includes native material.
   b. ^ = boring wall caved in 52 - 80 feet bgs.

Table 3

Monitoring Frequency
Compliance Monitoring Plan
BSB Property, Kent, Washington

Well	Containment System Performance Monitoring			
	Water Level Frequency	Sampling Frequency		Approximate Tubing Intake Depth (ft bgs)
		Field Parameters	Laboratory HVOC Analysis	
Shallow Aquifer Zone Monitoring Wells and Piezometers				
Gs	Quarterly	Twice Yearly	Twice Yearly	10.5
Hs	Quarterly	Twice Yearly	Twice Yearly	10
HY-1s	Monthly	Twice Yearly	Twice Yearly	16.5
HY-11s	Quarterly	Twice Yearly	Twice Yearly	13
HYCP-2	Quarterly	Twice Yearly	Twice Yearly	18
HYCP-7s	Monthly	Twice Yearly	Twice Yearly	18
P-1	Monthly	–	–	–
P-3	Monthly	–	–	–
P-5	Monthly	–	–	–
P-7	Monthly	–	–	–
P-9	Monthly	–	–	–
P-11	Monthly	–	–	–
P-13	Monthly	–	–	–
P-15	Monthly	–	–	–
Intermediate Aquifer Zone Monitoring Wells and Piezometers				
Gi	Quarterly	Twice Yearly	Twice Yearly	33
Hi	Quarterly	Twice Yearly	Twice Yearly	33
HY-1i	Monthly	Twice Yearly	Twice Yearly	35
HY-11i	Quarterly	Twice Yearly	Twice Yearly	31
HY-12i	Monthly	Twice Yearly	Twice Yearly	33.5
HY-13i	Monthly	Twice Yearly	Twice Yearly	33.5
HYCP-2i	Quarterly	Twice Yearly	Twice Yearly	30
HYCP-3i	Monthly	Twice Yearly	Twice Yearly	27
HYCP-7i	Monthly	Twice Yearly	Twice Yearly	29
P-2	Monthly	–	–	–
P-4	Monthly	–	–	–
P-6	Monthly	–	–	–
P-8	Monthly	–	–	–
P-10	Monthly	–	–	–
P-12	Monthly	–	–	–
P-14	Monthly	–	–	–
P-16	Monthly	–	–	–
Deep Aquifer Zone Monitoring Wells				
HY-1d	Monthly	–	–	–
HY-11d	Monthly	–	–	–
HY-108	Monthly	–	–	–
HY-117	Monthly	–	–	–
HY-122	Monthly	–	–	–
HY-125	Monthly	–	–	–
HYCP-7d	Monthly	–	–	–

Notes: 1. – = not applicable.
2. HVOCs = halogenated volatile organic compounds.
3. Field parameters = pH, specific conductance, temperature, dissolved oxygen, and ORP.
4. ft bgs = feet below ground surface.

Table 4

Field Equipment and Supplies
Compliance Monitoring Plan
BSB Property, Kent, Washington

Forms/Documentation
Field logbooks
Field sampling data sheets
Chain-of-custody/laboratory analysis report forms
Project photo log
Compliance Monitoring Plan and Health and Safety Plan
Tools
Fiberglass tape with stainless-steel weight
Tape measure calibrated to 0.1 inch
Decon brushes
Flashlight
Tool kit
Shovel
Groundwater Investigation and Sampling
pH/conductivity/temperature meters
dissolved oxygen/oxidation reduction potential/turbidity meters
Water-level probe
Meter calibration solutions
Peristaltic pump
Disposable plastic beakers
pH paper
Polyethylene tubing
Silicon tubing for peristaltic pump
Sample containers and labels
Liquinox
Distilled Water
Health and Safety Equipment
Fire extinguisher
Hard Hat
First aid kit
Safety glasses
Eyewash
Ear plugs
Tyvek®
Miscellaneous Equipment
Gloves – vinyl, nitrile, and neoprene
Duct tape
Spray paint, pencils, pens, labels
Waterproof markers
Water jugs and sprayers
Hazardous materials packaging
Bubble wrap and tape for shipping
Camera
Resealable plastic bags
Paper towels

Table 4

Field Equipment and Supplies
Compliance Monitoring Plan
BSB Property, Kent, Washington

Miscellaneous Equipment (continued)
Visqueen sheets
Buckets
Squirt bottle (wash)
Plastic funnel
Cotton gloves
Nalgene wash bottles
Reagent bottles
Coolers (sample shipping)
Scrub brushes
Plastic tubs
Ice, in leak-proof bags
Drinking water
Scale site map

Table 5

Analytical Methods and Sample Handling Details
Compliance Monitoring Plan
BSB Property, Kent, Washington

Analyses	Analytical Method	Water Container	Preservation	Max Holding Time
Laboratory Analyses				
Halogenated volatile organic compunds (HVOCs)	EPA 8260	3 x 40 mL VOA vial	Cool, 4°C, HCL (pH < 2), no headspace	14 days
Field Parameters				
pH	Probe/EPA 150.1	–	–	–
Specific conductance	Probe/EPA 120.1	–	–	–
Temperature	Probe/EPA 170.1	–	–	–
Dissolved oxygen (DO)	Probe/SM 4500	–	–	–
Oxidation/reduction potential (ORP)	Probe	–	–	–

Notes: EPA = US Environmental Protection Agency
SM = Standard Methods for the Examination of Water and Wastewater
VOA = volatile organic analysis
HCL = hydrochloric acid

Table 6

Laboratory and Field Quality Control Samples
Compliance Monitoring Plan
BSB Property, Kent, Washington

Matrix	QA/QC Analyses	Frequency
Field		
Water	Trip blank	1 per sampling event when samples are analyzed for VOCs
Water	Field duplicate	1 per 20 project samples (approximately)
Laboratory		
Water	Laboratory control sample (LCS)	Every analytical batch
Water	MS/MSD	1 per 20 project samples
Water	Method blank	Every analytical batch

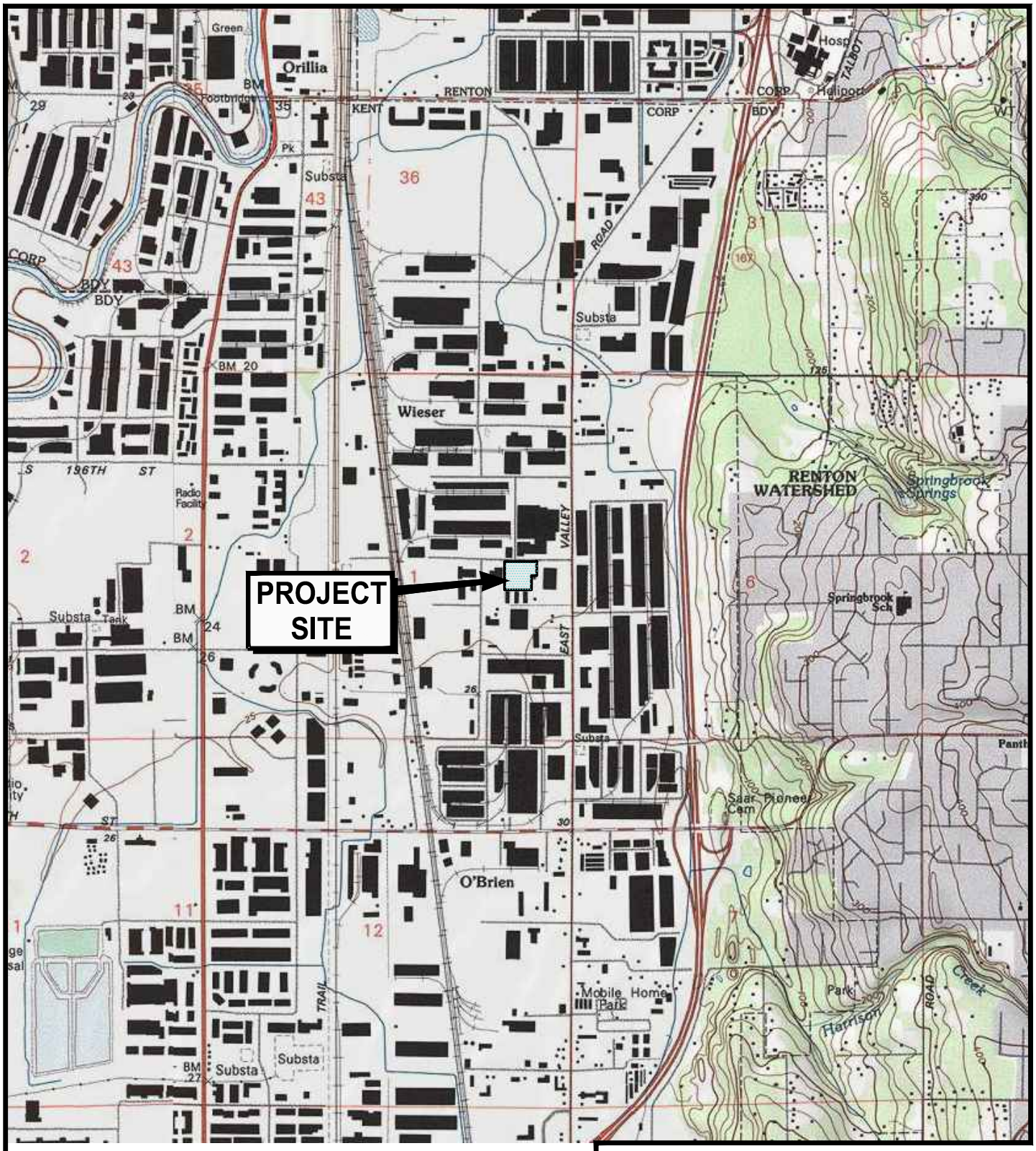
Table 7

Laboratory Deliverables
Compliance Monitoring Plan
BSB Property, Kent, Washington

The following deliverables will be required from the laboratory:

- A transmittal letter and case narrative which includes information about receipt of the samples, the analytical results, and any significant problems in any aspect of sample analysis (e.g., deviation from methodologies or quality control).
- Sample analytical results:
  - Water results in mg/L or µg/L
  - Method detection limit (MDL) or Method Reporting limit (MRL) for undetected values reported for each analyte on a sample-by-sample basis
  - Date of sample receipt
  - Date of sample preparation/extraction
  - Date of sample analysis
  - Method blank results, including the samples associated with each blank
  - As applicable:
    - Surrogate recovery results, reported as percent recoveries, including actual spike levels
    - Duplicate results
    - Matrix Spike (MS)/ Matrix Spike Duplicate (MSD) results reported as percent recoveries, including actual spike levels
    - Laboratory control sample (LCS) results
  - Copies of signed chain-of-custody forms

FIGURES



0 2000 4000

Scale in Feet

N

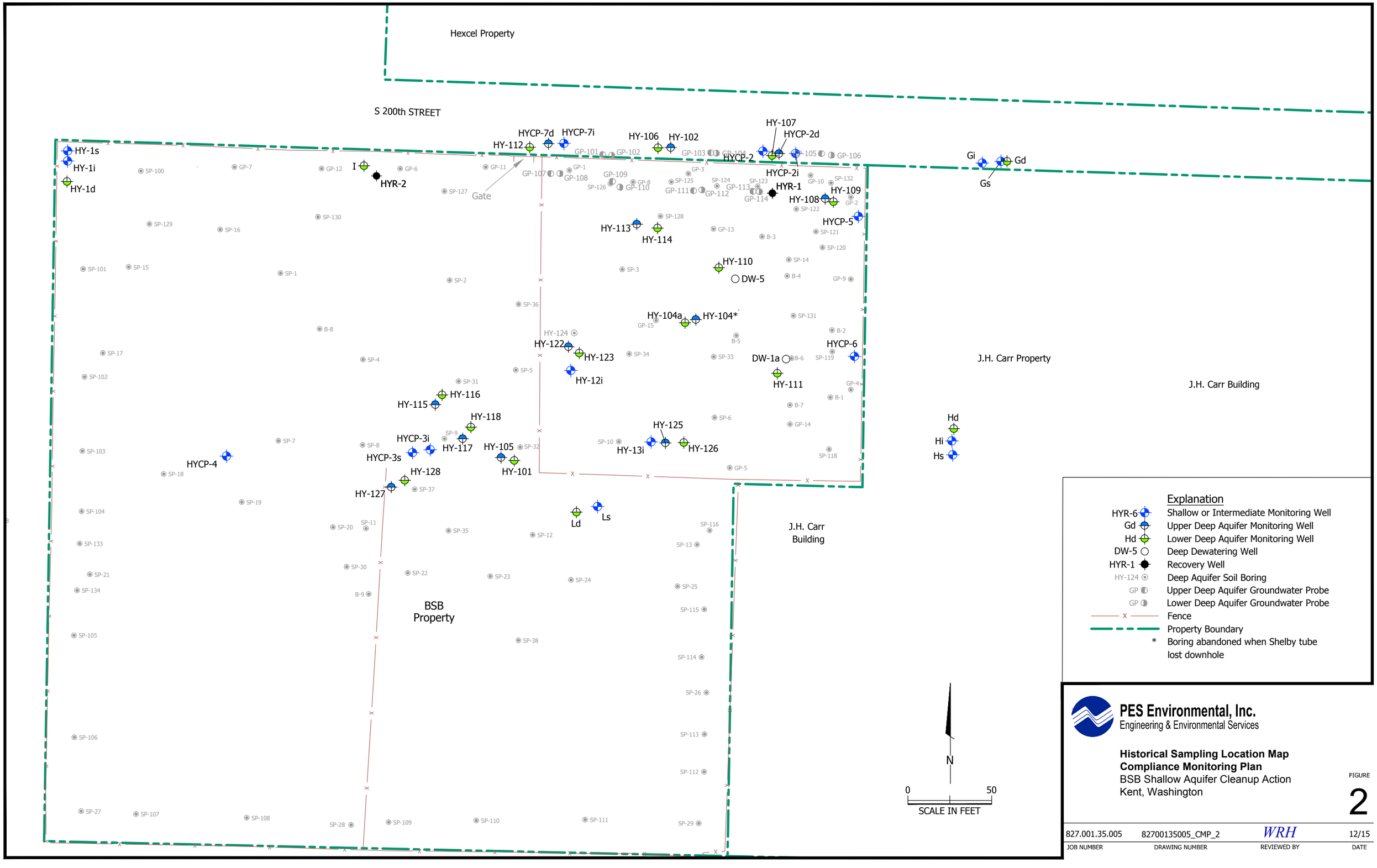
U.S.G.S. Topo Map - Renton, WA, 7.5-minute quadrangle.1949 revised 1994.

PES Environmental, Inc.
Engineering & Environmental Services

Property Location Map
Compliance Monitoring Plan
BSB Shallow Aquifer Cleanup Action
Kent, Washington

FIGURE
1

827.001.35.005	82700135005_CMP_1	WRH	12/15
JOB NUMBER	DRAWING NUMBER	REVIEWED BY	DATE



Explanation

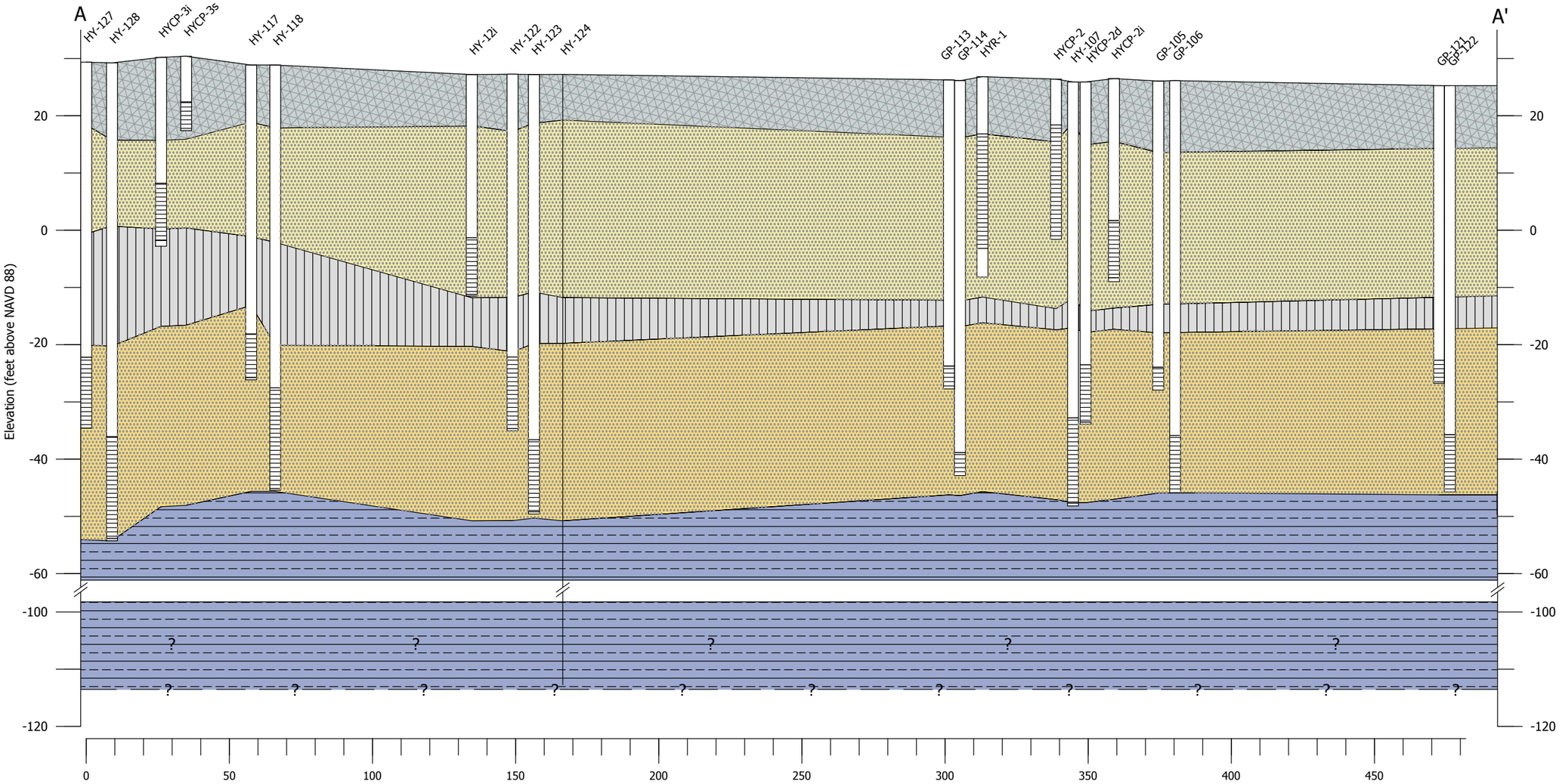
HYR-6	Shallow or Intermediate Monitoring Well
Gd	Upper Deep Aquifer Monitoring Well
Hd	Lower Deep Aquifer Monitoring Well
DW-5	Deep Dewatering Well
HYR-1	Recovery Well
HY-124	Deep Aquifer Soil Boring
GP	Upper Deep Aquifer Groundwater Probe
GP	Lower Deep Aquifer Groundwater Probe
x	Fence
	Property Boundary
*	Boring abandoned when Shelby tube lost downhole

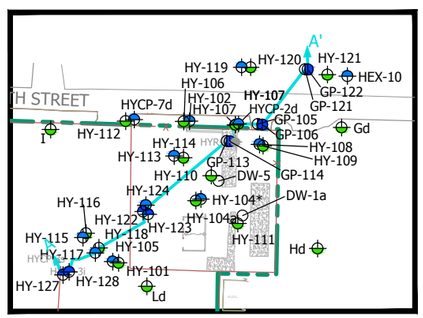
PES Environmental, Inc.
Engineering & Environmental Services

Historical Sampling Location Map
Compliance Monitoring Plan
BSB Shallow Aquifer Cleanup Action
Kent, Washington

FIGURE
2

827.001.35.005	82700135005_CMP_2	WRH	12/15
JOB NUMBER	DRAWING NUMBER	REVIEWED BY	DATE





Explanation

Well Screen

Soil Boring

? Base of layer E/F not penetrated during drilling, thickness unknown.

Layer A

Layer B

Layer C

Layer D

Layer E/F

20
0
Vertical Scale in Feet
0 40
Horizontal Scale in Feet
Vertical Exaggeration 2:1

Note: the temporary GP screens were abandoned after sampling

PES Environmental, Inc.
Engineering & Environmental Services

Typical Cross Section
Compliance Monitoring Plan
BSB Shallow Aquifer Cleanup Action
Kent, Washington

FIGURE
3

827.001.35.005	82700135005_CMP_3	WRH	12/15
JOB NUMBER	DRAWING NUMBER	REVIEWED BY	DATE

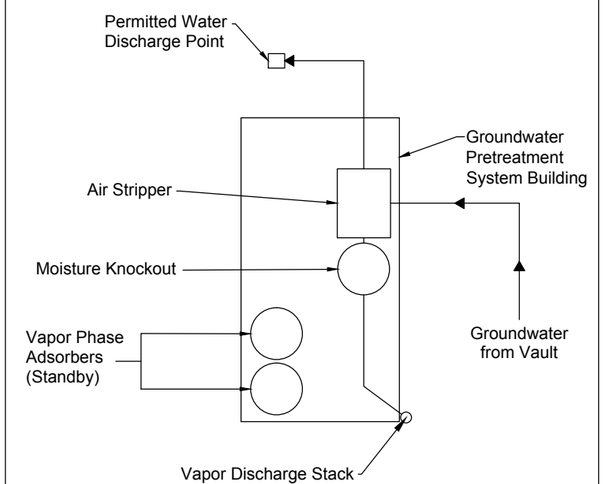
SOUTH 200TH STREET

HY-1s
HY-1i
HY-1d
P-8
P-7
HYCP-7d
HY-112
HYCP-7i
HYCP-7s
HY-106
HY-102
HY-107
HYCP-2d
HYCP-2
HYCP-2i
Gate
Permitted Discharge Point
Gate
Gi
Gd
Gs
HY-108
P-3
P-4
HY-109
P-5
P-6
HY-113
HY-114
P-1
P-2
HY-110
DW-5
Cell 1 Pump
Cell 6 Pump
Groundwater Collection Vault
Asphalt Cap
HY-122
HY-123
HY-12i
DW-1a
HY-111
HY-116
HY-115
HY-118
HY-117
HYCP-3i
HY-101
HY-105
HY-125
HY-13i
HY-126
P-13
P-14
P-16
P-15
HY-128
HY-127
Ld
Hd
Hi
Hs
BSB Property
JH Carr Property
P-9
P-10
P-11
P-12
N
0
50
SCALE IN FEET

Explanation

- HY-1s — Shallow or Intermediate Monitoring Well
- Gd — Upper Deep Aquifer Monitoring Well
- Hd — Lower Deep Aquifer Monitoring Well
- DW-5 — Former Upper Deep Aquifer Dewatering Well
- P-1 — Piezometer
- Soil-Bentonite Cutoff Wall
- Fence
- Asphalt Cap

Groundwater Pretreatment System Layout (Not to Scale)



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Cleanup Action Components Compliance Monitoring Plan
BSB Shallow Aquifer Cleanup Action
Kent, Washington

FIGURE 4

827.001.35.005	82700135005_CMP_4	WRH	12/15
JOB NUMBER	DRAWING NUMBER	REVIEWED BY	DATE

SOUTH 200TH STREET

84TH AVENUE SOUTH

HY-1s
HY-1i
HY-1d
P-8
P-7
HYCP-7d
HYCP-7i
HYCP-7s
HYCP-2
HYCP-2i
Permitted Discharge Point
Approximate Property Boundary
Gate
Gi
Gs
HY-108
P-3
P-4
P-1
P-2
P-5
P-6
Groundwater Collection Vault
Asphalt
HY-122
HY-12i
HY-125
P-13
P-14
HYCP-3i
HY-117
HY-13i
P-16
P-15
Hi
Hs
Grass
BSB Property
JH Carr Property
P-9
P-10
P-11
P-12
HY-11i
HY-11s
HY-11d

Explanation

- P-1 Piezometer
- HY-1s Shallow or Intermediate Monitoring Well
- HY-108 Upper Deep Aquifer Monitoring Well
- HY-1d Lower Deep Aquifer Monitoring Well
- Soil-Bentonite Cutoff Wall, Approximate Alignment
- x Fence

N

0 80

SCALE IN FEET

PES Environmental, Inc.
Engineering & Environmental Services

Compliance Monitoring Locations
Compliance Monitoring Plan
BSB Shallow Aquifer Cleanup Action
Kent, Washington

FIGURE 5

827.001.35.005	82700135005_CMP_5	WRH	12/15
JOB NUMBER	DRAWING NUMBER	REVIEWED BY	DATE

APPENDIX A

PIEZOMETER AND MONITORING WELL LOGS

Sweet, Edwards & Associates, Inc.

BORING LOG

PROJECT HYTEK Finishes — **Page** 1 of 2

Location S side 200th Approx. 410' W; Intersection S 200th and 84th Ave. — **Boring No.** G-Deep

Surface Elevation Approx. 21.04 feet — **Drilling Method** Hollow Stem Auger

Total Depth 73.5' — **Drilled By** Geotech Exploration

Date Completed 7/9/87 — **Logged By** J. Bailey

WELL DETAILS	PENE-TRATION TIME/ RATE	DEPTH (FEET)	SAMPLE NO.	SAMPLE TYPE	PERME-ABILITY TESTING	SYMBOL	LITHOLOGIC DESCRIPTION	WATER QUALITY
Volclay Grout; 2" Stainless Steel Riser		5	1	SSP		SW	0-0.5' concrete 0.5-3.5' Gravelly Sand, reddish brown, fine to coarse sand, some silt. subangular gravel.	▽
		10	2	SSP		SM	3.5-16' Silty Sand, reddish brown to olive black, very fine-fine sand, trace carbonaceous material, saturated below 7'.	
		15	3	SSP				
		20	4	SSP		SP	16-27' Sand, grayish black, medium to coarse sand, abundant red sand grains, occasional shell fragments.	
		25	5	SSP				
		30	6	SSP		SM	27-37' Silty Sand, dark gray, very fine to fine sand, abundant wood fragments, trace to some clay.	
		35	7	SSP				

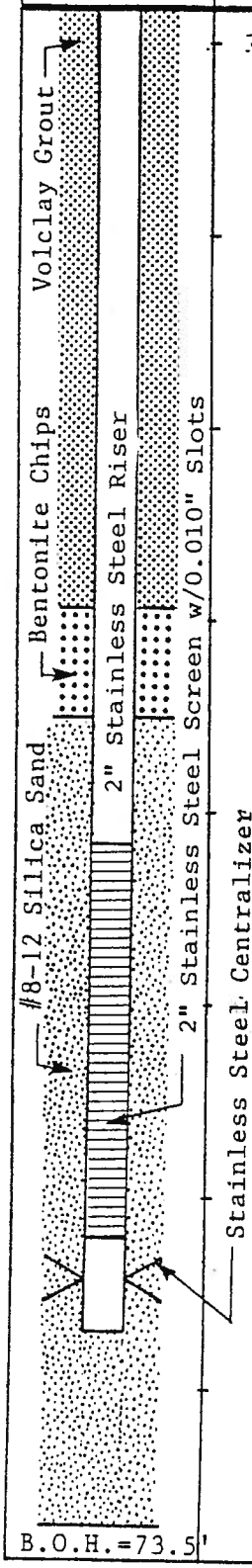
Sweet, Edwards & Associates, Inc.

BORING LOG

PROJECT HYTEK Finishes

Boring No. G-Deep

WELL DETAILS	PENE-TRATION TIME/ RATE	DEPTH (FEET)	SAMPLE NO.	SAMPLE TYPE	PERME-ABILITY TESTING	SYMBOL	LITHOLOGIC DESCRIPTION	WATER QUALITY
		35	7	SSP		SM	Silty Sand, - (cont.)	
		40	8	SSP		ML	37-42' Silt, dark greenish gray, trace to some very fine sand, occasional shell fragments, slightly plastic.	
		45	9	SSP		SP	42-67' Sand, grayish black, interbedded fine to medium and medium to coarse sand lenses, trace to some silt, numerous red sand grains, occasional shell and wood fragments.	
		50	10	SSP				
		55	11	SSP				
		60	12	SSP				
		65	13	SSP				
		70	14	SSP		SM	67-71' Silty Sand, dark gray, fine to very fine sand, trace to some clay, slightly plastic.	
						ML	71-73.5' Clayey Silt, dark gray, massive to finely laminated moderately plastic.	



See Figure 7 for details of other nested wells.

Sweet, Edwards & Associates, Inc.

BORING LOG

PROJECT HYTEK Finishes
Approx. 170' S & 400' W

Location intersection S200th & 84 Ave.

Boring No. H-Deep

Surface Elevation Approx. 22.79 feet

Drilling Method Hollow Stem Auger

Total Depth 71.0 feet

Drilled By GeoTech Exploration

Date Completed 7/6/87

Logged By J. S. Bailey

WELL DETAILS	PENE-TRATION TIME/ RATE	DEPTH (FEET)	SAMPLE NO.	SAMPLE TYPE	PERME-ABILITY TESTING	SYMBOL	LITHOLOGIC DESCRIPTION	WATER QUALITY
Volclay Grout; Stainless Steel Riser							0-0.5' ASPHALT	
						SW	0.5-3' Gravelly SAND, brown fine - coarse, some silt.	
						ML	3.0-5.5' SILT, olive gray, mottled, iron stained, wood fragments.	▽
		5	1	SS				
						SP	5.5-28' SAND, olive black to grayish black, fine to medium, numerous red sand grains, shell fragments, saturated below 6'.	
		10	2	SS				
		15	3	SS				
		20	4	SS				
		25	5	SS				
		30	6	SS		ML	28-32' SILT, medium gray to olive gray, slightly plastic, abundant wood fragments.	
						SP	32-38' SAND, dark gray, very fine to fine, some silt.	
		35	7	SS				

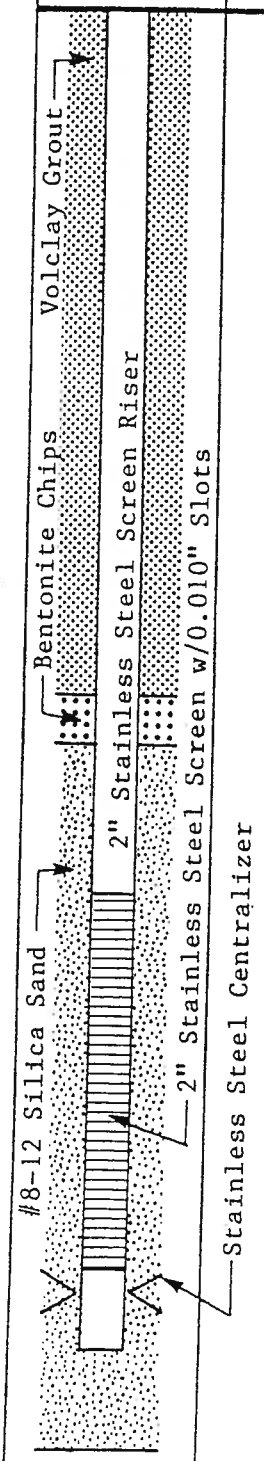
Sweet, Edwards & Associates, Inc.

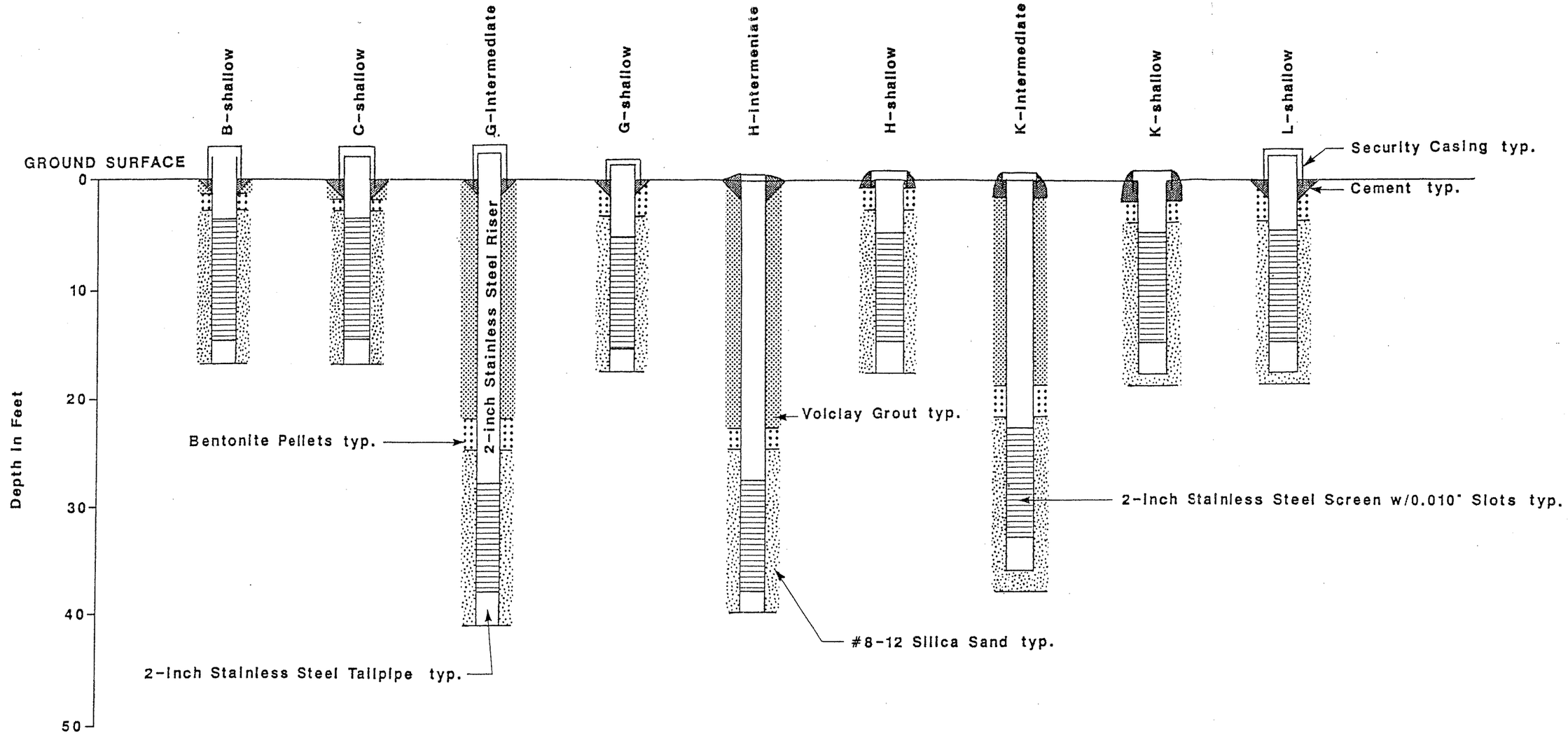
BORING LOG

PROJECT HYTEK Finishes

Boring No. H -Deep

WELL DETAILS	PENE-TRATION TIME/ RATE	DEPTH (FEET)	SAMPLE NO.	SAMPLE TYPE	PERME-ABILITY TESTING	SYMBOL	LITHOLOGIC DESCRIPTION	WATER QUALITY
		35	7	SS		SP	SAND,- (cont.)	
		40	8	SS			38-48' SILT/Silty SAND, olive gray, very fine sand, numerous shell fragments.	
		45	9	SS				
		50	10	SS			48-63' SAND, grayish black, medium to coarse, abundant shell fragments and red sand grains.	
		55	11	SS				
		60	12	SS				
		65	13	SS			63-68' Silty SAND, Grayish black, fine to very fine sand, occasional wood fragments.	
		70	14	SS		CL	68-71' SILTY CLAY, dark gray, moderately plastic/massive.	
							B.O.H.=71.0 feet See Figure 7 for details of other nested wells.	





NOTE: Refer to deep boring log for lithologic details and construction of deep screens.

HYTEK -Finishes

Well Completion Details
For Shallow and Intermediate Wells

Sweet, Edwards & Associates

	INITIALS	DATE
DRAWN BY	jlg	1/6/88
CHECKED BY	JJ	
REVISED		

Sweet, Edwards & Associates, Inc.

BORING LOG

PROJECT HYTEK **Page** 1 **of** 1

Location N.W. Corner of Parking Lot **Boring No.** HY-1

Surface Elevation Top PVC . 102.09 ft. **Drilling Method** Hollow Auger

Total Depth 20.5' **Drilled By** Sweet, Edwards & Assoc., Inc.

Date Completed 6/25/82 **Logged By** J.E. Edwards

WELL DETAILS	PENE-TRATION TIME/ RATE	DEPTH (FEET)	SAMPLE NO.	SAMPLE TYPE	PERME-ABILITY TESTING	SYMBOL	LITHOLOGIC DESCRIPTION	WATER QUALITY
Natural Heave; Gravel Pack; Bentonite Seal; 2" Riser; Screen; 10'; 16'; 19'		5	1	SS		ML-SM	3.5-5.0' Silty-Fine Sand to Fine Sandy Silt, brownish gray with gray mottling, soft, moist.	
		10	2	SS		ML	8.5-10.0' Silt, gray, some very fine sand, very soft, saturated.	
		15	3	SS		SP	13.5-15.0' Sand, gray to black, clean, loose, medium grained, poorly graded, saturated.	
							16.8-18.0' Silty-Clay, logged off auger tip.	
		20	4	SS		SP	19.0-20.5' Sand, as above.	
		25						

SEA-300-02a

Sweet, Edwards & Associates, Inc.

BORING LOG

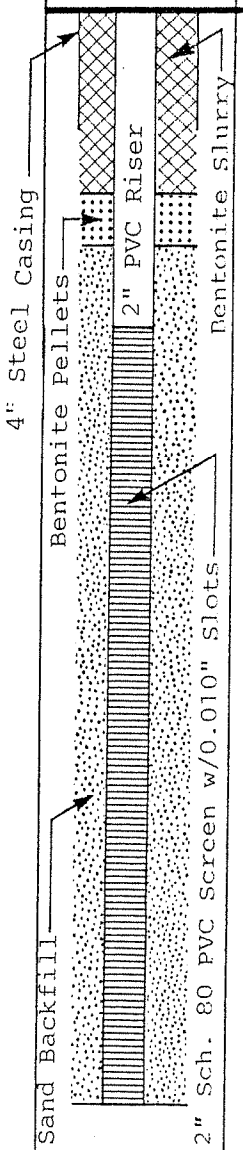
PROJECT HYTEK IV **Page** 1 **of** 1

Location _____ **Boring No.** HYCP-2

Surface Elevation _____ **Drilling Method** Hollow Stem Auger

Total Depth 28 feet **Drilled By** Kring Drilling

Date Completed 12/3/84 **Logged By** D.R. Dykes



DEPTH (FEET)	SAMPLE NO.	SAMPLE TYPE	SYMBOL	LITHOLOGIC DESCRIPTION
			GM	0-1.5' Fill, silty gravel, brown.
	5	SS	ML SM ML	3.0-3.5' Silt, brown, mottled orange. 3.5-4.0' Silty Sand, gray, fine. 4.0-4.5' Silt, gray, moist.
5				
	10	SS	SP ML	8.0-9.0' Sand, gray fine, some silt, roots. 9.0-9.5' Silt, gray.
10				
	15	SS	SM ML	13.0-14.5' Silty Sand and Silt, layered, gray, sand is very fine to fine, moist to saturated.
15				
	20	SS	SP/ML	18.0-19.5' Sand and Silt, gray, sand is fine to very fine, silt layers from 18.5 to 19 feet.
20				
	25	SS	SW	23.0-24.5 Sand, gray, very fine to medium, saturated.
25				
	30	SS	SW	28.0-29.5' Sand, same as above.
30				Bottom of boring 28.0 ft.
				Note: SS=Split Spoon Sample.

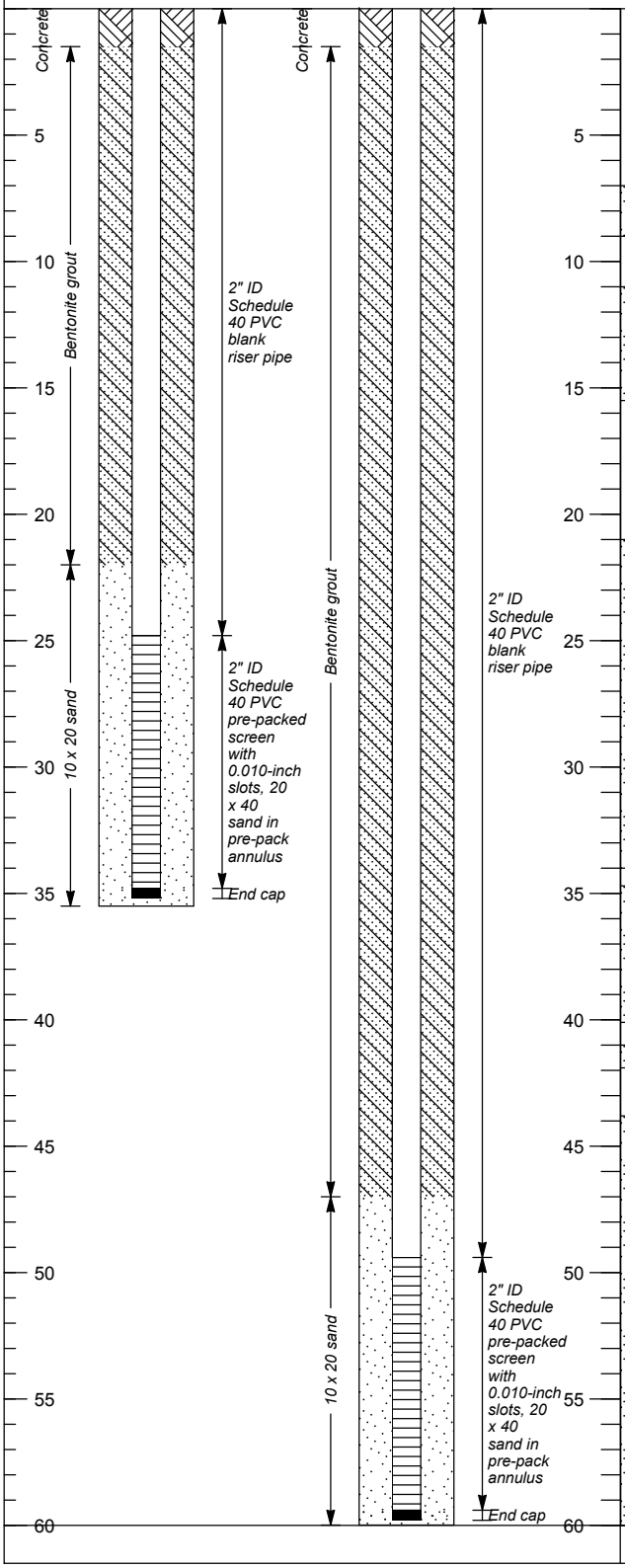
PENETRATION TIME/RATE: | PERMEABILITY TESTING: | WATER QUALITY:

SEA-300-02a

PES Environmental, Inc.
Engineering & Environmental Services

MONITORING WELLS HYCP-2i AND HYCP-2d

WELL COMPLETION DETAIL



SYMBOLS

MATERIALS DESCRIPTION

GRAY-BROWN SILT (ML), moist to wet.

GRAY SAND WITH SILT (SP), fine, trace to little silt.

GRAY SILT (ML), wet.

GRAY SAND (SP), wet, fine.

GRAY SILT (ML), wet, with occasional sand laminations.

BLACK SAND (SP), wet, fine, trace fines.

PINKISH GRAY SILT (ML)

BLACK SAND (SP), wet, fine to medium, trace fines.

GRAY SILT (ML), wet, little fine sand, scattered fine organic material.

GRAY SAND (SP) AND GRAY SILTY SAND (SM),

GRAY SILT (ML), wet, soft, low to medium plasticity, scattered shell fragments.

(16-inch diameter boring from 0 to 42 feet, 9-inch diameter boring from 42 to 60 feet.)

BLACK SAND (SP), wet, fine, trace fines, abundant shell fragments.

Note: HYCP-2i and HYCP-2d completed in separate borings.

PROJECT	BSB Property	DIAMETER OF HOLE	16/9 inches
LOCATION	Kent, Washington	TOTAL DEPTH OF HOLE	60 feet
JOB NUMBER	827.001.12		
GEOLOGIST/ENGINEER	Erin Shaver	DATE STARTED	1/8/08
DRILL RIG	Cascade Drilling Hollow Stem Auger	DATE COMPLETED	1/8/08

PLATE

BSB2-2WELLS BSB2-2WELLS.GPJ 4/2/08

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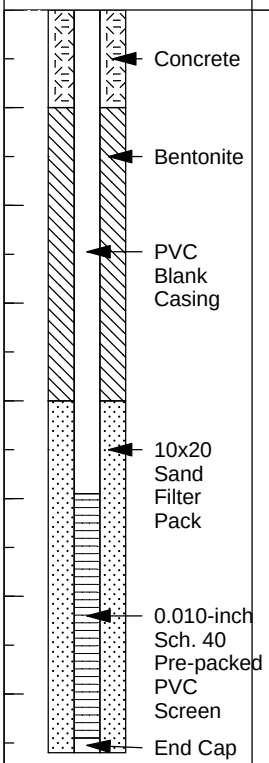
LOG OF MONITORING WELL: HY-7s



Depth (Feet)	Sample Recovery	Lithologic Description
0		Brown Silty Sand (SM), moist, loose, fine to coarse, little fine gravel, (FILL)
2	36	BROWN SILT (ML), medium plasticity, iron oxide staining throughout
4		Note: 3 to 5 feet: No Recovery
6		@ 5 feet: wet, very soft, trace fine sand
8	30	Note: 7.5 to 10 feet: No Recovery
10		BLACK SAND (SP), wet, fine, few fines
12	24	Note: 12 to 14 feet: No Recovery
14		
16	24	GRAY SILT (ML), medium plasticity
18		Bottom of boring @ 16 feet.
20		Well Completion Details: Well constructed with 1.5-inch i.d. Schedule 40 PVC pipe and a 0.010-inch machine slotted screen, pre-packed with 20x40 Colorado Silica Sand. Total Well Depth: 15.2 feet. Well Sump/Endcap: 14.9 to 15.2 feet. Well Screen: 9.9 to 14.9 feet. Well Blank: 0 to 9.9 feet. Filter Pack: 8 to 15.2 feet (10x20 Colorado Silica). Well Seal: 2 to 8 (hydrated bentonite chips). Surface Seal: 0.7 to 2 feet (concrete). Well Monument: Flush with grade steel monument.
22		
24		
26		
28		
30		

Project: BSB Shallow CA Start Up
Project Number: 827.001.24
Site Location: Kent, Washington
Logged By: L.Doody
Notes: Ecology Well Tag Number: BHK 263

Total Drilled Depth: 16 feet
Diameter of Boring: 3.5-inches
Drill Date: 12/08/11
Drilled By: Cascade Drilling L.P.
Drill Method: GeoProbe 6600

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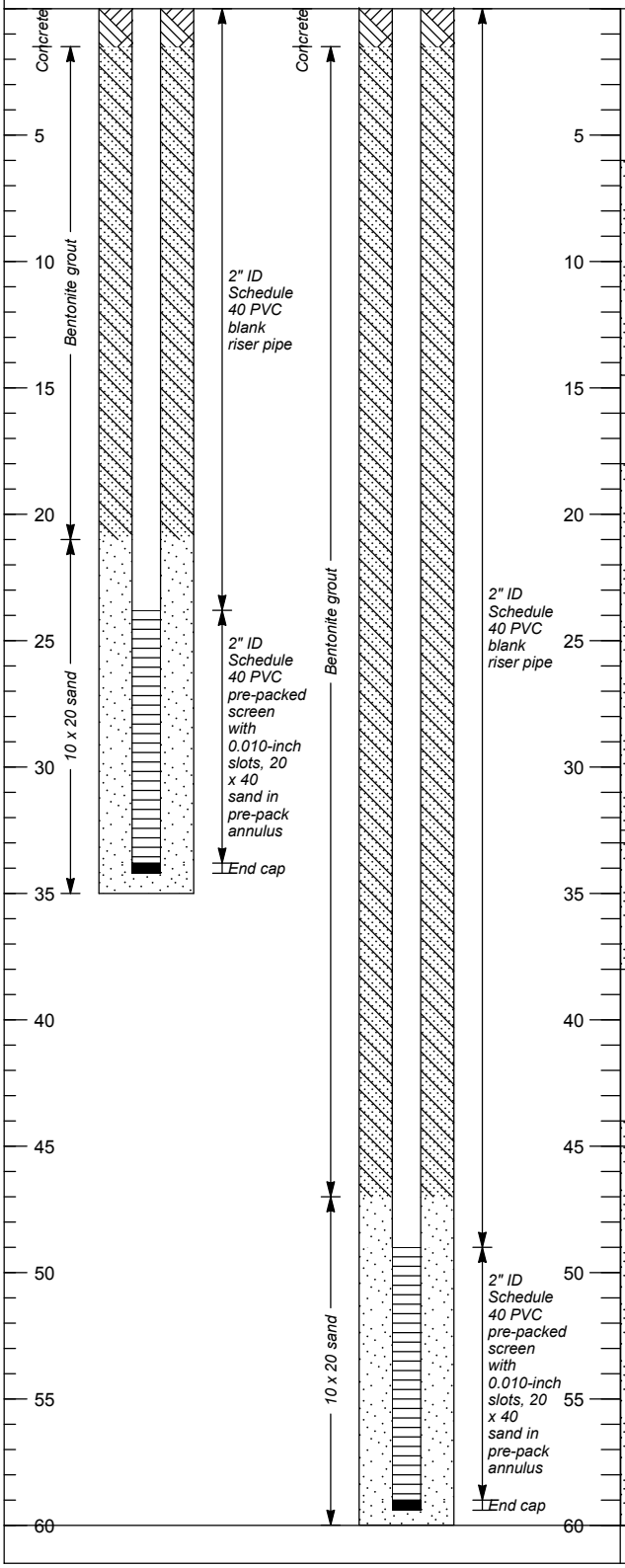
MONITORING WELLS HYCP-7i AND HYCP-7d

WELL COMPLETION DETAIL



SYMBOLS

MATERIALS DESCRIPTION

BROWN TO GRAY SILT (ML), moist, low plasticity, trace fine sand.

DARK GRAY SAND WITH SILT (SP), wet, few silt.

GRAY SILT (ML), low plasticity, trace sand.

DARK GRAY SANDY SILT (ML), nonplastic, some sand.

BLACK SAND (SP), wet, fine, trace fines, scattered wood debris.

GRAY SILT (ML)

BLACK SAND (SP), wet, fine to medium.

GRAY SILT (ML), wet, soft, low to medium plasticity, trace fine sand.
(16-inch diameter boring from 0 to 39 feet, 9-inch diameter boring from 39 to 60 feet.)

GRAY SILTY SAND (SM), wet, fine sand, scattered shell fragments.

BLACK SAND (SP), wet, fine to medium, trace fines.

Note: HYCP-7i and HYCP-7d completed in separate borings.

PROJECT	BSB Property	DIAMETER OF HOLE	16/9 inches
LOCATION	Kent, Washington	TOTAL DEPTH OF HOLE	60 feet
JOB NUMBER	827.001.12		
GEOLOGIST/ENGINEER	Erin Shaver	DATE STARTED	1/7/08
DRILL RIG	Cascade Drilling Hollow Stem Auger	DATE COMPLETED	1/7/08

PLATE

BSB2-2WELLS BSB2-2WELLS.GPJ 4/2/08

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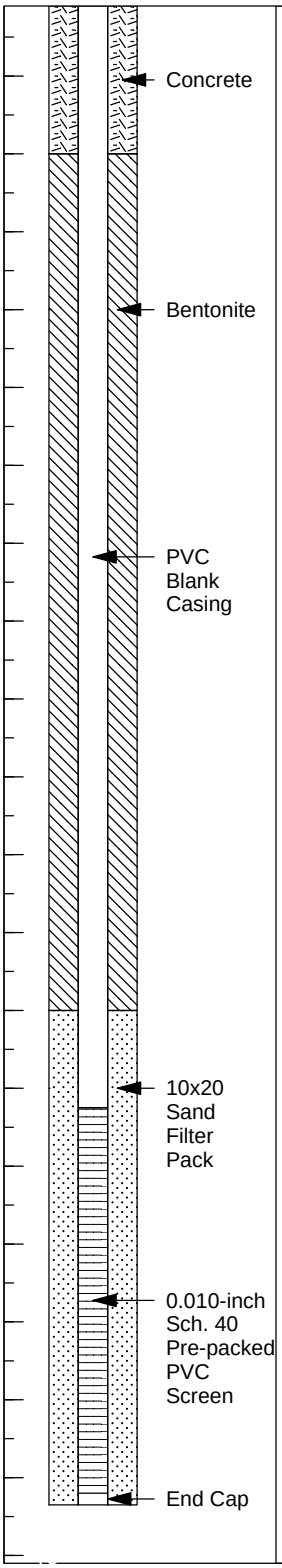
LOG OF MONITORING WELL: HY-12i

Well Completion	PID (PPM)	Depth (Feet)	Symbol	Lithologic Description
				NOTE: Soil in HY-12i not logged for lithology. NOTE: Boring drilled using hollow stem auger with wood plug. Well Completion Details: Well constructed with 2-inch i.d. Schedule 40 PVC pipe and a 0.010-inch machine slotted screen, pre-packed with 20x40 Colorado Silica Sand. Total Well Depth: 38.7 feet. Well Sump/Endcap: 38.4 to 38.7 feet. Well Screen: 28.5 to 38.4 feet. Well Blank: 0 to 28.5 feet. Filter Pack: 26 to 38.7 feet (10x20 Colorado Silica). Well Seal: 4 to 26 (hydrated bentonite chips) Surface Seal: 0.7 to 4 feet (concrete). Well Monument: Flush with grade steel monument. Washington State Department of Ecology Well Tag Number: BCM-983

NOTE: Bottom of boring: 38.7 feet.

Project: BSB Deep Aquifer Investigation: Phase 4
Project Number: 827.001.25
Site Location: Kent, Washington
Logged By: L.Doody
Notes: Soil not sampled for lithology

Total Drilled Depth: 38.7 feet
Diameter of Boring: 9-inches
Drill Date: 1/26/11
Drilled By: Cascade Drilling L.P.
Drill Method: Hollow Stem Auger

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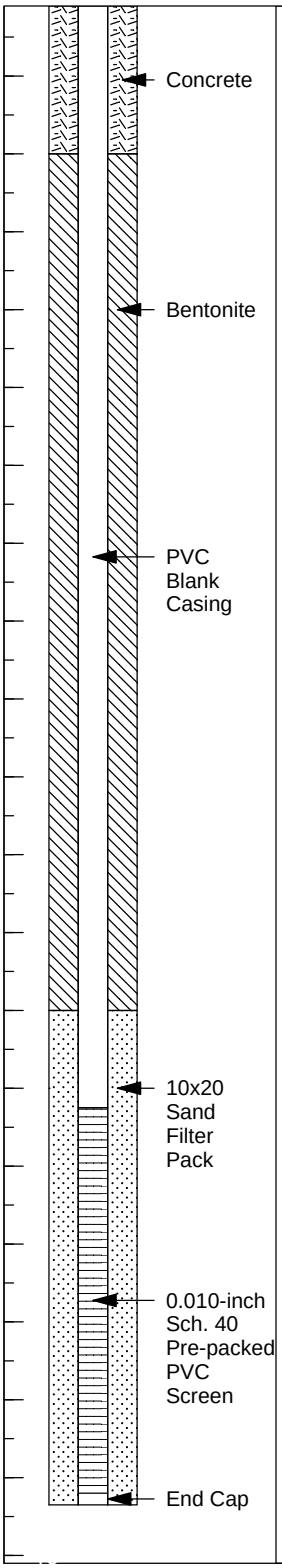
LOG OF MONITORING WELL: HY-13i

Well Completion	PID (PPM)	Depth (Feet)	Symbol	Lithologic Description
				NOTE: Soil in HY-13i not logged for lithology NOTE: Boring drilled using hollow stem auger with wood plug. Well Completion Details: Well constructed with 2-inch i.d. Schedule 40 PVC pipe and a 0.010-inch machine slotted screen, pre-packed with 20x40 Colorado Silica Sand. Total Well Depth: 38.7 feet. Well Sump/Endcap: 38.4 to 38.7 feet. Well Screen: 28.5 to 38.4 feet. Well Blank: 0 to 28.5 feet. Filter Pack: 26 to 38.7 feet (10x20 Colorado Silica). Well Seal: 4 to 26 (hydrated bentonite chips) Surface Seal: 0.7 to 4 feet (concrete). Well Monument: Flush with grade steel monument. Washington State Department of Ecology Well Tag Number: BCM-984
				NOTE: Bottom of boring: 38.7 feet.

Project: BSB Deep Aquifer Investigation: Phase 4
Project Number: 827.001.25
Site Location: Kent, Washington
Logged By: L.Doody
Notes: Soil not sampled for lithology

Total Drilled Depth: 37.8 feet
Diameter of Boring: 9-inches
Drill Date: 01/26/10
Drilled By: Cascade Drilling L.P.
Drill Method: Hollow Stem Auger

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LOG OF MONITORING WELL: HY-108

Well Completion	PID (PPM)	Sample ID and Time	Depth (Feet)	Symbol	Lithologic Description
					Ground Surface
Concrete			0		**GRAY SAND (SW)**
			2		**(Lithology from 0 - 35 feet bgs inferred from adjacent boring GP-2).**
			4		**GRAY SILT (ML)**
			6		
			8		
			10		
			12		
			14		**DARK GRAY SAND (SP)**
			16		**GRAY SILT (ML)**
			18		
			20		**DARK GRAY SAND (SP)**
			22		
			24		
			26		
			28		
			30		
			32		
			34		
	10		36		**PINKISH GRAY SILT (ML),** moist, firm, medium plasticity, slow dilatancy
	81.0				**BLACK SAND (SP),** moist, loose, fine, trace fines
			38		**GRAY SILT (ML),** wet, soft, trace fine sand, medium plasticty, slow dilatancy
			40		**SANDY SILT (ML),** wet, soft, low plasticity, slow dilatancy,

PVC Blank Casing

Bentonite

Project: BSB Diversified
Project No: 827.001.18
Site Location: Kent, WA
Logged By: L. Doody
Notes: Soil Sampled Continuously

Total Drilled Depth: 57 feet
Diameter of Boring: 0 - 40 feet: 9-inches / 40 - 57 feet: 6-inches
Drill Date: 2/16/10
Drilled By: Cascade Drilling Co.
Drill Method: Sonic Drill Rig

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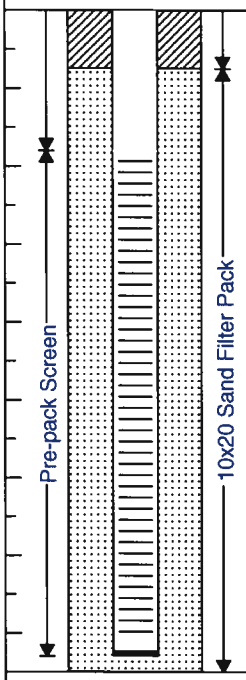
LOG OF MONITORING WELL: HY-108



PID (PPM)	Sample ID and Time	Depth (Feet)	Lithologic Description
	Shelby Tube 40.5 - 43	42	**SILTY SAND (SM),** wet, loose, fine, some fines **GRAY SILT (ML),** wet, very soft, trace fine sand, medium plasticity, slow dilatancy, scattered shells @ 42 feet: shells increase to abundant
37.0		44	**SILTY SAND (SM),** wet, loose, medium, little fines
0.0		46	**BLACK SAND (SP),** loose, fine, trace fines
0.0		48	**SILTY SAND (SM),** wet, dense, fine, some fines
0.0		50	**BLACK SAND (SP),** moist, loose, fine, trace fines
		52	
		54	
		56	
		58	Bottom of boring: 57 feet bgs.
		60	
		62	
		64	
		66	
		68	
		70	
		72	
		74	
		76	
		78	
		80	

Well Completion Details
Well constructed with 2-inch i.d. Schedule 40 PVC pipe and a 0.010-inch machine slotted screen, pre-packed with 20x40 Colorado Silica Sand.

Total Well Depth: 56.6 feet.
Well Sump/Endcap: 56.3 to 56.6 feet.
Well Screen: 43.8 to 56.3 feet.
Well Blank: 0 to 43.8 feet.
Filter Pack: 41.5 to 57 feet (10x20 Colorado Silica Sand around outer screen).
Well Seal: 2 to 41.5 feet (hydrated 3/8-inch bentonite chips).
Surface Seal: 0.7 to 2 feet (concrete).
Well Monument: Flush with grade steel monument.
Washington Department of Ecology Well Tag Number: BCP-130

Step-Casing Details
9-inch o.d. casing advanced to 40 feet.
Bentonite chips placed between 35 and 40 feet.
9-inch o.d. casing retracted to 36 feet, then advanced to 39 feet.
Let bentonite hydrate for 30 minutes.
6-inch o.d. casing advanced to 57 feet.

Project: BSB Diversified
Project No: 827.001.18
Site Location: Kent, WA
Logged By: L. Doody
Notes: Soil Sampled Continuously

Total Drilled Depth: 57 feet
Diameter of Boring: 0 - 40 feet: 9-inches / 40 - 57 feet: 6-inches
Drill Date: 2/16/10
Drilled By: Cascade Drilling Co.
Drill Method: Sonic Drill Rig

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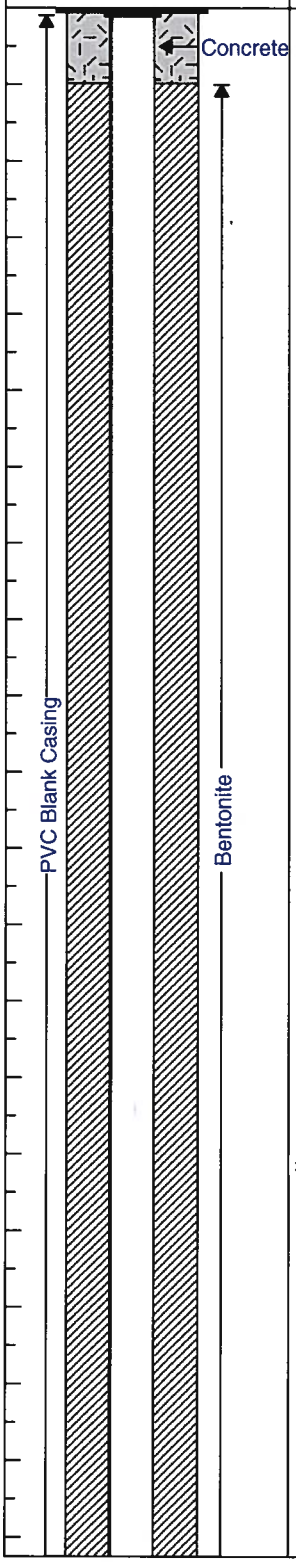
LOG OF MONITORING WELL: HY-117



Depth (Feet)	PID (PPM)	Sample ID and Time	Lithologic Description
0			Ground Surface
0	0.1		**SILTY GRAVEL WITH SAND (GM),** wet, loose, fine to coarse, little fines, trace cobbles
2	0.4		
4	0.1		
6	1.0		
8	2.2		**GRAY SILT (ML),** wet, firm
10	9.0		**DARK GRAY BLACK SAND (SP),** wet, loose, fine to medium, trace fines
12	36.6		
12	18.7		**GRAY SILTY SAND (SM),** wet, loose, fine, little fines @ 12.5 feet: 3-inch lens of gray silt
14	65.2		@ 14 feet: 4-inch lens of gray silt
14	5.8		
16	5.9		**GRAY SAND WITH SILT (SP),** wet, loose, fine, few fines
16	1.4		
18	6.5		@ 18.5 feet: 6-inch lens of gray silt
18	15.8		
20	37.2		**GRAY SILTY SAND (SM),** wet, loose, fine, little fines
20	101		**GRAY SILT WITH SAND (ML),** wet, soft, few fine sand, low plasticity
22	1013		**GRAY SILTY SAND (SM) INTERBEDDED WITH GRAY SILT (ML),** interbeds 1 to 4-inches thick
22	615		
24	1008		
24	212		
26	121		**BLACK SAND (SP),** wet, loose, fine to medium, trace fines
26	913		
28	434		@ 27.5 feet: 6-inch lens for gray silt
28	1706		
30	1921		**GRAY SILT (ML),** wet, firm, trace fine sand, low plasticity
30	>9999		
32	2247		
32	1533		@ 33 feet: abundant organic material
34	247		
34	75.8		
36	48.2		
36	7.0		**GRAY SILT WITH SAND (ML),** moist, firm, few fine sand, medium plasticity, medium dilatancy
38	3.8		
38	0.6		
40	0.6		@ 40 feet: trace sand, medium plasticity, slow dilatancy
40	2.3		

Project: BSB Diversified
Project No: 827.001.20
Site Location: Kent, WA
Logged By: E. Shaver
Notes: Soil Sampled Continuously

Total Drilled Depth: 56 feet
Diameter of Boring: 0 - 36 feet: 9-inches / 36 - 56 feet: 6-inches
Drill Date: 5/13/10
Drilled By: Cascade Drilling Co.
Drill Method: Sonic Drill Rig

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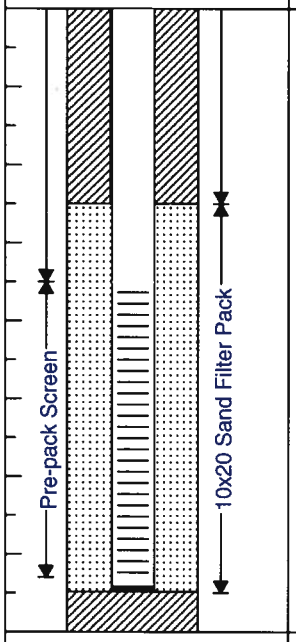
LOG OF MONITORING WELL: HY-117

Well Completion	PID (PPM)	Sample ID and Time	Depth (Feet)	Symbol	Lithologic Description
	2.3 0.7 0.3 0.8 4.1 0.0 0.3 0.2 0.1 0.1 0.1 1.0 0.2 0.8 0.4 1.4		42 44 46 48 50 52 54 56		**GRAY SILTY SAND (SM),** wet, medium dense, fine, some fines **GRAY SILT (ML),** moist, soft, low plasticity @ 45 feet: little shells, medium plasticity **BLACK SAND (SP),** moist, loose, fine, trace fines @ 50 feet: few fines **GRAY SILTY SAND (SM),** wet, medium dense, fine, little fines
			58 60 62 64 66 68 70 72 74 76 78 80		Bottom of boring: 56 feet. **Well Completion Details** Well constructed with 2-inch i.d. Schedule 40 PVC pipe and a 0.010-inch machine slotted screen, pre-packed with 20x40 Colorado Silica Sand. Total Well Depth: 55.0 feet. Well Sump/Endcap: 54.6 to 55.0 feet. Well Screen: 47.0 to 54.6 feet. Well Blank: 0 to 47 feet. Filter Pack: 45 to 55 feet (10x20 Colorado Silica Sand around outer screen). Well Seal: 2 to 45 feet and 55 to 56 (hydrated 3/8-inch bentonite chips). Surface Seal: 0.7 to 2 feet (concrete). Well Monument: Flush with grade steel monument. Washington Department of Ecology Well Tag Number: BCP-807 **Step-Casing Details** 9-inch o.d. casing advanced to 36 feet. Bentonite chips placed between 31and 36 feet. 9-inch o.d. casing retracted to 32 feet, then advanced to 35 feet. Let bentonite hydrate for 30 minutes. 6-inch o.d. casing advanced to 56 feet.

Project: BSB Diversified
Project No: 827.001.20
Site Location: Kent, WA
Logged By: E. Shaver
Notes: Soil Sampled Continuously

Total Drilled Depth: 56 feet
Diameter of Boring: 0 - 36 feet: 9-inches / 36 - 56 feet: 6-inches
Drill Date: 5/13/10
Drilled By: Cascade Drilling Co.
Drill Method: Sonic Drill Rig

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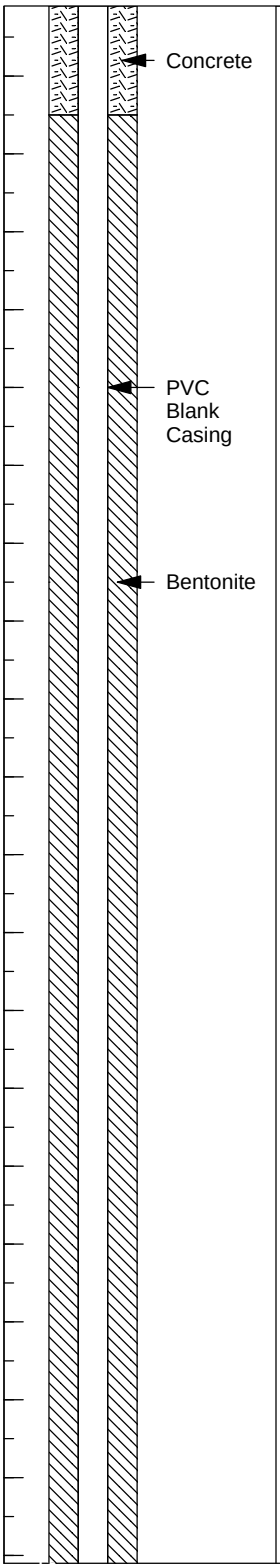
LOG OF MONITORING WELL: HY-122



PID (PPM)	Depth (Feet)	Symbol	Lithologic Description
	0		BROWN SAND WITH SILT AND GRAVEL (FILL)
	2		
	4		
0.0			BROWNISH GRAY SILT (ML), moist, soft, few fine sand, trace organic material (roots), medium plasticity, iron oxide staining throughout
0.0	6		
0.2			@ 5.5 feet: gray
0.0			@ 5.7 feet: wet
0.0	8		
NM			@ 9 feet: grading to sandy silt
NM			@ 9.5 feet: sandy silt grading to sand
NM	10		BLACK SAND (SP), wet, dense, fine to medium
0.1			@ 10 to 12 feet: No sample recovery
0.2	12		
0.2			DARK GRAY SILT (ML), moist, soft, few fine sand
0.3	14		DARK GRAY SILTY SAND (SM), wet, dense, fine, some fines
0.1			
	16		@ 18 to 22 feet: No sample recovery
NM			
NM	18		
NM			
	20		
			DARK GRAY SILTY SAND (SM) INTERBEDDED with SANDY SILT (ML)
119	22		
324			
1357			BLACK SAND WITH SILT (SP), wet, loose, fine to medium, few fines
1896	24		@ 23.5 to 26 feet: scattered discontinuous lenses of silt
1200			
357	26		@ 27 feet: fine
248			
	28		
			BLACK SAND (SP), wet, loose, fine to medium, trace fines
2.3	30		
1.0			
1.0	32		
1.0			
2.3	34		
8.1			
10.1	36		
17.2			
0.8	38		GRAY SILT (ML), moist, soft, few fine sand, medium plasticity
1.5			@ 38 feet: wet, elastic
242	40		@ 39 to 41 feet: moist, trace fine sand, scattered shells

Project: BSB Deep Aquifer Investigation: Phase 4
Project Number: 827.001.25
Site Location: Kent, Washington
Logged By: L.Doody
Notes: Soil Sampled Continuously

Total Drilled Depth: 63 feet
Diameter of Boring: 0 - 41 feet: 9-inches / 41 - 63 feet: 6-inches
Drill Date: 01/14 through 01/17/11
Drilled By: Cascade Drilling L.P.
Drill Method: Sonic Drill Rig

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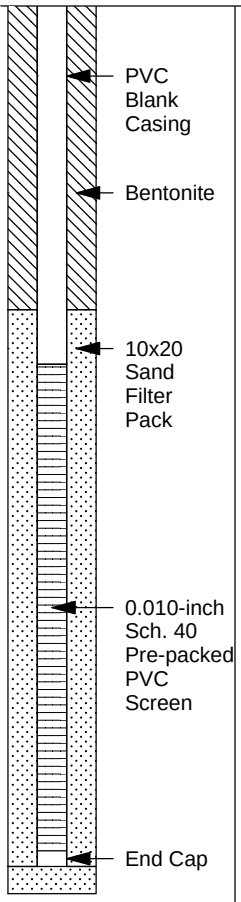
LOG OF MONITORING WELL: HY-122



PID (PPM)	Depth (Feet)	Lithologic Description
135		Note: Step-case @ 41 feet
100		
0.0	42	BLACK SILTY SAND (SM)
0.0		
0.0	44	GRAY SILT (ML), wet, soft, trace fine sand, high plasticity, elastic
0.0		@ 45 feet: scattered shells
0.0	46	
3.7		@ 47 to 48.5 feet: abundant scattered shells, little fine sand, low plasticity
2.4	48	
0.0		BLACK SAND WITH SILT (SP), moist, loose, fine to medium, few fines
0.0	50	
0.0		@ 51 feet: trace fines
0.0	52	
0.0		
0.0		@ 54 to 55 feet: scattered shells
0.1	54	@ 55 feet: interbedded sandy silt and sand with silt
0.1		BLACK SILTY SAND (SM), wet, loose, fine, some fines
0.1	56	
0.2		@ 57 feet: 3-inch interbed of abundant organic material
1.6	58	
11.3		BLACK SAND WITH SILT (SP), loose, fine to medium, few fines
	60	
13.5		
64.3	62	
	64	NOTE: Bottom of boring: 63 feet.
		Well Completion Details:
	66	Well constructed with 2-inch i.d. Schedule 40 PVC pipe and a 0.010-inch machine slotted screen, pre-packed with 20x40 Colorado Silica Sand.
	68	Total Well Depth: 62.3 feet.
		Well Sump/Endcap: 61.9 to 62.3 feet.
	70	Well Screen: 49.4 to 61.9 feet.
		Well Blank: 0 to 49.4 feet.
	72	Filter Pack: 48 to 63 feet (10x20 Colorado Silica).
		Well Seal: 3 to 48 (hydrated bentonite chips)
	74	Surface Seal: 0.7 to 2 feet (concrete).
		Well Monument: Flush with grade steel monument.
	76	Washington State Department of Ecology Well Tag Number: BCM-923
		Step-Casing Details:
	78	9-inch o.d. casing advanced to 41 feet.
		Bentonite chips placed between 37 and 41 feet.
	80	9-inch o.d. casing retracted to 38 feet, then advance to 40 feet.
		Let bentonite hydrate for 1 hour.
		6-inch o.d. casing advanced to 63 feet.

Project: BSB Deep Aquifer Investigation: Phase 4
Project Number: 827.001.25
Site Location: Kent, Washington
Logged By: L.Doody
Notes: Soil Sampled Continuously

Total Drilled Depth: 63 feet
Diameter of Boring: 0 - 41 feet: 9-inches / 41 - 63 feet: 6-inches
Drill Date: 01/14 through 01/17/11
Drilled By: Cascade Drilling L.P.
Drill Method: Sonic Drill Rig

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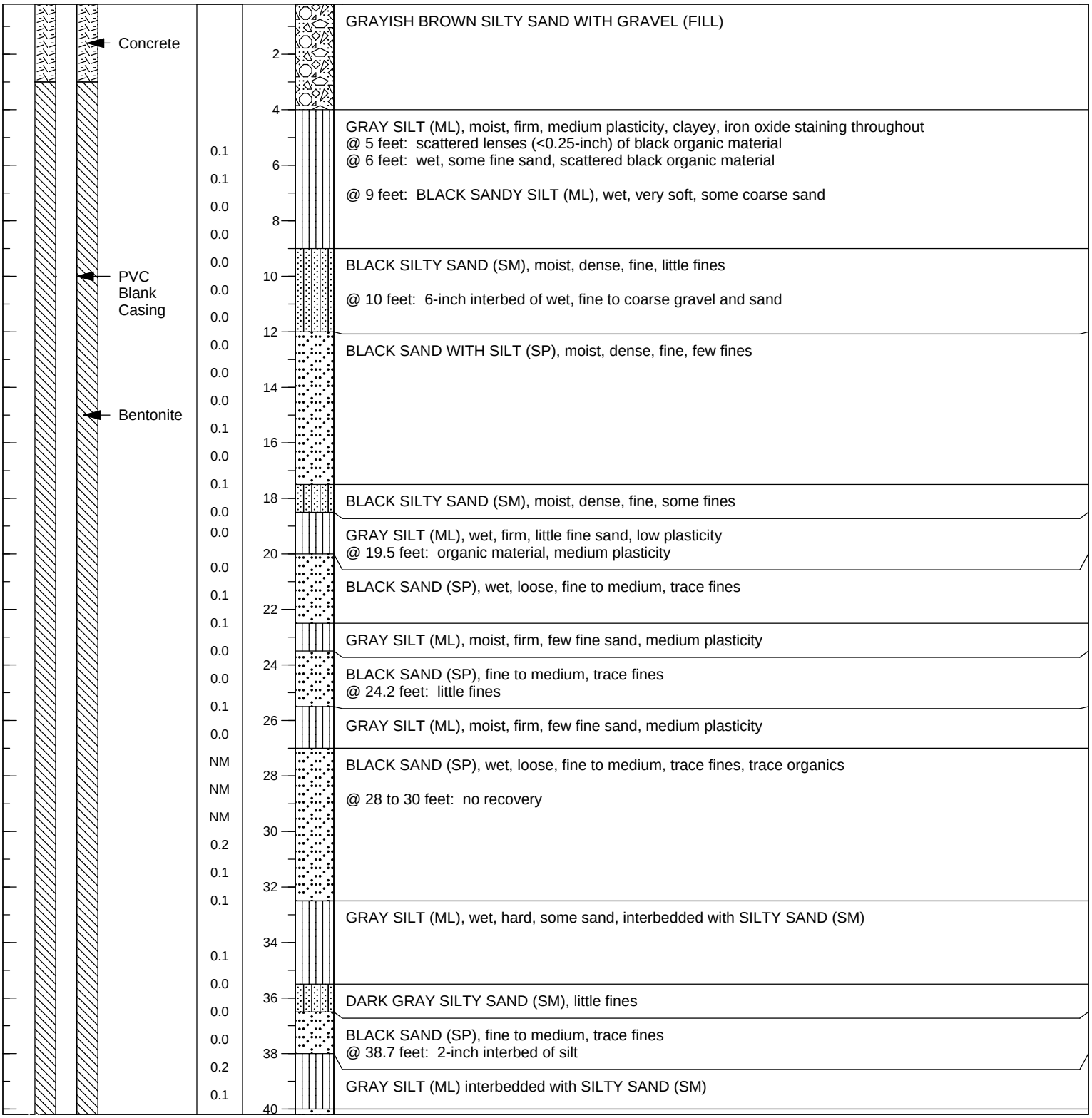
LOG OF MONITORING WELL: HY-125



Project: BSB Deep Aquifer Investigation: Phase 4
Project Number: 827.001.25
Site Location: Kent, Washington
Logged By: L.Doody
Notes: Soil Sampled Continuously

Total Drilled Depth: 59 feet
Diameter of Boring: 0 - 44 feet: 9-inches / 44 - 59 feet: 6-inches
Drill Date: 01/19/11
Drilled By: Cascade Drilling L.P.
Drill Method: Sonic Drill Rig

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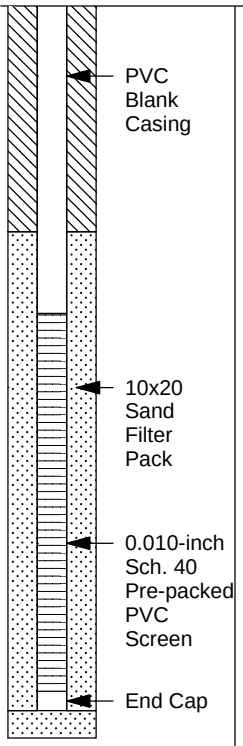
LOG OF MONITORING WELL: HY-125



PID (PPM)	Depth (Feet)	Symbol	Lithologic Description
0.1	40		
0.1	42		BLACK SAND (SP), wet, loose, fine to medium, trace fines @ 41 feet: little to some fines
0.0			
0.0	44		GRAY SILT (ML), moist, soft, medium plasticity, elastic Note: Step-case @ 44 feet. @ 44 feet: abundant shells
NM			
NM	46		@ 44.5 to 47 feet: Shelby tube sample
0.0			
0.0	48		GRAY SILTY SAND (SM), scattered shells, grading to sand (SP)
0.0			
0.0	50		BLACK SAND (SP), wet, loose, fine to medium, trace fines
0.0			
0.0	52		
0.0			
1.9	54		
5.8			
35			
20	56		
25			
50			
4.9	58		
16.1			
	60		NOTE: Bottom of boring: 59 feet. Well Completion Details: Well constructed with 2-inch i.d. Schedule 40 PVC pipe and a 0.010-inch machine slotted screen, pre-packed with 20x40 Colorado Silica Sand. Total Well Depth: 58.3 feet. Well Sump/Endcap: 57.8 to 58.3 feet. Well Screen: 48.1 to 57.8 feet. Well Blank: 0 to 48.1 feet. Filter Pack: 46 to 59 feet (10x20 Colorado Silica). Well Seal: 3 to 46 (hydrated bentonite chips) Surface Seal: 0.7 to 3 feet (concrete). Well Monument: Flush with grade steel monument. Washington State Department of Ecology Well Tag Number: BCM-925 Step-Casing Details: 9-inch o.d. casing advanced to 44 feet. Bentonite chips placed between 40 and 44 feet. 9-inch o.d. casing retracted to 41 feet, then advance to 43 feet. Let bentonite hydrate for 1 hour. 6-inch o.d. casing advanced to 59 feet.
	62		
	64		
	66		
	68		
	70		
	72		
	74		
	76		
	78		
	80		

Project: BSB Deep Aquifer Investigation: Phase 4
Project Number: 827.001.25
Site Location: Kent, Washington
Logged By: L.Doody
Notes: Soil Sampled Continuously

Total Drilled Depth: 59 feet
Diameter of Boring: 0 - 44 feet: 9-inches / 44 - 59 feet: 6-inches
Drill Date: 01/19/11
Drilled By: Cascade Drilling L.P.
Drill Method: Sonic Drill Rig

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LOG OF PIEZOMETER: P-1

Well Completion	Sample ID	Sample Recovery	Sample Interval	Depth (Feet)	Graphic Log	Lithologic Description
Concrete; Bentonite; PVC Blank Casing; 10x20 Sand Filter Pack; 0.010-inch Sch. 40 Pre-packed PVC Screen; End Cap		24		0		ASPHALT
				1		BROWN SILTY SAND WITH GRAVEL (FILL)
				2		BROWNISH GRAY SILTY SAND WITH GRAVEL (SM), dry, loose, little fines, few fine gravel
				4		@ 3 to 5 feet: little recovery, contact location inferred
		48		6		GRAY SILT (ML), wet, soft, medium plasticity, iron oxide staining throughout
				8		
				10		BLACK SAND (SP), wet, dense, fine, trace fines
		60		12		@ 12 feet: 6-inch interbed of gray, soft, medium plasticity silt (ML)
				14		@ 12.5 to 15.2 feet: few fines
				16		Bottom of boring @ 15.2 feet.
				18		Well Completion Details: Well constructed with 1.5-inch i.d. Schedule 40 PVC pipe with 0.010-inch machine slotted screen, pre-packed with 20x40 Colorado Silica Sand.
				20		Total Well Depth: 15.2 feet. Well Sump/Endcap: 14.9 to 15.2 feet. Well Screen: 9.9 to 14.9 feet. Well Blank: 0 to 9.9 feet. Filter Pack: 8 to 15.2 feet (10x20 Colorado Silica). Well Seal: 2 to 8 (hydrated bentonite chips) Surface Seal: 0 to 2 feet (concrete). Well Monument: Flush with grade steel monument.
				22		
				24		
				26		
				28		
				30		

Project: BSB Shallow Aquifer CA Startup
Project Number: 827.001.30.006
Site Location: Kent, Washington
Logged By: Leora Doody
Notes: Ecology Well Tag Number BHK 257

Total Drilled Depth: 15.2 feet
Diameter of Boring: 3.5 inches
Drill Date: 12/06/11
Drilled By: Cascade Drilling, L.P.
Drill Method: Geoprobe 6600

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LOG OF PIEZOMETER: P-2

Well Completion	Sample ID	Sample Recovery	Sample Interval	Depth (Feet)	Graphic Log	Lithologic Description
Concrete				0		ASPHALT
						BROWN SILTY SAND WITH GRAVEL (FILL), moist, fine to coarse, few fine gravel
Bentonite		36		2		BROWNISH GRAY SILT (ML), moist, hard, medium plasticity, iron oxide staining throughout
				4		
						@ 5 feet: 6-inch interbed of sandy silt with gravel, wet
				6		
		60		8		@ 8 feet: 6-inch interbed of sand with silt (SP) @ 8.5 feet: gray, soft, few fine sand
				10		@ 10 feet: brown, some fine sand
				12		BLACK SAND (SP), wet, fine
		48				GRAY SILT (ML), wet, soft, medium plasticity
				14		@ 13 feet: little fine sand, low plasticity
PVC Blank Casing				16		Note: 15 to 20 feet: No recovery, contact location inferred
		0		18		
				20		GRAY SILTY SAND (SM), wet, loose, fine, some fines
				22		GRAY SILT (ML), wet, soft, little fine sand, medium plasticity
		36				@ 22.5 feet: 3-inch interbed of sand (SP) Note: 23 to 26 feet: Little recovery, contact location inferred
				24		BLACK SAND (SP), wet, loose, fine to medium, few fines
				26		
10x20 Sand Filter Pack		48		28		
				30		

Project: BSB Shallow Aquifer CA Startup
Project Number: 827.001.24.006
Site Location: Kent, Washington
Logged By: Leora Doody
Notes: Ecology Well Tag Number BHK 255

Total Drilled Depth: 34.5 feet
Diameter of Boring: 3.5 inches
Drill Date: 12/06/11
Drilled By: Cascade Drilling, L.P.
Drill Method: Geoprobe 6600

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LOG OF PIEZOMETER: P-2

Well Completion	Sample ID	Sample Recovery	Sample Interval	Depth (Feet)	Graphic Log	Lithologic Description
0.010-inch Sch. 40 Pre-packed PVC Screen End Cap		54		30 32 34		PINKISH GRAY SILT (ML), wet, very soft, sticky
				36 38 40 42 44 46 48 50 52 54 56 58 60		Bottom of boring @ 34.5 feet. Well Completion Details: Well constructed with 1.5-inch i.d. Schedule 40 PVC pipe with 0.010-inch machine slotted screen, pre-packed with 20x40 Colorado Silica Sand. Total Well Depth: 34.5 feet. Well Sump/Endcap: 34.2 to 34.5 feet. Well Screen: 29.2 to 34.2 feet. Well Blank: 0 to 29.2 feet. Filter Pack: 27 to 34.5 feet (10x20 Colorado Silica). Well Seal: 2 to 27 (hydrated bentonite chips) Surface Seal: 0 to 2 feet (concrete). Well Monument: Flush with grade steel monument.

Project: BSB Shallow Aquifer CA Startup
Project Number: 827.001.24.006
Site Location: Kent, Washington
Logged By: Leora Doody
Notes: Ecology Well Tag Number BHK 255

Total Drilled Depth: 34.5 feet
Diameter of Boring: 3.5 inches
Drill Date: 12/06/11
Drilled By: Cascade Drilling, L.P.
Drill Method: Geoprobe 6600

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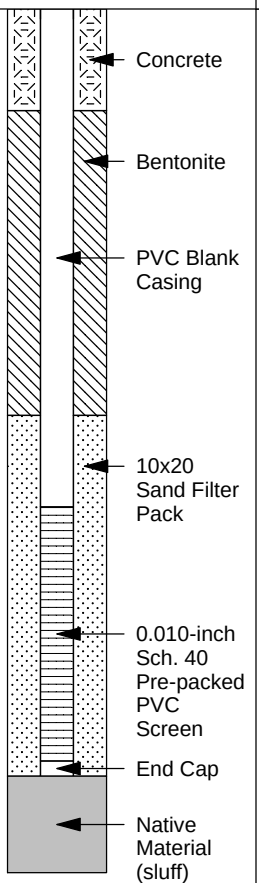
LOG OF PIEZOMETER: P-3



Sample ID	Sample Recovery	Sample Interval	Depth (Feet)	Graphic Log	Lithologic Description
			0		ASPHALT
			2		BROWN SILTY SAND WITH GRAVEL (FILL), moist, fine to coarse, few fine gravel
	42		4		BROWNISH GRAY SILTY SILTY SAND (SM), moist, loose, fine to coarse, little fines, few fine to coarse gravel @ 5 feet: few organics
			6		@ 7 feet: few fines (SP)
	54		8		GRAY SILT (ML), soft, few fine sand, medium plasticity @ 9 feet: increasing sand
			10		BLACK SAND (SP), wet, dense, fine, trace fines
	60		12		@ 12.3 feet: 8-inch interbed of gray, high plasticity silt, elastic @ 13 feet: few fines
			14		@ 14.5 feet: trace fines
	24		16		GRAY SILT (ML), soft, medium plasticity
			18		Bottom of boring @ 17 feet.
			20		Well Completion Details: Well constructed with 1.5-inch i.d. Schedule 40 PVC pipe with 0.010-inch machine slotted screen, pre-packed with 20x40 Colorado Silica Sand. Total Well Depth: 15.1 feet. Well Sump/Endcap: 14.8 to 15.1 feet. Well Screen: 9.8 to 14.8 feet. Well Blank: 0 to 9.8 feet. Filter Pack: 8 to 15.1 feet (10x20 Colorado Silica). Well Seal: 2 to 8 (hydrated bentonite chips) Surface Seal: 0 to 2 feet (concrete). Well Monument: Flush with grade steel monument.
			22		
			24		
			26		
			28		
			30		

Project: BSB Shallow Aquifer CA Startup
Project Number: 827.001.24.006
Site Location: Kent, Washington
Logged By: Leora Doody
Notes: Ecology Well Tag Number BHK 256

Total Drilled Depth: 17 feet
Diameter of Boring: 3.5 inches
Drill Date: 12/06/11
Drilled By: Cascade Drilling, L.P.
Drill Method: Geoprobe 6600

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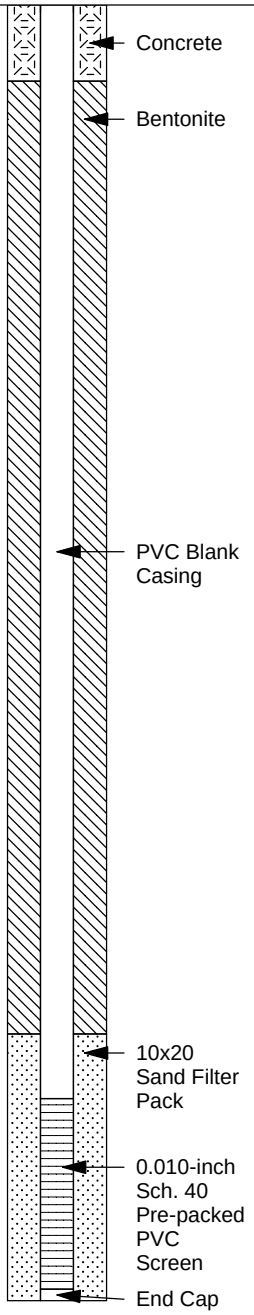
LOG OF PIEZOMETER: P-4

Well Completion	Sample ID	Sample Recovery	Sample Interval	Depth (Feet)	Graphic Log	Lithologic Description
				0		Boring not logged for lithology. See adjacent boring P-4A for lithology. Drove 3.5 inch casing with steel tip to 34 feet below ground surface (bgs) and installed piezometer. Well Completion Details: Well constructed with 1.5-inch i.d. Schedule 40 PVC pipe with 0.010-inch machine slotted screen, pre-packed with 20x40 Colorado Silica Sand. Total Well Depth: 34 feet. Well Sump/Endcap: 33.7 to 34 feet. Well Screen: 28.7 to 33.7 feet. Well Blank: 0 to 28.7 feet. Filter Pack: 27 to 34 feet (10x20 Colorado Silica). Well Seal: 2 to 27 (hydrated bentonite chips) Surface Seal: 0 to 2 feet (concrete). Well Monument: Flush with grade steel monument.
				34		Bottom of boring @ 34 feet.

Project: BSB Shallow Aquifer CA Startup
Project Number: 827.001.24.006
Site Location: Kent, Washington
Logged By: Leora Doody
Notes: Ecology Well Tag Number: BHK 254

Total Drilled Depth: 34 feet
Diameter of Boring: 3.5 inches
Drill Date: 12/06/11
Drilled By: Cascade Drilling, L.P.
Drill Method: Geoprobe 6600

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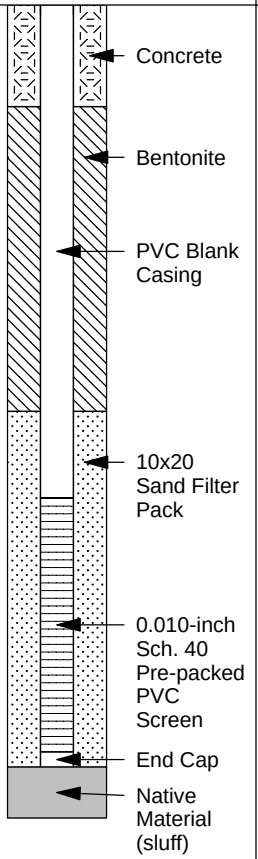
LOG OF PIEZOMETER: P-5



Sample ID	Sample Recovery	Depth (Feet)	Lithologic Description
		0	ASPHALT
	60	2	BROWN SILTY SAND (SM), moist, loose, little fines
		4	
		6	BROWN SILT (ML), iron oxide staining throughout
	60	8	@ 8 feet: gray
		10	BLACK SAND (SP), wet, fine to medium, trace fines
		12	GRAY SILT (ML), wet, medium plasticity
	60		GRAY SILTY SAND (SM), wet, fine to medium, some fines
		14	BLACK SAND (SP), wet, fine to medium, trace fines
		16	Bottom of boring @ 16 feet.
		18	Well Completion Details: Well constructed with 1.5-inch i.d. Schedule 40 PVC pipe with 0.010-inch machine slotted screen, pre-packed with 20x40 Colorado Silica Sand.
		20	Total Well Depth: 15 feet. Well Sump/Endcap: 14.7 to 15 feet. Well Screen: 9.7 to 14.7 feet. Well Blank: 0 to 9.7 feet. Filter Pack: 8 to 15 feet (10x20 Colorado Silica). Well Seal: 2 to 8 (hydrated bentonite chips). Surface Seal: 0 to 2 feet (concrete). Well Monument: Flush with grade steel monument.
		22	
		24	
		26	
		28	
		30	

Project: BSB Shallow Aquifer CA Startup
Project Number: 827.001.24.006
Site Location: Kent, Washington
Logged By: Leora Doody
Notes: Ecology Well Tag Number BHK 264

Total Drilled Depth: 16 feet
Diameter of Boring: 3.5 inches
Drill Date: 12/08/11
Drilled By: Cascade Drilling, L.P.
Drill Method: Geoprobe 6600

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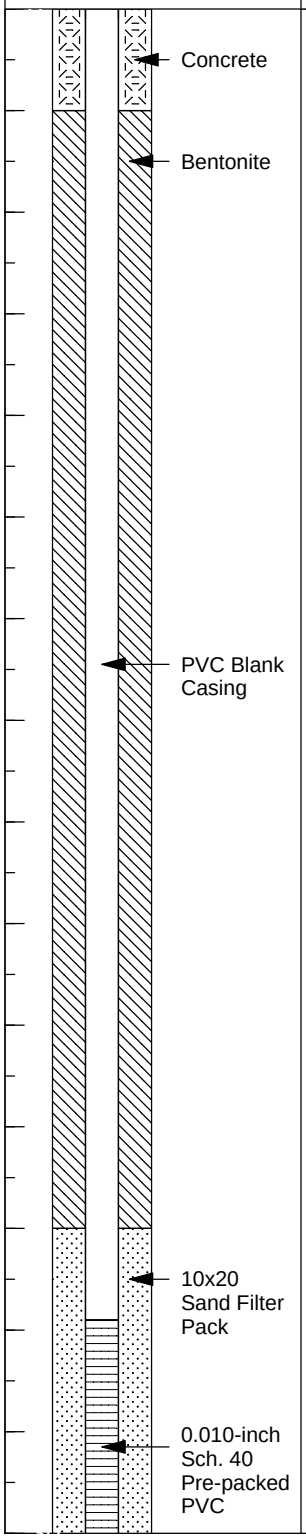
LOG OF PIEZOMETER: P-6



Sample ID	Sample Recovery	Sample Interval	Depth (Feet)	Graphic Log	Lithologic Description
			0		ASPHALT
	48		2		BROWN SILTY SAND WITH GRAVEL (FILL), moist, fine to coarse, few fine gravel
			4		BROWN SILT (ML), moist, few fine sand, medium plasticity, iron oxide staining throughout
	38		6		
			8		@ 7 feet: gray @ 7.8 feet: wet
			10		BLACK SAND WITH SILT (SP), wet, dense, fine, few fines
	38		12		GRAY SANDY SILT (ML), wet, hard, some fine sand
			14		@ 13 to 15 feet: Little recovery, contact location inferred
			16		BLACK SAND WITH SILT (SP), wet, dense, fine to medium, few fines
	60		18		GRAY SANDY SILT (ML), wet, hard, some fine sand, non-plastic
			20		@ 19.5 feet: few fine sand, medium plasticity @ 20 feet: soft, some fine sand, non-plastic
	48		22		
			24		BLACK SAND WITH SILT (SP), wet, dense, fine to coarse, few fines
			26		
	48		28		
			30		

Project: BSB Shallow Aquifer CA Startup
Project Number: 827.001.30.006
Site Location: Kent, Washington
Logged By: Leora Doody
Notes: Ecology Well Tag Number BHK 262

Total Drilled Depth: 38 feet
Diameter of Boring: 3.5 inches
Drill Date: 12/08/11
Drilled By: Cascade Drilling, L.P.
Drill Method: Geoprobe 6600

LOG OF PIEZOMETER: P-6

Well Completion	Sample ID	Sample Recovery	Sample Interval	Depth (Feet)	Graphic Log	Lithologic Description
Screen End Cap 10x20 Sand Native Material (sluff)		48 24		30 32 34 36 38		@ 35.7 feet: 6-inch interbed of pinkish gray, sticky silt (ML)
				40 42 44 46 48 50 52 54 56 58 60		Bottom of boring @ 38 feet. Well Completion Details: Well constructed with 1.5-inch i.d. Schedule 40 PVC pipe with 0.010-inch machine slotted screen, pre-packed with 20x40 Colorado Silica Sand. Total Well Depth: 31.1 feet. Well Sump/Endcap: 30.8 to 31.1 feet. Well Screen: 25.8 to 30.8 feet. Well Blank: 0 to 25.8 feet. Filter Pack: 24 to 35 feet (10x20 Colorado Silica). Well Seal: 2 to 24 (hydrated bentonite chips) Surface Seal: 0 to 2 feet (concrete). Well Monument: Flush with grade steel monument.

Project: BSB Shallow Aquifer CA Startup
Project Number: 827.001.30.006
Site Location: Kent, Washington
Logged By: Leora Doody
Notes: Ecology Well Tag Number BHK 262

Total Drilled Depth: 38 feet
Diameter of Boring: 3.5 inches
Drill Date: 12/08/11
Drilled By: Cascade Drilling, L.P.
Drill Method: Geoprobe 6600

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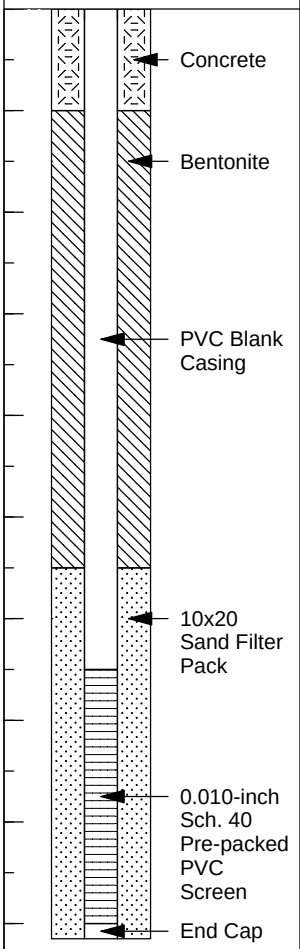
LOG OF PIEZOMETER: P-7

Well Completion	Sample ID	Sample Recovery	Sample Interval	Depth (Feet)	Graphic Log	Lithologic Description
		60		0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30		Note: Boring not sampled from 0 to 13 feet. See adjacent boring P-8 for lithology from 0 to 13 feet. BLACK SAND (SP), wet, dense, fine to medium, trace fines Bottom of boring @ 18.3 feet. Well Completion Details: Well constructed with 1.5-inch i.d. Schedule 40 PVC pipe with 0.010-inch machine slotted screen, pre-packed with 20x40 Colorado Silica Sand. Total Well Depth: 18.3 feet. Well Sump/Endcap: 18 to 18.3 feet. Well Screen: 13 to 18 feet. Well Blank: 0 to 13 feet. Filter Pack: 11 to 18.3 feet (10x20 Colorado Silica). Well Seal: 2 to 11 (hydrated bentonite chips) Surface Seal: 0 to 2 feet (concrete). Well Monument: Flush with grade steel monument.

Project: BSB Shallow Aquifer CA Startup
Project Number: 827.001.24.006
Site Location: Kent, Washington
Logged By: Leora Doody
Notes: Ecology Well Tag Number BHK 277

Total Drilled Depth: 18.3 feet
Diameter of Boring: 3.5 inches
Drill Date: 12/09/11
Drilled By: Cascade Drilling, L.P.
Drill Method: Geoprobe 6600

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LOG OF PIEZOMETER: P-8

Well Completion	Sample ID	Sample Recovery	Sample Interval	Depth (Feet)	Graphic Log	Lithologic Description
Concrete				0		ASPHALT
				2		BROWN SILTY SAND WITH GRAVEL (FILL), moist, fine to coarse, few fine gravel
Bentonite		48				LIGHT BROWN SANDY SILT (ML), dry, some fine sand, low plasticity
				4		
				6		@ 6.5 feet: bluish gray
		48		8		@ 8 feet: wet, soft, medium plasticity, trace organic material
				10		@ 10 feet: pinkish gray
				12		@ 12 feet: bluish gray
PVC Blank Casing		48		14		BLACK SAND (SP), wet, loose, fine to medium, trace fines
				16		
		54		18		@ 17.5 feet: grading to silty sand
				20		BROWNISH GRAY SILT (ML), wet, soft, medium plasticity, abundant organic material @ 20 feet: 6-inch interbed of blackish brown organic material
				22		BLACK SAND (SP), wet, dense, fine, trace fines
		30		24		
				26		
10x20 Sand Filter Pack		42		28		
				30		

Project: BSB Shallow Aquifer CA Startup
Project Number: 827.001.24.006
Site Location: Kent, Washington
Logged By: Leora Doody
Notes: Ecology Well Tag Number BHK 276

Total Drilled Depth: 38.3 feet
Diameter of Boring: 3.5 inches
Drill Date: 12/09/11
Drilled By: Cascade Drilling, L.P.
Drill Method: Geoprobe 6600

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LOG OF PIEZOMETER: P-8

Well Completion	Sample ID	Sample Recovery	Sample Interval	Depth (Feet)	Graphic Log	Lithologic Description
0.010-inch Sch. 40 Pre-packed PVC Screen End Cap		48 36		30 32 34 36 38		@ 35.5 to 36.3 feet: interbedded sand and silt
				40 42 44 46 48 50 52 54 56 58 60		Bottom of boring @ 38.3 feet. Well Completion Details: Well constructed with 1.5-inch i.d. Schedule 40 PVC pipe with 0.010-inch machine slotted screen, pre-packed with 20x40 Colorado Silica Sand. Total Well Depth: 38.3 feet. Well Sump/Endcap: 28 to 38 feet. Well Screen: 28 to 38 feet. Well Blank: 0 to 28 feet. Filter Pack: 26 to 38 feet (10x20 Colorado Silica). Well Seal: 2 to 26 (hydrated bentonite chips) Surface Seal: 0 to 2 feet (concrete). Well Monument: Flush with grade steel monument.

Project: BSB Shallow Aquifer CA Startup
Project Number: 827.001.24.006
Site Location: Kent, Washington
Logged By: Leora Doody
Notes: Ecology Well Tag Number BHK 276

Total Drilled Depth: 38.3 feet
Diameter of Boring: 3.5 inches
Drill Date: 12/09/11
Drilled By: Cascade Drilling, L.P.
Drill Method: Geoprobe 6600

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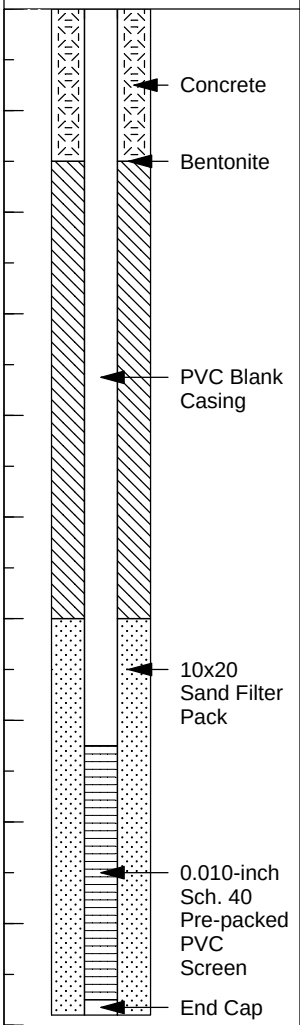
LOG OF PIEZOMETER: P-9

Well Completion	Sample ID	Sample Recovery	Sample Interval	Depth (Feet)	Graphic Log	Lithologic Description
				0		Boring not logged for lithology. See adjacent boring P-10 for lithology.
				20		Piezometer installed with a hollow stem auger with wood plug. Well Completion Details: Well constructed with 1.5-inch i.d. Schedule 40 PVC pipe with 0.010-inch machine slotted screen, pre-packed with 20x40 Colorado Silica Sand. Total Well Depth: 19.8 feet. Well Sump/Endcap: 19.5 to 19.8 feet. Well Screen: 14.5 to 19.5 feet. Well Blank: 0 to 14.5 feet. Filter Pack: 12 to 19.8 feet (10x20 Colorado Silica). Well Seal: 3 to 12 (hydrated bentonite chips) Surface Seal: 0 to 3 feet (concrete). Well Monument: Flush with grade steel monument.

Project: BSB Shallow Aquifer CA Startup
Project Number: 827.001.24.006
Site Location: Kent, Washington
Logged By: Leora Doody
Notes: Ecology Well Tag Number: BHK 283

Total Drilled Depth: 19.8 feet
Diameter of Boring: 9 inches
Drill Date: 12/14/11
Drilled By: Cascade Drilling, L.P.
Drill Method: Hollow Stem Auger

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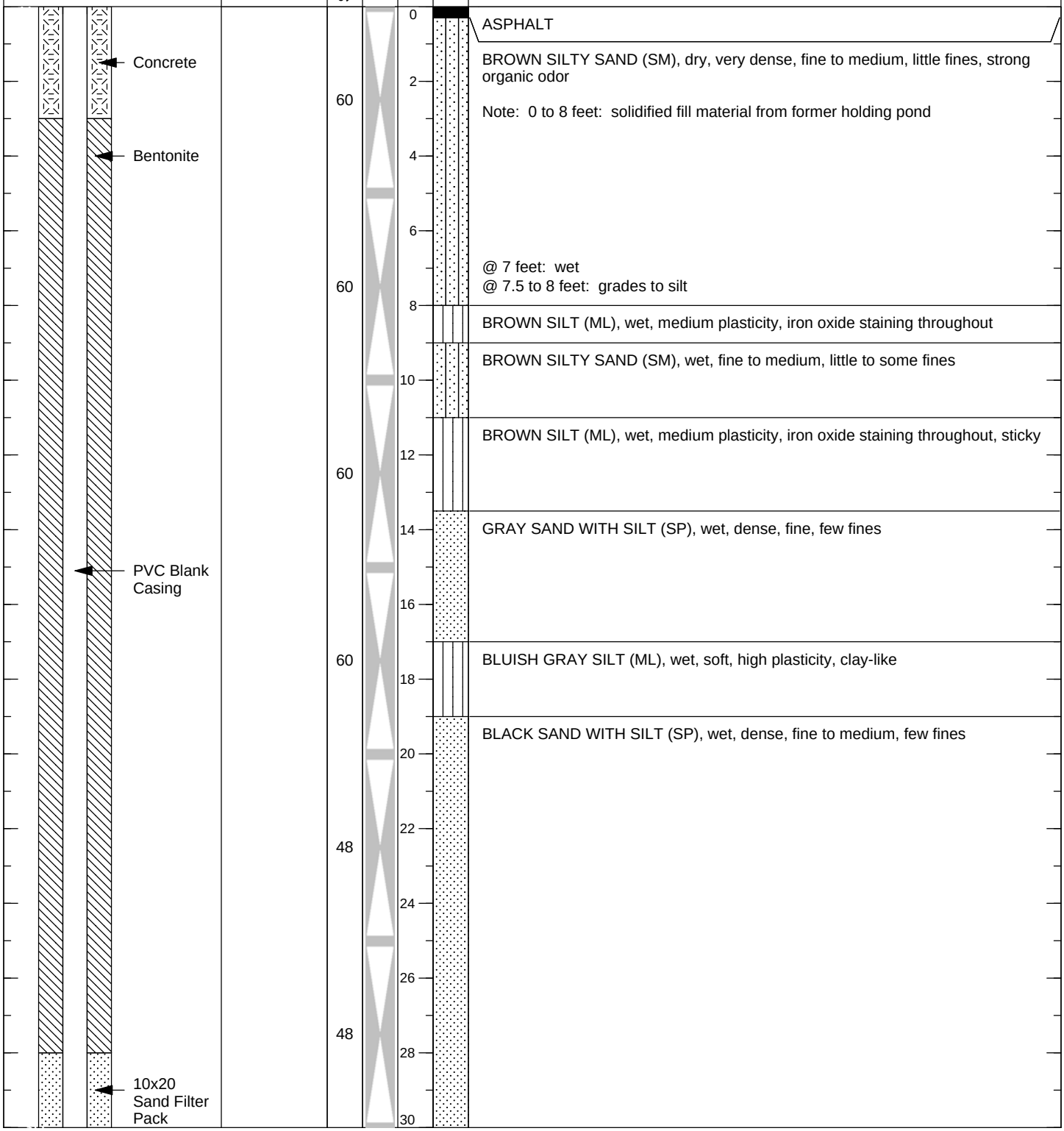
LOG OF PIEZOMETER: P-10



Project: BSB Shallow Aquifer CA Startup
Project Number: 827.001.24.006
Site Location: Kent, Washington
Logged By: Leora Doody
Notes: Ecology Well Tag Number: BHK 282

Total Drilled Depth: 37 feet
Diameter of Boring: 9 inches
Drill Date: 12/14/11
Drilled By: Cascade Drilling, L.P.
Drill Method: Hollow Stem Auger

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LOG OF PIEZOMETER: P-10

Well Completion	Sample ID	Sample Recovery	Sample Interval	Depth (Feet)	Graphic Log	Lithologic Description
0.010-inch Sch. 40 Pre-packed PVC Screen; End Cap; Native Material (sluff)		42		30		@ 30 feet: trace organic material
				32		
				34		@ 33.5 feet: 3-inch interbed of silt with organics
		24		36		GRAY SILT (ML), wet, soft, trace fine sand, medium plasticity @ 36.3 feet: 4-inch interbed of sticky pinkish gray silt
				38		Bottom of boring @ 37 feet. Note: Initial boring drilled with geoprobe on 12/8/12. Piezometer installed with a hollow stem auger on 12/14/12. Well Completion Details: Well constructed with 1.5-inch i.d. Schedule 40 PVC pipe with 0.010-inch machine slotted screen, pre-packed with 20x40 Colorado Silica Sand. Total Well Depth: 35.5 feet. Well Sump/Endcap: 35.2 to 35.5 feet. Well Screen: 30.2 to 35.2 feet. Well Blank: 0 to 30.2 feet. Filter Pack: 28 to 35.5 feet (10x20 Colorado Silica). Well Seal: 3 to 28 (hydrated bentonite chips) Surface Seal: 0 to 3 feet (concrete). Well Monument: Flush with grade steel monument.
				40		
				42		
				44		
				46		
				48		
				50		
				52		
				54		
				56		
				58		
				60		

Project: BSB Shallow Aquifer CA Startup
Project Number: 827.001.24.006
Site Location: Kent, Washington
Logged By: Leora Doody
Notes: Ecology Well Tag Number: BHK 282

Total Drilled Depth: 37 feet
Diameter of Boring: 9 inches
Drill Date: 12/14/11
Drilled By: Cascade Drilling, L.P.
Drill Method: Hollow Stem Auger

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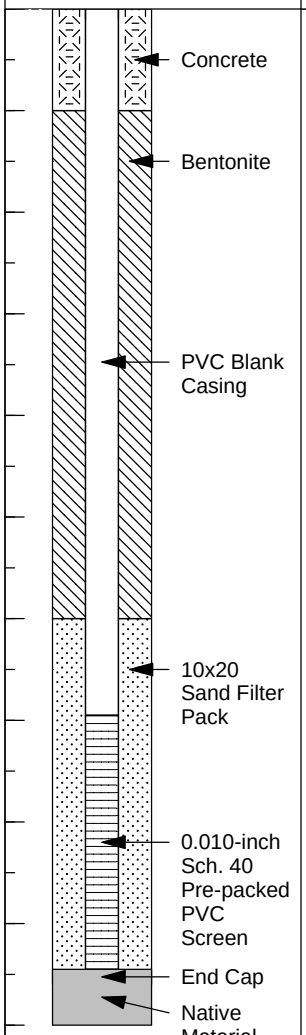
LOG OF PIEZOMETER: P-11



Sample ID	Sample Recovery	Sample Interval	Depth (Feet)	Graphic Log	Lithologic Description
			0		ASPHALT
			2		BROWN SILTY SAND WITH GRAVEL (FILL), moist, fine to coarse, few fine gravel
	60				BROWN SILTY SAND (SM), moist, dense, fine, some fines
			4		
			6		
	36		8		@ 7 feet: wet
					Note: 8 to 10 feet: Little recovery, contact location inferred
			10		BROWN SILT (ML), wet, soft, little fines, non-plastic
	48		12		
			14		INTERBEDDED SILTY SAND (SM) AND SILT (ML)
	24		16		
			18		DARK GRAY SAND WITH SILT (SP), wet, dense, fine, few fines
	36		20		Bottom of boring @ 20 feet.
			22		Well Completion Details: Well constructed with 1.5-inch i.d. Schedule 40 PVC pipe with 0.010-inch machine slotted screen, pre-packed with 20x40 Colorado Silica Sand.
			24		Total Well Depth: 19.2 feet. Well Sump/Endcap: 18.9 to 19.2 feet. Well Screen: 14.9 to 18.9 feet. Well Blank: 0 to 14.9 feet. Filter Pack: 12 to 19.2 feet (10x20 Colorado Silica). Well Seal: 2 to 12 (hydrated bentonite chips) Surface Seal: 0 to 2 feet (concrete). Well Monument: Flush with grade steel monument.
			26		
			28		
			30		

Project: BSB Shallow Aquifer CA Startup
Project Number: 827.001.24.006
Site Location: Kent, Washington
Logged By: Leora Doody
Notes: Ecology Well Tag Number BHK 265

Total Drilled Depth: 19.2 feet
Diameter of Boring: 3.5 inches
Drill Date: 12/08/11
Drilled By: Cascade Drilling, L.P.
Drill Method: Geoprobe 6600

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LOG OF PIEZOMETER: P-12

Well Completion	Sample ID	Sample Recovery	Sample Interval	Depth (Feet)	Graphic Log	Lithologic Description
Concrete				0		ASPHALT
				2		BROWN SILTY SAND WITH GRAVEL (FILL), moist, fine to coarse, few fine gravel
Bentonite		36				BROWN SILTY SAND (SM), moist, dense, fine, some fines
				4		
				6		
		42				BROWN SILT (ML), wet, medium plasticity, iron oxide staining throughout
				8		
				10		BROWN SILTY SAND (SM), wet, fine, little fines
		48		12		
				14		DARK GRAY SAND WITH SILT (SP), wet, dense, fine, few fines
PVC Blank Casing				16		
		60		18		
				20		
		60		22		
				24		
				26		@ 25 feet: fine to medium, trace fines
		42		28		
10x20 Sand Filter Pack				30		

Project: BSB Shallow Aquifer CA Startup
Project Number: 827.001.24.006
Site Location: Kent, Washington
Logged By: Leora Doody
Notes: Ecology Well Tag Number BHK 275

Total Drilled Depth: 37 feet
Diameter of Boring: 3.5 inches
Drill Date: 12/09/11
Drilled By: Cascade Drilling, L.P.
Drill Method: Geoprobe 6600

PES Environmental, Inc.
Engineering & Environmental Services

LOG OF PIEZOMETER: P-12

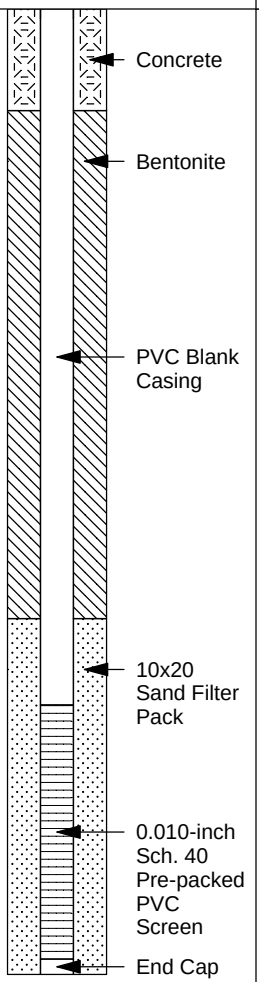
Well Completion	Sample ID	Sample Recovery	Sample Interval	Depth (Feet)	Graphic Log	Lithologic Description
0.010-inch Sch. 40 Pre-packed PVC Screen; End Cap; Native Material (sluff)		42		30		
				32		
				34		
		24		36		GRAY SILT (ML), wet, soft, trace fine sand, medium plasticity
				38		Bottom of boring @ 37 feet. Well Completion Details: Well constructed with 1.5-inch i.d. Schedule 40 PVC pipe with 0.010-inch machine slotted screen, pre-packed with 20x40 Colorado Silica Sand. Total Well Depth: 35.2 feet. Well Sump/Endcap: 34.9 to 35.2 feet. Well Screen: 29.9 to 34.9 feet. Well Blank: 0 to 29.9 feet. Filter Pack: 28 to 35.2 feet (10x20 Colorado Silica). Well Seal: 2 to 28 (hydrated bentonite chips) Surface Seal: 0 to 2 feet (concrete). Well Monument: Flush with grade steel monument.
				40		
				42		
				44		
				46		
				48		
				50		
				52		
				54		
				56		
				58		
				60		

Project: BSB Shallow Aquifer CA Startup
Project Number: 827.001.24.006
Site Location: Kent, Washington
Logged By: Leora Doody
Notes: Ecology Well Tag Number BHK 275

Total Drilled Depth: 37 feet
Diameter of Boring: 3.5 inches
Drill Date: 12/09/11
Drilled By: Cascade Drilling, L.P.
Drill Method: Geoprobe 6600

PES Environmental, Inc.
Engineering & Environmental Services

LOG OF PIEZOMETER: P-13



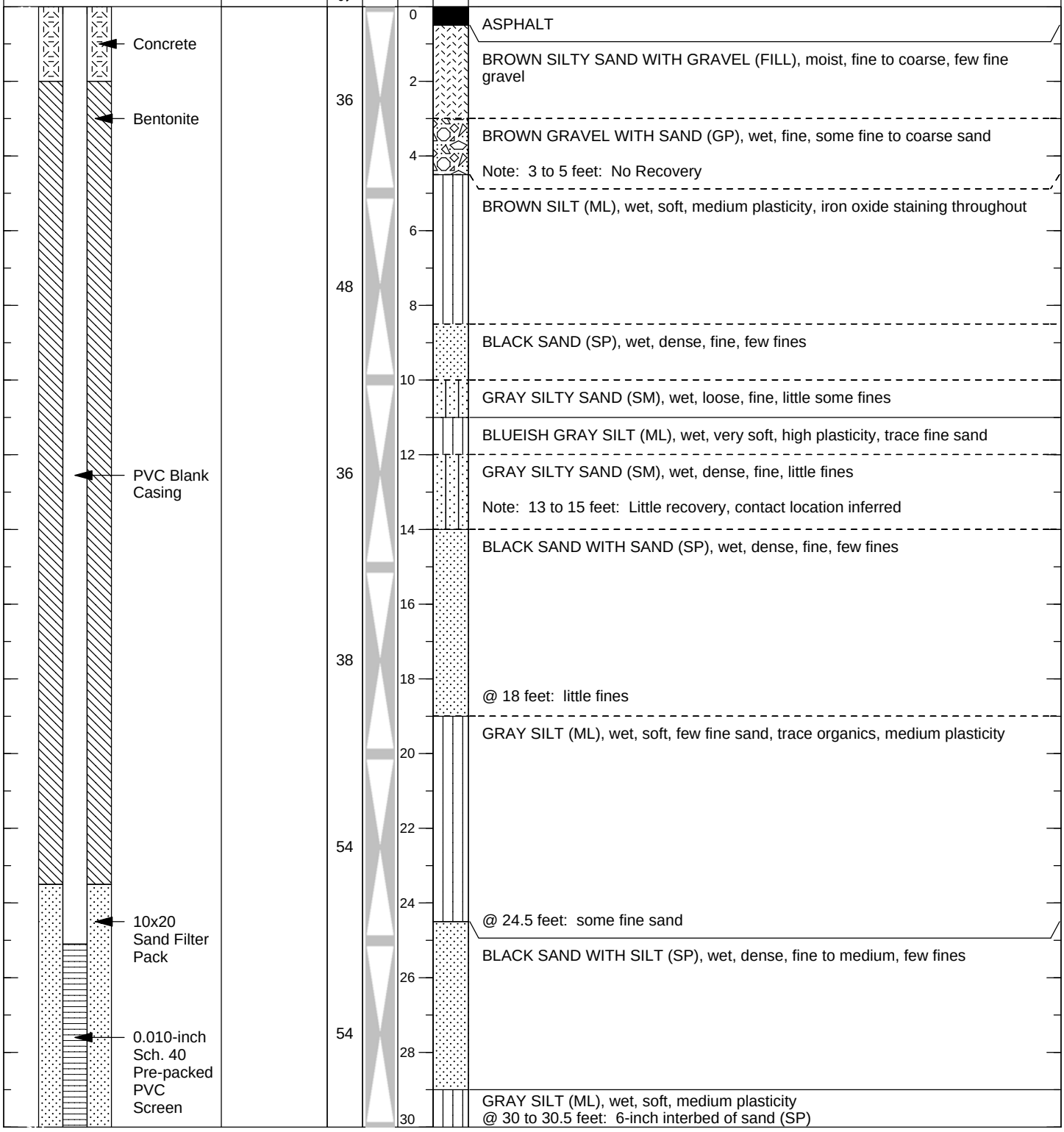
Sample ID	Sample Recovery	Sample Interval	Depth (Feet)	Graphic Log	Lithologic Description
			0		ASPHALT
	58		2		BROWN SILTY SAND WITH GRAVEL (FILL), moist, fine to coarse, few fine gravel
			4		BROWN SILTY SAND (SM), moist, fine to coarse, little fines, few fine gravel
			6		BROWN GRAVEL WITH SAND (GP), wet, fine, some fine to coarse sand
	60		8		BROWN SILT (ML), wet, soft, medium plasticity, iron oxide staining throughout
			10		GRAYISH BROWN SAND (SP), wet, dense, fine, trace fines
	60		12		BLUISH GRAY SILT (ML), wet, medium plasticity, sticky @ 12.5 to 13 feet: 6-inch interbed of sand (SP)
			14		BLACK SAND (SP), wet, fine, few fines
	36		16		
			18		
			20		Bottom of boring @ 19 feet. Well Completion Details: Well constructed with 1.5-inch i.d. Schedule 40 PVC pipe with 0.010-inch machine slotted screen, pre-packed with 20x40 Colorado Silica Sand. Total Well Depth: 19 feet. Well Sump/Endcap: 18.7 to 19 feet. Well Screen: 13.7 to 18.7 feet. Well Blank: 0 to 13.7 feet. Filter Pack: 12 to 19 feet (10x20 Colorado Silica). Well Seal: 2 to 12 (hydrated bentonite chips) Surface Seal: 0 to 2 feet (concrete). Well Monument: Flush with grade steel monument.
			22		
			24		
			26		
			28		
			30		

Project: BSB Shallow Aquifer CA Startup
Project Number: 827.001.24.006
Site Location: Kent, Washington
Logged By: Leora Doody
Notes: Ecology Well Tag Number BHK 261

Total Drilled Depth: 19 feet
Diameter of Boring: 3.5 inches
Drill Date: 12/07/11
Drilled By: Cascade Drilling, L.P.
Drill Method: Geoprobe 6600

PES Environmental, Inc.
Engineering & Environmental Services

LOG OF PIEZOMETER: P-14



Project: BSB Shallow Aquifer CA Startup
Project Number: 827.001.24.006
Site Location: Kent, Washington
Logged By: Leora Doody
Notes: Ecology Well Tag Number BHK 258

Total Drilled Depth: 31 feet
Diameter of Boring: 3.5 inches
Drill Date: 12/07/11
Drilled By: Cascade Drilling, L.P.
Drill Method: Geoprobe 6600

PES Environmental, Inc.
Engineering & Environmental Services

LOG OF PIEZOMETER: P-14

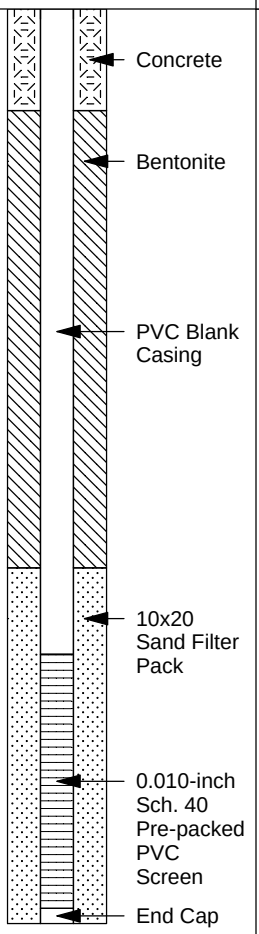
Well Completion	Sample ID	Sample Recovery	Sample Interval	Depth (Feet)	Graphic Log	Lithologic Description
End Cap Native Material (sluff)		12		30		
				32		Bottom of boring @ 31 feet. Well Completion Details: Well constructed with 1.5-inch i.d. Schedule 40 PVC pipe with 0.010-inch machine slotted screen, pre-packed with 20x40 Colorado Silica Sand. Total Well Depth: 30.4 feet. Well Sump/Endcap: 30.1 to 30.4 feet. Well Screen: 25.1 to 30.1 feet. Well Blank: 0 to 25.1 feet. Filter Pack: 23.5 to 30.4 feet (10x20 Colorado Silica). Well Seal: 2 to 23.5 (hydrated bentonite chips) Surface Seal: 0 to 2 feet (concrete). Well Monument: Flush with grade steel monument.
				34		
				36		
				38		
				40		
				42		
				44		
				46		
				48		
				50		
				52		
				54		
				56		
				58		
				60		

Project: BSB Shallow Aquifer CA Startup
Project Number: 827.001.24.006
Site Location: Kent, Washington
Logged By: Leora Doody
Notes: Ecology Well Tag Number BHK 258

Total Drilled Depth: 31 feet
Diameter of Boring: 3.5 inches
Drill Date: 12/07/11
Drilled By: Cascade Drilling, L.P.
Drill Method: Geoprobe 6600

PES Environmental, Inc.
Engineering & Environmental Services

LOG OF PIEZOMETER: P-15



Sample ID	Sample Recovery	Sample Interval	Depth (Feet)	Graphic Log	Lithologic Description
			0		ASPHALT
			2		BROWN SILTY SAND WITH GRAVEL (FILL), moist, fine to coarse, few fine gravel
	48				BROWN SILTY SAND (SM), moist, fine to coarse, little fines, few fine gravel
			4		BROWN GRAVEL WITH SAND (GP), wet, fine, some fine to coarse sand
			6		BROWN SILT (ML), wet, soft, medium plasticity, iron oxide staining throughout
	48		8		BLACK SAND (SP), wet, dense, fine, trace fines
			10		
	54		12		BLUISH GRAY SILT (ML), wet, medium plasticity
			14		BLACK SAND (SP), wet, fine, few fines
	36		16		
			18		@ 17 feet: 6-inch interbed of gray, very soft silt (ML)
			20		Bottom of boring @ 18 feet.
			22		Well Completion Details: Well constructed with 1.5-inch i.d. Schedule 40 PVC pipe with 0.010-inch machine slotted screen, pre-packed with 20x40 Colorado Silica Sand. Total Well Depth: 18 feet. Well Sump/Endcap: 17.7 to 18 feet. Well Screen: 12.7 to 17.7 feet. Well Blank: 0 to 12.7 feet. Filter Pack: 11 to 18 feet (10x20 Colorado Silica). Well Seal: 2 to 11 (hydrated bentonite chips) Surface Seal: 0 to 2 feet (concrete). Well Monument: Flush with grade steel monument.
			24		
			26		
			28		
			30		

Project: BSB Shallow Aquifer CA Startup
Project Number: 827.001.24.006
Site Location: Kent, Washington
Logged By: Leora Doody
Notes: Ecology Well Tag Number BHK 260

Total Drilled Depth: 18 feet
Diameter of Boring: 3.5 inches
Drill Date: 12/07/11
Drilled By: Cascade Drilling, L.P.
Drill Method: Geoprobe 6600

PES Environmental, Inc.
Engineering & Environmental Services

LOG OF PIEZOMETER: P-16

Well Completion	Sample ID	Sample Recovery	Sample Interval	Depth (Feet)	Graphic Log	Lithologic Description
Concrete				0		ASPHALT
				2		BROWN SILTY SAND WITH GRAVEL (FILL), moist, fine to coarse, few fine gravel
Bentonite		48				
				4		BROWN SILTY SAND (GP), wet, fine to coarse, little fines, few fine gravel Note: 5 to 6 feet: Not Sampled, contact location inferred
				6		BROWN SILT (ML), wet, soft, medium plasticity, iron oxide staining throughout
		42		8		GRAY SILTY SAND (SM), wet, dense, fine, little fines
				10		
PVC Blank Casing				12		BLUEISH GRAY SILT (ML), wet, very soft, high plasticity, trace fine sand
		60		14		BLACK SAND WITH SAND (SP), wet, dense, fine, few fines @ 14.5 feet: 7-inch interbed of silty sand (SM)
				16		
		60		18		
				20		
				22		GRAY SILT (ML), wet, soft, few fine sand, trace organics, medium plasticity
		42		24		BLACK SAND WITH SILT (SP), wet, dense, fine, few fines
10x20 Sand Filter Pack				26		
0.010-inch Sch. 40 Pre-packed PVC Screen		60		28		
				30		GRAY SANDY SILT (ML), wet, soft, some fine sand, @ 29.5 to 30.5 feet: 12-inch interbed of sand (SP)

Project: BSB Shallow Aquifer CA Startup
Project Number: 827.001.24.006
Site Location: Kent, Washington
Logged By: Leora Doody
Notes: Ecology Well Tag Number BHK 259

Total Drilled Depth: 31 feet
Diameter of Boring: 3.5 inches
Drill Date: 12/07/11
Drilled By: Cascade Drilling, L.P.
Drill Method: Geoprobe 6600

PES Environmental, Inc.
Engineering & Environmental Services

LOG OF PIEZOMETER: P-16

Well Completion	Sample ID	Sample Recovery	Sample Interval	Depth (Feet)	Graphic Log	Lithologic Description
End Cap Native Material (fill)				30		
				32		Bottom of boring @ 31 feet. Well Completion Details: Well constructed with 1.5-inch i.d. Schedule 40 PVC pipe with 0.010-inch machine slotted screen, pre-packed with 20x40 Colorado Silica Sand. Total Well Depth: 30.4 feet. Well Sump/Endcap: 30.1 to 30.4 feet. Well Screen: 25.1 to 30.1 feet. Well Blank: 0 to 25.1 feet. Filter Pack: 23.5 to 30.4 feet (10x20 Colorado Silica). Well Seal: 2 to 23.5 (hydrated bentonite chips) Surface Seal: 0 to 2 feet (concrete). Well Monument: Flush with grade steel monument.
				34		
				36		
				38		
				40		
				42		
				44		
				46		
				48		
				50		
				52		
				54		
				56		
				58		
				60		

Project: BSB Shallow Aquifer CA Startup
Project Number: 827.001.24.006
Site Location: Kent, Washington
Logged By: Leora Doody
Notes: Ecology Well Tag Number BHK 259

Total Drilled Depth: 31 feet
Diameter of Boring: 3.5 inches
Drill Date: 12/07/11
Drilled By: Cascade Drilling, L.P.
Drill Method: Geoprobe 6600

APPENDIX B

HEALTH AND SAFETY PLAN

PES Environmental, Inc.
Engineering & Environmental Services

SITE-SPECIFIC HEALTH & SAFETY PLAN

BSB PROPERTY
8202 South 200th Street,
Kent, WA
BSB Diversified Company, Inc.

Prepared by:
PES ENVIRONMENTAL, INC.
1215 Fourth Avenue, Suite 1350
Seattle, Washington 98161
206-529-3980

Project Number: 827.001.035

Date: **11/04/2015**
Revision: **3.0**

Copy #: _____ ☐Controlled ☐Uncontrolled

SITE HEALTH AND SAFETY PLAN REVIEW AND APPROVALS

BSB Property
8202 S 200th Street,
Kent, WA

PES Environmental, Inc. (PES) has developed this Site-Specific Health and Safety Plan (HASP) for use by PES, its subcontractors, and visitors to the BSB Property. PES claims no responsibility for its use by others. This plan covers activities with the potential for exposure to contaminated environmental media during the project. The intent of this plan is to meet the requirements of the Washington State Division of Occupational Safety and Health (DOSH) Hazardous Waste Operations Regulation (WAC 296-843). It is not intended to address normal safety practices on construction sites, such as those covered in the DOSH Safety Standards for Construction Work (WAC 296-155). Finally, even with this plan in place, each subcontractor remains responsible for the health and safety of their own individual employees and subcontractors.

Note: This plan is written for the specific site conditions, purposes, dates, and personnel specified. This HASP must be re-evaluated and updated annually or when site conditions or scope of work changes.

Project Number: 827.001.035

Date: **11/04/2015**
Revision: **3.0**

Approved by: _____ Date: _____
William R. Haldeman, LHG, R.G.
Associate Hydrogeologist

Approved by: _____ Date: _____
Brian O'Neal
Associate Engineer

TABLE OF CONTENTS

1.0 HEALTH AND SAFETY CONTACT INFORMATION

SITE LOCATION:	BSB Property 8202 S 200th Street, Kent, WA

See Attached Figure 1 for Site Plan and Directions

PROJECT MANAGER:	Bill Haldeman, PES 206-529-3980 ext. 107 (desk) 425-922-0254 (mobile)
PROJECT ENGINEER:	Brian O'Neal, PES 206-529-3980 ext. 104 (desk) 425-241-2627 (mobile)
SEATTLE HEALTH & SAFETY OFFICER:	Kelly Rankich, PES 206-529-3980 ext. 117 (desk) 206-303-7915 (mobile)
CLIENT CONTACT:	John FitzSimons, BSB (845) 790-9550
NEAREST WALK-IN CLINIC:	North Benson Clinic Urgent Care 10555 SE Carr Rd. Building M 425-656-4270
NEAREST HOSPITAL:	Valley Medical Center 400 South 43rd Street, Renton, WA 425-228-3450

See Attached Figure 2 for a Route to the Hospital

2.0 SCOPE OF WORK

This HASP is intended to cover activities in areas where contamination may be encountered at the BSB Property 8282 South 200th Street, Kent, WA. These activities include:

- Water level monitoring and groundwater sampling activities
- Groundwater Pretreatment system O&M

The PES Safety Practices for Field Personnel is included with this plan as Appendix A. A job hazard analysis that evaluates the hazards associated with each of these tasks is included with this HASP as Appendix B. The job hazard analysis includes more detail on specific tasks to be performed as part of this project.

This HASP is limited to the activities listed above. If PES personnel are involved in any additional activities for this project, this HASP must be revised to address the specific health and safety concerns related to those activities. Such work cannot be initiated until the revised HASP has been updated and approved.

3.0 SITE CHARACTERISTICS

3.1 Site Location and Description

The BSB Property site is located on the south side of South 200th Street, west of 84th Avenue South in Kent, Washington. The 4.2-acre Property is currently a fenced, vacant lot that slopes gently to the north. The area surrounding the Property is topographically flat and is zoned "Limited Industrial." The Property is bounded on the north by South 200th Street and the Hexcel Corporation (Hexcel) industrial facility. Commercial and industrial park properties are located to the west and south of the Property, and the Carr industrial facility is immediately to the east of the Property.

3.2 Site History

The Hytek Finishes Company formerly operated a metal finishing and electroplating plant at the site. The plant was located north of 200th Street, and wastes were formerly treated and stored in a waste treatment area located south of 200th Street. The waste treatment area contained a wastewater holding lagoon, treatment tanks, a sludge holding lagoon, sludge drying beds, and a chemical storage area.

As a result of past activities on the site, the following contaminants have been identified in soil and groundwater:

- Tetrachloroethene (PCE)
- Trichloroethene (TCE)
- Cis-1,2-dichloroethene (cDCE)
- Vinyl chloride (VC)

4.0 PERSONNEL REQUIREMENTS

4.1 Employee and Contractor Responsibilities

Each person is responsible for his/her own health and safety, for completing tasks in a safe manner, and for reporting any unsafe acts or conditions to his/her supervisor and the Project Manager (PM). All persons on site are responsible for continuous adherence to health and safety procedures during the performance of any project work. In no case may work be performed in a manner which conflicts with the intent of, or the inherent safety precautions expressed in, this HASP or the client's health and safety policies.

After due warning, persons who violate procedure and work rules may be dismissed from the site, terminated, or have their contract revoked. Blatant disregard or repeated infractions of health and safety policies are grounds for disciplinary action up to, and including, dismissal, and/or removal from the project.

All PES and subcontractor personnel are required to read and acknowledge their understanding of this HASP. Safety acknowledgement forms are included in Appendix C. All project personnel are expected to abide by the requirements of this HASP and cooperate with project

management and safety representatives in ensuring a safe and healthful work site. Site personnel are required to immediately report any of the following to the Site PM or Project Scientist:

- Accidents and injuries, no matter how minor;
- Unexpected or uncontrolled release of chemical substances;
- Any sign or symptoms of chemical exposure;
- Any unsafe or malfunctioning equipment; and
- Any changes in site conditions which may affect the health and safety of project personnel.

No one is permitted on site without prior approval of the PES Project Supervisor or Project Manager or their designee.

4.2 Specific Site Organization Structure

Team Member	Function
Bill Haldeman	Project Manager (PES)
Nick Pogoncheff	Corporate Health and Safety Manager (PES)
PES Site Workers	Site Safety Officer (PES)
Russell Stolsen	Site Worker (PES)
Karsten Springstead	Site Worker (PES)
Chris DeBoer	Site Worker (PES)

Duties of the PM include:

- Maintain control, authority, and responsibility for health and safety on the project;
- Act as the liaison with the client regarding project health and safety to ensure adequate precautions are made for protection of PES staff;
- Support the Corporate Health and Safety Manager in developing the HASP;
- Support the Site Safety Officer (SSO) in providing the required equipment and authority required to carry out the project safely; and
- Maintain and provide quality control of all health and safety documentation, including site briefing forms, HASP signature sheet, air monitoring records, accident reports, etc.

Duties of the Corporate Health and Safety Manager include:

- Develop and coordinate the HASP;
- Determine appropriate monitoring, if necessary, so that employees are not exposed to hazardous substances above established Permissible Exposure Limits (PELs) or action levels per this plan;
- Communicate requirements to the PES Project Manager;
- Respond to field requests for assistance in safety and health from PES employees and the SSO; and

- Provide assistance in obtaining training of site workers, hazard communication, and other assistance, as required.

Duties of the SSO include:

- Maintain sign in sheets for daily briefings and HASP review for PES employees and subcontractors;
- Ensure PES responsibilities for safety and health are being implemented by daily inspections;
- Communicate requirements to field personnel and subcontractors;
- Consult with the PES Corporate Health and Safety Manager and PM regarding new or unanticipated site hazards;
- Perform safety record keeping; and
- Verify that medical monitoring and training have been performed.

Duties of the Site Workers include:

- Conduct daily safety briefings;
- Read and follow the HASP;
- Check all personal safety equipment to ensure it is in good working condition prior to entering the site;
- Monitor site conditions during work activities where hazardous environments may be present;
- Implement Site Safety and Health requirements in the field;
- Record any variances in conditions;
- Record any illness, disease, injury, or death of any person on the site;
- Immediately report any accidents/illness, spills, unsafe conditions, any unusual smells or chemical smell to the SSO;
- Incidents must be reported on a daily basis in detail for spills or accidents; and
- Immediately report any symptoms of exposure.

4.3 Training

4.3.1 Classroom Training

All personnel conducting site work involving intrusive activities where the potential exists for exposure to contaminated soils or groundwater (drilling, excavation, trench work, etc.) shall have completed 40 hours of classroom-style health and safety training and three days of on-site training, as required by OSHA 29 CFR 1910.120 and WAC 296-843. In addition, the PM and Project Engineer have received an additional eight hours of supervisory training specified by the same regulations.

Forty-hour hazardous waste site trained personnel shall also be current in their annual refresher training and enrolled in the medical surveillance program which shall include the employee's ability to wear respiratory protection devices.

Personnel performing work activities that are non-intrusive or otherwise not expected to expose them to hazardous chemicals, contaminated soil, or groundwater (concrete cutting, electricians,

plumbers, surveyors, etc.) are not required to hold the 40-hour hazardous waste training. They shall receive site-specific training concerning the potential hazards associated with this project site.

4.3.2 Field Training

An initial site-specific training session or briefing shall be conducted by the PM or SSO prior to commencement of work and/or entering the site. During this initial training session, employees shall be instructed on the following topics:

- Personnel responsibilities;
- Content and implementation of the HASP;
- Site hazards and controls;
- Site-specific hazardous procedures (i.e., intrusive activities, etc.);
- Limited access to and around intrusive work activities (i.e., electricians, plumbers, etc.);
- Medical and training requirements;
- Use of direct reading monitoring equipment;
- Levels of protection;
- Action levels for upgrading/downgrading levels of personal protective equipment (PPE); and
- Emergency information, including local emergency response team phone numbers, route to nearest hospital, and emergency response procedures.

In addition to the initial site briefing conducted at the commencement of the project, supplemental brief safety meetings shall be conducted by the SSO to discuss potential health and safety hazards associated with upcoming tasks, and necessary precautions to be taken.

4.4 Medical Surveillance

Employees assigned to duties on hazardous waste sites or that require them to wear respirators will, prior to work, be assessed by a physician to determine if they are qualified for the scheduled work. The PES Occupational Health Care Provider for hazardous waste and respiratory protection medical monitoring is:

Valley Medical Occupational Health Clinic
3600 Lind Avenue SW, Suite 170
Renton, Washington
(425) 656-5020

Prior to assignment to duties requiring the use of respirators, each employee will be evaluated by a physician. A description of the type of respirator, duties to be performed, and any other pertinent information will be provided to the physician. The examination will include, but not be limited to the following:

- A history of family, individual, and prior chemical exposures (either work or hobby). This is usually in the form of a written questionnaire;
- A "hands-on" examination by the physician;
- Spirometry testing (test of lung capacity); and
- Other tests that the examining physician feels are advised or as necessary per WAC 296-849-120 (Exposure and Medical Monitoring – benzene exposure).

A written report of findings will be made on each employee listing any restrictions. The medical status of the employees will be assessed at least annually or more often if circumstances indicate the need.

5.0 SITE CONTROL

5.1 Work Area Control

This project requires that access to the work area be controlled to protect both the worker and the public. This access control may require fences, barricades, traffic control devices, use of flaggers, caution tape, and other methods to keep the work area secure and provide a visual barrier to help keep the curious or unaware public from entering active work areas.

5.2 Work Zones

Site control will be maintained by establishing clearly identified work zones. These will include the exclusion zone, decontamination zone (contaminant reduction zone), and support zone, as defined below.

5.2.1 Exclusion Zone

Only persons with appropriate training (40-hour Hazardous Waste Operations/8-hour Refresher) and authorization from the SSO will enter this zone. Traffic cones, barrier tapes, and warning signs will be used, as necessary, to establish the zone boundary.

5.2.2 Decontamination Zone (Contaminant Reduction Zone)

A decontamination zone (contaminant reduction zone) will be established just outside each temporary exclusion zone to decontaminate equipment and personnel, as discussed below. This zone will be clearly delineated from the exclusion zone and support zone using traffic cones, barrier tapes, and warning signs as necessary. The decontamination zone may have boot, glove, and rain gear wash and rinse buckets/wading pools, brushes, and a source of additional water (hose or water buckets) for cleaning. Used wash water will be collected for removal as contaminated water. Care will be taken to prevent contact with used wash water on a daily basis. Damaged or disposable PPE will be placed in plastic garbage bags for interim storage and disposal, as appropriate.

5.2.3 Support Zone

A support zone will be established outside the contamination reduction area to stage clean equipment, don protective clothing, take rest breaks, rehydrate, etc. This zone will be clearly delineated from the decontamination zone and exclusion zone using the means noted above.

6.0 SITE HAZARD INFORMATION

The job hazard analysis for this project is attached to this Plan as Appendix B. The job hazard analysis includes more detail on specific hazards identified.

6.1 Chemical Hazards

The chemical hazards identified at this site include the following:

- Tetrachloroethene (PCE)
- Trichloroethene (TCE)
- Cis-1,2-Dichloroethene (cDCE)
- Vinyl chloride (VC)

The primary routes of exposure for these contaminants are the inhalation of vapors, gases or particulate, inhalation of contaminated soil particulate, direct skin contact with contaminated media, or the accidental ingestion of contaminated soil or water. See Appendix D for information about each of these chemicals.

The identified site contaminants and maximum documented concentrations are listed in Table 1 below. The DOSH Permissible Exposure Limit (PEL) for each contaminant is listed.

Table 1
Maximum Concentration Encountered or Anticipated On Site

Potential Site Contaminants	Concentration in Groundwater (ppm)	Concentration in Soil-Gas (ppm)	PEL-TWA (STEL or Ceiling)
Total VOCs	115	Unknown	100 ppm (naphtha limit)
1,1-Dichloroethene (1,1-DCE)	0.05	Unknown	None
cDCE	42	Unknown	200 ppm
1,1-Dichloroethane (1,1-DCA)	0.067	Unknown	100 ppm
Methylene chloride	0.027	Unknown	25 ppm (ST = 125 ppm)
PCE	0.004	Unknown	100 ppm (C = 200 ppm)
1,1,1-Trichloroethane (TCA)	0.005	Unknown	350 ppm (ST = 450 ppm)
TCE	77	Unknown	100 ppm (ST = 200 ppm)
VC	59	Unknown	1 ppm (ST = 5 ppm)

TWA = 8 hour time-weighted average
STEL = Short-term exposure limit

6.2 Physical Hazards

The physical hazards identified at this site include the following:

- Slip/Trip/Hit Fall Hazards
- Dust/Wind
- Facility/Traffic
- Hand and Power Tools

- Noise
- Back Injury/Heavy Lifting
- Heat Stress
- Cold-Related Illnesses

The PES Safety Practices for Field Personnel is included with this plan as Appendix A. Safety procedures and guidelines for these site-specific hazards are attached to this plan in Appendix B.

6.3 Biological Hazards

Specific activities that involve site walkovers in highly vegetated areas may pose potential exposure to insects, plants, and bacteria. No biological hazards are expected to be encountered at the Site.

7.0 SITE HAZARD CONTROL

The job hazard analysis for this project is attached to this Plan as Appendix B. The job hazard analysis includes more detail on specific hazard controls.

7.1 Administrative Controls

Avoid exposure to vapors and contaminated dust by working upwind of borings, wells, and other sources of contamination whenever possible. Avoid skin contact with contaminants by wearing specified PPE when working near contaminated soil or water. Avoid exposure via inadvertent ingestion by refraining from eating, drinking, smoking, or chewing gum while working, and by washing hands and face thoroughly before breaks and at the end of the shift.

7.2 Engineering Controls

If feasible, use intrinsically safe portable fans to control the concentration of volatile organic compounds in the employee's breathing zone prior to the use of respiratory protection devices. Avoid or eliminate activities that may cause generation of contaminated soil dust.

7.3 Personal Protective Equipment

The initial protection level for all site activities is Level D. As site activities progress, levels of PPE are subject to change or to modification. Upgrading of PPE can occur when action levels are exceeded or whenever the need arises to protect the safety and health of site personnel. Levels of PPE will not be downgraded without prior approval from the Project Health and Safety Manager or Technician.

Table 2
Protection Levels

Activity	Initial Level of Protection	Equipment Requirements
General site activities outside of the exclusion zone	D	Work clothing, hardhat, steel-toed work boots, and eye protection. Wear traffic vests on site if working during vehicular traffic hours or around heavy equipment. Work gloves, if required.
Drilling, well installation or decommissioning, and well development (if applicable)	D	Protection for General Site Activities, plus wear nitrile gloves and Tyvek coveralls when the possibility exists for contact with contaminated water or soil. Change gloves frequently to minimize the chance for breakthrough. Use a face-shield if the chance exists for splash onto face or clothing, and hearing protection when working near a drill rig. Upgrade to Level C protection if exposure monitoring results warrant.
Groundwater monitoring and sampling	D	Protection for General Site Activities, plus wear nitrile gloves when the possibility exists for contact with contaminated water. Change gloves frequently to minimize the chance for breakthrough. Use a face-shield if the chance exists for splash onto face or clothing. Upgrade to Level C protection if exposure monitoring results warrant.

7.4 Decontamination

7.4.1 Personnel

Procedures for decontamination must be followed to prevent the spread of contamination and to eliminate the potential for chemical exposure. A decontamination station will be set up at each activity site where contaminated media may be encountered in the contamination reduction zone. Personnel are expected to perform a gross decontamination prior to leaving the exclusion zone of any of these sites. All personnel working in the exclusion zone are expected to observe decontamination procedures.

The Support Zone will contain:

- Restroom facility;
- Drinking water and cups;
- First aid kit;
- Extra gloves and chemical-resistant clothing, as required; and
- Towels and wipes.

Gross Decontamination includes:

- Remove coveralls and gloves;
- Spray off rain gear and rubber gloves;
- Wash hands and face.

Drink breaks are to be taken at the outside edge of the contamination reduction zone following decontamination.

7.4.2 Vehicles and Heavy Equipment

The surfaces of all heavy equipment that come into contact with contaminated soils or water will be cleaned prior to removal from site with power-washer or heavy brooms. The SSO is responsible for assuring decontamination activities are sufficient at minimizing the potential for transport of contaminants off-site.

8.0 AIR MONITORING

The following is the air monitoring plan for the project:

8.1 Volatile Organic Compounds

Exposure monitoring for volatile organic compounds shall be conducted using a photoionization detector (PID) whenever visible sheens or product odors are present. The exposure monitoring shall be conducted in the worker's breathing zone (BZ) every 15 minutes while odors or visible sheens exist, and readings recorded in a field notebook. Exposure monitoring for VOCs shall be performed every five minutes if PID readings approach 5 ppm in the BZ.

If air concentrations of organic vapors in the worker's BZ should meet or exceed 5 ppm for a time period greater than five minutes, workers will be required to upgrade to Level C personal protective equipment, including the use of air-purifying respirators (equipped with organic vapor/HEPA cartridges), unless the non-presence of vinyl chloride/benzene is confirmed through the use of Draeger tubes.

Upgrade to Level C protection immediately if VOC concentrations exceed 10 ppm in the worker's BZ. If organic vapor concentrations drop back down below 5 ppm, the level of personal protective equipment can be downgraded to Level D protection.

If VOC concentrations in the worker's BZ exceed 25 ppm, the area must be evacuated and allowed to ventilate to less than 25 ppm in the BZ. If VOC concentrations exceed 100 ppm in the worker's BZ, the area will be evacuated.

Table 3
Exposure Monitoring Action Levels

Activity	Instrument*	Action Level**	Level of Protection
General site activities, excavation, drilling, and well installation / abandonment activities	Use a PID to conduct exposure monitoring whenever product odors or visible sheens are present.	5 ppm or greater in the BZ for > 5 minutes	Level C unless the non-presence of vinyl chloride or benzene is confirmed using Draeger tubes.
		> 10 ppm in the BZ	C
		> 25 ppm in the BZ	Evacuate area, contact Project H&S Manager, allow area to ventilate
		> 100 ppm in the BZ	Evacuate area
Any type of hot work, or other work that could produce sparks	LEL meter or Methane Meter	LEL < 10%	Continue work
		LEL 10 to 20%	Ventilate to reduce LEL and Continue work
		LEL > 20%	Stop any hot work or spark producing activity, evacuate area until levels are below 10%
NOTE: * = monitoring instruments shall be calibrated and maintained according to manufacturers' specifications and at a minimum calibration shall occur once daily. ** = action levels should be based on DOSH PELs.			

The discovery of any condition that would suggest the existence of a situation more hazardous than anticipated shall result in the evacuation of site personnel and re-evaluation by the safety officer and project manager of the hazard and the level of protection.

9.0 EMERGENCY RESPONSE

Emergencies can range from minor to serious conditions. Various procedures for responding to site emergencies are listed in this section. The Site Superintendent (SS) is responsible for contacting local emergency services in emergency situations. Various individual site characteristics will determine preliminary action to be taken to assure that these emergency procedures are successfully implemented in the event of an emergency. Emergency contact information is in Appendix E of this HASP and posted in the job site office.

In the event of an uncontrolled release of hazardous materials on the site, PES will evacuate immediately. They will not perform emergency response operations such as spill cleanup, rescue, or any other critical tasks. PES will rely on emergency responders to perform those tasks.

9.1 Accident, Injury, and Illness Reporting and Investigation

PES employees are required to immediately report to their direct supervisor all occupational injuries, illnesses, accidents, and near miss incidents having the potential for injury. Any supervisor (but preferably the supervisor directly responsible for the involved employees) with first-hand knowledge of an incident is required to:

- Immediately arrange for appropriate medical attention and notify the responsible health and safety representative.

- Inform the PES Corporate Health and Safety Officer of all incidents requiring medical attention by calling 1 (800) 737-4450. Provide the following information:

- Employee name
- Name of treating medical facility and phone number
- Brief description of incident

Injury and/or incident reports, including those involving motor vehicles, must be submitted to the appropriate health and safety representative within one business day of the incident.

Subcontractor employees shall notify their supervisors and the associated PES Project Manager of any incidents or injuries while engaged in a PES project.

9.2 Emergency Procedures for Contaminated Personnel

Whenever possible, personnel should be decontaminated in the contamination reduction zone before administering first aid.

Skin Contact — Remove contaminated clothing, wash immediately with water, use soap, if available.

Inhalation — Remove victim from contaminated atmosphere. Remove any respiratory protection equipment. Initiate artificial respiration, if necessary. Transport to the hospital.

Ingestion — Remove from contaminated atmosphere. Do not induce vomiting if victim is unconscious. Also never induce vomiting when acids, alkalis, or petroleum products are suspected. Transport to the hospital, if necessary.

9.3 Emergency Equipment/First Aid

The emergency equipment to be located on site either in site trailers or company vehicles include at a minimum:

- First aid kit;
- Emergency eye wash;
- ABC fire extinguisher;
- Potable water; and
- Telephone/two-way radios.

9.3.1 Site Evacuation

In the event of an emergency situation such as fire, explosion, significant release of toxic materials, an air horn or other appropriate device will be sounded for approximately 10 seconds indicating the initiation of evacuation procedures. Personnel in the field will be notified through radio communications to evacuate the area. All personnel in both the restricted and non-restricted area will evacuate and assemble near the Support Zone or other safe area as identified by the SM prior to the beginning of field operations. The location shall be upwind of the site, if possible. The evacuation routes and muster points are indicated on the site plan in Figure 1 of Appendix E.

9.3.2 Spill and Release Contingencies

If a spill has occurred, the first step is controlling the spread of contamination if possible. The site Supervisor will immediately contact site Project Management to inform them of the spill and activate emergency spill procedures.

APPENDIX A

PES SAFETY PRACTICES FOR FIELD PERSONNEL

Field operations shall be conducted in accordance with the minimum safety practices described below required for all PES employees on all projects.

1.0 GENERAL SITE SAFETY

1.1 Safe Driving

Operators of vehicles on company business must:

- Evaluate conditions of the vehicle and observe deficiencies of the vehicle before commencing operation.
- Driver must be in possession of a valid driver's license.
- Wear seat belts/available safety restraint systems in all vehicles.
- Drive defensively, be courteous, and obey all traffic rules and regulations.
- Do not exceed posted speed limits.
- Do not pick up hitchhikers.
- Do not use cell phones while driving.
- Under no circumstances should a PES employee operate a vehicle while under the influence of intoxicating beverages, drugs, or other substances.
- Operate the vehicle at a SAFE speed in cases of inclement weather, heavy traffic, or other road hazards. Be especially aware of the hazards of black ice, particularly on bridges and overpasses.
- Remove keys and lock unattended vehicles.

All accidents involving a vehicle being operated on business, regardless of circumstances or severity, will be reported to the Project Manager within 24 hours. It is important to note that this is done not to find fault, but to analyze specific incidents for future accident prevention.

1.2 Facility/Traffic

Cargo/transfer terminal sites and other work sites with high traffic flow and limited visibility present a significant hazard to PES field staff. Since this is an area of extremely high risk, it is important that the following health and safety policies and procedures are followed. While visual devices are generally effective, the use of a structural barrier (such as a company vehicle) is a more sure method of protection should a vehicle driver fail to see an employee. Barriers shall be used on work sites when it is possible to do so without adversely affecting the project work or other client considerations. Employees are reminded to maintain a high degree of awareness of moving vehicles on the site. The following guidelines concerning traffic warning devices should be followed when working in traffic flow areas:

- Meet with the Facility Manger or Client Contact at the start of fieldwork to discuss equipment and personnel access to the work area;
- Obtain any facility-related emergency information, i.e., facility alarms, response phone numbers, evacuation areas, and special hazards;

- High visibility vests shall be worn by employees when working around traffic flow areas. Ensure that there is a clear line of sight between approaching traffic and the work area;
- Orange cones are typically used to direct traffic flow on roadways, but are not always appropriate as a flagging device on PES project sites. Due to the low height, a cone can be easily overlooked, especially when a motorist is backing up. Tubular markers at least 4-feet high with flags attached at the top are more visible. Alternatively, type I barricade with flagging at the top may be used. One option often used with cones is to place an object on the cones that will make noise if struck by a car; and
- When two or more PES employees are together on a site and a site specific activity has a high risk of impact from vehicular traffic, one employee shall act as a look-out for the other employee performing the specific work activity.

1.3 Hazardous Waste Sites

- PES field personnel are to be thoroughly briefed on the anticipated hazards, equipment requirements, safety practices, emergency procedures, and communications methods, both initially and in daily briefings.
- At sites with known or suspected contamination, appropriate work areas for field personnel support, contaminant reduction, and exclusion will be designated and maintained.
- Eating, drinking, chewing gum or tobacco, smoking, or any practice that increase the probability of hand-to-mouth transfer and ingestion of materials is prohibited in any area where the possibility of contamination exists.
- Hands must be thoroughly washed when leaving a contaminated or suspected contaminated area before eating, drinking, or any other activities.
- Contaminated protective equipment shall not be removed from the work area until it has been properly decontaminated or containerized on site.
- Avoid activities that may cause dust. Removal of materials from protective clothing or equipment by blowing, shaking, or any means which may disperse materials into the air is prohibited.
- All field personnel will, whenever possible, remain upwind of drilling rigs, open excavations, boreholes, etc.
- Field personnel are specifically prohibited from entering into excavations, trenches, or other confined spaces deeper than 4 feet. Unattended boreholes must be properly covered or otherwise protected.

1.4 Respiratory Protection

- The PES Respiratory Protection Program will be followed whenever a respirator is required.
- Field personnel must use the "buddy system" when wearing any respiratory protective devices. Communications between members must be maintained at all times. Emergency communications shall be prearranged in case unexpected situations arise. Visual contact must be maintained between pairs on site, and team members should stay close enough to assist each other in the event of an emergency.
- Personnel should be cautioned to inform each other of subjective symptoms of chemical exposure such as headache, dizziness, nausea, and irritation of the respiratory tract.

- No excessive facial hair that interferes with a satisfactory fit of the facepiece-to-face seal will be allowed on personnel required to wear respiratory protective equipment.
- The selection, use, and maintenance of respiratory protective equipment shall meet the requirements of established PES procedures, recognized consensus standards (AIHA, ANSI, NIOSH), and shall comply with the requirements set forth in 29 CFR 1910.134 and WAC 296-841.

1.5 Back Injury Prevention

Back injuries on the job are costing employers in the U.S.A. approximately 6.5 billion annually. Eight out of ten people will suffer a back injury during their life time, either on or off the job. Many of these injuries could be prevented by adhering to the following proper lifting concepts:

- Keep the load close to the body. Arrange tasks so that the load will be close to the body and at a proper and safe height which will not require bending or stooping. Tighten stomach muscles to offset the force of the load.
- Keep the load within reach. Try to arrange tasks to eliminate handling loads below 20 inches or above 50 inches. Try to keep the lifting zone between your shoulders and the knuckles.
- Control the load size. Loads which extend beyond 16 inches in front of the body put excessive lifting stress on the body and should be handled by two people or lifting aids should be employed.
- Maintain proper alignment of body. The task should be designed so that twisting of the body is minimized or eliminated. Twisting while carrying a load increases injury potential significantly.
- Lift with your legs. Your leg muscles are the strongest in your body. Always bend your knees and use your leg muscles when you go toward the floor whether you have a load or not. Do not bend at your waist if it can be avoided.
- Balance your load if possible. An evenly balanced load is much easier and much safer to handle than an off balance load. Grasp the object at opposite corners if possible.
- Avoid excessive weights if possible. Mechanical aids should be used for loads which are greater than those which can be handled safely by one person.
- Lift in a comfortable manner. Workers should use a lifting position that feels comfortable for them, however, they should bend their knees and keep their back as straight as possible when performing a lift. Your feet should be shoulder width apart in order to get the best footing possible.
- Lift smoothly and gradually. Quick jerking lifting motions increase sudden and abrupt stress to the back. This type of aggressive movement can affect the discs, muscles, and the ligaments. A well controlled and smooth lifting motion will reduce the likelihood of injury.
- Most importantly, think before lifting.

In addition to these lifting techniques it is also important to implement the proper carrying techniques as follows:

- Eliminate carrying where possible. If possible, conveyors, trucks, small loaders, and other mechanical equipment should be considered. Carts and dollies should be employed when surface conditions permit. Surface conditions can be altered with plywood or other materials.
- Use two-handed carries where possible. Using a two handed carry method helps to balance the load even out the body stress.

- Keep the load close to the body. Keeping the load in close and lifting in as erect a position as possible helps to reduce the stress to the lower spine.
- Keep your arms straight. Less stress is created on the muscles and ligaments when your arms are kept straight during a carry. Contraction of the muscles will quickly increase fatigue and the possibility of an accident.
- Balance the load. A balanced load is similar to the two handed carry. The load is evenly distributed across the body and the stress is also evenly shared.
- Avoid carrying any material on stairs. Carrying on stairs will obstruct your vision and increase the likelihood of slip and fall. The bumping of the load on your leg as you climb or descend increase the chance of an injury.
- Reduce the weight if possible. When the weight of the lifts is high look for ways to reduce the weight. Use smaller containers, put less in containers, indicate fill levels, and locate lighter containers.
- Use handles. Make the task easier by adding handles where possible. If numerous repetitions are required, it may be possible to design a handled device to accommodate a two handed carrying task.

In addition to these lifting and carrying techniques it is also important to consider pushing and pulling tasks:

- Eliminate manual pushing and pulling where possible. Look at those tasks that are repeated often to see if they can be modified or altered in a way that reduces pushing and pulling. consider mechanical aids, powered conveyors, gravity slides, and chutes.
- Reduce the necessary force. Force required is a function of weight, gravity and friction. Look for opportunities to reduce these factors. Improved bearings, larger wheels, reduced weight, improved rolling surfaces, lubrication, and improved regular maintenance are all opportunities for reducing work force and stress.
- Push load instead of pulling. Studies indicate that pushing loads rather than pulling them is the safest approach. There is less stress on muscles, joints, and ligaments. As in lifting, pushing pressure should be applied firmly, but gradually. Avoid aggressive impacts.

There are also a number of guidelines to follow when addressing tasks that involve shoveling operations:

- Choose correct shovel type. The shovel should be appropriate for the material and the project. Light, loose, and fluffy materials should be handled with a scoop type shovel. A smaller shovel like a spade should be used for more dense material.
- Use a long-handled shovel. A long handled shovel should be provided to avoid stooping during shoveling activities. Take the time to obtain the correct tool for the job.
- Maintain load to 10 pounds per shovelful. The general rule of thumb for the average work situation is 10 pounds per shovel load. Work performed is a function of repetition and load. Increasing shovel loads will increase fatigue as repetitions increase and it will also increase the potential for injury.

Drum handling operations can be made safer by considering the following techniques:

- Use a drum cart where feasible. A four wheel cart is preferred for drum handling because it is more stable, better latched, and has a better handle positioning. In addition, it is more easily tipped back and held in place when the drums are loaded.
- Do not rotate from horizontal to vertical unless nearly empty. Only empty or nearly empty drums should be rotated from horizontal to vertical. A tipster or forklift with a proper drum handling attachment is the preferred method.
- Use handling equipment for moving drums from one level to another. Whenever possible pallets, scales, and conveyors should be recessed in the floor to avoid raising drums to another level. If not, drums should be handled on a low platform or an incline adapter should be provided.
- Limit drum weight to 450 to 500 pounds. Regardless of the material involved, drums should only be filled to a maximum weight of 700 pounds. Drums over 300 pounds shall not be handled by hand. Use of mechanical equipment is required. *(Example: water = 8.6 lb per gallon x 52 gallons = 447.2 lbs)*
- Limit travel distance to 30 feet. The other general guideline regarding drum handling involves keeping drum transport to a maximum of thirty feet.

1.6 Slip / Trip / Hit / Fall Hazards

Slip/trip/hit and fall injuries are the most frequent of all injuries to workers. They occur for a wide variety of reasons, but can be minimized by the following prudent practices:

- Spot check the work area to identify hazards;
- Establish and utilized a pathway which is most free of slip and trip hazards;
- Beware of trip hazards such as wet floors, slippery surfaces, and uneven surfaces or terrain;
- Carry loads which you can see over;
- Keep work area clean and free of clutter, especially in storage rooms and walkways;
- Communicate hazards to on-site personnel;
- Secure all loose clothing, ties, and remove jewelry while around machinery;
- Report and/or remove hazards; and
- Keep a safe buffer zone between workers using equipment and tools.

2.0 CONSTRUCTION SAFETY

2.1 Utility Clearance

- Subsurface work shall not be performed at any location until the area has been cleared by a utility locator firm to be free of underground utilities or other obstructions.
- Elevated superstructures (e.g., drill rig, backhoe, scaffolding, ladders, cranes) shall remain a distance of 10 feet away from utility lines and 20 feet away from power lines. Distance from utility lines may be adjusted by the Project Manager or request information from the project Health & Safety Manager, depending on actual voltage of the lines.

2.2 Drilling Safety

The following practices shall be adhered to when working around drill rigs.

- Be aware of overhead obstructions.
- Employees working around drill rigs shall not wear any loose-fitting clothing which has the potential to caught in moving machinery.
- During freezing weather, do not touch any metal parts of the drill rig with exposed flesh. Freezing of moist skin to metal can occur almost instantaneously.
- Adequately cover or protect all unattended boreholes to prevent drill rig personnel or site visitors from stepping or falling into the borehole.
- Personnel shall wear steel-toed shoes, safety glasses, hearing protection and hard hats during drilling operations.
- The area shall be roped off, marked or posted, to keep the area clear of pedestrian traffic or spectators.
- All personnel should be instructed in the use of the emergency kill switch on the drill rig.

2.3 Heavy Equipment Operations

Working around heavy equipment can be dangerous because of the size and power of the equipment, the limited operator field of vision, and the noise levels that can be produced by the equipment. Heavy equipment to be utilized at the site may include a variety of backhoes, dozers, track loaders, and off-road trucks.

The following practices shall be followed by operators when using heavy equipment.

- Equipment shall be inspected daily by the operator to ensure that the equipment is in safe operating condition.
- No riding on vehicles or equipment except in fixed seats.
- Seat belts shall be worn at all times.
- Backup alarms, automatically activated and loud enough to be heard above background noise are required on all heavy equipment.
- Parking brakes should always be applied on parked equipment.
- Equipment should never be operated closer than 10 feet from utility lines.
- Windshields must be maintained clean and free of visual obstructions.

To ensure the safety of PES personnel in the work area, the following safety procedures regarding heavy equipment must be reviewed prior to and followed during work activities:

- Ensure that equipment operators are trained and/or experienced in the operation of the specific equipment.
- Personnel should never approach a piece of heavy equipment without the operator's acknowledgment and stoppage of work or yielding to the employee.
- Never walk under the load of a bucket or stand beside an opening truck bed.
- Maintain visual contact with the operator when in close proximity to the heavy equipment.
- Wear hearing protection while on or around heavy equipment, when normal conversation cannot be heard above work operations.
- Steel-toed shoes, safety glasses, and a hard hat shall be worn for all work conducted near heavy equipment.

2.4 Hand Tools

Use of hand tools may expose workers to cuts, lacerations, or puncture wounds if adequate hand protection is not worn or tools are improperly used or stored. Damaged hand tools may also expose employees to injuries from shattered tools and flying debris.

The following safe work practices apply to the use of hand tools:

- Only use a tool for its designed use.
- Do not use damaged tools.
- Driving faces of hammers, chisels, drift pins, bars, and similar tools must be inspected to eliminate mushroomed heads, broken faces and other defects.
- Tools must be returned to their proper storage place.
- Sharp tools must not be carried in pockets.
- Wood handles must be sound and securely wedged or fastened to the tool. Tape must not be used to cover defects such as cracks.
- When hand tools are being used overhead, those working or standing below must be notified.
- Always wear safety glasses to protect the eyes.
- Wear leather or other gloves if appropriate.

2.5 Power Tools

- All power tools must be in good condition and free of any damage.
- All power tools must be double insulated or equipped with a grounding plug. Grounding features (three-prong plugs) must not be defeated by use of adapters unless the adapter is appropriately grounded.
- All power cords and extension cords must be in good condition with undamaged insulation. Plugs and boots must also be in good condition and undamaged.
- Power tools must be unplugged whenever serviced or when not being used.

2.6 Noise

Excessive noise is hazardous not only for its potential to damage hearing, but also its potential to disrupt communications and instructions.

- All employees will have access to disposal ear plugs with a Noise Reduction Rating of not less than 30.
- Earplugs must be worn in any environment where workers must raise their voices to be heard while standing at a distance of 3 feet or less.
- Earplugs must be worn by any personnel working around active concrete cutting or sawing equipment.

3.0 WEATHER EXTREMES

3.1 Heat Extremes

Heat extremes at work can cause physical discomfort, loss of efficiency and attention to safety, and personal injury. Age, weight, degree of physical fitness, degree of acclimatization, metabolism, use of alcohol or drugs, and a variety of medical conditions such as hypertension all affect a person's sensitivity to heat. The type of clothing worn must be considered. Prior heat injury predisposes an individual to additional injury.

The fluid loss and dehydration resulting from physical activity puts outdoors laborers at particular risk. Certain medications predispose individuals to heat stress, such as drugs that alter sweat production (antihistamines, anti-psychotics, antidepressants) or interfere with the body's ability to regulate temperature. Persons with heart or circulatory diseases or those who are on "low salt" diets should consult with their physicians prior to working in hot environments.

It is difficult to predict just who will be affected and when, because individual susceptibility varies. In addition, environmental factors include more than the ambient air temperature. Radiant heat, air movement, conduction, and relative humidity all affect an individual's response to heat.

3.1.1 Heat-Related Illnesses

Heat rash, also known as prickly heat, may occur in hot and humid environments where sweat is not easily removed from the surface of the skin by evaporation. It can normally be prevented by resting in a cool place and allowing the skin to dry.

Fainting (heat syncope) may be a problem for the worker unacclimatized to a hot environment who simply stands still in the heat. Victims usually recover quickly after a brief period of lying down. Moving around, rather than standing still, will usually reduce the possibility of fainting.

Heat cramps, painful spasms of the muscles, are caused when workers drink large quantities of water but fail to replace their bodies' salt loss. Tired muscles, those used for performing the work, are usually the ones most susceptible to cramps. Cramps may occur during or after working hours and may be relieved by taking liquids by mouth or saline solutions intravenously for quicker relief, if medically determined to be required.

Heat exhaustion results from loss of fluid through sweating when a worker has failed to drink enough fluids or take in enough salt or both. The worker with heat exhaustion still sweats but experiences extreme weakness or fatigue, giddiness, nausea, or headache. The skin is clammy and moist, the complexion pale or flushed, and the body temperature is normal or slightly higher. Treatment is usually simple: the victim should rest in a cool place and drink an electrolyte solution (a beverage used by athletes to quickly restore potassium, calcium, and magnesium salts) such as Gatorade®. Severe cases involving victims who vomit or lose consciousness may require longer treatment under medical supervision.

Heat stroke, the most serious health problem for workers in hot environments, is caused by the failure of the body's internal mechanism to regulate its core temperature. Sweating stops and the body can no longer rid itself of excess heat. Signs include mental confusion, delirium, loss of consciousness, convulsions or coma; a body temperature of 106 degrees F or higher; and hot dry skin which may be red, mottled, or bluish. Victims of heat stroke will die unless treated promptly. While awaiting medical help, the victim must be removed to a cool area and his or her clothing soaked with cool water. He or she

should be fanned vigorously to increase cooling. Prompt first aid can prevent permanent injury to the brain and other vital organs.

3.1.2 Protection and Controls

The Washington State Department of Occupational Safety and Health (DOSH) regulates heat-related illness in WAC 296-62. DOSH defined HRI triggers based on the type of clothes worn, ambient temperature, and whether the work is conducted in sun or shade.

	Work in direct sun	**Work in shade**
Work Clothes (standard construction clothes	89° F	96° F
Double-layer woven clothes (coveralls over work clothes)	77° F	87° F
Vapor barrier (Tyvek, etc)	52° F	62° F

At or above these trigger conditions, the provisions of the HRI rule become mandatory. The HRI includes requirements for a written procedure, water on site, and training of staff and supervisors.

Written Procedures
The employer must establish, implement, and maintain written procedures to reduce to the extent feasible the risks of heat-related illness which include the following elements:

- Identification and evaluation of temperature, humidity, and other environmental factors associated with heat-related illness
- Provisions to reduce to the extent feasible the risks of heat-related illness which include the following elements:
  - The provision of rest breaks as needed to reduce to the extent feasible the risks of heat-related illness
  - Encourage frequent consumption of water
  - Procedures for responding to signs or symptoms of possible heat-related illness and accessing medical aid
  - Employees are responsible for monitoring their own personal factors for heat-related illness, including ensuring they consume adequate water.

Drinking Water
Drinking water must be provided and made readily available in sufficient quantity to provide at least one quart per employee per hour. Employers may begin the shift with smaller quantities of drinking water if they have effective procedures for replenishment during the shift as needed to allow employees to drink one quart or more per hour.

Training
Training in the following topics must be provided to all employees who may be exposed to a heat-related illness hazard.

- The environmental factors that contribute to the risk of heat-related illness;
- General awareness of personal factors that may increase susceptibility to heat illness including, but not limited to, an individual's age, degree of acclimatization, medical conditions, water consumption, alcohol consumption, caffeine consumption, nicotine use, and use of prescription and nonprescription medications that affect hydration or other physiological responses to heat;
- The employer's procedures for identifying, evaluating, and controlling exposure;
- The importance of removing personal protective equipment that increases exposure to heat-related illness hazards during all breaks when feasible;
- The importance of frequent consumption of small quantities of water. One quart or more over the course of an hour may be necessary when the work environment is hot and employees may be sweating more than usual in the performance of their duties;
- The importance of acclimatization;
- The different types of heat-related illness and the common signs and symptoms of heat-related illness;
- The importance of immediately reporting to the employer, directly or through the employee's supervisor, symptoms or signs of heat illness in themselves, or in co-workers;
- The employer's procedures for responding to symptoms of possible heat-related illness, including how emergency medical services will be provided should they become necessary; and
- The purpose and requirements of this standard.

Prior to supervising employees who are working in conditions that may present heat-related illness hazards, supervisors must have training on the following topics:

- The procedures the supervisor is to follow to implement the HRI rule;
- The procedures the supervisor is to follow when an employee exhibits signs or symptoms consistent with possible heat-related illness, including emergency response procedures;
- Procedures for moving employees to a place where they can be reached by an emergency medical service provider, if necessary; and
- How to provide clear and precise directions to the emergency medical provider who needs to find the work site.

3.2 Cold Extremes

Cold temperatures can also pose health hazards to site workers. Injuries from cold extremes may be classified into two categories: local or general.

Local injuries include:

- Frostnip;
- Frostbite;
- Trench foot;
- Chilblains; and
- Raynaud’s Phenomenon.

General injuries include:

- hypothermia

Major factors contributing to cold injury are exposure to humidity and high winds, contact with wetness or metal, inadequate clothing, age, and general health. Allergies, vascular disease, excessive smoking or drinking, and certain drugs and medicines present physical conditions that can compound the effects of exposure to a cold environment. A cold stress guidelines table is included at the end of this section for quick reference.

Wind chill, or the cooling effect of moving air, is of critical importance when evaluating the cold exposure of site workers. The potential for frostbite and hypothermia increases greatly with combined cold temperatures and high wind speeds. Workers should inform the site superintendent, or site safety officer, if their hands, face, or feet feel numb, and workers should monitor each other for patches of pale or white skin on the face and ears.

3.2.1 Cold-Related Illnesses

Frostnip occurs when the face or extremities are exposed to a cold wind, causing the skin to turn white. Frostnip is considered a minor condition with no permanent damage, as long as the human tissue is warmed up in time. If not, the condition can progress to frostbite.

Frostbite is the freezing of the body tissues due to exposure to extremely low temperatures, resulting in damage to and loss of tissue. Frostbite occurs because of inadequate circulation or insulation, resulting in freezing of fluids around the cells of the body tissues. Most vulnerable parts of the body are the nose, cheeks, ears, fingers, and toes.

The freezing point of the skin is about 30° F. Frostbite can affect outer layers of skin or can include the tissues beneath. Damage can be serious, with permanent loss of movement in the affected parts, scarring, necrotic tissue, and amputation resulting.

There are three degrees of frostbite. First degree is freezing without blistering and peeling; second degree is freezing with blistering and peeling; and third degree is freezing with death of skin tissues and possibly the deeper tissues.

The following are symptoms of frostbite:

- Skin changes color to white or grayish-yellow, progresses to reddish-violet, and finally turns black as the tissue dies.
- Pain may be felt at first, but subsides.
- Blisters may appear.
- Affected part is cold and numb.

The first symptom of frostbite is usually an uncomfortable sensation of coldness, followed by numbness. Tingling, stinging, cramping and aching feelings will follow. Frostbite of the outer layer of the skin has a waxy or whitish look and is firm to the touch. Cases of deep frostbite cause severe injury. The victim is often unaware of the frostbite until someone else observes these symptoms. It is therefore important to use the “buddy system” when working in cold environments, so that symptoms of overexposure can be monitored.

Trench foot is swelling of the foot caused by long continuous exposure to cold without freezing, combined with persistent dampness or immersion in water. Edema (swelling), tingling, itching and severe pain occurs, followed by blistering, necrotic tissue and ulcerations.

Chilblains have similar symptoms as trench foot, except that other areas of the body are impacted. The cold exposure damages capillary beds in the skin, which in turn can cause redness, itching, blisters, and inflammation.

Raynaud's Phenomenon is the abnormal constriction of the blood vessels of the finger on exposure to cold temperatures, resulting in blanching of the fingertips. Numbness, itching, tingling, or a burning sensation may occur during related attacks. The disease is also associated with the use of vibrating hand tools in a condition sometimes called White Finger Disease. Persistent cold sensitivity, ulceration, and amputations can occur in severe cases.

Hypothermia is a condition of reduced body temperature. Most cases develop in air temperatures between 30-50° F, not taking wind-chill factor into consideration. Symptoms of hypothermia include personality changes, reduced mental alertness, irrationality, and uncontrollable shivering. The heartbeat slows and sometimes becomes irregular, weakening the pulse and changing blood pressure. Changes in the body chemistry cause severe shaking or rigid muscles, vague or slow speech, memory lapses, incoherence, and drowsiness. Cool skin, slow irregular breathing, low blood pressure, apparent exhaustion, and fatigue after rest may precede complete collapse.

As the core body temperature drops, the victim can become listless, confused, and make little or no effort to keep warm. Pain in the extremities can be the first warning of dangerous exposures to cold. At a core body temperature of about 85° F, serious problems develop due to significant drops in blood pressure, pulse rate, and respiration.

Sedative drugs and alcohol increase the risk of hypothermia. Sedative drugs interfere with the transmission of impulses to the brain. Alcohol dilates blood vessels near the skin's surface, increasing heat loss, and lowering body temperature.

3.2.2 Treatment

In all cases, remove the person to a warm, dry place. If clothing is wet, remove and replace with dry clothing. Keep person warm. Rewarming of the person should be gradual to avoid stroke symptoms. Dehydration may result in cold injury due to a significant change in blood flow to the extremities. If the person is conscious and alert, warm, sweet liquids should be provided. Coffee and other caffeinated liquids should be avoided because of diuretic and circulatory effects. Extremities affected by frostbite should be gradually warmed up and returned to normal temperature. Moist compresses should be applied; begin with lukewarm compresses and slowly increase the temperature as changes in skin temperature are detected. Transport to a medical facility as soon as possible.

3.2.3 Prevention and Controls

To reduce adverse health effects from cold exposure, adopt the following work practices:

- Provide adequate dry insulating clothing to maintain core temperature above 98.6° F to workers if work is performed in air temperature below 40° F. Wind chill cooling rates and the cooling power of air are critical factors. The higher the wind speed and the lower the temperature in the work area, the greater the insulation value of the protective clothing required.

- If the air temperature is of 32° F or less, hands should be protected by gloves or mittens.
- If available clothing does not give adequate protection to prevent cold injury, work should be modified or suspended until adequate clothing is made available, or until weather conditions improve.
- Use heated warming shelters available nearby (e.g., on-site trailer) at regular intervals, the frequency depending on the severity of the environmental exposure. When entering the heated shelter, remove the outer layer of clothing and loosen the remainder of clothing to permit heat evaporation or change to dry work clothing.
- Provide warm, sweet drinks (e.g., hot chocolate) and soups at the work site for calorie intake and fluid volume. Limit the intake of coffee because of the diuretic and circulatory effects of caffeine.
- Include the weight and bulk of clothing in estimating the required work performance and weights to be lifted by the worker.
- Implement a buddy system in which workers are responsible for observing fellow workers for early signs and symptoms of cold stress.
- Employees that are not acclimatized should not work full-time in cold until they become accustomed to the working conditions and required protective clothing.
- Observe work and warming regimen as shown in the following table.

The following table describes the cooling power of wind on exposed flesh. This information can be used as a guide for determining equivalent chill temperatures when the wind is present in cold environments.

Cooling Power of Wind on Exposed Flesh Expressed as an Equivalent Temperature*

Estimated Wind Speed (in mph)	Actual Temperature Reading (^{0}F)											
	50	40	30	20	10	0	-10	-20	-30	-40	-50	-60
	Equivalent Chill Temperature (^{0}F)											
Calm	50	40	30	20	10	0	-10	-20	-30	-40	-50	-60
5	48	37	27	16	6	-5	-15	-26	-36	-47	-57	-68
10	40	28	16	4	-9	-24	-33	-46	-58	-70	-83	-95
15	36	22	9	-5	-18	-32	-45	-58	-72	-85	-99	-112
20	32	18	4	-10	-25	-39	-53	-67	-82	-96	-110	-121
25	30	16	0	-15	-29	-44	-59	-74	-82	-104	-118	-133
30	28	13	-2	-18	-33	-48	-63	-79	-94	-109	-129	-140
35	27	11	-4	-20	-35	-51	-67	-82	-98	-113	-129	-145
40	26	10	-6	-21	-37	-53	-69	-85	-100	-116	-132	-148
(Wind speeds greater than 40 mph have little additional effect)	**LITTLE DANGER** In less than an hour with dry skin. Maximum danger of false sense of security.				**INCREASING DANGER** Danger from freezing of exposed flesh within one minute.			**GREAT DANGER** Flesh may freeze within 30 seconds.				
	Trench foot may occur at any point on this chart.											

* Developed by U.S. Army Research Institute of Environmental Medicine, Natick, MA.

The following table shows the recommended number of breaks that should be taken per hour based upon the air temperature and wind speeds encountered. This table also lists the maximum sustained work period (in minutes) allowed when working under these conditions.

Work/Warming Regimen*

Air Temperature - Sunny Sky		No Noticeable Wind		5 mph Wind		10 mph Wind		15 mph Wind		20 mph Wind	
^{0}C (approx.)	^{0}F (approx.)	Max Work Period	# of breaks	Max Work Period	# of breaks	Max Work Period	# of breaks	Max Work Period	# of breaks	Max Work Period	# of breaks
-26 to -28	-15 to -19	(Norm Breaks) 1		(Norm Breaks) 1		75 min.	2	55 min.	3	40 min.	4
-29 to –31	-20 to -24	(Norm Breaks) 1		75 min.	2	55 min.	3	40 min.	4	30 min.	5
-32 to –34	-25 to -29	75 min.	2	55 min.	3	40 min.	4	30 min.	5	non-emergency work should cease	
-35 to –37	-30 to -34	55 min.	3	40 min.	4	30 min.	5	non-emergency work should cease		non-emergency work should cease	
-38 to –39	-35 to -39	40 min.	4	30 min.	5	non-emergency work should cease		non-emergency work should cease		non-emergency work should cease	
-40 to –42	-40 to -44	30 min.	5	non-emergency work should cease		non-emergency work should cease		non-emergency work should cease		non-emergency work should cease	
-43 and below	-45 and below	non-emergency work should cease		non-emergency work should cease		non-emergency work should cease		non-emergency work should cease		non-emergency work should cease	

* Developed by the American Conference of Governmental Industrial Hygienists

APPENDIX B

1.0 JOB HAZARD ANALYSIS

Work Activity	Hazard	Risk	Recommended Controls
Walking at the site	Slips, trips, and falls	Low	Be aware of truck traffic, open wells or vaults, and any stored materials.
Tools and equipment	Physical injury/noise	Moderate	Wear PPE equipment – hard hats, steel-toed boots, safety glasses with side shields, and hearing protection. Equipment must be in good working order, be the correct tool for the task, and have required safety features (e.g., backup alarm, guards). Proper energy isolation, lock-out/tag-out, tagging and flagging must be applied when repairing tools and equipment. Operators will be made aware of ground personnel in their operating range. Additional precautions will be made if the lighting or visibility conditions are poor. All equipment will have backup alarms. All operators are required to wear safety belts while operating equipment.
	Dusty, windy conditions	Low	Air purifying respirators with organic vapor/HEPA cartridges will be donned when dusty, windy conditions exist and dust ingestion is likely.
Severe weather conditions	Poor visibility, temperature extremes, and high winds will increase the risk of physical hazards	High	The SSO will determine when work should be minimized or postponed due to weather conditions.
Cold/heat stress	Skin and extremities	High	The SSO will verify that personnel have proper clothing for the environment in which they are working and that drinking water is available.

Work Activity	Hazard	Risk	Recommended Controls
O&M and groundwater monitoring activities	Hazardous atmospheres, direct contact with contaminants	Low to moderate	Wear PPE equipment – hard hats, steel-toed boots, safety glasses with side shields, and hearing protection. Level D work. Check that proper monitoring instruments and tools are used and that lockout/tag out is used, if applicable. Check for heat/cold stress and dehydration. Use appropriate decontamination procedures.
	Elevated heights/falls	High	Use fall protection devices and wear appropriate PPE.
Sump and vault monitoring	Hazardous energy, and potential chemical exposure	Moderate	Lockout/tag out, exposure monitoring, and wear appropriate PPE.
Surface monitoring	Potential chemical exposures	Moderate	Exposure monitoring and wear appropriate PPE.

APPENDIX C

1.0 PROJECT SAFETY ACKNOWLEDGEMENT FORMS

SITE HEALTH and SAFETY PLAN ACKNOWLEDGMENT

I understand and agree to abide by the provisions as detailed in the PES Health and Safety Plan and this Site HASP for the activities described in the Project Work Plans. Failure to comply with these provisions may lead to disciplinary action, which may include dismissal from the work site, termination of employment or, for subcontractors, termination of the work contract.

Printed Name	Company	Signature	Date

(Make additional copies as needed.)

2.0 BRIEFING SIGN-OFF FORM

The Project Manager or On-site Project Scientist shall sign this form after she/he has conducted a pre-entry briefing. Each PES, Inc. employee, and subcontractor, conducting field work shall sign this form after the pre-entry briefing is completed and prior to commencing work on site. A copy of this signed form shall be kept at the site and the original sent to the project manager for inclusion into the project file.

Site Personnel Sign-off

☐ I have received a copy of the Site-Specific Health and Safety Plan.

☐ I have read the Plan and will comply with the provisions contained therein.

☐ I have attended a pre-entry briefing outlining the specific health and safety provisions on this site.

Name: _____ Date: _____

Name: _____ Date: _____

Name: _____ Date: _____

Name: _____ Date: _____

Name: _____ Date: _____

PES ENVIRONMENTAL, INC. Project Manager

☐ A pre-entry briefing has been conducted by myself on _____.

☐ I deferred the pre-entry briefing responsibility to the Health and Safety Officer.

Name:_____ Date:_____

APPENDIX D

Right to Know Hazardous Substance Fact Sheet

Common Name: **TETRACHLOROETHYLENE**

Synonyms: Ethylene Tetrachloride; Perchloroethylene

Chemical Name: Ethene, Tetrachloro-

Date: March 2002 Revision: October 2011

CAS Number: 127-18-4

RTK Substance Number: 1810

DOT Number: UN 1897

EMERGENCY RESPONDERS >>>> SEE LAST PAGE

Description and Use

Tetrachloroethylene is a clear, colorless liquid with a sweet *Ether*-like odor. It is used as a dry cleaning solvent, heat transfer medium, degreaser, solvent, and drying agent for metals.

- **ODOR THRESHOLD = 5 to 50 ppm**
- Odor thresholds vary greatly. Do not rely on odor alone to determine potentially hazardous exposures.

Reasons for Citation

- **Tetrachloroethylene** is on the Right to Know Hazardous Substance List because it is cited by OSHA, ACGIH, DOT, NIOSH, NTP, DEP, IARC, IRIS, NFPA and EPA.
- This chemical is on the Special Health Hazard Substance List.

SEE GLOSSARY ON PAGE 5.

FIRST AID

Eye Contact

- Immediately flush with large amounts of water for at least 15 minutes, lifting upper and lower lids. Remove contact lenses, if worn, while rinsing.

Skin Contact

- Quickly remove contaminated clothing. Immediately wash contaminated skin with large amounts of soap and water.

Inhalation

- Remove the person from exposure.
- Begin rescue breathing (using universal precautions) if breathing has stopped and CPR if heart action has stopped.
- Transfer promptly to a medical facility.
- Medical observation is recommended for 24 to 48 hours after overexposure, as pulmonary edema may be delayed.

EMERGENCY NUMBERS

Poison Control: 1-800-222-1222

CHEMTREC: 1-800-424-9300

NJDEP Hotline: 1-877-927-6337

National Response Center: 1-800-424-8802

Hazard Summary

Hazard Rating	NJDOH	NFPA
HEALTH	3	2
FLAMMABILITY	-	0
REACTIVITY	-	0

CARCINOGEN
POISONOUS GASES ARE PRODUCED IN FIRE
DOES NOT BURN

Hazard Rating Key: 0=minimal; 1=slight; 2=moderate; 3=serious; 4=severe

- **Tetrachloroethylene** can affect you when inhaled and by passing through the skin.
- **Tetrachloroethylene** should be handled as a CARCINOGEN--WITH EXTREME CAUTION.
- **Tetrachloroethylene** can cause reproductive damage.
- Contact can irritate and burn the skin and eyes. Prolonged or repeated exposure can cause drying and cracking of the skin with rash, redness and blisters.
- Exposure can irritate the eyes, nose and throat.
- Inhaling **Tetrachloroethylene** can irritate the lungs. Higher exposures may cause a build-up of fluid in the lungs (pulmonary edema), a medical emergency.
- Exposure can cause headache, dizziness, lightheadedness, nausea, vomiting, and passing out.
- **Tetrachloroethylene** may damage the liver and kidneys and affect the nervous system and heart.

Workplace Exposure Limits

OSHA: The legal airborne permissible exposure limit (PEL) is **100 ppm** averaged over an 8-hour workshift, **200 ppm**, not to be exceeded during any 15-minute work period, and **300 ppm** as a maximum peak for 5-minutes during any 3-hour period.

NIOSH: Recommends that exposure to occupational carcinogens be limited to the lowest feasible concentration.

ACGIH: The threshold limit value (TLV) is **25 ppm** averaged over an 8-hour workshift and **100 ppm** as a STEL (short-term exposure limit).

- **Tetrachloroethylene** is a PROBABLE CARCINOGEN in humans. There may be no safe level of exposure to a carcinogen, so all contact should be reduced to the lowest possible level.
- The above exposure limits are for air levels only. When skin contact also occurs, you may be overexposed, even though air levels are less than the limits listed above.

Determining Your Exposure

- Read the product manufacturer's Material Safety Data Sheet (MSDS) and the label to determine product ingredients and important safety and health information about the product mixture.
- For each individual hazardous ingredient, read the New Jersey Department of Health Hazardous Substance Fact Sheet, available on the RTK website (www.nj.gov/health/eoh/rtkweb) or in your facility's RTK Central File or Hazard Communication Standard file.
- You have a right to this information under the New Jersey Worker and Community Right to Know Act and the Public Employees Occupational Safety and Health (PEOSH) Act if you are a public worker in New Jersey, and under the federal Occupational Safety and Health Act (OSHA) if you are a private worker.
- The New Jersey Right to Know Act requires most employers to label chemicals in the workplace and requires public employers to provide their employees with information concerning chemical hazards and controls. The federal OSHA Hazard Communication Standard (29 CFR 1910.1200) and the PEOSH Hazard Communication Standard (N.J.A.C. 12:100-7) require employers to provide similar information and training to their employees.

This Fact Sheet is a summary of available information regarding the health hazards that may result from exposure. Duration of exposure, concentration of the substance and other factors will affect your susceptibility to any of the potential effects described below.

Health Hazard Information

Acute Health Effects
The following acute (short-term) health effects may occur immediately or shortly after exposure to **Tetrachloroethylene**:

- Contact can irritate and burn the skin and eyes.
- Exposure can irritate the eyes, nose and throat.
- Inhaling **Tetrachloroethylene** can irritate the lungs causing coughing and/or shortness of breath. Higher exposures may cause a build-up of fluid in the lungs (pulmonary edema), a medical emergency, with severe shortness of breath.
- Exposure can cause headache, dizziness, lightheadedness, incoordination, nausea, vomiting, and passing out.

Chronic Health Effects
The following chronic (long-term) health effects can occur at some time after exposure to **Tetrachloroethylene** and can last for months or years:

Cancer Hazard
- **Tetrachloroethylene** is a PROBABLE CARCINOGEN in humans. There is evidence that it causes cancer of the liver, esophagus, bladder, and other types of cancer in humans. It has also been shown to cause cancer of the liver and leukemia in animals.
- Many scientists believe there is no safe level of exposure to a carcinogen.

Reproductive Hazard
- **Tetrachloroethylene** may damage the developing fetus.
- **Tetrachloroethylene** may decrease fertility in males and females and may damage the male (testes) and female (ovaries) reproductive systems in animals.
- There is limited evidence that **Tetrachloroethylene** causes spontaneous abortions.

Other Effects
- Prolonged or repeated exposure can cause drying and cracking of the skin with rash, redness and blisters.
- **Tetrachloroethylene** may damage the liver and kidneys and affect the nervous system and heart

Medical

Medical Testing
For frequent or potentially high exposure (half the TLV or greater), the following are recommended before beginning work and at regular times after that:

- Liver and kidney function tests

If symptoms develop or overexposure is suspected, the following are recommended:

- Consider chest x-ray after acute overexposure
- Exam of the nervous system
- EKG

Any evaluation should include a careful history of past and present symptoms with an exam. Medical tests that look for damage already done are not a substitute for controlling exposure.

You have a legal right to request copies of your medical testing under the OSHA Access to Employee Exposure and Medical Records Standard (29 CFR 1910.1020).

Mixed Exposures
- Smoking can cause heart disease, lung cancer, emphysema, and other respiratory problems. It may worsen respiratory conditions caused by chemical exposure. Even if you have smoked for a long time, stopping now will reduce your risk of developing health problems.
- More than light alcohol consumption can cause liver damage. Drinking alcohol can increase the liver damage caused by **Tetrachloroethylene.**

Workplace Controls and Practices

Very toxic chemicals, or those that are reproductive hazards or sensitizers, require expert advice on control measures if a less toxic chemical cannot be substituted. Control measures include: (1) enclosing chemical processes for severely irritating and corrosive chemicals, (2) using local exhaust ventilation for chemicals that may be harmful with a single exposure, and (3) using general ventilation to control exposures to skin and eye irritants. For further information on workplace controls, consult the NIOSH document on Control Banding at www.cdc.gov/niosh/topics/ctrlbanding/.

The following work practices are also recommended:

- Label process containers.
- Provide employees with hazard information and training.
- Monitor airborne chemical concentrations.
- Use engineering controls if concentrations exceed recommended exposure levels.
- Provide eye wash fountains and emergency showers.
- Wash or shower if skin comes in contact with a hazardous material.
- Always wash at the end of the workshift.
- Change into clean clothing if clothing becomes contaminated.
- Do not take contaminated clothing home.
- Get special training to wash contaminated clothing.
- Do not eat, smoke, or drink in areas where chemicals are being handled, processed or stored.
- Wash hands carefully before eating, smoking, drinking, applying cosmetics or using the toilet.

In addition, the following may be useful or required:

- Where possible, transfer **Tetrachloroethylene** from drums or other containers to process containers in an enclosed system.

Personal Protective Equipment

The OSHA Personal Protective Equipment Standard (29 CFR 1910.132) requires employers to determine the appropriate personal protective equipment for each hazard and to train employees on how and when to use protective equipment.

The following recommendations are only guidelines and may not apply to every situation.

Gloves and Clothing

- Avoid skin contact with **Tetrachloroethylene**. Wear personal protective equipment made from material that can not be permeated or degraded by this substance. Safety equipment suppliers and manufacturers can provide recommendations on the most protective glove and clothing material for your operation.
- The recommended glove materials for **Tetrachloroethylene** are Polyvinyl Alcohol, Silver Shield®/4H®, Viton, Viton/Butyl and Barrier®.
- The recommended protective clothing materials for **Tetrachloroethylene** are Tychem® F, CPF3, BR, CSM and TK; and Trellchem® HPS and VPS, or the equivalent.
- All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work.

Eye Protection

- Wear indirect vent goggles when working with liquids that may splash, spray or mist. A face shield is also required if the liquid is severely irritating or corrosive to the skin and eyes.

Respiratory Protection

Improper use of respirators is dangerous. Respirators should only be used if the employer has implemented a written program that takes into account workplace conditions, requirements for worker training, respirator fit testing, and medical exams, as described in the OSHA Respiratory Protection Standard (29 CFR 1910.134).

- Where the potential exists for exposure to **Tetrachloroethylene**, use a NIOSH approved respirator with an organic vapor cartridge. More protection is provided by a full facepiece respirator than by a half-mask respirator, and even greater protection is provided by a powered-air purifying respirator.
- Leave the area immediately if (1) while wearing a filter or cartridge respirator you can smell, taste, or otherwise detect **Tetrachloroethylene**, (2) while wearing particulate filters abnormal resistance to breathing is experienced, or (3) eye irritation occurs while wearing a full facepiece respirator. Check to make sure the respirator-to-face seal is still good. If it is, replace the filter or cartridge. If the seal is no longer good, you may need a new respirator.
- Consider all potential sources of exposure in your workplace. You may need a combination of filters, prefilters or cartridges to protect against different forms of a chemical (such as vapor and mist) or against a mixture of chemicals.
- Where the potential exists for exposure over **25 ppm**, use a NIOSH approved supplied-air respirator with a full facepiece operated in a pressure-demand or other positive-pressure mode. For increased protection use in combination with an auxiliary self-contained breathing apparatus or an emergency escape air cylinder.
- Exposure to **150 ppm** is immediately dangerous to life and health. If the possibility of exposure above **150 ppm** exists, use a NIOSH approved self-contained breathing apparatus with a full facepiece operated in a pressure-demand or other positive-pressure mode equipped with an emergency escape air cylinder.

Fire Hazards

If employees are expected to fight fires, they must be trained and equipped as stated in the OSHA Fire Brigades Standard (29 CFR 1910.156).

- Extinguish fire using an agent suitable for type of surrounding fire. **Tetrachloroethylene** itself does not burn.
- POISONOUS GASES ARE PRODUCED IN FIRE, including *Hydrogen Chloride* and *Phosgene*.
- Use water spray to keep fire-exposed containers cool.

Spills and Emergencies

If employees are required to clean-up spills, they must be properly trained and equipped. The OSHA Hazardous Waste Operations and Emergency Response Standard (29 CFR 1910.120) may apply.

If **Tetrachloroethylene** is spilled or leaked, take the following steps:

- Evacuate personnel and secure and control entrance to the area.
- Eliminate all ignition sources.
- Absorb liquids in dry sand, earth, or a similar material and place into sealed containers for disposal.
- Ventilate area of spill or leak.
- DO NOT wash into sewer.
- It may be necessary to contain and dispose of **Tetrachloroethylene** as a HAZARDOUS WASTE. Contact your state Department of Environmental Protection (DEP) or your regional office of the federal Environmental Protection Agency (EPA) for specific recommendations.

Handling and Storage

Prior to working with **Tetrachloroethylene** you should be trained on its proper handling and storage.

- **Tetrachloroethylene** reacts violently with *finely dispersed* or *finely divided* METALS (such as ALUMINUM, BARIUM, LITHIUM, BERYLLIUM and ZINC).
- **Tetrachloroethylene** is not compatible with OXIDIZING AGENTS (such as PERCHLORATES, PEROXIDES, PERMANGANATES, CHLORATES, NITRATES, CHLORINE, BROMINE and FLUORINE); SULFURIC ACID; NITRIC ACID; SODIUM HYDROXIDE; and POTASSIUM HYDROXIDE.
- **Tetrachloroethylene** slowly decomposes in WATER to form acids such as *Hydrogen Chloride*.
- **Tetrachloroethylene** decomposes slowly with heating, and with exposure to ultraviolet light or on contact with hot surfaces, to form toxic *Hydrogen Chloride* and *Phosgene gases*.
- Store in tightly closed containers in a cool, well-ventilated area.

Occupational Health Information Resources

The New Jersey Department of Health offers multiple services in occupational health. These services include providing informational resources, educational materials, public presentations, and industrial hygiene and medical investigations and evaluations.

For more information, please contact:

New Jersey Department of Health
Right to Know
PO Box 368
Trenton, NJ 08625-0368
Phone: 609-984-2202
Fax: 609-984-7407
E-mail: rtk@doh.state.nj.us
Web address: http://www.nj.gov/health/eoh/rtkweb

GLOSSARY

ACGIH is the American Conference of Governmental Industrial Hygienists. They publish guidelines called Threshold Limit Values (TLVs) for exposure to workplace chemicals.

Acute Exposure Guideline Levels (AEGLs) are established by the EPA. They describe the risk to humans resulting from once-in-a lifetime, or rare, exposure to airborne chemicals.

Boiling point is the temperature at which a substance can change its physical state from a liquid to a gas.

A **carcinogen** is a substance that causes cancer.

The **CAS number** is unique, identifying number, assigned by the Chemical Abstracts Service, to a specific chemical.

CFR is the Code of Federal Regulations, which are the regulations of the United States government.

A **combustible** substance is a solid, liquid or gas that will burn.

A **corrosive** substance is a gas, liquid or solid that causes destruction of human skin or severe corrosion of containers.

The **critical temperature** is the temperature above which a gas cannot be liquefied, regardless of the pressure applied.

DEP is the New Jersey Department of Environmental Protection.

DOT is the Department of Transportation, the federal agency that regulates the transportation of chemicals.

EPA is the Environmental Protection Agency, the federal agency responsible for regulating environmental hazards.

ERG is the Emergency Response Guidebook. It is a guide for emergency responders for transportation emergencies involving hazardous substances.

Emergency Response Planning Guideline (ERPG) values provide estimates of concentration ranges where one reasonably might anticipate observing adverse effects.

A **fetus** is an unborn human or animal.

A **flammable** substance is a solid, liquid, vapor or gas that will ignite easily and burn rapidly.

The **flash point** is the temperature at which a liquid or solid gives off vapor that can form a flammable mixture with air.

IARC is the International Agency for Research on Cancer, a scientific group.

Ionization Potential is the amount of energy needed to remove an electron from an atom or molecule. It is measured in electron volts.

IRIS is the Integrated Risk Information System database on human health effects that may result from exposure to various chemicals, maintained by federal EPA.

LEL or **Lower Explosive Limit**, is the lowest concentration of a combustible substance (gas or vapor) in the air capable of continuing an explosion.

mg/m^3 means milligrams of a chemical in a cubic meter of air. It is a measure of concentration (weight/volume).

A **mutagen** is a substance that causes mutations. A **mutation** is a change in the genetic material in a body cell. Mutations can lead to birth defects, miscarriages, or cancer.

NFPA is the National Fire Protection Association. It classifies substances according to their fire and explosion hazard.

NIOSH is the National Institute for Occupational Safety and Health. It tests equipment, evaluates and approves respirators, conducts studies of workplace hazards, and proposes standards to OSHA.

NTP is the National Toxicology Program which tests chemicals and reviews evidence for cancer.

OSHA is the federal Occupational Safety and Health Administration, which adopts and enforces health and safety standards.

PEOSHA is the New Jersey Public Employees Occupational Safety and Health Act, which adopts and enforces health and safety standards in public workplaces.

Permeated is the movement of chemicals through protective materials.

ppm means parts of a substance per million parts of air. It is a measure of concentration by volume in air.

Protective Action Criteria (PAC) are values established by the Department of Energy and are based on AEGLs and ERPGs. They are used for emergency planning of chemical release events.

A **reactive** substance is a solid, liquid or gas that releases energy under certain conditions.

STEL is a Short Term Exposure Limit which is usually a 15-minute exposure that should not be exceeded at any time during a work day.

A **teratogen** is a substance that causes birth defects by damaging the fetus.

UEL or **Upper Explosive Limit** is the highest concentration in air above which there is too much fuel (gas or vapor) to begin a reaction or explosion.

Vapor Density is the ratio of the weight of a given volume of one gas to the weight of another (usually *Air*), at the same temperature and pressure.

The **vapor pressure** is a force exerted by the vapor in equilibrium with the solid or liquid phase of the same substance. The higher the vapor pressure the higher concentration of the substance in air.

Right to Know Hazardous Substance Fact Sheet

Emergency Responders Quick Reference

Common Name: **TETRACHLOROETHYLENE**

Synonyms: Ethene, Tetrachloro-; Ethylene Tetrachloride; Perchloroethylene
CAS No: 127-18-4
Molecular Formula: $Cl_2C=CCl_2$
RTK Substance No: 1810
Description: Clear, colorless liquid with a sweet *Ether*-like odor

HAZARD DATA

Hazard Rating	Firefighting	Reactivity
3 - Health **0 - Fire** **0 - Reactivity** **DOT#:** UN 1897 **ERG Guide #:** 160 **Hazard Class:** 6.1 (Toxic)	Extinguish fire using an agent suitable for type of surrounding fire. **Tetrachloroethylene** itself does not burn. POISONOUS GASES ARE PRODUCED IN FIRE, including *Hydrogen Chloride* and *Phosgene*. Use water spray to keep fire-exposed containers cool.	**Tetrachloroethylene** reacts violently with *finely dispersed* or *finely divided* METALS (such as ALUMINUM, BARIUM, LITHIUM, BERYLLIUM and ZINC). **Tetrachloroethylene** is not compatible with OXIDIZING AGENTS (such as PERCHLORATES, PEROXIDES, PERMANGANATES, CHLORATES, NITRATES, CHLORINE, BROMINE and FLUORINE); SULFURIC ACID; NITRIC ACID; SODIUM HYDROXIDE; and POTASSIUM HYDROXIDE. **Tetrachloroethylene** slowly decomposes in WATER to form acids such as *Hydrogen Chloride*. **Tetrachloroethylene** decomposes slowly with heating, and with exposure to ultraviolet light or on contact with hot surfaces, to form toxic *Hydrogen Chloride* and *Phosgene gases*.

SPILL/LEAKS

Isolation Distance:

Spill: 50 meters (150 feet)
Fire: 800 meters (1/2 mile)

Absorb liquids in dry sand, earth, or a similar material and place into sealed containers for disposal.
DO NOT wash into sewer.
Tetrachloroethylene is toxic to aquatic organisms and may cause long term effects on the aquatic environment.

PHYSICAL PROPERTIES

Odor Threshold:	5 to 50 ppm
Flash Point:	Noncombustible
Vapor Density:	5.8 (air = 1)
Vapor Pressure:	14 mm Hg at 68°F (20°C)
Specific Gravity:	1.62 (water = 1)
Water Solubility:	Very slightly soluble
Boiling Point:	250°F (121°C)
Freezing Point:	-2°F (-19°C)
Ionization Potential:	9.32 eV
Molecular Weight:	165.8

EXPOSURE LIMITS

OSHA:	100 ppm, 8-hr TWA; 200 ppm, Ceiling; 300 ppm, Peak
NIOSH:	Lowest feasible concentration
ACGIH:	25 ppm, 8-hr TWA; 100 ppm, STEL
IDLH:	150 ppm

The Protective Action Criteria values are:
PAC-1 = 35 ppm PAC-2 = 230 ppm
PAC-3 = 1,200 ppm

PROTECTIVE EQUIPMENT

Gloves:	Polyvinyl Alcohol, Silver Shield®/4H®, Viton, Viton/Butyl and Barrier® (>8-hr breakthrough)
Coveralls:	Tychem® F, CPF3, BR and CSM; Trellchem® HPS and VPS (>8-hr breakthrough)
Respirator:	<25 ppm - full facepiece APR with *Organic vapor filters* Spills or Fire - SCBA

HEALTH EFFECTS

Eyes:	Irritation and burns
Skin:	Irritation and burns (skin absorbable)
Inhalation:	Nose, throat and lung irritation with coughing and severe shortness of breath (pulmonary edema) Headache, dizziness, lightheadedness, and passing out
Chronic:	Cancer (liver, esophagus and bladder)

FIRST AID AND DECONTAMINATION

Remove the person from exposure.
Flush eyes with large amounts of water for at least 15 minutes. Remove contact lenses if worn.
Quickly remove contaminated clothing and wash contaminated skin with large amounts of soap and water.
Begin artificial respiration if breathing has stopped and CPR if necessary.
Transfer promptly to a medical facility.
Medical observation is recommended as symptoms may be delayed.

Right to Know Hazardous Substance Fact Sheet

Common Name: **TRICHLOROETHYLENE**

Synonyms: Ethylene Trichloride; TCE; Trichloroethene

Chemical Name: Ethene, Trichloro-

Date: January 2000 Revision: December 2008

CAS Number: 79-01-6

RTK Substance Number: 1890

DOT Number: UN 1710

EMERGENCY RESPONDERS >>>> SEE BACK PAGE

Description and Use

Trichloroethylene is a clear, colorless liquid with a sweet odor. It is used as a degreaser for metal parts, as a solvent and fumigant, and to make other chemicals.

- **ODOR THRESHOLD = 1.4 ppm**
- Odor thresholds vary greatly. Do not rely on odor alone to determine potentially hazardous exposures.

Hazard Summary

Hazard Rating	NJDOH	NFPA
HEALTH	3	2
FLAMMABILITY	-	1
REACTIVITY	-	0

CARCINOGEN
POISONOUS GASES ARE PRODUCED IN FIRE
CONTAINERS MAY EXPLODE IN FIRE

Hazard Rating Key: 0=minimal; 1=slight; 2=moderate; 3=serious; 4=severe

Reasons for Citation

- **Trichloroethylene** is on the Right to Know Hazardous Substance List because it is cited by OSHA, ACGIH, DOT, NIOSH, NTP, DEP, IARC, IRIS, NFPA and EPA.
- This chemical is on the Special Health Hazard Substance List.

SEE GLOSSARY ON PAGE 5.

FIRST AID

Eye Contact

- Immediately flush with large amounts of water for at least 15 minutes, lifting upper and lower lids. Remove contact lenses, if worn, while flushing. Seek medical attention.

Skin Contact

- Quickly remove contaminated clothing. Immediately wash contaminated skin with large amounts of soap and water. Seek medical attention.

Inhalation

- Remove the person from exposure.
- Begin rescue breathing (using universal precautions) if breathing has stopped and CPR if heart action has stopped.
- Transfer promptly to a medical facility.

EMERGENCY NUMBERS

Poison Control: 1-800-222-1222
CHEMTREC: 1-800-424-9300
NJDEP Hotline: 1-877-927-6337
National Response Center: 1-800-424-8802

- **Trichloroethylene** can affect you when inhaled and by passing through the skin.
- **Trichloroethylene** should be handled as a CARCINOGEN--WITH EXTREME CAUTION.
- Contact can irritate and burn the skin and eyes with possible eye damage.
- Exposure can cause headache, dizziness, lightheadedness, and passing out. Very high exposure can cause irregular heartbeat, which can be fatal.
- **Trichloroethylene** may cause a skin allergy.
- Repeated exposure may cause personality changes such as depression, anxiety or irritability.
- **Trichloroethylene** may damage the liver and kidneys.

Workplace Exposure Limits

OSHA: The legal airborne permissible exposure limit (PEL) is **100 ppm** averaged over an 8-hour workshift, and **200 ppm**, not to be exceeded during any 15-minute work period, and **300 ppm** as a 5-minute peak in any 2-hour work period.

NIOSH: Recommends that exposure to occupational carcinogens be limited to the lowest feasible concentration.

ACGIH: The threshold limit value (TLV) is **10 ppm** averaged over an 8-hour workshift and **25 ppm** as a STEL (short-term exposure limit).

- **Trichloroethylene** is a PROBABLE CARCINOGEN in humans. There may be no safe level of exposure to a carcinogen, so all contact should be reduced to the lowest possible level.
- The above exposure limits are for air levels only. When skin contact also occurs, you may be overexposed, even though air levels are less than the limits listed above.

Determining Your Exposure

- Read the product manufacturer's Material Safety Data Sheet (MSDS) and the label to determine product ingredients and important safety and health information about the product mixture.
- For each individual hazardous ingredient, read the New Jersey Department of Health Hazardous Substance Fact Sheet, available on the RTK website (www.nj.gov/health/eoh/rtkweb) or in your facility's RTK Central File or Hazard Communication Standard file.
- You have a right to this information under the New Jersey Worker and Community Right to Know Act, the Public Employees Occupational Safety and Health (PEOSH) Act if you are a public worker in New Jersey, and under the federal Occupational Safety and Health Act (OSHA) if you are a private worker.
- The New Jersey Right to Know Act requires most employers to label chemicals in the workplace and requires public employers to provide their employees with information concerning chemical hazards and controls. The federal OSHA Hazard Communication Standard (29 CFR 1910.1200) and the PEOSH Hazard Communication Standard (N.J.A.C. 12:100-7) require employers to provide similar information and training to their employees.

This Fact Sheet is a summary of available information regarding the health hazards that may result from exposure. Duration of exposure, concentration of the substance and other factors will affect your susceptibility to any of the potential effects described below.

Health Hazard Information

Acute Health Effects
The following acute (short-term) health effects may occur immediately or shortly after exposure to **Trichloroethylene**:

- Contact can irritate and burn the skin and eyes with possible eye damage.
- Exposure can cause headache, dizziness, lightheadedness, visual disturbances, nausea and vomiting, and passing out. Very high exposure can cause irregular heartbeat, which can be fatal.

Chronic Health Effects
The following chronic (long-term) health effects can occur at some time after exposure to **Trichloroethylene** and can last for months or years:

Cancer Hazard
- **Trichloroethylene** is a PROBABLE CARCINOGEN in humans. There is evidence that it causes liver, kidney, and lung cancer in animals.
- Many scientists believe there is no safe level of exposure to a carcinogen.

Reproductive Hazard
- There is limited evidence that **Trichloroethylene** is a teratogen in animals. Until further testing has been done, it should be treated as a possible teratogen in humans.
- There is limited evidence that **Trichloroethylene** may affect fertility and may damage the male reproductive system (including decreasing the sperm count) in animals.

Other Effects
- **Trichloroethylene** may cause a skin allergy. If allergy develops, very low future exposure can cause itching and a skin rash.
- Repeated exposure may cause personality changes such as depression, anxiety or irritability, and memory loss.
- **Trichloroethylene** may damage the liver and kidneys.

Medical

Medical Testing
For frequent or potentially high exposure (half the TLV or greater, or significant skin contact) the following are recommended before beginning work and at regular times after that:

- Liver and kidney function tests

If symptoms develop or overexposure is suspected, the following are recommended:

- Exam of the nervous system
- Evaluation by a qualified allergist can help diagnose skin allergy.
- Urinary *Trichloroacetic Acid* level (for repeated exposures) or blood **Trichloroethylene** levels (for acute exposure)
- Special 24-48 hour EKG (Holter monitor) to observe and record abnormal heart rhythms

Any evaluation should include a careful history of past and present symptoms with an exam. Medical tests that look for damage already done are not a substitute for controlling exposure.

Request copies of your medical testing. You have a legal right to this information under the OSHA Access to Employee Exposure and Medical Records Standard (29 CFR 1910.1020).

Mixed Exposures
- More than light alcohol consumption can cause liver damage. Drinking alcohol can increase the liver damage caused by **Trichloroethylene**.

Workplace Controls and Practices

Very toxic chemicals, or those that are reproductive hazards or sensitizers, require expert advice on control measures if a less toxic chemical cannot be substituted. Control measures include: (1) enclosing chemical processes for severely irritating and corrosive chemicals, (2) using local exhaust ventilation for chemicals that may be harmful with a single exposure, and (3) using general ventilation to control exposures to skin and eye irritants. For further information on workplace controls, consult the NIOSH document on Control Banding at www.cdc.gov/niosh/topics/ctrlbanding/.

The following work practices are also recommended:

- Label process containers.
- Provide employees with hazard information and training.
- Monitor airborne chemical concentrations.
- Use engineering controls if concentrations exceed recommended exposure levels.
- Provide eye wash fountains and emergency showers.
- Wash or shower if skin comes in contact with a hazardous material.
- Always wash at the end of the workshift.
- Change into clean clothing if clothing becomes contaminated.
- Do not take contaminated clothing home.
- Get special training to wash contaminated clothing.
- Do not eat, smoke, or drink in areas where chemicals are being handled, processed or stored.
- Wash hands carefully before eating, smoking, drinking, applying cosmetics or using the toilet.

In addition, the following may be useful or required:

- Where possible, transfer **Trichloroethylene** from drums or other containers to process containers in an enclosed system.

Personal Protective Equipment

The OSHA Personal Protective Equipment Standard (29 CFR 1910.132) requires employers to determine the appropriate personal protective equipment for each hazard and to train employees on how and when to use protective equipment.

The following recommendations are only guidelines and may not apply to every situation.

Gloves and Clothing

- Avoid skin contact with **Trichloroethylene**. Wear personal protective equipment made from material which can not be permeated or degraded by this substance. Safety equipment suppliers and manufacturers can provide recommendations on the most protective glove and clothing material for your operation.
- Safety equipment manufacturers recommend Silver Shield®/4H®, Viton and Barrier® for gloves, and Tychem® F, BR, LV, Responder®, and TK; Zytron® 500; ONESuit® TEC; and Trellchem® HPS and VPS, or the equivalent, as protective materials for clothing.
- All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work.

Eye Protection

- Wear indirect-vent, impact and splash resistant goggles when working with liquids.
- Wear non-vented, impact resistant goggles when working with fumes, gases, or vapors.
- Wear a face shield along with goggles when working with corrosive, highly irritating or toxic substances.

Respiratory Protection

Improper use of respirators is dangerous. Respirators should only be used if the employer has implemented a written program that takes into account workplace conditions, requirements for worker training, respirator fit testing, and medical exams, as described in the OSHA Respiratory Protection Standard (29 CFR 1910.134).

- Where the potential exists for exposure over **10 ppm**, use a NIOSH approved supplied-air respirator with a full facepiece operated in a pressure-demand or other positive-pressure mode. For increased protection use in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode.
- Exposure to **1,000 ppm** is immediately dangerous to life and health. If the possibility of exposure above **1,000 ppm** exists, use a NIOSH approved self-contained breathing apparatus with a full facepiece operated in a pressure-demand or other positive-pressure mode equipped with an emergency escape air cylinder.

Fire Hazards

If employees are expected to fight fires, they must be trained and equipped as stated in the OSHA Fire Brigades Standard (29 CFR 1910.156).

- **Trichloroethylene** may burn, but does not readily ignite.
- Use dry chemical, CO_2, water spray or alcohol-resistant foam as extinguishing agents.
- POISONOUS GASES ARE PRODUCED IN FIRE, including *Hydrogen Chloride* and *Phosgene*.
- CONTAINERS MAY EXPLODE IN FIRE.
- Use water spray to keep fire-exposed containers cool.
- Use water spray to reduce vapors.
- **Trichloroethylene** accumulates static charge.

Spills and Emergencies

If employees are required to clean-up spills, they must be properly trained and equipped. The OSHA Hazardous Waste Operations and Emergency Response Standard (29 CFR 1910.120) may apply.

If **Trichloroethylene** is spilled or leaked, take the following steps:

- Evacuate personnel and secure and control entrance to the area.
- Eliminate all ignition sources.
- Absorb liquids in vermiculite, dry sand, earth, fly ash or cement powder and place into sealed containers for disposal.
- Use water spray to keep containers cool.
- Ventilate and wash area after clean-up is complete.
- DO NOT wash into sewer.
- It may be necessary to contain and dispose of **Trichloroethylene** as a HAZARDOUS WASTE. Contact your state Department of Environmental Protection (DEP) or your regional office of the federal Environmental Protection Agency (EPA) for specific recommendations.

Handling and Storage

Prior to working with **Trichloroethylene** you should be trained on its proper handling and storage.

- **Trichloroethylene** will react explosively with *finely divided* or *powdered* BARIUM, BERYLLIUM, and MAGNESIUM.
- **Trichloroethylene** reacts with ACTIVE METALS (such as LITHIUM, SODIUM and TITANIUM) to cause flashing and sparks and will react with STRONG BASES (such as SODIUM HYDROXIDE and POTASSIUM HYDROXIDE) and EPOXIDES to form spontanously flammable *Dichloroacetylene*.
- **Trichloroethylene** is not compatible with STRONG ACIDS (such as HYDROCHLORIC, SULFURIC and NITRIC); ISOCYANATES; EPICHLOROHYDRIN; ALCOHOLS; and GLYCOLS.
- Store in tightly closed containers in a cool, well-ventilated area away from COMBUSTIBLES, LIGHT and MOISTURE.
- Use only non-sparking tools and equipment, especially when opening and closing containers of **Trichloroethylene**.
- Metal containers involving the transfer of **Trichloroethylene** should be grounded and bonded as **Trichloroethylene** accumulates static charge.

Occupational Health Information Resources

The New Jersey Department of Health offers multiple services in occupational health. These services include providing informational resources, educational materials, public presentations, and industrial hygiene and medical investigations and evaluations.

For more information, please contact:

New Jersey Department of Health
Right to Know
PO Box 368
Trenton, NJ 08625-0368
Phone: 609-984-2202
Fax: 609-984-7407
E-mail: rtk@doh.state.nj.us
Web address: http://www.nj.gov/health/eoh/rtkweb

GLOSSARY

ACGIH is the American Conference of Governmental Industrial Hygienists. They publish guidelines called Threshold Limit Values (TLVs) for exposure to workplace chemicals.

Acute Exposure Guideline Levels (AEGLs) are established by the EPA. They describe the risk to humans resulting from once-in-a lifetime, or rare, exposure to airborne chemicals.

Boiling point is the temperature at which a substance can change its physical state from a liquid to a gas.

A **carcinogen** is a substance that causes cancer.

The **CAS number** is unique, identifying number, assigned by the Chemical Abstracts Service, to a specific chemical.

CFR is the Code of Federal Regulations, which are the regulations of the United States government.

A **combustible** substance is a solid, liquid or gas that will burn.

A **corrosive** substance is a gas, liquid or solid that causes destruction of human skin or severe corrosion of containers.

DEP is the New Jersey Department of Environmental Protection.

DOT is the Department of Transportation, the federal agency that regulates the transportation of chemicals.

EPA is the Environmental Protection Agency, the federal agency responsible for regulating environmental hazards.

ERG is the Emergency Response Guidebook. It is a guide for emergency responders for transportation emergencies involving hazardous substances.

Emergency Response Planning Guideline (ERPG) values provide estimates of concentration ranges where one reasonably might anticipate observing adverse effects.

A **fetus** is an unborn human or animal.

A **flammable** substance is a solid, liquid, vapor or gas that will ignite easily and burn rapidly.

The **flash point** is the temperature at which a liquid or solid gives off vapor that can form a flammable mixture with air.

IARC is the International Agency for Research on Cancer, a scientific group.

Ionization Potential is the amount of energy needed to remove an electron from an atom or molecule. It is measured in electron volts.

IRIS is the Integrated Risk Information System database on human health effects that may result from exposure to various chemicals, maintained by federal EPA.

LEL or **Lower Explosive Limit**, is the lowest concentration of a combustible substance (gas or vapor) in the air capable of continuing an explosion.

mg/m^3 means milligrams of a chemical in a cubic meter of air. It is a measure of concentration (weight/volume).

A **mutagen** is a substance that causes mutations. A **mutation** is a change in the genetic material in a body cell. Mutations can lead to birth defects, miscarriages, or cancer.

NFPA is the National Fire Protection Association. It classifies substances according to their fire and explosion hazard.

NIOSH is the National Institute for Occupational Safety and Health. It tests equipment, evaluates and approves respirators, conducts studies of workplace hazards, and proposes standards to OSHA.

NTP is the National Toxicology Program which tests chemicals and reviews evidence for cancer.

OSHA is the federal Occupational Safety and Health Administration, which adopts and enforces health and safety standards.

PEOSHA is the New Jersey Public Employees Occupational Safety and Health Act, which adopts and enforces health and safety standards in public workplaces.

Permeated is the movement of chemicals through protective materials.

ppm means parts of a substance per million parts of air. It is a measure of concentration by volume in air.

Protective Action Criteria (PAC) are values established by the Department of Energy and are based on AEGLs and ERPGs. They are used for emergency planning of chemical release events.

A **reactive** substance is a solid, liquid or gas that releases energy under certain conditions.

STEL is a Short Term Exposure Limit which is usually a 15-minute exposure that should not be exceeded at any time during a work day.

A **teratogen** is a substance that causes birth defects by damaging the fetus.

UEL or **Upper Explosive Limit** is the highest concentration in air above which there is too much fuel (gas or vapor) to begin a reaction or explosion.

Vapor Density is the ratio of the weight of a given volume of one gas to the weight of another (usually *Hydrogen*), at the same temperature and pressure.

The **vapor pressure** is a force exerted by the vapor in equilibrium with the solid or liquid phase of the same substance. The higher the vapor pressure the higher concentration of the substance in air.

NJ Health New Jersey Department of Health

Right to Know Hazardous Substance Fact Sheet

Emergency Responders Quick Reference

Common Name: **TRICHLOROETHYLENE**

Synonyms: Ethylene Trichloride; TCE; Trichloroethene
CAS No: 79-01-6
Molecular Formula: C_2HCl_3
RTK Substance No: 1890
Description: Clear, colorless liquid with a sweet, *Chloroform-like* odor

HAZARD DATA

Hazard Rating	Firefighting	Reactivity
3 - Health **1 - Fire** **0 - Reactivity** **DOT#:** UN 1710 **ERG Guide #:** 160 **Hazard Class:** 6.1 (Poison)	**Trichloroethylene** may burn, but does not readily ignite. Use dry chemical, CO_2, water spray or alcohol-resistant foam as extinguishing agents. POISONOUS GASES ARE PRODUCED IN FIRE, including *Hydrogen Chloride* and *Phosgene*. CONTAINERS MAY EXPLODE IN FIRE. Use water spray to keep fire-exposed containers cool. Use water spray to reduce vapors. **Trichloroethylene** accumulates static charge.	**Trichloroethylene** will react explosively with *finely divided* or *powdered* BARIUM, BERYLLIUM, and MAGNESIUM. **Trichloroethylene** reacts with ACTIVE METALS (such as LITHIUM, SODIUM and TITANIUM) to cause flashing and sparks. **Trichloroethylene** will react with STRONG BASES (such as SODIUM HYDROXIDE and POTASSIUM HYDROXIDE) and EPOXIDES to form spontaneously flammable *Dichloroacetylene*. **Trichloroethylene** is not compatible with STRONG ACIDS (such as HYDROCHLORIC, SULFURIC and NITRIC); ISOCYANATES; EPICHLOROHYDRIN; ALCOHOLS; and GLYCOLS.

SPILL/LEAKS

Isolation Distance:

Spill: 50 meters (150 feet)
Fire: 800 meters (1/2 mile)
Absorb liquids in vermiculite, dry sand, earth, fly ash or cement powder and place into sealed containers for disposal.
DO NOT wash into sewer.
Use only non-sparking tools and equipment, especially when opening and closing containers of **Trichloroethylene**.
Metal containers should be grounded and bonded as **Trichloroethylene** accumulates static charge.
Trichloroethylene is slightly toxic to aquatic life.

PHYSICAL PROPERTIES

Odor Threshold:	1.4 ppm
Flash Point:	>200°F (93°C)
LEL:	8%
UEL:	10.5%
Auto Ignition Temp:	788°F (420°C)
Vapor Density:	4.5 (air = 1)
Vapor Pressure:	58 mm Hg at 68°F (20°C)
Specific Gravity:	1.5 (water = 1)
Water Solubility:	Slightly soluble
Boiling Point:	189°F (87°C)
Melting Point:	-99°F (-73°C)
Ionization Potential:	9.5 eV
Molecular Weight:	131.4

EXPOSURE LIMITS

ACGIH: 10 ppm, 8-hr TWA; 25 ppm, 15-min STEL
IDLH: 1,000 ppm
The Protective Action Criteria values are:
PAC-1 = 130 ppm
PAC-2 = 450 ppm
PAC-3 = 3,800 ppm

PROTECTIVE EQUIPMENT

Gloves:	Silver Shield®/4H®, Viton and Barrier® (>8-hr breakthrough)
Coveralls:	Tychem® F, BR, LV, Responder®, and TK; Zytron® 500; ONESuit® TEC; and Trellchem® HPS and VPS (>8-hr breakthrough)
Respirator:	>10 ppm - Supplied air or SCBA

HEALTH EFFECTS

Eyes:	Irritation and burns
Skin:	Irritation and burns
Inhalation:	Headache, dizziness, lightheadedness, visual disturbances, nausea and vomiting, and passing out
Chronic:	Cancer (liver, kidney, and lung) in animals

FIRST AID AND DECONTAMINATION

Remove the person from exposure.
Flush eyes with large amounts of water for at least 15 minutes. Remove contact lenses if worn. Seek medical attention.
Quickly remove contaminated clothing and wash contaminated skin with large amounts of soap and water. Seek medical attention.
Begin artificial respiration if breathing has stopped and CPR if necessary.
Transfer promptly to a medical facility.

Right to Know Hazardous Substance Fact Sheet

Common Name: **VINYL CHLORIDE**

Synonyms: Chloroethylene; Monochloroethylene; VCM

Chemical Name: Ethene, Chloro-

Date: June 2001 Revision: November 2010

CAS Number: 75-01-4

RTK Substance Number: 2001

DOT Number: UN 1086

EMERGENCY RESPONDERS >>>> SEE LAST PAGE

Description and Use

Vinyl Chloride is a colorless gas, with a sweet odor at high concentrations, that is usually handled as a liquid under pressure. It is used to make *Polyvinyl Chloride* for pipes, wire, and cable coatings, and in furniture, automobiles, and adhesives.

- **ODOR THRESHOLD = >3,000 ppm**
- Odor thresholds vary greatly. Do not rely on odor alone to determine potentially hazardous exposures.

Hazard Summary

Hazard Rating	NJDOH	NFPA
HEALTH	4	2
FLAMMABILITY	4	4
REACTIVITY	2	2

CARCINOGEN
FLAMMABLE AND REACTIVE
POISONOUS GASES ARE PRODUCED IN FIRE
CONTAINERS MAY EXPLODE IN FIRE

Hazard Rating Key: 0=minimal; 1=slight; 2=moderate; 3=serious; 4=severe

Reasons for Citation

- **Vinyl Chloride** is on the Right to Know Hazardous Substance List because it is cited by OSHA, ACGIH, DOT, NIOSH, NTP, DEP, IARC, IRIS, NFPA and EPA.
- This chemical is on the Special Health Hazard Substance List.

SEE GLOSSARY ON PAGE 5.

FIRST AID

Eye Contact
- Immediately flush with large amounts of water for at least 30 minutes, lifting upper and lower lids. Remove contact lenses, if worn, while flushing. Seek medical attention.

Skin Contact
- Immerse affected part in warm water. Seek medical attention.

Inhalation
- Remove the person from exposure.
- Begin rescue breathing (using universal precautions) if breathing has stopped and CPR if heart action has stopped.
- Transfer promptly to a medical facility.

EMERGENCY NUMBERS

Poison Control: 1-800-222-1222
CHEMTREC: 1-800-424-9300
NJDEP Hotline: 1-877-927-6337
National Response Center: 1-800-424-8802

- **Vinyl Chloride** can affect you when inhaled.
- **Vinyl Chloride** is a CARCINOGEN and MUTAGEN. HANDLE WITH EXTREME CAUTION.
- **Vinyl Chloride** can cause reproductive damage.
- Exposure to **Vinyl Chloride** can severely irritate and burn the skin and eyes with possible eye damage. Contact with the *liquid or gas* can cause frostbite.
- Inhaling **Vinyl Chloride** can irritate the nose, throat and lungs.
- **Vinyl Chloride** can cause headache, nausea, vomiting, dizziness, fatigue, weakness and confusion. Higher levels can cause lightheadedness and passing out.
- Prolonged or repeated exposure can damage the liver, nervous system and lungs.
- Repeated exposure can damage the skin (scleroderma), bones (acro-osteolysis) and blood vessels in the hands (Raynaud's Syndrome).
- **Vinyl Chloride** is FLAMMABLE and REACTIVE and a DANGEROUS FIRE and EXPLOSION HAZARD.
- EXPLOSIVE POLYMERIZATION may occur at elevated temperatures if **Vinyl Chloride** is not inhibited.

Workplace Exposure Limits

OSHA: The legal airborne permissible exposure limit (PEL) is **1 ppm** averaged over an 8-hour workshift and **5 ppm**, not to be exceeded during any 15-minute work period.

NIOSH: Recommends that exposure to occupational carcinogens be limited to the lowest feasible concentration.

ACGIH: The threshold limit value (TLV) is **1 ppm** averaged over an 8-hour workshift.

- **Vinyl Chloride** is a CARCINOGEN in humans. There may be no safe level of exposure to a carcinogen, so all contact should be reduced to the lowest possible level.

Determining Your Exposure

- Read the product manufacturer's Material Safety Data Sheet (MSDS) and the label to determine product ingredients and important safety and health information about the product mixture.
- For each individual hazardous ingredient, read the New Jersey Department of Health Hazardous Substance Fact Sheet, available on the RTK website (www.nj.gov/health/eoh/rtkweb) or in your facility's RTK Central File or Hazard Communication Standard file.
- You have a right to this information under the New Jersey Worker and Community Right to Know Act and the Public Employees Occupational Safety and Health (PEOSH) Act if you are a public worker in New Jersey, and under the federal Occupational Safety and Health Act (OSHA) if you are a private worker.
- The New Jersey Right to Know Act requires most employers to label chemicals in the workplace and requires public employers to provide their employees with information concerning chemical hazards and controls. The federal OSHA Hazard Communication Standard (29 CFR 1910.1200) and the PEOSH Hazard Communication Standard (N.J.A.C. 12:100-7) require employers to provide similar information and training to their employees.

This Fact Sheet is a summary of available information regarding the health hazards that may result from exposure. Duration of exposure, concentration of the substance and other factors will affect your susceptibility to any of the potential effects described below.

Health Hazard Information

Acute Health Effects
The following acute (short-term) health effects may occur immediately or shortly after exposure to **Vinyl Chloride**:

- Exposure to **Vinyl Chloride** can severely irritate and burn the skin and eyes with possible eye damage. Contact with the *liquid or gas* can cause frostbite.
- Inhaling **Vinyl Chloride** can irritate the nose, throat and lungs causing coughing, wheezing and/or shortness of breath.
- **Vinyl Chloride** can cause headache, nausea, vomiting, dizziness, fatigue, weakness and confusion. Higher levels can cause lightheadedness and passing out.

Chronic Health Effects
The following chronic (long-term) health effects can occur at some time after exposure to **Vinyl Chloride** and can last for months or years:

Cancer Hazard
- **Vinyl Chloride** is a CARCINOGEN in humans. It has been shown to cause liver, brain, lung, and other types of cancer.
- Many scientists believe there is no safe level of exposure to a carcinogen.

Reproductive Hazard
- **Vinyl Chloride** may damage the developing fetus.
- There is limited evidence that **Vinyl Chloride** is a teratogen in animals. Until further testing has been done, it should be treated as a possible teratogen in humans.
- There is limited evidence that **Vinyl Chloride** may damage the male reproductive system (including decreasing the sperm count) and may affect male fertility.
- An excess of spontaneous abortions has been reported among spouses of workers who had been exposed to **Vinyl Chloride**.

Other Effects
- Prolonged or repeated exposure can damage the liver, nervous system and lungs.
- Repeated exposure can cause a disease called "scleroderma." This causes the skin to become very smooth, tight and shiny. It causes the bones of the fingers to erode (acro-osteolysis), and damages the blood vessels in the hands or feet (Raynaud's syndrome). This causes the fingers or toes to turn numb, pale or blue, with even mild cold exposure.

Medical

Medical Testing
Before first exposure and every 12 months thereafter, OSHA requires your employer to provide (for persons exposed to **0.5 ppm** of **Vinyl Chloride**) a work and medical history and exam which shall include:

- Liver function tests
- Chest x-ray and lung function tests

If symptoms develop or overexposure is suspected, the following are recommended:

- Exam of the nervous system
- Exam of the skin

OSHA requires your employer to provide you and your doctor with a copy of the OSHA **Vinyl Chloride** Standard (29 CFR 1910.1017).

Any evaluation should include a careful history of past and present symptoms with an exam. Medical tests that look for damage already done are not a substitute for controlling exposure.

Request copies of your medical testing. You have a legal right to this information under the OSHA Access to Employee Exposure and Medical Records Standard (29 CFR 1910.1020).

Mixed Exposures
- More than light alcohol consumption can cause liver damage. Drinking alcohol may increase the liver damage caused by **Vinyl Chloride**.

Workplace Controls and Practices

Very toxic chemicals, or those that are reproductive hazards or sensitizers, require expert advice on control measures if a less toxic chemical cannot be substituted. Control measures include: (1) enclosing chemical processes for severely irritating and corrosive chemicals, (2) using local exhaust ventilation for chemicals that may be harmful with a single exposure, and (3) using general ventilation to control exposures to skin and eye irritants. For further information on workplace controls, consult the NIOSH document on Control Banding at www.cdc.gov/niosh/topics/ctrlbanding/.

The following work practices are also recommended:

- Label process containers.
- Provide employees with hazard information and training.
- Monitor airborne chemical concentrations.
- Use engineering controls if concentrations exceed recommended exposure levels.
- Provide eye wash fountains and emergency showers.
- Wash or shower if skin comes in contact with a hazardous material.
- Always wash at the end of the workshift.
- Change into clean clothing if clothing becomes contaminated.
- Do not take contaminated clothing home.
- Get special training to wash contaminated clothing.
- Do not eat, smoke, or drink in areas where chemicals are being handled, processed or stored.
- Wash hands carefully before eating, smoking, drinking, applying cosmetics or using the toilet.

In addition, the following may be useful or required:

- Specific actions are required for this chemical by OSHA. Refer to the OSHA **Vinyl Chloride** Standard (29 CFR 1910.1017).
- Before entering a confined space where **Vinyl Chloride** may be present, check to make sure that an explosive concentration does not exist.
- Transfer **Vinyl Chloride** from cylinders or other containers to process containers in an enclosed system.

Personal Protective Equipment

The OSHA Personal Protective Equipment Standard (29 CFR 1910.132) requires employers to determine the appropriate personal protective equipment for each hazard and to train employees on how and when to use protective equipment.

The following recommendations are only guidelines and may not apply to every situation.

Gloves and Clothing

- Avoid skin contact with **Vinyl Chloride**. Wear personal protective equipment made from material which can not be permeated or degraded by this substance. Safety equipment suppliers and manufacturers can provide recommendations on the most protective glove and clothing material for your operation.
- The recommended glove materials for **Vinyl Chloride** are Viton, Viton/Butyl, Silver Shield®/4H® and Barrier®.
- The recommended protective clothing materials for **Vinyl Chloride** are Tychem® BR, CSM and TK; and Trellchem® HPS and VPS or the equivalent.
- Where exposure to cold equipment, vapors, or liquid may occur, employees should be provided with *insulated* gloves and special clothing designed to prevent the freezing of body tissues.
- All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work.

Eye Protection

- Wear non-vented, impact resistant goggles when working with fumes, gases, or vapors.
- Wear a face shield along with goggles when working with corrosive, highly irritating or toxic substances.
- Do not wear contact lenses when working with this substance.

Respiratory Protection

Improper use of respirators is dangerous. Respirators should only be used if the employer has implemented a written program that takes into account workplace conditions, requirements for worker training, respirator fit testing, and medical exams, as described in the OSHA Respiratory Protection Standard (29 CFR 1910.134).

- Where the potential exists for exposure over **1 ppm**, use a NIOSH approved supplied-air respirator with a full facepiece operated in a pressure-demand or other positive-pressure mode. For increased protection use in combination with an auxiliary self-contained breathing apparatus or an emergency escape air cylinder.
- DO NOT USE CHEMICAL CARTRIDGE OR CANISTER RESPIRATORS.

Fire Hazards

If employees are expected to fight fires, they must be trained and equipped as stated in the OSHA Fire Brigades Standard (29 CFR 1910.156).

- **Vinyl Chloride** is a FLAMMABLE AND REACTIVE GAS that can EXPLOSIVELY POLYMERIZE if not inhibited.
- DO NOT attempt to extinguish fire unless flow can be stopped. Shut off supply or let burn.
- Use dry chemical or CO_2 for small fires.
- POISONOUS GASES ARE PRODUCED IN FIRE, including *Hydrogen Chloride* and *Phosgene*.
- CONTAINERS MAY EXPLODE IN FIRE.
- Use water spray to reduce vapors and to keep containers cool.
- Vapor is heavier than air and may travel a distance to cause a fire or explosion far from the source or flash back.
- Flow or agitation may generate electrostatic charges.
- **Vinyl Chloride** may form an ignitable vapor/air mixture in closed tanks or containers.

Spills and Emergencies

If employees are required to clean-up spills, they must be properly trained and equipped. The OSHA Hazardous Waste Operations and Emergency Response Standard (29 CFR 1910.120) may apply.

If **Vinyl Chloride** is leaked, take the following steps:

- Evacuate personnel and secure and control entrance to the area.
- Eliminate ignition sources.
- Ventilate area of leak to disperse the gas.
- Stop flow of gas. If source of leak is a cylinder and the leak cannot be stopped in place, remove the leaking cylinder to a safe place in the open air, and repair leak or allow cylinder to empty.
- Absorb liquids in dry sand, earth, or a similar material and place into sealed containers for disposal.
- Turn leaking cylinder with leak up to prevent escape of gas in liquid state.
- Ventilate area of spill or leak.
- Keep **Vinyl Chloride** out of confined spaces, such as sewers, because of the possibility of an explosion.
- DO NOT wash into sewer.
- It may be necessary to contain and dispose of **Vinyl Chloride** as a HAZARDOUS WASTE. Contact your state Department of Environmental Protection (DEP) or your regional office of the federal Environmental Protection Agency (EPA) for specific recommendations.

Handling and Storage

Prior to working with **Vinyl Chloride** you should be trained on its proper handling and storage.

- A regulated, marked area should be established where **Vinyl Chloride** is handled, used or stored as required by the OSHA **Vinyl Chloride** Standard (29 CFR 1910.1017).
- **Vinyl Chloride** can polymerize rapidly or explosively when exposed to elevated temperatures (over 125°F (52°C)), or when exposed to AIR or LIGHT in the presence of a CATALYST.
- **Vinyl Chloride** reacts violently with OXIDIZING AGENTS (such as PERCHLORATES, PEROXIDES, PERMANGANATES, CHLORATES, NITRATES, CHLORINE, BROMINE and FLUORINE).
- **Vinyl Chloride** is not compatible with WATER; METALS (such as COPPER, ALUMINUM, IRON and STEEL); METAL CARBIDES; and METAL ALLOYS as fires and/or explosions may occur.
- *Phenol* should be used as an inhibitor to prevent violent polymerization of **Vinyl Chloride**.
- Store in tightly closed containers in a cool, well-ventilated area away from MOISTURE, HEAT SOURCES and METALS.
- Sources of ignition, such as smoking and open flames, are prohibited where **Vinyl Chloride** is used, handled, or stored.
- Metal containers involving the transfer of **Vinyl Chloride** should be grounded and bonded.
- Use explosion-proof electrical equipment and fittings wherever **Vinyl Chloride** is used, handled, manufactured, or stored.
- Use only non-sparking tools and equipment, especially when opening and closing containers of **Vinyl Chloride**.
- **Vinyl Chloride** may accumulate static electricity.

Occupational Health Information Resources

The New Jersey Department of Health offers multiple services in occupational health. These services include providing informational resources, educational materials, public presentations, and industrial hygiene and medical investigations and evaluations.

For more information, please contact:

New Jersey Department of Health
Right to Know
PO Box 368
Trenton, NJ 08625-0368
Phone: 609-984-2202
Fax: 609-984-7407
E-mail: rtk@doh.state.nj.us
Web address: http://www.nj.gov/health/eoh/rtkweb

GLOSSARY

ACGIH is the American Conference of Governmental Industrial Hygienists. They publish guidelines called Threshold Limit Values (TLVs) for exposure to workplace chemicals.

Acute Exposure Guideline Levels (AEGLs) are established by the EPA. They describe the risk to humans resulting from once-in-a lifetime, or rare, exposure to airborne chemicals.

Boiling point is the temperature at which a substance can change its physical state from a liquid to a gas.

A **carcinogen** is a substance that causes cancer.

The **CAS number** is unique, identifying number, assigned by the Chemical Abstracts Service, to a specific chemical.

CFR is the Code of Federal Regulations, which are the regulations of the United States government.

A **combustible** substance is a solid, liquid or gas that will burn.

A **corrosive** substance is a gas, liquid or solid that causes destruction of human skin or severe corrosion of containers.

The **critical temperature** is the temperature above which a gas cannot be liquefied, regardless of the pressure applied.

DEP is the New Jersey Department of Environmental Protection.

DOT is the Department of Transportation, the federal agency that regulates the transportation of chemicals.

EPA is the Environmental Protection Agency, the federal agency responsible for regulating environmental hazards.

ERG is the Emergency Response Guidebook. It is a guide for emergency responders for transportation emergencies involving hazardous substances.

Emergency Response Planning Guideline (ERPG) values provide estimates of concentration ranges where one reasonably might anticipate observing adverse effects.

A **fetus** is an unborn human or animal.

A **flammable** substance is a solid, liquid, vapor or gas that will ignite easily and burn rapidly.

The **flash point** is the temperature at which a liquid or solid gives off vapor that can form a flammable mixture with air.

IARC is the International Agency for Research on Cancer, a scientific group.

Ionization Potential is the amount of energy needed to remove an electron from an atom or molecule. It is measured in electron volts.

IRIS is the Integrated Risk Information System database on human health effects that may result from exposure to various chemicals, maintained by federal EPA.

LEL or **Lower Explosive Limit**, is the lowest concentration of a combustible substance (gas or vapor) in the air capable of continuing an explosion.

mg/m^3 means milligrams of a chemical in a cubic meter of air. It is a measure of concentration (weight/volume).

A **mutagen** is a substance that causes mutations. A **mutation** is a change in the genetic material in a body cell. Mutations can lead to birth defects, miscarriages, or cancer.

NFPA is the National Fire Protection Association. It classifies substances according to their fire and explosion hazard.

NIOSH is the National Institute for Occupational Safety and Health. It tests equipment, evaluates and approves respirators, conducts studies of workplace hazards, and proposes standards to OSHA.

NTP is the National Toxicology Program which tests chemicals and reviews evidence for cancer.

OSHA is the federal Occupational Safety and Health Administration, which adopts and enforces health and safety standards.

PEOSHA is the New Jersey Public Employees Occupational Safety and Health Act, which adopts and enforces health and safety standards in public workplaces.

Permeated is the movement of chemicals through protective materials.

ppm means parts of a substance per million parts of air. It is a measure of concentration by volume in air.

Protective Action Criteria (PAC) are values established by the Department of Energy and are based on AEGLs and ERPGs. They are used for emergency planning of chemical release events.

A **reactive** substance is a solid, liquid or gas that releases energy under certain conditions.

STEL is a Short Term Exposure Limit which is usually a 15-minute exposure that should not be exceeded at any time during a work day.

A **teratogen** is a substance that causes birth defects by damaging the fetus.

UEL or **Upper Explosive Limit** is the highest concentration in air above which there is too much fuel (gas or vapor) to begin a reaction or explosion.

Vapor Density is the ratio of the weight of a given volume of one gas to the weight of another (usually *Air*), at the same temperature and pressure.

The **vapor pressure** is a force exerted by the vapor in equilibrium with the solid or liquid phase of the same substance. The higher the vapor pressure the higher concentration of the substance in air.

Right to Know Hazardous Substance Fact Sheet

Emergency Responders Quick Reference

Common Name: **VINYL CHLORIDE**

Synonyms: Chloroethylene; Monochloroethylene; VCM
CAS No: 75-01-4
Molecular Formula: $CH_2 = CHCl$
RTK Substance No: 2001

Description: Colorless gas, with a sweet odor at high concentrations, that is usually handled as a liquid under pressure

HAZARD DATA

Hazard Rating	Firefighting	Reactivity
4 - Health **4 - Fire** **2 - Reactivity** **DOT#:** UN 1086 **ERG Guide #:** 116P **Hazard Class:** 2.1 (Flammable Gas)	FLAMMABLE AND REACTIVE GAS that can EXPLOSIVELY POLYMERIZE if not inhibited. DO NOT attempt to extinguish fire unless flow can be stopped. Shut off supply or let burn. Use dry chemical or CO_2 for small fires. POISONOUS GASES ARE PRODUCED IN FIRE, including *Hydrogen Chloride* and *Phosgene*. CONTAINERS MAY EXPLODE IN FIRE. Use water spray to reduce vapors and to keep containers cool. Vapor is heavier than air and may travel a distance to cause a fire or explosion far from the source or flash back. Flow or agitation may generate electrostatic charges. **Vinyl Chloride** may form an ignitable vapor/air mixture in closed tanks or containers.	**Vinyl Chloride** can polymerize rapidly or explosively when exposed to elevated temperatures (over 125°F (52°C)), or when exposed to AIR or LIGHT in the presence of a CATALYST. **Vinyl Chloride** reacts violently with OXIDIZING AGENTS (such as PERCHLORATES, PEROXIDES, PERMANGANATES, CHLORATES, NITRATES, CHLORINE, BROMINE and FLUORINE). **Vinyl Chloride** is not compatible with WATER; METALS (such as COPPER, ALUMINUM, IRON and STEEL); METAL CARBIDES; and METAL ALLOYS as fires and/or explosions may occur. *Phenol* should be used as an inhibitor to prevent violent polymerization of **Vinyl Chloride.** **Vinyl Chloride** may accumulate static electricity.

SPILL/LEAKS

Isolation Distance:

Spill: 100 meters (330 feet)

Fire: 800 meters (1/2 mile)

Stop flow of gas. If source of leak is a cylinder and the leak cannot be stopped in place, remove the leaking cylinder to a safe place in the open air, and repair leak or allow cylinder to empty.

Absorb liquids in dry sand, earth, or a similar material and place into sealed containers for disposal.

Keep **Vinyl Chloride** out of confined spaces, such as sewers, because of the possibility of an explosion.

Turn leaking cylinder with leak up to prevent escape of gas in liquid state.

Use nonsparkling tools and ground and bond containers when transferring **Vinyl Chloride.**

Vinyl Chloride is hazardous to the environment.

PHYSICAL PROPERTIES

Odor Threshold:	>3,000 ppm
Flash Point:	-108°F (-78°C)
LEL:	3.6%
UEL:	33%
Auto Ignition Temp:	882°F (472°C)
Vapor Density:	2.2 (air = 1)
Vapor Pressure:	2,524 mm Hg at 68°F (20°C)
Specific Gravity:	0.9 (water = 1)
Water Solubility:	Very slightly soluble
Boiling Point:	17°F (-8.3°C)
Freezing Point:	-245° to -256°F (-154° to -160°C)
Ionization Potential:	9.99 eV
Critical Temperature:	306° to 317.3°F (152° to 158.5°C)
Molecular Weight:	62.5

EXPOSURE LIMITS

OSHA: 1 ppm, 8-hr TWA; 5 ppm, Ceiling
NIOSH: Lowest feasible concentration
ACGIH: 1 ppm, 8-hr TWA

The Protective Action Criteria values are:
PAC-1 = 250 ppm PAC-2 = 1,200 ppm
PAC-3 = 4,800 ppm

PROTECTIVE EQUIPMENT

Gloves: Insulated Viton, Viton/Butyl, Silver Shield®/4H® and Barrier® (>8-hr breakthrough)

Coveralls: Tychem® BR, CSM and TK; Trellchem HPS and VPS (8-hr breakthrough)
>10% of the LEL wear flash protection or turnout gear

Respirator: SCBA

HEALTH EFFECTS

Eyes: Irritation and burns, contact with *liquid* or *gas* may cause frostbite

Skin: Irritation and burns, contact with *liquid* or *gas* may cause frostbite

Inhalation: Nose, throat and lung irritation with coughing, wheezing and shortness of breath
Headache, dizziness, lightheadedness and passing out

Chronic: Cancer (liver, brain, and lung) in humans

FIRST AID AND DECONTAMINATION

Remove the person from exposure.

Flush eyes with large amounts of water for at least 30 minutes. Remove contact lenses if worn. Seek medical attention.

Immerse affected part in warm water. Seek medical attention.

Begin artificial respiration if breathing has stopped and CPR if necessary.

Transfer promptly to a medical facility.

New Jersey Department of Health and Senior Services

HAZARDOUS SUBSTANCE FACT SHEET

Common Name: **1,2-DICHLOROETHYLENE**

CAS Number: 540-59-0
DOT Number: UN 1150

RTK Substance number: 0653
Date: September 1996 Revision: July 2002

HAZARD SUMMARY

* **1,2-Dichloroethylene** can affect you when breathed in.
* **1,2-Dichloroethylene** can irritate the skin causing a rash or burning feeling on contact.
* **1,2-Dichloroethylene** can irritate the eyes on contact.
* Breathing **1,2-Dichloroethylene** can irritate the nose, throat and lungs.
* Exposure to a high concentration can cause you to become dizzy, lightheaded and to pass out.
* Repeated exposure may affect the liver and kidneys.
* **1,2-Dichloroethylene** is a FLAMMABLE and REACTIVE chemical and a FIRE and EXPLOSION HAZARD.

IDENTIFICATION

1,2-Dichloroethylene is a colorless liquid with an *Ether*-like odor. It is used as a solvent for organic materials.

REASON FOR CITATION

* **1,2-Dichloroethylene** is on the Hazardous Substance List because it is regulated by OSHA and cited by ACGIH, DOT, NIOSH, DEP, NFPA and EPA.
* This chemical is on the Special Health Hazard Substance List because it is **FLAMMABLE** and **REACTIVE**.
* Definitions are provided on page 5.

HOW TO DETERMINE IF YOU ARE BEING EXPOSED

The New Jersey Right to Know Act requires most employers to label chemicals in the workplace and requires public employers to provide their employees with information and training concerning chemical hazards and controls. The federal OSHA Hazard Communication Standard, 1910.1200, requires private employers to provide similar training and information to their employees.

* Exposure to hazardous substances should be routinely evaluated. This may include collecting personal and area air samples. You can obtain copies of sampling results from your employer. You have a legal right to this information under OSHA 1910.1020.
* If you think you are experiencing any work-related health problems, see a doctor trained to recognize occupational diseases. Take this Fact Sheet with you.

WORKPLACE EXPOSURE LIMITS

OSHA: The legal airborne permissible exposure limit (PEL) is **200 ppm** averaged over an 8-hour workshift.

NIOSH: The recommended airborne exposure limit is **200 ppm** averaged over a 10-hour workshift.

ACGIH: The recommended airborne exposure limit is **200 ppm** averaged over an 8-hour workshift.

WAYS OF REDUCING EXPOSURE

* Where possible, enclose operations and use local exhaust ventilation at the site of chemical release. If local exhaust ventilation or enclosure is not used, respirators should be worn.
* Wear protective work clothing.
* Wash thoroughly immediately after exposure to **1,2-Dichloroethylene** and at the end of the workshift.
* Post hazard and warning information in the work area. In addition, as part of an ongoing education and training effort, communicate all information on the health and safety hazards of **1,2-Dichloroethylene** to potentially exposed workers.

This Fact Sheet is a summary source of information of all potential and most severe health hazards that may result from exposure. Duration of exposure, concentration of the substance and other factors will affect your susceptibility to any of the potential effects described below.

HEALTH HAZARD INFORMATION

Acute Health Effects

The following acute (short-term) health effects may occur immediately or shortly after exposure to **1,2-Dichloroethylene**:

* **1,2-Dichloroethylene** can irritate the skin causing a rash or burning feeling on contact.
* **1,2-Dichloroethylene** can irritate the eyes on contact.
* Breathing **1,2-Dichloroethylene** can irritate the nose, throat and lungs.
* Exposure to a high concentration can cause you to become dizzy, lightheaded and to pass out.

Chronic Health Effects

The following chronic (long-term) health effects can occur at some time after exposure to **1,2-Dichloroethylene** and can last for months or years:

Cancer Hazard

* According to the information presently available to the New Jersey Department of Health and Senior Services, **1,2-Dichloroethylene** has not been tested for its ability to cause cancer in animals.

Reproductive Hazard

* According to the information presently available to the New Jersey Department of Health and Senior Services, **1,2-Dichloroethylene** has not been tested for its ability to affect reproduction.

Other Long-Term Effects

* Repeated exposure may affect the liver and kidneys.

MEDICAL

Medical Testing

If symptoms develop or overexposure is suspected, the following are recommended:

* Liver and kidney function tests.

Any evaluation should include a careful history of past and present symptoms with an exam. Medical tests that look for damage already done are not a substitute for controlling exposure.

Request copies of your medical testing. You have a legal right to this information under OSHA 1910.1020.

Mixed Exposures

* Because more than light alcohol consumption can cause liver damage, drinking alcohol may increase the liver damage caused by **1,2-Dichloroethylene**.

WORKPLACE CONTROLS AND PRACTICES

Unless a less toxic chemical can be substituted for a hazardous substance, **ENGINEERING CONTROLS** are the most effective way of reducing exposure. The best protection is to enclose operations and/or provide local exhaust ventilation at the site of chemical release. Isolating operations can also reduce exposure. Using respirators or protective equipment is less effective than the controls mentioned above, but is sometimes necessary.

In evaluating the controls present in your workplace, consider: (1) how hazardous the substance is, (2) how much of the substance is released into the workplace and (3) whether harmful skin or eye contact could occur. Special controls should be in place for highly toxic chemicals or when significant skin, eye, or breathing exposures are possible.

In addition, the following controls are recommended:

* Where possible, automatically pump liquid **1,2-Dichloroethylene** from drums or other storage containers to process containers.
* Before entering a confined space where **1,2-Dichloroethylene** may be present, check to make sure that an explosive concentration does not exist.

Good **WORK PRACTICES** can help to reduce hazardous exposures. The following work practices are recommended:

* Workers whose clothing has been contaminated by **1,2-Dichloroethylene** should change into clean clothing promptly.
* Contaminated work clothes should be laundered by individuals who have been informed of the hazards of exposure to **1,2-Dichloroethylene**.
* Eye wash fountains should be provided in the immediate work area for emergency use.
* If there is the possibility of skin exposure, emergency shower facilities should be provided.
* On skin contact with **1,2-Dichloroethylene**, immediately wash or shower to remove the chemical. At the end of the workshift, wash any areas of the body that may have contacted **1,2-Dichloroethylene**, whether or not known skin contact has occurred.
* Do not eat, smoke, or drink where **1,2-Dichloroethylene** is handled, processed, or stored, since the chemical can be swallowed. Wash hands carefully before eating, drinking, applying cosmetics, smoking, or using the toilet.

PERSONAL PROTECTIVE EQUIPMENT

WORKPLACE CONTROLS ARE BETTER THAN PERSONAL PROTECTIVE EQUIPMENT. However, for some jobs (such as outside work, confined space entry, jobs done only once in a while, or jobs done while workplace controls are being installed), personal protective equipment may be appropriate.

OSHA 1910.132 requires employers to determine the appropriate personal protective equipment for each hazard and to train employees on how and when to use protective equipment.

The following recommendations are only guidelines and may not apply to every situation.

Clothing

* Avoid skin contact with **1,2-Dichloroethylene**. Wear solvent-resistant gloves and clothing. Safety equipment suppliers/ manufacturers can provide recommendations on the most protective glove/clothing material for your operation.
* All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work.

Eye Protection

* Wear indirect-vent, impact and splash resistant goggles when working with liquids.
* Wear a face shield along with goggles when working with corrosive, highly irritating or toxic substances.
* Contact lenses should not be worn when working with this substance.

Respiratory Protection

IMPROPER USE OF RESPIRATORS IS DANGEROUS. Such equipment should only be used if the employer has a written program that takes into account workplace conditions, requirements for worker training, respirator fit testing and medical exams, as described in OSHA 1910.134.

* Where the potential exists for exposure over **200 ppm**, use a NIOSH approved full facepiece respirator with an organic vapor cartridge. Increased protection is obtained from full facepiece powered-air purifying respirators.
* If while wearing a filter or cartridge respirator you can smell, taste, or otherwise detect **1,2-Dichloroethylene**, or if while wearing particulate filters abnormal resistance to breathing is experienced, or eye irritation occurs while wearing a full facepiece respirator, leave the area immediately. Check to make sure the respirator-to-face seal is still good. If it is, replace the filter or cartridge. If the seal is no longer good, you may need a new respirator.
* Be sure to consider all potential exposures in your workplace. You may need a combination of filters, prefilters or cartridges to protect against different forms of a chemical (such as vapor and mist) or against a mixture of chemicals.
* Where the potential for high exposure exists, use a MSHA/NIOSH approved supplied-air respirator with a full facepiece operated in a pressure-demand or other positive-pressure mode. For increased protection use in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode.
* Exposure to **1,000 ppm** is immediately dangerous to life and health. If the possibility of exposure above **1,000 ppm** exists, use a NIOSH approved self-contained breathing apparatus with a full facepiece operated in a pressure-demand or other positive-pressure mode.

HANDLING AND STORAGE

* Prior to working with **1,2-Dichloroethylene** you should be trained on its proper handling and storage.
* **1,2-Dichloroethylene** forms explosive hazards with METAL and METAL ALLOYS (such as POTASSIUM, LITHIUM, MAGNESIUM, ALUMINUM DUSTS, COPPER and COPPER ALLOYS).
* Mixtures with NITRIC ACID can be detonated by HEAT, IMPACT or FRICTION.
* **1,2-Dichloroethylene** is not compatible with OXIDIZING AGENTS (such as PERCHLORATES, PEROXIDES, PERMANGANATES, CHLORATES, NITRATES, CHLORINE, BROMINE and FLUORINE); STRONG BASES (such as SODIUM HYDROXIDE and POTASSIUM HYDROXIDE); DIFLUOROMETHYLENE DIHYPOFLUORITE; and NITROGEN TETRAOXIDE.
* Store in tightly closed containers in a cool, well-ventilated area away from AIR, LIGHT and MOISTURE as **1,2-Dichloroethylene** will decompose to form *Hydrogen Chloride*.
* Sources of ignition, such as smoking and open flames, are prohibited where **1,2-Dichloroethylene** is used, handled, or stored.
* Metal containers involving the transfer of **1,2-Dichloroethylene** should be grounded and bonded.
* Use only non-sparking tools and equipment, especially when opening and closing containers of **1,2-Dichloroethylene**.
* Wherever **1,2-Dichloroethylene** is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

QUESTIONS AND ANSWERS

Q: If I have acute health effects, will I later get chronic health effects?

A: Not always. Most chronic (long-term) effects result from repeated exposures to a chemical.

Q: Can I get long-term effects without ever having short-term effects?

A: Yes, because long-term effects can occur from repeated exposures to a chemical at levels not high enough to make you immediately sick.

Q: What are my chances of getting sick when I have been exposed to chemicals?

A: The likelihood of becoming sick from chemicals is increased as the amount of exposure increases. This is determined by the length of time and the amount of material to which someone is exposed.

Q: When are higher exposures more likely?

A: Conditions which increase risk of exposure include physical and mechanical processes (heating, pouring, spraying, spills and evaporation from large surface areas such as open containers), and "confined space" exposures (working inside vats, reactors, boilers, small rooms, etc.).

Q: Is the risk of getting sick higher for workers than for community residents?

A: Yes. Exposures in the community, except possibly in cases of fires or spills, are usually much lower than those found in the workplace. However, people in the community may be exposed to contaminated water as well as to chemicals in the air over long periods. This may be a problem for children or people who are already ill.

The following information is available from:

New Jersey Department of Health and Senior Services
Occupational Health Service
PO Box 360
Trenton, NJ 08625-0360
(609) 984-1863
(609) 984-7407 (fax)

Web address: http://www.state.nj.us/health/eoh/odisweb/

Industrial Hygiene Information

Industrial hygienists are available to answer your questions regarding the control of chemical exposures using exhaust ventilation, special work practices, good housekeeping, good hygiene practices, and personal protective equipment including respirators. In addition, they can help to interpret the results of industrial hygiene survey data.

Medical Evaluation

If you think you are becoming sick because of exposure to chemicals at your workplace, you may call personnel at the Department of Health and Senior Services, Occupational Health Service, who can help you find the information you need.

Public Presentations

Presentations and educational programs on occupational health or the Right to Know Act can be organized for labor unions, trade associations and other groups.

Right to Know Information Resources

The Right to Know Infoline (609) 984-2202 can answer questions about the identity and potential health effects of chemicals, list of educational materials in occupational health, references used to prepare the Fact Sheets, preparation of the Right to Know Survey, education and training programs, labeling requirements, and general information regarding the Right to Know Act. Violations of the law should be reported to (609) 984-2202.

DEFINITIONS

ACGIH is the American Conference of Governmental Industrial Hygienists. It recommends upper limits (called TLVs) for exposure to workplace chemicals.

A **carcinogen** is a substance that causes cancer.

The **CAS number** is assigned by the Chemical Abstracts Service to identify a specific chemical.

A **combustible** substance is a solid, liquid or gas that will burn.

A **corrosive** substance is a gas, liquid or solid that causes irreversible damage to human tissue or containers.

DEP is the New Jersey Department of Environmental Protection.

DOT is the Department of Transportation, the federal agency that regulates the transportation of chemicals.

EPA is the Environmental Protection Agency, the federal agency responsible for regulating environmental hazards.

A **fetus** is an unborn human or animal.

A **flammable** substance is a solid, liquid, vapor or gas that will ignite easily and burn rapidly.

The **flash point** is the temperature at which a liquid or solid gives off vapor that can form a flammable mixture with air.

HHAG is the Human Health Assessment Group of the federal EPA.

IARC is the International Agency for Research on Cancer, a scientific group that classifies chemicals according to their cancer-causing potential.

A **miscible** substance is a liquid or gas that will evenly dissolve in another.

mg/m^3 means milligrams of a chemical in a cubic meter of air. It is a measure of concentration (weight/volume).

A **mutagen** is a substance that causes mutations. A **mutation** is a change in the genetic material in a body cell. Mutations can lead to birth defects, miscarriages, or cancer.

NAERG is the North American Emergency Response Guidebook. It was jointly developed by Transport Canada, the United States Department of Transportation and the Secretariat of Communications and Transportation of Mexico. It is a guide for first responders to quickly identify the specific or generic hazards of material involved in a transportation incident, and to protect themselves and the general public during the initial response phase of the incident.

NCI is the National Cancer Institute, a federal agency that determines the cancer-causing potential of chemicals.

NFPA is the National Fire Protection Association. It classifies substances according to their fire and explosion hazard.

NIOSH is the National Institute for Occupational Safety and Health. It tests equipment, evaluates and approves respirators, conducts studies of workplace hazards, and proposes standards to OSHA.

NTP is the National Toxicology Program which tests chemicals and reviews evidence for cancer.

OSHA is the Occupational Safety and Health Administration, which adopts and enforces health and safety standards.

PEL is the Permissible Exposure Limit which is enforceable by the Occupational Safety and Health Administration.

PIH is a DOT designation for chemicals which are Poison Inhalation Hazards.

ppm means parts of a substance per million parts of air. It is a measure of concentration by volume in air.

A **reactive** substance is a solid, liquid or gas that releases energy under certain conditions.

A **teratogen** is a substance that causes birth defects by damaging the fetus.

TLV is the Threshold Limit Value, the workplace exposure limit recommended by ACGIH.

The **vapor pressure** is a measure of how readily a liquid or a solid mixes with air at its surface. A higher vapor pressure indicates a higher concentration of the substance in air and therefore increases the likelihood of breathing it in.

>>>>>>>>>>>>>>>>> EMERGENCY INFORMATION <<<<<<<<<<<<<<<<<

Common Name: **1,2-DICHLOROETHYLENE**
DOT Number: **UN 1150**
NAERG Code: **130P**
CAS Number: **540-59-0**

Hazard rating	NJDHSS	NFPA
FLAMMABILITY	-	3
REACTIVITY	-	2
FLAMMABLE AND REACTIVE POISONOUS GASES ARE PRODUCED IN FIRE CONTAINERS MAY EXPLODE IN FIRE		

Hazard Rating Key: 0=minimal; 1=slight; 2=moderate; 3=serious; 4=severe

FIRE HAZARDS

* **1,2-Dichloroethylene** is a FLAMMABLE LIQUID.
* Use dry chemical, CO_2, or foam extinguishers as water may not be effective in fighting fires.
* POISONOUS GASES ARE PRODUCED IN FIRE, including *Hydrogen Chloride* and *Phosgene*.
* CONTAINERS MAY EXPLODE IN FIRE.
* Use water spray to keep fire-exposed containers cool.
* Vapors may travel to a source of ignition and flash back.
* Vapor is heavier than air and may travel a distance to cause a fire or explosion far from the source.
* If employees are expected to fight fires, they must be trained and equipped as stated in OSHA 1910.156.

SPILLS AND EMERGENCIES

If **1,2-Dichloroethylene** is spilled or leaked, take the following steps:

* Evacuate persons not wearing protective equipment from area of spill or leak until clean-up is complete.
* Remove all ignition sources.
* Absorb liquids in vermiculite, dry sand, earth, or a similar material and deposit in sealed containers.
* Ventilate and wash area after clean-up is complete.
* Keep **1,2-Dichloroethylene** out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations.
* It may be necessary to contain and dispose of **1,2-Dichloroethylene** as a HAZARDOUS WASTE. Contact your state Department of Environmental Protection (DEP) or your regional office of the federal Environmental Protection Agency (EPA) for specific recommendations.
* If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

FOR LARGE SPILLS AND FIRES immediately call your fire department. You can request emergency information from the following:

CHEMTREC: (800) 424-9300
NJDEP HOTLINE: 1-877-WARN-DEP

HANDLING AND STORAGE (See page 3)

FIRST AID

For POISON INFORMATION call 1-800-222-1222

Eye Contact

* Immediately flush with large amounts of water for at least 15 minutes, occasionally lifting upper and lower lids.

Skin Contact

* Remove contaminated clothing. Wash contaminated skin with soap and water.

Breathing

* Remove the person from exposure.
* Begin rescue breathing (using universal precautions) if breathing has stopped and CPR if heart action has stopped.
* Transfer promptly to a medical facility.

PHYSICAL DATA

Vapor Pressure: 180-265 mm Hg at 68°F (20°C)
Flash Point: 36°F (2°C)
Water Solubility: Very slightly soluble

OTHER COMMONLY USED NAMES

Chemical Name:
Ethene, 1,2-Dichloro-
Other Names:
Acetylene Dichloride; trans-Dichloroethylene; sym-Dichloroethylene

NEW JERSEY DEPARTMENT OF HEALTH AND SENIOR SERVICES
Right to Know Program
PO Box 368, Trenton, NJ 08625-0368
(609) 984-2202

APPENDIX E

1.0 EMERGENCY RESPONSE RESOURCES

<table>
<tr><th colspan="3">EMERGENCY INFORMATION</th></tr>
<tr><th>Contact</th><th>Phone Number</th><th>Hospital Directions</th></tr>
<tr><td>Local Police</td><td>911</td><td rowspan="3"></td></tr>
<tr><td>Fire Department</td><td>911</td></tr>
<tr><td>Ambulance</td><td>911</td></tr>
<tr><td>Local Hospital: Valley Medical Center</td><td>425-228-3450</td><td>Hospital Directions and Route Maps on last page.</td></tr>
<tr><td>Project Manager and Site Health and Safety Officer:
Bill Haldeman
Work
Cell
Home</td><td>

(206) 529-3980
(425) 922-0254
(425) 402-1737</td><td rowspan="3">Emergency Response

-----Call for Aid FIRST------

PES Environmental, Inc.
1215 Fourth Avenue, Suite 1350
Seattle, WA

• Call PES office, inform them of emergency
• Meet emergency responder at the entrance
• Contact Project Manager</td></tr>
<tr><td>PES H&S Officer:
Kelly Rankich
Work
Cell
Home</td><td>

(206) 529-3980
(206) 303-7915
(425) 844-1131</td></tr>
<tr><td>Senior Engineer:
Matt Dahl
Work
Cell</td><td>

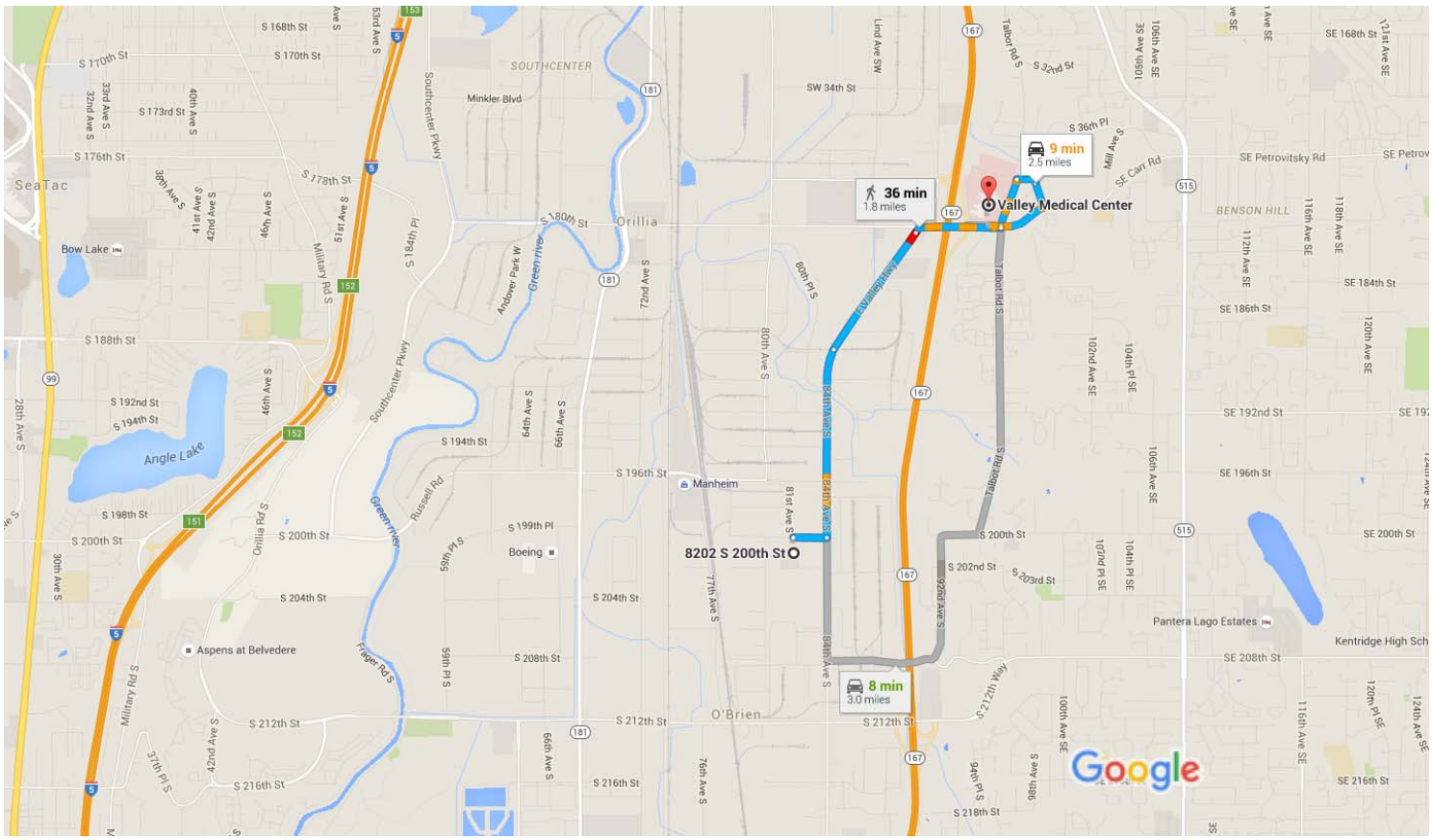
(206) 529-3980
(425) 922-0872</td></tr>
<tr><td>Client:
John FitzSimons
Work</td><td>

(845) 790-9550</td><td>INCIDENT REPORTING
For any incidents involving medical attention, please provide:
• Employee name
• Name of treating facility and phone number
• Description of incident
• Follow the instructions on the medical forms.
• Supervisor complete the Supervisor’s Employee Injury Report</td></tr>
</table>

Google Maps

8202 S 200th St, Kent, WA 98032 to Valley Medical Center

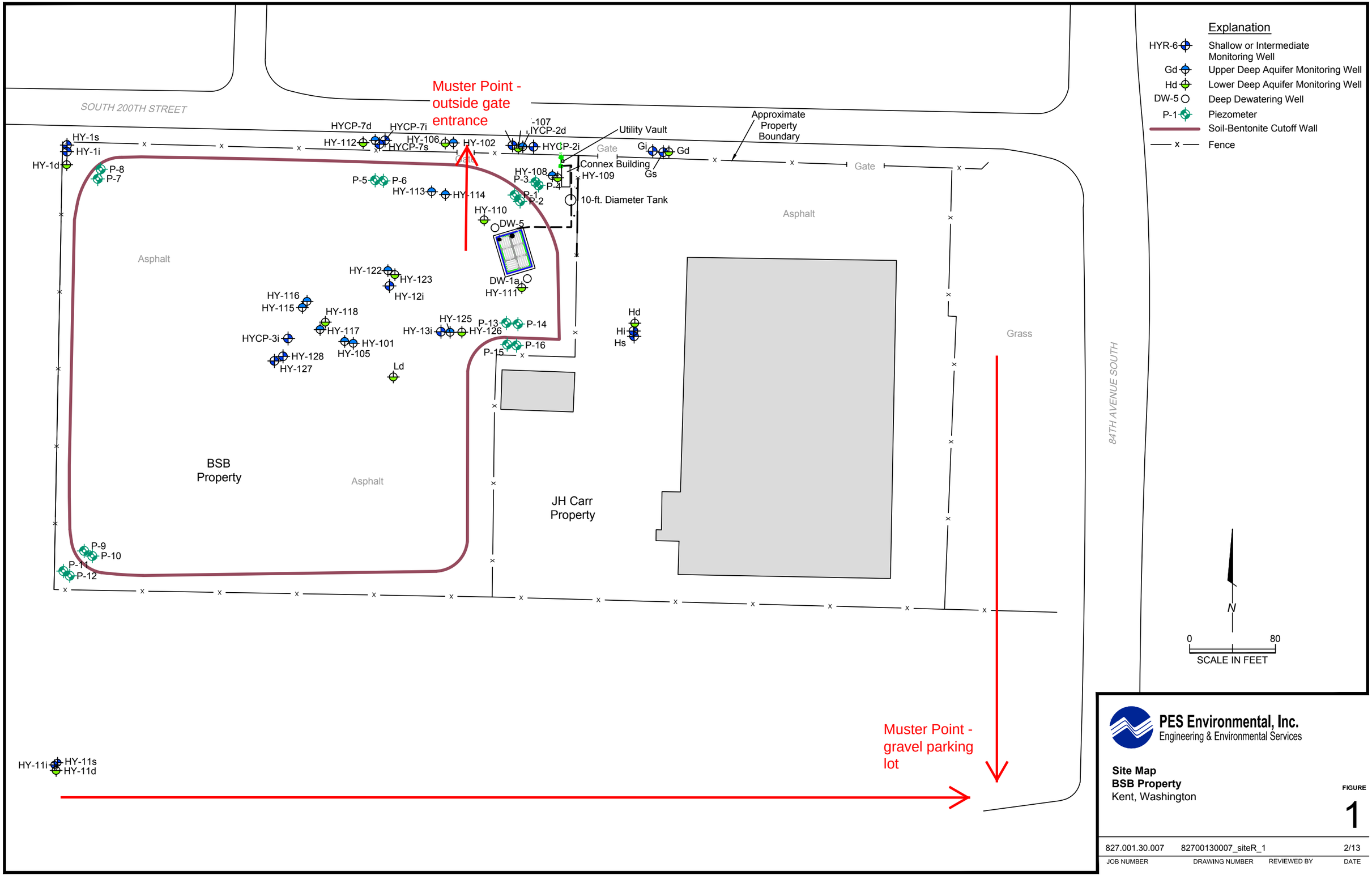
Drive 2.5 miles, 9 min



Map data ©2015 Google 2000 ft

8 min

9 min



PES Environmental, Inc.
Engineering & Environmental Services

Site Map
BSB Property
Kent, Washington

FIGURE
1

827.001.30.007	82700130007_siteR_1		2/13
JOB NUMBER	DRAWING NUMBER	REVIEWED BY	DATE

APPENDIX C

FIELD FORMS

PES Environmental, Inc.

Engineering & Environmental Services

Page: of
Date/Time:
Project Name:
Job No:
Recorded By:
Sampled By:

WELL DEVELOPMENT FORM

Well ID:

Pump Phase: **Start:** ___________ **Stop:** ___________

Time	Total Gallons Removed	Flow Rate (GPM)	Depth to Water (fbgs)	Pump Intake (fbgs)	Turbidity	Observations (color, well condition, odor, cloudiness, etc.)

Surge Phase: **Start:** ___________ **Stop:** ___________

Comments:

Pump Phase: **Start:** ___________ **Stop:** ___________

Time	Total Gallons Removed	Flow Rate (GPM)	Depth to Water (fbgs)	Pump Intake (fbgs)	Turbidity	Observations (color, well condition, odor, cloudiness, etc.)

Surge Phase: **Start:** ___________ **Stop:** ___________

Comments:

Pump Phase: **Start:** ___________ **Stop:** ___________

Time	Total Gallons Removed	Flow Rate (GPM)	Depth to Water (fbgs)	Pump Intake (fbgs)	Turbidity	Observations (color, well condition, odor, cloudiness, etc.)

Surge Phase: **Start:** ___________ **Stop:** ___________

Comments:

PES Environmental, Inc.
Engineering & Environmental Services

PAGE: OF

DATE:

WATER LEVEL DATA FORM

PROJECT: **BSB**

JOB No:

FIELD PERSONNEL:

MEASURING INSTRUMENT: □ ELECTRONIC SOUNDER

RECORDED BY:

TIME ON-SITE: TIME OFF-SITE:

MEASURING POINT: TOP of PVC

WEATHER : TEMPERATURE: PRECIPITATION:

Well I.D.	Time Well Cap Removed	Time	Depth to Water (feet)	Time	Depth to Water (feet)	Time	Depth to Water (feet)	Comments
Gs								
Gi								
Hs								
Hi								
HYCP-2								
HYCP-2i								
HYCP-7s								
HYCP-7i								
HYCP-7d								
HY-1s								
HY-1i								
HY-1d								
HYCP-3i								
HY-12i								
HY-13i								
HY-117								
HY-122								
HY-125								
HY-108								
HY-11s								
HY-11i								
HY-11d								
P-1								
P-2								
P-3								
P-4								
P-5								
P-6								
P-7								
P-8								
P-9								

PES Environmental, Inc.
Engineering & Environmental Services

PAGE: OF

DATE:

WATER LEVEL DATA FORM

PROJECT: **BSB**

JOB No:

FIELD PERSONNEL:

MEASURING INSTRUMENT: □ ELECTRONIC SOUNDER

RECORDED BY:

TIME ON-SITE: TIME OFF-SITE:

MEASURING POINT: TOP of PVC

WEATHER : TEMPERATURE: PRECIPITATION:

Well I.D.	Time Well Cap Removed	Time	Depth to Water (feet)	Time	Depth to Water (feet)	Time	Depth to Water (feet)	Comments
P-10								
P-11								
P-12								
P-13								
P-14								
P-15								
P-16								
Cell-1 Riser								
Cell-6 Riser								

PES Environmental, Inc.

Engineering & Environmental Services

Page:	of
Date/Time:	
Project Name:	
Job No:	
Recorded By:	
Sampled By:	

GROUNDWATER SAMPLING FORM

Well Type:	☐ Monitoring	☐ Extraction	☐ Other		Well No:
Well Material:	☐ PVC	☐ Stainless Steel	☐ Other		

WELL PURGING

PURGE VOLUME

Casing Diameter (D in inches)

☐ 2-inch ☐ 4-inch ☐ 6-inch ☐ Other _____

Total Depth of Casing (TD in feet below top of casing): _____

Water-Level Depth (WL in feet below top of casing): _____

Pump rate: approximately _____ mL/minute

PURGING METHOD

☐ Bailer - type: _____

☐ Submersible ☐ Centrifugal ☐ Bladder

☐ Peristaltic - Type: _____

PUMP INTAKE SETTING

☐ Bottom ☐ Top ☐ Middle: _____

Depth in feet (BTOC): _____

Screen interval feet (BTOC) from _____ to _____

FIELD PARAMETER MEASUREMENTS

START TIME: _____ STOP TIME: _____ TOTAL GALLONS REMOVED: _____

Time	Gallons Removed	pH	Conductivity (µmhos/cm)	Temperature (ºC)	DTW (feet bgs)	ORP	DO	Observations (color, well condition, odor, cloudiness, etc.)

Notes:

WELL SAMPLING

☐ Bailer ☐ Peristalic

Sample No.	Time	Volume	Analyses	Bottle Type	Preservative

QUALITY CONTROL SAMPLES

Duplicate Sample No.	Time	Volume	Analyses	Bottle Type	Preservative
Field Blank Sample No.	**Time**	**Volume**	**Analyses**	**Bottle Type**	**Preservative**

PES Environmental, Inc.
Engineering & Environmental Services

PAGE	OF
DATE:	

DAILY FIELD REPORT

PROJECT:	
JOB No:	
PROJECT MANAGER:	
RECORDED BY:	

TIME	DESCRIPTION, COMMENTS, NOTES, ETC.

ATTACHMENTS: ☐ NO ☐ YES

DESCRIPTION:

SIGNATURE

PES ENVIRONMENTAL
DAILY SAFETY MEETING CHECKLIST

Project Name: _____ Date: _____

Project Number: _____ Presented by: _____

Check the Topics/Information Reviewed:

- ☐ Safety glasses, hard hat, safety boots
- ☐ Site safety plan review and location
- ☐ Equipment and machinery familiarization
- ☐ Employee right-to-know/MSDS location
- ☐ Open pits, excavations, and site hazards
- ☐ Vehicle safety and driving/road conditions
- ☐ Portable tool safety and awareness
- ☐ Overhead utility locations and clearance
- ☐ First aid, safety, and PPE location
- ☐ Sharp object, rebar, and scrap metal hazards
- ☐ Safety is everyone's responsibility
- ☐ Latex gloves inner/nitrile gloves outer
- ☐ Excavation/trenching inspections/documentation
- ☐ Full-face respirators with proper cartridges
- ☐ Upgrade to level ___ at: PID(___eV)>___ppm
- ☐ Work stoppage at: PID(___eV) >___ppm, %LEL>10%
- ☐ Slips, trips, and falls
- ☐ Directions to hospital
- ☐ Anticipated visitors
- ☐ Electrical ground fault
- ☐ Public safety and fences
- ☐ Excavator swing and loading
- ☐ Orderly site and housekeeping
- ☐ Smoking in designated areas
- ☐ Leather gloves for protection
- ☐ Effects of the night before
- ☐ Vibration related injuries
- ☐ Fire extinguisher locations
- ☐ Eye wash station locations
- ☐ Decontamination procedures
- ☐ Daily work scope
- ☐ Emergency protocol
- ☐ Parking and laydown
- ☐ Hot work permits
- ☐ Strains and sprains
- ☐ Noise hazards
- ☐ No horseplay
- ☐ Heat and cold stress
- ☐ Backing up hazards
- ☐ Accidents are costly
- ☐ Dust and vapor control
- ☐ Refueling procedures
- ☐ Confined space entry
- ☐ Flying debris hazards

Discussion/Comments/Follow-up Actions: _____

_____

_____

_____

NAME	SIGNATURE	COMPANY

Instructions:

- Conduct a daily safety meeting prior to beginning each day's site activities.
- Complete form, obtain signatures, and file with the Daily Summary.
- Follow up on any noted items and document resolution of any action items.

Field Drum Inventory Form

PES PROJECT NUMBER:

JOB NAME:

ADDRESS:

PES FIELD REPRESENTATIVE:

Drum ID#	Generation Date	Waste Material (decon wtr, dv wtr, etc.)	Well ID(s)	Volume (gal)	Waste Description (decon water, development water, etc.)